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New Economic Geography and the City

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New Economic Geography and the City

Abstract

New economic geography (NEG) has proven to be very useful in dealing with a large number of issues. Yet, in this paper we do not discuss the canonical NEG models and their vast number of extensions. Rather, we provide an overview of recent developments in the NEG literature that build on the idea that the difference in the economic performance of regions is explained by the behavior and interactions between households and firms located within them. This means that we consider NEG models which take into account land markets, thereby the internal structure and industrial mix of urban agglomerations.

Keywords: city size, city structure, firms location, households location

JEL Classification: R0

Nouvelle Economie Géographique et développement urbain

Résumé

La Nouvelle Economie Géographique (NEG) s'est avéré être très adapté pour traiter un grand nombre de questions. Dans cet article, nous ne discutons pas des modèles canoniques de la NEG et de leurs nombreuses extensions. Nous présentons un aperçu des récents développements de cette littérature qui s'appuient sur l'idée que la différence dans la performance économique des régions s'explique par le comportement et les interactions entre les ménages et les entreprises. Cela signifie que nous considérons des modèles NEG qui prennent en compte les marchés fonciers, ainsi que la structure interne et la composition industrielle des agglomérations urbaines.

Mots-clefs : taille de la ville, structure des villes, localisation des entreprises, localisation des ménages

Classification JEL : R0

New Economic Geography and the City

1 Introduction

Ever since the publication of Krugman's (1991) pioneering paper, New Economic Geography (NEG) has given new life to spatial economics, which since then has made enormous progress by any previous yardstick. The very name 'New Economic Geography' seems chosen to stir a debate: is NEG economic geography proper or rather spatial economics? And is there anything really new in it? To the best of our knowledge, no economist before Krugman had been able to show how regional imbalances can arise within the realm of general equilibrium theory. To achieve this, Krugman has borrowed concepts and tools developed in modern economic theory, especially the Dixit and Stiglitz (1977) model of monopolistic competition, which is the workhorse of new growth and trade theories. As for transport costs, Krugman uses the iceberg technology: only a fraction of a good shipped between two places reaches the destination, the missing share having melted on the way. This ingenious modeling trick, due to Samuelson (1954), allows integrating positive shipping costs without having to deal explicitly with a transport sector. Hence, Dixit, Stiglitz and Samuelson form the trinity under which Krugman has combined increasing returns, commodity trade and the mobility of production factors within his now famous "core-periphery" model.

In NEG, the distribution of activities emerges as the unintentional outcome of a myriad of decisions made by firms and households pursuing their own interest. Thus, *methodologically, NEG belongs to mainstream economics*. This is probably what distinguishes most NEG from economic geography proper. Our choice to focus on NEG only does not reflect any prejudice on our part. It is mainly driven by the need to stress how this approach can be used to highlight old and new issues. Being deeply rooted in mainstream economics, NEG has strong connections with several branches of modern economic theory, including industrial organization and international trade, but also with the new theories of growth and development. This permits cross-fertilizations which have been out of reach for a long time. We also want to stress that differences between alternative approaches are often overemphasized. Indeed, NEG and evolutionary economic geography share many common results (Jovanovic 2009). Furthermore, in terms of its subject matter, NEG cannot be considered alien to regional science and geography. Moreover, many ideas and concepts NEG builds on have been around for a long time, both in economics and regional science (Ottaviano and Thisse 2005). For example, the fundamental idea that the interplay between different types of scale economies and transport costs is critical for the way the space-economy is organized, and so at various spatial scales (cities, regions, countries, continents), was known (at least) since the work of Weber and Lösch (McCann 2001). It is fair to say, however, that those ideas were fairly disparate and in search of a synthesis.

It is now widely recognized that Krugman's main contribution was his entirely different and new approach to the origin of regional imbalance. Under constant returns, firms find it profitable to disperse their production to bring it closer to customers, as this will reduce transport costs without lowering productive efficiency. Such a space-economy is the quintessence of self-sufficiency: if the distribution of factor endowments is uniform, the economy reduces to a

Robinson Crusoe-type economy where each person produces for his or her own consumption. Under these circumstances, only differences in endowments of immobile production factors can explain the marked differences in the spatial distribution of activities, and hence the need for interregional and international trade.

To a large extent, relying on first nature to explain the existence of large urban agglomerations and sizable trade flows amounts to playing Hamlet without the Prince. Krugman squarely tackles this problem by assuming that firms operate under increasing returns and imperfect competition on the product market. Such a combination is orthogonal to the standard paradigm of constant returns and perfect competition, which has dominated mainstream economic theory for a long time. Furthermore, to the trade-off between increasing returns and transport costs, Krugman (1980) has added a third variable: the size of spatially separated markets. The main accomplishment of NEG has been to highlight *how market size interacts with scale economies internal to firms and transport costs to shape the space-economy.*

In NEG, the market outcome stems from the interplay between a dispersion force and an agglomeration force operating within a full-fledged general equilibrium model. In Krugman (1991) and Fujita et al. (1999), the dispersion force stems from the spatial immobility of farmers whose demands for the manufactured good are to be met. The agglomeration force is more involved and requires a more detailed description. If a larger number of manufactures is located in one region, the number of varieties locally produced is larger too. Then, manufactured goods are available at lower prices in the larger region because local varieties are cheaper than imported varieties. This in turn induces consumers living in the smaller region to move toward the larger region, where they may enjoy a higher standard of living. The resulting increase in the numbers of consumers creates a larger demand for the manufactured good, which, therefore, leads additional firms to locate therein. This implies the availability of more varieties in the region in question but less in the other because there are scale economies at the firm's level. Consequently, as noticed by Krugman (1991, p.486), *circular causation* à la Myrdal (1957) is present because these two effects reinforce each other: "manufactures production will tend to concentrate where there is a large market, but the market will be large where manufactures production is concentrated." The great accomplishment of Krugman was to integrate all these various effects within a unified framework and to show that the *level* of transport costs is the key-determining factor for the organization of the space-economy.

When transport costs are sufficiently low, Krugman (1991) showed that manufactures are concentrated in a single region that becomes the *core* of the economy, whereas the other region, called the *periphery*, supplies only the agricultural good. Firms are able to exploit scale economies by selling more in the larger market without losing much business in the smaller market. For exactly the opposite reasons, the economy displays a symmetric regional pattern of production when transport costs are high: because the local markets are now protected by geographical separation, firms relax competition by being dispersed across regions. Hence, the core-periphery model allows for the possibility of convergence or divergence between regions, whereas the neoclassical model, based on constant returns and perfect competition, would predict convergence only. It is worth stressing that the dual structure made of a core and a periphery is brought about by market forces only as it is obtained in a setting formed by two regions that are ex ante identical. These results hold true in more general settings such as those discussed in great detail in Fujita et al. (1999) and Baldwin et al. (2003).

By focusing on the interactions between the product and labor markets, Krugman's work remains in the tradition of international trade. Although we recognize the limits of this approach, we believe it delivers a powerful framework which has proven to be very useful in dealing with a large number of issues. Yet, in this chapter we do not discuss the canonical NEG models and their vast number of extensions. Rather, we provide an overview of recent developments in the NEG literature, which fits better the space-economy of developed economies. In particular, we build on the idea that the difference in the economic performance of regions is, to some extent, explained by the behavior and interactions between households and firms that are located within them. *The focus thus shifts from the nation-state to the city-region*. Therefore, we discuss NEG-like models in which the internal structure and industrial mix of urban agglomerations are determined with a land market.

To be precise, we start by focussing on the causes and consequences of the internal structure of cities because the way they are organized has a major impact of the well-being of people. In particular, housing and commuting costs, which we call *urban costs*, account for a large share of consumers' expenditures. For example, in the United States housing accounts on average for 20% of household budgets while 18% of total expenditures is spent on car purchases, gasoline, and other related expenses which do not include the cost of time spent in traveling. In 2000, the total cost of people's journeys inside the Paris metropolitan area amounted to a staggering 34.3 billion euros, which is just over 8% of the local GDP. As for housing, the price per square meter is, on average, 80% higher in Paris than in the rest of France. This leads us to concur with Helpman (1998) for whom urban costs are the main dispersion force at work in modern urbanized economies.

In this alternative setting, an agglomeration is structured as a monocentric city in which firms gather in a central business district. Competition for land among consumers gives rise to land rent and commuting costs that both increase with population size. In other words, our approach endows regions with an urban structure which is absent in standard NEG models. As a result, the space-economy is the outcome of the interaction between two types of mobility costs: the transport costs of commodities and the commuting costs borne by workers. The results presented in Section 2 for a monocentric city differ from those obtained by Krugman: *the evolution of commuting costs within cities, instead of transport costs between cities, becomes the key-factor explaining how the space-economy is organized*. Moreover, despite the many advantages provided by the inner city through an easy access to highly specialized services, the abyssal fall in communication costs has led firms or developers to form enterprise zones or edge cities (Henderson and Mitra 1996). We then go one step further by allowing firms to form secondary business centers. This analysis shows how polycentricity allows reducing urban costs, which in turn permits a big city to retain its dominant position by accommodating a large share of activities.

