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**The New Economic
Geography:
a survey of the
literature**