Another change of focus is on services rather than manufactures. The bulk of the NEG literature has concentrated on manufacturing sectors, although employment in modern cities is found mainly in firms providing nontradable consumption (b2c) services. While the Industrial Revolution fostered the emergence of manufacturing cities, services continue to show a taste for cities that manufacturing sectors no longer have (Bairoch 1985). As stressed by Glaeser et al. (2001), the success of a city depends more than before on its role as a center of consumption, that is, on the supply of local amenities and services. Even though NEG conveys the image of an economy formed by an urban core hosting manufactures and a rural hinterland specialized in agriculture, a pattern now obsolete in developed countries, recent contributions to NEG pay more attention to the role played by local services in urban development. In Section 3, we recognize that services (e.g., health care, restaurants and movie theaters) are conditioned on precise locations and study their intercity distribution. We then add a new dimension to the above analysis by blending a service sector and a manufacturing sector in an economy in which workers display both sectoral and spatial mobility.

These ideas are presented through the lenses of a new framework. NEG being to some extent a collection of specific examples, we have no reason to apologize for using another specific model, that is, the linear model of monopolistic competition proposed by Tabuchi and Thisse (2006), which is much easier to handle than CES-based models. As for the transport cost, it is added to the production cost and measured in terms of the numéraire. This avoids imposing binding relationships between prices and shipping costs. By yielding linear equilibrium conditions, this model delivers a full analytical solution that captures in a simple way the pro-competitive effects associated with market size and market integration. To accomplish this task, we use a NEG-like model that takes into account the following fundamental aspects of urban development: (i) cities can be monocentric or polycentric; (ii) cities supply non-housing services as well as tradable goods; and (iii) cities have heterogeneous demographic structures involving different types of individuals (e.g. workers and retirees) who are attracted by different location factors. Moreover, the framework we use displays enough versatility to tackle new issues which are difficult to cope with by using the standard framework of NEG. We are well aware that the reader accustomed to NEG might be surprised by our choice of menu. It is worth stressing that the basic model used in this chapter can replicate the main results obtained by Krugman and others. It thus belongs to NEG. The seemingly different approach followed here has been chosen in the hope of convincing the skeptical regional scientist that NEG is a lively field that still has a high potential for future research.

The remainder of this survey reflects the above methodological choices. The basic model is presented in Section 2 and the market outcome is compared to Krugman's core-periphery structure. We show how commuting costs and population density impact on the location of economic activities *between* and *within* cities. The subsequent section focuses on nontradable consumption services and their interactions with tradable manufactured goods. To illustrate the potential of NEG in the study of policy-driven problems, Section 4 addresses the implications of an aging population for the urban system and the environmental and economic consequences of compact cities characterized by a high population density. Section 5 concludes.

2 Cities and manufacturing firms

The economy is formed by two regions, labeled $r = A, B$, and populated by $L > 0$ consumers who are free to choose where to live. To ease the burden of notation, we choose the unit of labor for $L = 1$. Unlike the standard core-periphery model where regions are pretty much spaceless places, we recognize explicitly that any sizeable human settlement takes the form of a city where economic agents compete for land; cities are assumed to be anchored and separated by a given physical distance.

There is one manufacturing sector and three goods: land (housing), a produced good, which is differentiated and tradable, and an unproduced homogeneous good, which is the numéraire. Space is one-dimensional and the opportunity cost of land is zero. Each region can be urbanized by accommodating firms and consumers according to rules described below. Whenever a city exists, it has a central business district (CBD) where firms set up. Because NEG has nothing really new to add to the reasons explaining why CBDs exist, it is convenient to assume that CBDs pre-exist.

As discussed in the introduction, the main reason for the existence of cities is the presence of increasing returns. Under scale economies internal to firms, consumers have direct access to the locally produced varieties, the number of which depends on the size of the local market. When they display a love for variety or when the city population is formed by individuals having each idiosyncratic tastes for ideal varieties, consumers are also inclined to consume varieties produced in other places. This in turn prompts trade in differentiated commodities across spatially separated markets. As observed by Hicks (1969, p.56): "The extension of trade does not primarily imply more goods. . . . The variety of goods is increased, with all the widening of life that entails. There can be little doubt that the main advantage that will accrue to those with whom our merchants are trading is a gain of precisely this kind." However, foreign varieties must be imported at a positive transport cost, which tends to make them more expensive.

The standard thought experiment of NEG is now well known: how do firms and consumers locate when the cost of shipping the manufactured good *between* regions/cities steadily decreases? Once we account for a description of the space-economy that fits better the contemporary world, this thought experiment must be supplemented by another one, i.e. the impact of commuting costs *within* cities. In sum, both the transport costs of commodities and the commuting costs of people must be taken into account to understand how economic activities are distributed across space.

2.1 Agglomeration and commuting costs

We assume that the lot size is fixed and normalized to 1 where the tallness (i.e. the number of floors) of buildings is given by $\delta > 0$ regardless of their location in the city. As a consequence, the parameter δ is the *population density* which also measures the city's compactness. Consequently, when the total population of city r is λ_r, the city is described by an interval of length λ_r/δ. At the residential equilibrium all consumers reach the same utility level. If land is available on both sides of the CBD, the residential equilibrium involves a symmetric distribution of consumers around the CBD with city r's right hand side limit at

$$\bar{x}_r = \frac{\lambda_r}{2\delta}.$$

A. Consumers. Consumers share the same quasi-linear preferences which implies that the land ownership structure has no impact on our results. Denoting by n the total mass of varieties, the utility derived from consuming q_i units of variety $i \in [0, n]$ is given by

$$u(q_i) = \alpha q_i - \frac{\beta}{2} q_i^2 - \frac{\gamma}{2n} q_i \int_0^n q_j \mathrm{d}j. \tag{1}$$

The parameters α, β and γ are interpreted as follows: $\alpha > 0$ measures the desirability of the manufactured good with respect to the numéraire; $\gamma > 0$ is the degree of substitutability between variety i and any other variety, whence a higher γ means that varieties are less differentiated. The parameter β expresses the desirability of variety i with respect to the total consumption: a high value of β means that a consumer aims at equalizing her consumption over the entire range of varieties. This parameter therefore measures the intensity of consumers' love for variety. Moreover, (1) shows that the marginal utility of variety i decreases with its own consumption as well as with the total consumption of the manufactured good.
Preferences are obtained by nesting the subutility (1) into a linear utility:

$$U(q_0, q_{i\leq n}) = q_0 + \alpha \int_0^n q_i \mathrm{d}i - \frac{\beta}{2} \int_0^n q_i^2 \mathrm{d}i - \frac{\gamma}{2n} \int_0^n q_i \left(\int_0^n q_j \mathrm{d}j \right) \mathrm{d}i \tag{2}$$

where q_0 is the quantity of the numéraire. The lot size being fixed, there is no need to specify how housing enters into preferences. In what follows, we ease the burden of notation by adopting two normalizations which entail no less of generality: the unit of the numéraire is chosen for $\alpha = 1$ and the unit of the manufactured good for $\gamma = 1$ to hold.
Each consumer supplies inelastically one unit of labor. Consumers commute to the CBD where jobs are located and earn an income w_r which is determined at the equilibrium. The unit commuting cost is given by $t > 0$, and thus a consumer located at $x > 0$ bears a commuting cost equal to tx units of the numéraire. In addition, each consumer is endowed with $\bar{q}_0 > 0$ units of the numéraire, which is sufficiently large for the individual consumption of the homogeneous good to be strictly positive at the equilibrium outcome. Hence, the budget constraint faced by a consumer living in city r is given by

$$\int_0^n q_{ir} p_{ir} \mathrm{d}i + q_0 + R_r(x)/\delta + tx = w_r + \bar{q}_0 \tag{3}$$

where p_{ir} (q_{ir}) is the price (consumption) of variety i in city r and w_r the wage paid by the firms set up in city r's CBD. In this expression, $R_r(x)$ the land rent at x, and thus $R_r(x)/\delta$ is the price paid by a consumer to reside at x.
A consumer chooses her location and consumption bundle so as to maximize her utility (2) subject to the budget constraint (3). This yields the following demand for variety i:

$$q_{ir} = \frac{1}{\beta + 1} - \frac{p_{ir}}{\beta} + \frac{1}{\beta(\beta + 1)} \bar{p}_r \tag{4}$$

where

$$\bar{p}_r = \frac{1}{n} \int_0^n p_{ir} \mathrm{d}i$$

is the average price prevailing in city r. The demand (4) captures in the very simple way the impact of competition on a firm's demand: a higher (lower) average price shifts upward (downward) the demand for variety i because local competition is softer (tougher), thus making variety i more (less) attractive to city r-consumers.
In what follows, we call "urban costs" the sum of housing and commuting costs borne by a city r-consumer residing at any location x:

$$UC_r(x) = R_r(x)/\delta + tx.$$

Let $\Psi_r(x)$ be the highest price a worker is willing to pay to reside at location x in city r. Because there is only one type of labor, the equilibrium land rent is such that

$$R_r^*(x) = \delta \max \{\Psi_r(x), 0\} .$$

The lot size being fixed, a marginal hike in the commuting trip must be equal to the decrease in the bid rent Ψ_r, that is, $\partial\Psi_r/\partial x + t = 0$. Hence, $\Psi_r(x) = k - tx$ where k is a constant. Since the land rent at $\bar{x}_r$ is equal to the opportunity cost of land, here zero, we have $k = t\bar{x}_r$, and thus, $\Psi_r(x) = t\lambda_r/2\delta - tx$. Therefore, the price paid to reside at x is the mirror image of the corresponding commuting costs:

$$R_r^*(x)/\delta = t\left(\frac{\lambda_r}{2\delta} - x\right) \qquad \text{for } x < \bar{x}_r. \tag{5}$$

Hence, the price paid by a consumer to live at $x > 0$ decreases with the population density since the average commuting cost is shorter.
The urban costs borne by consumers in city r do not depend on their residential location within this city and are equal to

$$UC_r = \frac{t\lambda_r}{2\delta}. \tag{6}$$

Because they increase with city size, *urban costs act here as the dispersion force*. As expected, intercity differences in urban costs increase with commuting costs and decrease with population density.
It remains to close the model by specifying the structure of land ownership. Unless explicitly mentioned, we assume for simplicity that the aggregate land rent is distributed to absentee landlords.

B. Producers. Firms produce a differentiated and tradable good under monopolistic competition and increasing returns; for simplicity, they do not use land. A firm produces a single variety and any two firms supply two differentiated varieties. Producing a variety of the manufactured good requires a fixed number ϕ of labor units. Hence, the total mass of varieties supplied in the economy is given by $n = 1/\phi$ and the mass of firms producing in city r by $n_r = \lambda_r/\phi$. So a lower value of ϕ means a higher labor productivity. Note that λ_r is also the share of firms located in city r.
Markets are segmented, that is, each firm is able to set a price specific to the market in which its output is sold (Engel and Rogers 2001). Because preferences and technologies are symmetric, firms sell their varieties at the same price in each city. Thus, we may disregard the index i and write the profits earned by a city r-firm as follows ($s \neq r$):

$$\pi_r = p_{rr}q_r(p_{rr})\lambda_r + (p_{rs} - \tau)q_s(p_{rs})\lambda_s - \phi w_r$$

where p_{rr} is the price set by the local firms, p_{rs} the delivered price charged by the local firms in city s and τ the shipping cost.
The average price in city r is given by

$$\bar{p}_r = n_r p_{rr} + n_s p_{sr}.$$

where p_{sr} the delivered price charged by the foreign firms in city r.
Plugging this expression into (4) and solving the first-order conditions yield the equilibrium prices:

$$p_{rr}^* = \frac{2\beta + \tau\lambda_s}{2(2\beta + 1)} \quad \text{and} \quad p_{rs}^* = p_{ss}^* + \frac{\tau}{2}. \tag{7}$$

Both prices p_{rr}^* and p_{sr}^* capture the pro-competitive effects associated with a larger number of local competitors and lower transport costs. In other words, the prices of local and imported varieties are lower in large cities than in small ones. This results runs against the conventional wisdom which holds that tradables are more expensive in larger cities because land rents and wages are higher therein. Note, first, that this argument overlooks the fact that, given the continual flows of new goods, the consumer price index for urban consumers almost completely ignores the quality improvements of existing goods and the introduction of new goods which allows consumers to substitute low-priced goods for high-priced goods. Controlling for these effects, Handbury and Weinstein (2011) use a dataset covering 10-20 million purchases of grocery items and find that prices for the same goods are indeed significantly lower in larger cities. This highlights a trade-off which has been neglected in the urban economics literature: *consumers bear higher urban costs in larger cities but the tradable goods are supplied at lower prices*.
Furthermore, (7) shows that trade exacerbates competition in each city though the consumer (c.i.f.) price of imported varieties is higher than that of domestic varieties because distant firms have to cover the cost of shipping their output. Therefore, consumption is biased toward locally produced goods. By contrast, the producer (f.o.b.) price of imported varieties is smaller than that of local varieties. There is freight absorption to facilitate the penetration of varieties produced in distant places. Last, for intercity trade to occur and its pro-competitive effects to become concrete, transport costs cannot be too high: $p_{rs}^* - \tau > 0$. This condition holds regardless of the spatial distribution of firms if and only if $\tau < \tau_{\text{trade}} \equiv 2\beta/(2\beta + 1) < 1$.
Urban labor markets are local while labor market clearing implies that the creation and destruction of firms is governed by the location of consumers. Specifically, the equilibrium wage is determined by a bidding process in which potential firms compete for workers by offering them higher and higher wages until no firm can profitably enter the market. Put simply, operating profits are completely absorbed by the wage bill. The equilibrium quantities sold are given by $q_{rr}^* = p_{rr}^*/\beta$ and $q_{rs}^* = (p_{rs}^* - \tau)/\beta$. Plugging the equilibrium prices and quantities into π_r and solving for w_r gives the equilibrium wage in city r:

$$w_r^* = [\lambda_r (p_{rr}^*)^2 + \lambda_s (p_{rs}^* - \tau)^2]/\phi.$$

Ottaviano and Thisse (2002) have shown that w_r^* increases (decreases) at a decreasing (increasing) rate with λ_r when ϕ is large (small) as well as when τ is small (large). In other words, the equilibrium wage rises with the size of the local market when the labor productivity is high, shipping goods is cheap, or both. This implies that a higher wage need not be associated with a larger city. Such a result conflicts with the widespread idea that a higher employment density is associated with higher wages (Combes et al. 2008; Puga 2010). Standard estimates of the density elasticity of wages typically range from 0.02 to 0.05. However, if the existence of agglomeration economies is now well documented, the literature has been less successful in identifying the relative importance of the channels through which they percolate.

Last, observe that the size of the product and labor markets is endogenous when consumers are mobile. Indeed, when consumers move from one city to the other, they bring with them both their production and consumption capacities. As a consequence, both the numbers of consumers and workers change.

C. The formation of manufacturing clusters. The locational choice made by a consumer is driven by the indirect utility level she reaches in a city:

$$V_r(L_r) = CS_r + w_r^* - UC_r + q_0^* \tag{8}$$

where CS_r is the consumer surplus evaluated at the equilibrium prices and q_0^* is the equilibrium consumption of the numéraire. Hence, when choosing the city where she lives a consumer takes into account the income she earns, the level of urban costs she bears, and the consumer surplus she enjoys in the city. Thus, though the individual demands (4) are unaffected by income, the migration decision takes income into account. Everything else equal, workers are pulled by the higher wage region. The population becoming larger, the local demand for the manufactured good is raised, which attracts additional firms.

Although the present framework differs from Krugman's (1991), it captures the same effects. It also encapsulates the following fundamental trade-off, which is absent in Krugman: concentrating people and firms in a small number of large cities minimizes the cost of shipping commodities among urban areas but makes work-trips (as well as many other within-city trips) longer; when dispersion prevails, consumers bear lower commuting costs but goods are more expensive because each city produces a small number of varieties and shipping them to the other cities is costly. Thus, both configurations give rise to specific spatial costs.

The economy is in equilibrium when no consumer has an incentive to change place. Denoting by λ the endogenous share of consumers residing in city A, a *spatial equilibrium* arises at $1/2 \leq \lambda^* < 1$ when the utility differential $\Delta V(\lambda^*) \equiv V_A(\lambda^*) - V_B(\lambda^*) = 0$. When $\Delta V(1) \geq 0$, $\lambda^* = 1$ and thus all consumers and firms are set up in city A. Thus, location choices exhibit strategic complementarity (substitutability) when the $\Delta V(\lambda)$ is increasing (decreasing). NEG models typically display several spatial equilibria. In such a context, it is convenient to use stability as a selection device since an unstable equilibrium is unlikely to happen. An interior equilibrium is *stable* if, for any marginal deviation away from the equilibrium, the incentive system provided by the market brings the distribution of consumers back to the original one. This is so if and only if the slope of the utility differential ΔV is strictly negative at λ^*. By contrast, an agglomerated equilibrium is stable whenever it exists.

Replacing each term of V_r by its expression leads to the following utility differential:

$$\Delta V(\lambda) = -\left[\frac{t}{\delta} - \frac{\Lambda(\tau)}{\phi}\right]\left(\lambda - \frac{1}{2}\right) \tag{9}$$

where

$$\Lambda(\tau) \equiv \frac{\tau[4\beta(3\beta+2) - (6\beta^2 + 6\beta + 1)\tau]}{2\beta(2\beta+1)^2}$$

with $\Lambda(\tau) > 0$ because τ is smaller than τ_{trade}.

It follows immediately from (9) that $\lambda = 1/2$ is always a spatial equilibrium. This equilibrium is stable when t exceeds $\delta\Lambda(\tau)/\phi$. Otherwise, the manufacturing sector is concentrated into a single city. As a result, *when commuting costs steadily decrease, there is a transition from dispersion to agglomeration*. The intuition behind this result is straightforward. When t is large, urban costs are sufficiently high to prevent the emergence of a big city. By contrast, there is agglomeration when t is small because the gains from variety overcome the land market crowding effect. Note also that increasing the population density δ amounts to decreasing the level of commuting costs. Hence, a high population density, a high labor productivity, or both makes agglomeration more likely. This is because a larger city allows individuals to consume a wider range of varieties priced at a lower level.

Finally, note that the catastrophic nature of the bifurcation obtained both here and in Krugman (1991) is an artifact due to the assumption of identical consumers. Once it is recognized that consumers are heterogeneous in their migration behavior, the transition becomes smooth (Tabuchi and Thisse 2002). Therefore, the interest generated by the result of sudden urbanization is unwarranted.

Though very simple, the above model allows understanding the role played by commuting costs in shaping the space-economy. Consumers having a love for variety, they are attracted by the city supplying the wider range of local varieties, which are cheaper to buy than the imported varieties. By moving to this city, consumers increase the size of the local market, which makes local competition tougher. However, migration flows crowd out the land market and raise the urban costs borne by consumers residing in this city. Eventually, market clearing and labor mobility balance these various forces and select a spatial pattern involving either two small cities or one large city.

Note the difference with Krugman (1991): here low transport costs are associated with the dispersion of activities. Indeed, when τ is very small, we have $\Lambda(\tau) \approx 0$, which implies $\delta\Lambda(\tau) - t\phi < 0$. Consequently, firms and consumers are located in two small cities. This is because consumers have more or less the same access to the whole range of varieties but obviate paying high urban costs through dispersion. This means that lowering transport costs induces the (partial) de-industrialization of large manufacturing cities and the relocation of manufactures in small cities or even in rural areas.

On the contrary, when τ is large and slightly smaller than τ_{trade}, $\Lambda(\tau)$ takes on its largest value so that $\delta\Lambda(\tau)/\phi$ is more likely to exceed t. Indeed, when transport costs are high, the agglomeration of the manufacturing sector allows consumers to have direct access to all varieties at a low price while firms are able to better exploit scale economies. In other words, high transport costs are likely be associated with the agglomeration of activities.

To sum up, a drop in the cost of shipping commodities fosters the spatial decentralization of jobs and production: *Krugman's prediction is thus reversed*. This difference in results is simple to explain. In the above model, urban costs rise when consumers join the larger city, which strengthens the dispersion force. Simultaneously, lowering transport costs facilitates intercity trade. Combining the two forces tells us why dispersion arises. By contrast, in the core-periphery model developed by Krugman (1991), the spatial concentration of workers does not generate any cost in the core. Furthermore, the dispersion force stems from immobile farmers who live in what becomes the periphery. This force gets weaker when farmers can be supplied at a lower cost. Consequently, manufacturing firms choose to locate in the same region to benefit from a larger market. Krugman's conclusions thus hold in our setting provided that commuting costs are low and a sufficiently large share of consumers is immobile.

D. The bell-shaped curve of spatial development. The above analysis suggests that the way the space-economy is organized depends on the interplay between transport and commuting costs. Historically, it is well known that both costs have fallen at an unprecedented pace (Bairoch 1985). Therefore, what matters is the relative evolution of these two types of costs. For a long time, high transport costs have been the main impediment to trade. Even though the report of the "death of distance" is premature, it is clear that, within developed countries, the cost of shipping commodities has reached today a level which is much lower than commuting costs, which remain relatively high. As a consequence, the main dispersion force no longer lies in the cost of supplying distant markets, but in the level of urban costs. Under these circumstances, we may speculate that, though economic integration has initially fostered a more intensive agglomeration of economic activities, its continuation is liable to generate a redeployment of activities that could lead to a kind of geographical evening-out. In short, one may expect the process of spatial development to unfold according to a *bell-shaped curve*.
To be precise, agglomeration occurs during the second phase of the integration process. The dispersion in the first and third integration phases emerges for very different reasons. In the former phase, the manufacturing sector is dispersed because shipping its output is expensive; in the latter phase, because the smaller city has comparative advantage in terms of urban costs. Simply put, the relationship between economic integration and spatial inequality is not monotone: *while the first stages of economic integration exacerbate regional disparities, once a certain threshold is reached, additional integration starts undoing them* (for a more detailed discussion of the bell curve, see Combes et al., 2008).

2.2 The decentralization of jobs within cities

As seen above, globalization could well challenge the supremacy of large cities, the reason being that the escalation of urban costs would shift employment from large monocentric cities to small cities where these costs are lower. However, this argument relies on the assumption that cities have a monocentric morphology. The main point we wish to stress here is that decentralizing the production of goods in secondary employment districts (SBD) may allow large cities to retain a high share of firms and jobs. Under these circumstances, firms are able to pay lower wages while retaining most of the benefits generated by large urban agglomerations. For example, Timothy and Wheaton (2001) report substantial variations in wages according to intra-urban location (15% higher in central Boston than in outlying work zones, 18% between central Minneapolis and the fringe counties). As they enjoy living on larger plots and/or move along with firms, consumers may also want to live in suburbia. Consequently, the creation of subcenters within a city, i.e. the formation of a *polycentric city*, appears to be a natural way to alleviate the burden of urban costs. It is, therefore, no surprise that Anas et al. (1998, p. 1442) observe that "polycentricity is an increasingly prominent feature of the landscape."
For the redeployment of activities in a polycentric pattern to happen, firms set up in SBDs must be able to maintain a good access to the main urban center, which requires low communication costs. For example, about half of the business services consumed by US firms located in suburbia are supplied in city centers. By focusing on urban and communication costs, we recognize that both agglomeration and dispersion may take two quite separate forms because they are now compounded by the *centralization* or *decentralization* of activities within the same city. Such a

distinction is crucial for understanding the interactions between cities and trade.

A. Polycentric cities. We build on Cavailhès et al. (2007) and extend the above model by allowing manufacturing firms to locate in the CBD or to form a SBD on each side of the CBD. Both the CBD and the SBDs are surrounded by residential areas occupied by consumers. Because the higher-order services are still provided in the CBD, firms established in a SBD must incur a communication cost $K > 0$ so that the profit of a firm located in a SBD is given by $\pi_r - K$ whereas π_r is the profit of a firm established in CBD. In what follows, the superscript C is used to describe variables related to the CBD, whereas S describes the variables associated with a SBD.

Denote by y_r the right endpoint of the area formed by residents working in the CBD and by z_r the right endpoint of the residential area on the right-hand side of the SBD, which is also the outer limit of city r. Let x_r^S be the center of the SBD in city r. It is easy to show that these points are given by

$$y_r = \frac{\theta_r \lambda_r}{2\delta} \qquad x_r^S = \frac{(1+\theta_r)\lambda_r}{4\delta} \tag{10}$$

where $\theta_r < 1$ is the share of jobs located in the city r-CBD.

At a city equilibrium, each worker maximizes her utility subject to her budget constraint, each firm maximizes its profits, and markets clear. Individuals choose their workplace (CBD or SBD) and their residential location for given land rents and wages in the CBD (w_r) and in the SBD (w_r^S). The wage wedge between the CBD and a SBD is given by

$$w_r^C - w_r^S = t(2y_r - x_r^S) = \frac{t}{\delta}\frac{3\theta_r - 1}{4}\lambda_r \tag{11}$$

where we have used the expressions for y_r and x_r^S given in (10). In other words, the difference in the wages paid in the CBD and in the SBD compensates exactly the worker for the difference in the corresponding commuting costs. Moreover, the wage wedge is positive as long as $\theta_r > 1/3$, that is, the size of the CBD exceeds the size of each SBD. Note also that a larger population in city r raises the wage wedge. Indeed, as the average commuting cost rises, firms located in the CBD must pay a higher wage to their workers.

Within each workplace (CBD or SBD), the equilibrium wages are determined by a bidding process in which firms compete for workers by offering them higher wages until no firm can profitably enter the market. Hence, the equilibrium wages are related through the following expressions: $w_r^{C*} = w_r^*$ and $w_r^{S*} = w_r^* - K/\phi$. Given these equilibrium wages and the location of workers, firms choose to locate either in the CBD or in a SBD. At the city equilibrium, no firm has an incentive to change place within the city and no worker wants to change her working place and/or her residence.

Substituting w_r^{C*} and w_r^{S*} into (11) and solving with respect to θ_r yields:

$$\theta_r^* = \min\left\{\frac{1}{3} + \frac{4\delta K}{3t\phi\lambda_r}, 1\right\} \tag{12}$$

which always exceeds $1/3$. Clearly, the city is polycentric ($\theta_r^* < 1$) if and only if $K < t\phi\lambda_r/2\delta$. The higher the communication costs, the lower the commuting cost, or both, the larger the CBD. In the limit, both SBDs shrink smoothly and the city becomes monocentric. In contrast, a larger population fosters the emergence of a polycentric city.

B. The emergence of polycentric cities. The utility differential between cities now depends on the degree of job decentralization within each city. The indirect utility of an individual working in the CBD is still given by (8) but the urban costs (6) are replaced by the following expression:

$$UC_r \equiv \frac{t\lambda_r}{2\delta}\theta_r^*.$$

Everything else equal, urban costs take on lower values when jobs are decentralized into the SBDs. As a consequence, the existence of SBDs allows the large cities to maintain their primacy.

The utility differential (9) becomes

$$\Delta V(\lambda) = -\left[\frac{t}{3\delta} - \frac{\Lambda(\tau)}{\phi}\right]\left(\lambda - \frac{1}{2}\right)$$

when both cities are polycentric and

$$\Delta V(\lambda) \equiv -2\left[\frac{2t}{3\delta} - \frac{\Lambda(\tau)}{\phi}\right]\lambda + \left[\frac{t}{\delta} - \frac{\Lambda(\tau)}{\phi} - \frac{4K}{3}\right]$$

when only one city is polycentric ($\theta_1^* < \theta_2^* = 1$).

Unlike standard models but as in Cavailhès et al. (2007), the economy displays a richer set of stable equilibrium configurations: (i) dispersion with two identical monocentric cities; (ii) agglomeration within a single monocentric city; (iii) partial agglomeration with one large polycentric city and a small monocentric city; (iv) agglomeration within a single polycentric city and (v) dispersion with two identical polycentric cities. Once communication costs are low enough, the economy traces out the following path when the ratio t/δ steadily decreases. By inducing high urban costs, a high t/δ-ratio leads to the dispersion and decentralization of jobs, that is, the economy involves two polycentric cities. When δ gets higher or t lower, urban costs decrease sufficiently for the centralization of jobs within one city to emerge at the market outcome. However, urban costs remain high enough for the equilibrium to involve two cities having different sizes and structures. Last, when the t/δ-ratio takes on very low values, urban costs become almost negligible, which allows saving the cost of shipping the manufactured good through the existence of a single city.

The multiplicity of stable equilibria has also an important implication that has been overlooked in the literature: *different types of spatial patterns may coexist under identical technological and economic conditions*. It should be no surprise, therefore, to observe different types of urban systems in the real world.

3 Cities and services

In Section 2, as in most NEG models, consumers have access to the entire range of produced varieties. As observed by Handbury and Weinstein (2011), residents of larger cities have, ceteris paribus, access to more varieties than residents of smaller cities. The rising share of nontradable consumption services explains, to some extent, this fact. What distinguishes service cities from the manufacturing cities is that the cost of shipping local services are prohibitive. Consequently, consumers have access only to the varieties produced in the city in which they live.

3.1 Cities as local service-providers

To start with, we consider a setting with no manufacturing sector and focus on the impact of commuting costs on the spatial distribution of non-housing services. The circumstances in which one large city or two small cities emerge is the issue discussed in this section.
Consumer preferences are given by (2), except that the set of available varieties in city r is now given by n_r instead of n. The profits earned by a city r-firm are given by

$$\pi_r = p_r q_r(p_r)\lambda_r - w_r\phi.$$

Because service firms compete only on their local market, the equilibrium price of a city r-variety is obtained by setting $\lambda_s = 0$ in (7):

$$p_r^* = \frac{\beta}{2\beta - 1} \equiv \mathbf{p} \tag{13}$$

which is the same in the two cities. Observe that a stronger love for variety yields a higher market price because service firms have more market power.
The consumer surplus generated by a single variety is equal to $S = (1 - \mathbf{p})^2/\beta$, which is independent of the city size. Because the value of S does not play any role in the analysis undertaken here, we set $S = 1$. As for the total surplus, it is equal to the number $n_r = \lambda_r/\phi$ of locally produced varieties, which increases with both the city size and the labor productivity. Put simply, *consumers living in larger cities have access to more nontradable services*.
The urban labor markets being local, the equilibrium wage paid by firms established in city r is equal to

$$w_r^* = \mathbf{p}^2\lambda_r/\phi.$$

In other words, wages are higher in larger cities because the local market is bigger. Observe that this correlation does not reflect a difference in well-being. As expected, w_r^* also increases when workers are more productive because more firms compete on urban labor markets.
Replacing each term of V_r by its expression leads to the following utility differential:

$$\Delta V(\lambda) = -\left[\frac{t}{\delta} - \frac{2(1 + \mathbf{p}^2)}{\phi}\right]\left(\lambda - \frac{1}{2}\right)$$

As in subsection 2.1, the symmetric pattern ($\lambda^* = 1/2$) is always a spatial equilibrium. However, when $t/\delta < 2(1 + \mathbf{p}^2)/\phi$, this equilibrium is unstable because the utility differential is positive for all values of λ. The market outcome therefore involves a single large city accommodating all consumers ($\lambda^* = 1$). Thus, *even in the absence of trade, consumers and firms may choose to be agglomerated within a single large city*. This is so when (i) commuting costs are low, (ii) the population density is high, and (iii) the array of local services is wide. The intuition is fairly straightforward. By being agglomerated in a single city, consumers have access to all varieties. Furthermore, low fixed costs favors the entry of additional firms, which widens the range of varieties and increases consumers' utility who have a love for variety. As a consequence, the emergence of a large city is more likely to occur when the service sector is able to provide a larger number of differentiated varieties. Hence, labor-saving innovations such as the development of new information and communication technologies pushes toward the concentration of services in large cities.

By contrast, when $t/\delta > 2(1+\mathbf{p}^2)/\phi$, the symmetric equilibrium is stable. This is because the gains from variety do not compensate consumers for the higher urban costs they would bear in the large city. In this case, instead of seeking variety, consumers aim to reduce urban costs, and thus the population is equally dispersed between the two cities. Dispersion may even take the concrete form of a larger number of smaller cities, which are determined by the trade-off between urban costs and the gains from variety. To sum up, when commuting costs steadily decrease a service economy shifts from dispersion to agglomeration because the latter allows individuals to consume all services and to earn higher wages.

3.2 The size and industrial structure of cities

We now take a broader perspective by considering a two-sector economy in which labor is perfectly mobile between locations *and* sectors. The objective is to determine the interindustry distribution of consumers as well as their residential location between and within cities.
The economy involves a manufacturing sector supplying a freely tradable good ($\tau = 0$) and another sector producing a nontradable service (other than land) for local consumption. Focusing on such an industrial mix allow revisiting the export base theory grounded in the assumption that the urban economy can be divided into two very broad sectors, i.e. a basic sector whose fortunes depends largely in external factors and a nonbasic sector which depends on local factors. The tenet of this theory holds that the basic sector is the prime cause of local economic growth (Tiebout 1956).

A. The export base theory revisited. The manufactured good is denoted by 1 and the non-housing service by 2. The utility derived from consuming q_i units of a variety i of good $j = 1,2$ is given by (1). In other words, the parameters associated with the utility arising from consuming one variety of the manufactured product or of the consumption service are identical. This assumption does not affect qualitatively the properties of the spatial equilibria. Indeed, because good 1-varieties are available everywhere at the same price, the consumer surplus generated by the consumption of the manufactured good is the same regardless of the city in which consumers live. Furthermore, the profits earned by the manufacturing firms are the same regardless of the city in which they are located. Thus, the equilibrium values of the consumer surplus and wage associated with good 1 do not play any role in workers' decision to move. As a consequence, assuming that the parameters of (1) are the same for goods 1 and 2 entails no loss of generality for the determination of the sectoral and spatial structure of the economy.
Preferences now involve two non-housing goods and are given by

$$U(q_0; q_{ij}) = \sum_{j=1,2} \left[\int_0^{n_j} q_{ij} \mathrm{d}i - \frac{\beta n_j}{2(n_1+n_2)} \int_0^{n_j} q_{ij}^2 \mathrm{d}i - \frac{1}{2(n_1+n_2)} \int_0^{n_j} q_{ij} \left(\int_0^{n_j} q_{kj} \mathrm{d}k \right) \mathrm{d}i \right] + q_0 \tag{14}$$

where q_{ij} is the quantity of variety $i \in [0, n_j]$ of good $j = 1, 2$. Because good 1 is tradable, the total number n_1 of good 1-varieties is available in both cities, whereas n_2 is the number of good 2-varieties supplied in the city where the consumer lives. Consumers having a love for variety may vary between goods and services, the second term of (14) is weighted by the ratio $n_j/(n_1+n_2)$. This captures the idea that a good supplied as a small range of varieties has more impact on the consumer's well-being than a good made available through a large array of varieties. Note that the following analysis can be extended to cope with different attitudes toward variety by assuming that $\beta_1 \neq \beta_2$.

Let λ_{ir} be the number of consumers working in sector $i = 1, 2$ and living city $r = A, B$. Labor being mobile between cities and sectors, the λ_{ir} are endogenous and determined in equilibrium. Labor market-clearing implies

$$n_1 = \frac{\lambda_{1A} + \lambda_{1B}}{\phi_1} \qquad n_{2r} = \frac{\lambda_{2r}}{\phi_2}. \tag{15}$$

Labor being mobile between sectors, in equilibrium it must be that $w_r = w_{1r} = w_{2r}$. Letting $\lambda_r = \lambda_{1r} + \lambda_{2r}$ be the population residing in city r, the budget constraint of a consumer residing in city r may be written as follows:

$$n_1 p_1 q_{1r} + n_{2r} p_{2r} q_{2r} + \frac{t}{\delta}\frac{\lambda_r}{2} + q_0 = \overline{q}_0 + w_r$$

where p_1 is the common price of a good 1-variety, p_{2r} the consumer price of a good 2-variety in city r and q_0 the consumption of the numéraire.

It is readily verified that the individual demand for a good i-variety in city r is given by

$$q_{1r} = \left(\frac{1}{1+\beta} - \frac{p_1}{\beta} + \frac{\bar{p}_1}{\beta(\beta+1)}\right)\left(1 + \frac{n_{2r}}{n_1}\right) \tag{16}$$

$$q_{2r} = \left(\frac{1}{1+\beta} - \frac{p_{2r}}{\beta} + \frac{\bar{p}_{2r}}{\beta(\beta+1)}\right)\left(1 + \frac{n_1}{n_{2r}}\right). \tag{17}$$

Whereas the average price $\bar{p}_1$ is defined over the entire range of good 1-varieties because good 1 is tradable, $\bar{p}_{2r}$ is defined only over the range of good 2-varieties produced in city r. Although this demand system involves no income effect, it displays a rich pattern of substitution via the relative number of varieties. Specifically, when the number of good i-varieties available in city r increases, the individual demands for good j-varieties are shifted upward because good j becomes relatively more attractive. In particular, the size and distribution of the service sector (n_{2r}) affects individual demands for the manufactured good in each city (see (17)). Unlike the export base theory which maintains that the industries producing tradable goods are the economic base of the urban economy, the model used here shows that *a growing service sector impacts positively on the local demand for the tradable good*.

Likewise, the size of the manufacturing sector (n_1) affects the individual demand for services in each city and, therefore, the spatial distribution of this sector. In contrast, the distribution of manufacturing firms has no direct impact on individual demands for good 1 because trading this good is costless. This suggests that manufacturing firms are indifferent between locations. But they are not because their workers are attracted by cities supplying a wide range of services.

Let

$$\pi_{1r} \equiv p_1[q_{1A}(p_1)\lambda_A + q_{1B}(p_1)\lambda_B] - \phi_1 w_r$$

be the profits earned by a manufacturing firm established in city r. As in subsection 2.1, when choosing its own price, each firm treats parametrically the wage w_r as well as the average prices $\bar{p}_{1A}$ and $\bar{p}_{1B}$. Setting $\tau = 0$ in (7) yields the equilibrium price of good 1, which is constant and the same in both cities: $p_1^* = \mathbf{p}$. When they are not agglomerated, manufacturing firms therefore make the same operating profits in both cities. This implies that they pay the same wage w_1^* to their workers. As a consequence, there is factor price equalization: $w_1^* = w_{1r}^* = w_{2r}^*$. In this event, the urban cost differential is exactly compensated by the difference in the number of nontradable services supplied in each city. Simply put, *consumers choose to live in a larger city where they bear higher urban costs because they have access to a wider array of local services*. Profits being zero in equilibrium, the wage paid by a manufacturing firm is equal to

$$w_1^* = \mathbf{p}^2 \sum_{r=A,B} \frac{n_r \lambda_r}{n_1 \phi_1} \tag{18}$$

where $n_r = n_1 + n_{2r}$.
The profits made by a service firm set up in city r are given by

$$\pi_{2r} = p_{2r} q_{2r} \lambda_r - \phi_2 w_{2r}$$

where p_{2r} is the price quoted by such a firm. Because substitution effects go through the numbers of varieties only, the equilibrium price of a good 2-variety is given by (13). This in turn implies that the equilibrium wage paid by the service firms located in city r is

$$w_{2r}^* = \mathbf{p}^2 \frac{n_r \lambda_r}{n_{2r} \phi_2} \tag{19}$$

which varies with the size (λ_r) and the sectoral mix (n_r/n_{2r}) of the city. Note that the service sector is never agglomerated. Otherwise, w_{2r}^* becomes arbitrarily large when there is no service firms in city r ($n_{2r} = 0$).
Since $S = 1$, the welfare of a consumer working in sector i and living in city r is given by

$$V_{ir} = n_1 + n_{2r} + w_r^* - \frac{t}{\delta} \frac{\lambda_r}{2}.$$

This shows how consumers' well-being depends on the spatial and sectoral distribution of jobs.

B. Urban hierarchy. A *spatial-sectoral equilibrium* arises when no worker has an incentive to change place and/or to switch job. The stability of such an equilibrium is studied by using the myopic evolutionary dynamics (Fujita et al. 1999):

$$\dot{\lambda}_{ir} = \lambda_{ir} \left(V_{ir} - \bar{V} \right) \tag{20}$$

where $\bar{V} = \Sigma_i \Sigma_r V_{ir}$ is the average utility in the entire economy. Note that in (20) the choices of jobs and locations are treated in a symmetric way.
In what follows, we focus on the case in which the manufacturing sector is not fully agglomerated ($0 < \lambda_{1r}^* < 1$). In this event, we have $w_1^* = w_{2r}^*$. Using $p_1^* = p_2^* = \mathbf{p}$, the wage equality implies that $\sum_r n_{2r}^* \phi_2 = n_1^* \phi_1$. As a consequence, the labor force is equally split between the two sectors ($\lambda_1^* = \lambda_2^* = 1/2$).
The utility differential is now given by

$$V_{ir} - \bar{V} = \frac{2\delta - \phi_2 t}{\phi_2 \delta} \left(\lambda_{2r} - \frac{1}{4} \right) \lambda_s - \frac{t}{\delta} \left(\lambda_{1r} - \frac{1}{4} \right) \lambda_s \tag{21}$$

where λ_s is the city s-population (recall that w_{ir}^* is equal to the average wage). Solving the system (21) shows that there are two candidate equilibria (up to a permutation between A and B):

$$\lambda_{1A}^* = \lambda_{2A}^* = 1/4 \tag{22}$$

and

$$\lambda_{1A}^* = \frac{1}{4} + \frac{(2\delta - \phi_2 t)\sqrt{\Delta}}{4\phi_1\phi_2 t} \qquad \lambda_{2A}^* = \frac{1}{4} + \frac{\sqrt{\Delta}}{4\phi_1} \tag{23}$$

where

$$\Delta \equiv \phi_1^2 + 2\phi_1\phi_2 - 2\phi_1\phi_2^2 t/\delta.$$

In both configurations, the total number of good i-varieties is given by $n_i^* = 1/2\phi_i$, and thus the industrial mix $n_1^*/n_2^* = \phi_2/\phi_1$ in the global economy depends on the relative productivity of labor in the two sectors. By contrast, when the asymmetric configuration prevails, *cities differ not only in size but also in industrial structures*.

As in Section 2, the symmetric pattern (22), which involves two cities having the same size and the same industrial mix, is always a spatial-sectoral equilibrium. On the other hand, the asymmetric configuration (23) is a (stable) equilibrium if and only if $\Delta > 0$, i.e.

$$\frac{t}{\delta} < \frac{\phi_1}{2\phi_2^2} + \frac{1}{\phi_2}.$$

In other words, commuting costs (population density) must be sufficiently low (high) for a large city (A) and a small city (B) to coexist. Moreover,

$$\lambda_A^* - \lambda_B^* = \frac{\delta\sqrt{\Delta}}{\phi_1\phi_2 t} \geq 0$$

implies that a lower t or a higher δ gradually enlarges the population gap between the two cities. Though workers are identical, there is no catastrophic bifurcation: small changes in commuting costs generate small changes in the location *and* the composition of economic activities. In other words, accounting for the possibility of changing jobs smooths out the process of migration.

A few remarks are in order. First, the existence of a nontradable service selects a well-defined distribution of the footloose industry 1. More precisely, except for fairly high commuting costs, the nontradable sector acts as a centripetal force that results in the (partial) agglomeration of the manufacturing sector. Second, as long as $t < 2\delta/\phi_2$ holds, the larger city supplies a wider array of varieties of each good than the smaller city ($\lambda_{1A}^* > 1/4 > \lambda_{1B}^*$ and $\lambda_{2A}^* > 1/4 > \lambda_{2B}^*$). In this case, the urban system displays a Christaller-like *hierarchy*: by supplying a larger array of services, city A attracts more consumers than city B. Though the demand for the manufactured good is higher therein (see (16)), this does not attract more manufactured workers because this good is shipped at zero cost. Thus, the process of circular causation comes to an end. Note, however, that the population gap between the two cities grows when the service sector becomes more productive.

Third, when $t > 2\delta/\phi_2$ holds, the larger city has a larger labor share in the service sector, whereas the smaller city has a larger labor share in the manufacturing sector:

$$\frac{\lambda_{1B}^*}{\lambda_B^*} > \frac{1}{2} > \frac{\lambda_{1A}^*}{\lambda_A^*} \qquad \frac{\lambda_{2A}^*}{\lambda_A^*} > \frac{1}{2} > \frac{\lambda_{2B}^*}{\lambda_B^*}.$$

In this event, the urban system involves *diversified but relatively specialized cities*. This is because the size advantage associated with the larger city no longer compensates enough manufacturing workers for the higher urban costs they would bear there. This result is consistent with Ricardo's comparative advantage theory: the larger city has a comparative advantage in nontradables because it has a larger local market; the smaller city' comparative advantage is its lower level of urban costs. Note that a city's comparative advantage is not given; it emerges from market interactions and labor mobility.
Fourth, and last, the export base theory predicts that an increase in the local size of the basic sector induces a more than proportionate increase in the city size. It is readily verified that the equilibrium condition $V_{iA}^* = V_{iB}^*$ yields

$$\lambda_A^* = \frac{1}{2}\frac{\delta - \phi_2 t}{2\delta - \phi_2 t} + \frac{2\delta}{2\delta - \phi_2 t}\lambda_{1A}^*$$

where $2\delta/(2\delta - t\phi_2) > 1$ is the "regional multiplier". Hence, a shock that makes the basic sector larger (λ_{1A}^*) boosts a more than proportionate growth of the city size (λ_A^*) by attracting more services. However, a larger nonbasic sector also leads to the expansion of the basic sector, which means that the nonbasic sector can be an engine for urban growth.
Observe that the impact of the nonbasic sector on total employment is higher in the larger city because the service sector is relatively more concentrated in city A than in city B when $t/\delta < 1/\phi_2$. Indeed, $V_{iA} = V_{iB}$ implies that

$$\lambda_A^* = \frac{\phi_2 t - \delta}{2\phi_2 t} + \frac{2\delta}{t\phi_2}\lambda_{2A}^*$$

so that the regional multiplier of the nonbasic sector exceeds of the regional multiplier of the basic sector when $t/\delta < 1/\phi_2$, an inequality which is more likely to hold when the productivity in the nonbasic sector is high.

4 The future of cities

One may wonder how the kind of approach surveyed in the foregoing sections may help understand some of the main challenges faced by cities in the twenty-first century. In what follows, we consider two different issues which have important policy implications: (i) the growing share of retirees in developed countries, whose income does not come from labor and (ii) the environmental impact of the rapid urbanization in emerging countries like China and India.

4.1 Cities in aging nations

The old-age dependency ratio (the ratio people aged 65 and older to people aged 15 to 64) is projected to double by 2050 within the European Union, with four persons of working age for every elderly citizen to only two. This ratio is expected to be lower in the United States, with a rise from 19 to 32%, but higher in Japan, with a rise from 25 in 2000 to 72% in 2050. Such demographic changes are likely to have a major impact on cities because the retirees are driven by location factors that differ from those governing workers' residential choices. Workers' welfare depends on local services, land rent and wages, whereas rentiers' welfare depends only upon local services/amenities and land rent. As a consequence, when the share of old people takes on a sufficiently high value, the process of circular causation *à la* Myrdal sparked by workers' location choice could well be challenged.

To study how the urban system might change as the old-age dependency ratio rises, we consider the model of subsection 3.2 in which the population is split between two groups of consumers, i.e. the *elderly* and the *workers* whose respective numbers are $\rho \geq 0$ and $1-\rho \geq 0$. City B is endowed with an amenity $a > 0$, which is valued only by the elderly. We close the model by assuming that land is collectively owned by the elderly. The income of a retiree is, therefore, given by the aggregate land rent (ALR) divided by the total number of elderly (ρ). Workers and retirees have different unit commuting costs, t and θ, respectively. We assume $\theta > t$. The case where $t > \theta$ leads to more cumbersome expressions which do not affect the nature of our main results. What matters for our purpose is that a city's urban costs increase with the number of retirees residing there.

Let s_r be the share of elderly people living in city $r = A, B$. City r-population is then given by $\lambda_r = (\lambda_{1r} + \lambda_{2r})(1-\rho) + s_r\rho$. Besides λ_{1r} and λ_{2r}, we have to determine s_r. If the elderly are those living close to the CBD, workers' urban costs borne are now as follows:

$$UC_r = t\frac{(\lambda_{1r} + \lambda_{2r})(1-\rho) + s_r\rho}{2\delta}$$

which is equal to (6) when $\rho = 0$. It thus varies with the distribution of activities as well as with the way the retirees distribute themselves between the two cities.

Because of the asymmetry in the amenity supply, the elderly's equilibrium condition is given by $V_A^o - V_B^o = a$ with $V_r^0 = n_1 + n_{2r} + ALR/\rho - UC_r^o$. The urban costs UC_r^o borne by the retirees are given by

$$UC_r^o = \theta\frac{s_r\rho}{2} + t\frac{(\lambda_{1r} + \lambda_{2r})(1-\rho)}{2}.$$

The equilibrium distribution of the elderly between cities is the same regardless of the spatial and sectoral allocation of workers:

$$s_B^* = \frac{1}{2} + \frac{a}{\rho(\theta - t)}. \tag{24}$$

As expected, more elderly choose to live in the city endowed with the amenity advantage than in the working-city. A larger share of elderly in the economy increases the number ρs_B^* of old people living in city B. Likewise, the number of old people residing in city A increases, thus meaning that *the population of both cities gets older*.

When the share of the elderly people in the economy is not too high, the economy displays two stable equilibria. In the former one, the mobility of the elderly does not jeopardize the existing urban hierarchy, whereas it does in the latter one (Gaigné and Thisse 2009). This could explain why there are contradicting opinions regarding the evolution of urban systems in aging nations. The equilibrium in which the working-city remains the primate city, while the other city accommodates the larger share of retirees, is the one that agrees with current empirical evidence (Chen and Rosenthal 2008). The corresponding equilibrium distribution of workers between sectors and cities is as follows:

$$\lambda_{1A}^* = \frac{1}{4} + \frac{(2 - t\phi_2)\sqrt{\Delta_a}}{4t\phi_1\phi_2} + \frac{a}{(1-\rho)(\theta - t)} \qquad \lambda_{2A}^* = \frac{1}{4} + \frac{\sqrt{\Delta_a}}{4\phi_1} \tag{25}$$

where

$$\Delta_a \equiv \phi_1(\phi_1 + 2\phi_2) - \frac{2t\phi_1\phi_2^2}{1-\rho} < \Delta.$$

Note that (25) boils down to (23) when $\rho = a = 0$.

Thus, *workers and retirees are not attracted by the same city*. Moreover, as shown by (24) and (25), when city B's local government improves its amenity supply, city B attracts a growing number of retirees, whereas the number of jobs in the working-city rises. This provides a rationale for recent empirical evidence, which suggests that retirees and workers tend to live separately as the old-age dependency ratio increases.

Moreover, an aging population (a higher ρ) induces the dispersion of services at the expense of the working-city while its effect on the manufacturing sector is ambiguous. In other words, an increasing share of retirees may challenge the performance of the working-city. As a result, if the agglomeration of manufactures and services generates benefits not taken into account in the model, the economy will incur efficiency losses. In addition, employment in the working-city decreases because the elderly-city attracts more services. However, beyond some limit the migration of retirees toward the amenity-city raises the level of urban costs and/or decreases the supply of local services. This restores, to some extent, the attractiveness of the working-city. Nevertheless, this need not be true for the services which still benefit from a big market in the elderly-city. Regardless of old-age dependency ratio, the working-city remains the larger one ($\lambda_A^* > \lambda_B^*$).

To sum up, though in an aging nation the relocation of consumption services weakens the supremacy of the working-cities, these ones maintain their primacy. Indeed, as long as it is more profitable for the bulk of manufactures to congregate, a large share of services is prompted to set up therein. In addition, as the population gets older, cities diverge in their job and demographic structures. Yet, the supply of consumption services should prevent the complete spatial separation of workers and retirees.

4.2 Are compact cities ecologically desirable?

The transport sector is a large and growing emitter of greenhouse gases (GHG). It accounts for 30% of total GHG emissions in the US and approximately 20% of GHG emissions in the EU-15. Moreover, road-based transport accounts for a very large share of GHG emissions generated by the transport sector. For example, in the US, nearly 60% of GHG emissions stem from gasoline consumption for private vehicle use, while a share of 20% is attributed to freight trucks, with an increase of 75% from 1990 to 2006. Although new technological solutions will improve energy efficiency, other initiatives are needed, such as mitigation policies based on the reduction of average distances travelled by commodities and people.

A. The ecological trade-off between commuting and shipping costs. We have seen that transporting people and commodities involves economic costs. It also implied ecological costs that obey the fundamental trade-off of subsection 2.1: the agglomeration of firms and people in a few large cities minimizes the emissions of GHG stemming from shipping commodities, but increases those generated by longer commuting; dispersing people and firms across numerous

small cities has the opposite costs and benefits. If cities are more compact (i.e. a higher population density δ), then, keeping population and firms fixed, the costs associated with the former spatial configuration (concentration) fall relative to those associated with the latter (dispersion) because people commute over shorter distances. However, when one recognizes that firms and people choose their location in order to maximize profits and utility, a policy that aims to make cities more compact will affect the intercity pattern of activities by fostering their progressive agglomeration, thus raising the level of GHG within fewer and larger cities. Therefore, the ecological effects of an increasing-density policy are a priori ambiguous (Gaigné et al. 2011).
To illustrate how this trade-off operates, we consider the model of subsection 2.1 and assume that the carbon footprint E of the urban system stems from the total distance travelled by commuters within cities (C) and the total quantity of the manufactured good shipped between cities (T):

$$E = e_C C + e_T T$$

where e_C is the amount of GHG generated by one unit of distance travelled by a consumer, while shipping one unit of the manufactured good between cities generates e_T units of carbon dioxides.
Because consumers are symmetrically distributed on each side of the CBD, the value of C depends on the intercity distribution of the manufacturing sector and is given by

$$C = \frac{1}{4\delta}(\lambda_r^2 + \lambda_s^2).$$

Clearly, the emission of GHG stemming from commuting increases is minimized when the manufacturing sector is evenly dispersed between two cities ($\lambda_r = \lambda_s = 1/2$).
Regarding the value of T, it is given by the sum of equilibrium trade flows:

$$T = \frac{\phi[4\beta - (4\beta + 1)\tau]}{2(2\beta + 1)\beta}\lambda_r\lambda_s$$

where $T > 0$ because $\tau < \tau_{\text{trade}}$. As expected, T is minimized when consumers and firms are agglomerated within a single city ($\lambda_r = 0$ or 1). Note also that T increases when shipping goods becomes cheaper because there is more intercity trade. Hence, transportation policies that foster lower shipping costs give rise to a larger emission of GHG.
Thus, E is described by a concave or convex parabola in λ, so that the emission of GHG is minimized either at $\lambda = 1$ or at $\lambda = 1/2$. Therefore, it is sufficient to evaluate the sign of $E(1;\delta) - E(1/2;\delta)$, which is negative if and only if $\delta > \delta_e$ where

$$\delta_e \equiv \frac{e_C}{e_T}\frac{(2\beta + 1)\beta}{\phi[4\beta - (4\beta + 1)\tau]}.$$

Thus, the agglomeration of activities within a single city is ecologically desirable if and only if $\delta > \delta_e$. Otherwise, dispersion is the best ecological outcome. As a consequence, *agglomeration or dispersion is not by itself the most preferable pattern from the ecological point of view*. Contrary to general beliefs, large compact cities need not imply low levels of pollution. For agglomeration to be ecologically desirable, the population density must be sufficiently high for the average commuting distance to be small enough.

B. Does the market yield a good, or a bad, ecological outcome? As seen in subsection 2.1, $\lambda = 1/2$ is a stable equilibrium if δ is smaller than $\delta_m \equiv \phi t/\Lambda(\tau)$. Otherwise, the manufacturing sector is concentrated into a single city. Because $\delta_m = 0$ at $t = 0$ and increases with t, while δ_e is independent of t, the two curves δ_m and δ_e intersect once. As a result, *the market yields either the best or the worst ecological outcome*.

Specifically, there exists a unique value $\bar{t}$ such that $\delta_m = \delta_e$. Consider, first, the case where t exceeds $\bar{t}$. If $\delta < \delta_m$, the market outcome involves two cities. Keeping this configuration unchanged, a more compact city (i.e. a higher δ) always reduces the emissions of pollutants. Once δ exceeds δ_m, the economy gets agglomerated, thus leading to a downward jump in the GHG emissions. Further increases in δ allow for lower emissions of GHG. Hence, when commuting costs are high, a denser city always yields lower emissions of GHG. Assume now that $t < \bar{t}$. As in the foregoing, provided that $\delta < \delta_m$, the market outcome involves dispersion while the pollution level decreases when the city gets more compact. When δ crosses δ_m from below, the pollution now displays an upward jump. In other words, when commuting costs are low, *more compact cities need not be ecologically desirable*.

Consequently, once it is recognized that consumers and firms are mobile, what matters for the total emission of GHG is the mix between city compactness (δ) and city size (λ), thus pointing to the need of coordinating environmental policies at the local and global levels. In other words, environmental policies must focus on the urban system as a whole and not on individual cities. When it is recognized that the internal structure of cities may change with population density (see subsection 2.2), the ecological effects of an increasing-density policy are even more ambiguous: more compactness favors the centralization of jobs at the city center. Gaigné et al. (2011) point out that, unless commuting to SBDs generates a massive use of private cars, compact and monocentric cities may generate more pollution than polycentric and dispersed cities. By lowering urban costs without reducing the benefits generated by large urban agglomerations, the creation of SBCs would allow large cities both reducing GHG emissions and enjoying agglomeration economies.

5 Where do we stand?

The idea of spatial interaction is central to regional science. Broadly defined, spatial interaction refers to flows across space that are subject to various types of spatial frictions, such as traded goods, migrations, capital movements, interregional grants, remittances, and the interregional transmission of knowledge and business cycle effects. Though the NEG literature has for the most part focused on the mobility of goods and production factors, these issues are at the heart of NEG. Instead of writing one more review of the vast literature produced in the footsteps of Krugman (1991), we have chosen to highlight the role that NEG may play in understanding the process of urban development. Specifically, through several major trade-offs we have covered a range of issues that highlight the working of urban systems. To do so, we have used very simple models, which vastly contrast with the heavy mathematical apparatus employed in the literature.

To a large extent, the lack of attention paid by economists to earlier contributions in regional science is unwarranted. Regional scientists and geographers have developed several models, such as those ranging from the entropy to the gravity and logit models, which have proven to be very effective in predicting and explaining different types of flows. By ignoring this body of research, economists have sometimes rediscovered the wheel and missed the opportunity of developing much earlier a sound theory of the space-economy. But equally unwarranted is the acrimony expressed by many geographers soon after the diffusion of Krugman's work: they miss the importance of working with a fully consistent microeconomic model, especially the need of using a well-defined market structure and a precise specification of the externalities at work.

Cities of the twenty-first century face new and important challenges, such as climate change, aging population, crime, poverty, social exclusion, food security, the supply and management of transportation and communication infrastructure, and competition among the few world's largest cities. It is, therefore, fundamental to have sound theoretical models which can be used as guidelines in developing empirical research and designing new policies. Is NEG a useful tool? For many important urban questions, we believe the answer is yes. From the methodological standpoint, NEG has two major merits. First, the decisions made by firms and households are based on land rents, wages and prices, which are themselves endogenous and related to the size and structure of cities. Second, NEG takes into account the fact that households and firms may relocate between and within cities in response to major changes in their economic environment. The branches of modern economics NEG is connected with provide a set of tools and concepts that permit to tackle new and challenging issues.

Nevertheless, NEG suffers from a major drawback, which has been brushed aside in most of the literature: it is built on a two-location setting. Yet, it is well known that a firm's location is the balance of a system of forces pulling the firm in various directions. The new fundamental ingredient that a multi-location setting brings about is that spatial frictions between any two cities are likely to be different. As a consequence, the *relative position* of a city within the whole network of interactions matters (Behrens et al. 2007). Another key insight one can derive in a multi-location economy is that any change in the underlying parameters has in general complex impacts which vary in non-trivial ways with the properties of the graph representing the spatial economy. When there are only two locations, any change in structural parameters necessarily affects directly either one of the two cities, or both. On the contrary, when there are more than two locations, any change in parameters that directly involves only two cities now generates spatial spillover effects that are unlikely to leave the remaining cities unaffected. More work is called for here but one should not expect a simple answer.

Last, the literature features two distinct models of competition in space (i.e. spatial competition à la Hotelling (1929) and monopolistic competition in Krugman-like settings). Each one seems to describe competition on two different spatial scales. Indeed, the former fits well competition "in the small," which involves shopping malls, retailers and service-providers located within the same city; the latter provides a fairly good approximation of competition "in the large," that is, competition among producers supplying several cities and countries. A theory encompassing both settings is needed to understand better how consumer prices are formed within different urban neighborhood as well as in cities having different sizes and morphologies. The industrial organization literature on vertical relationships linking upstream (global) and downstream (local) firms through carriers is a good point where to start.

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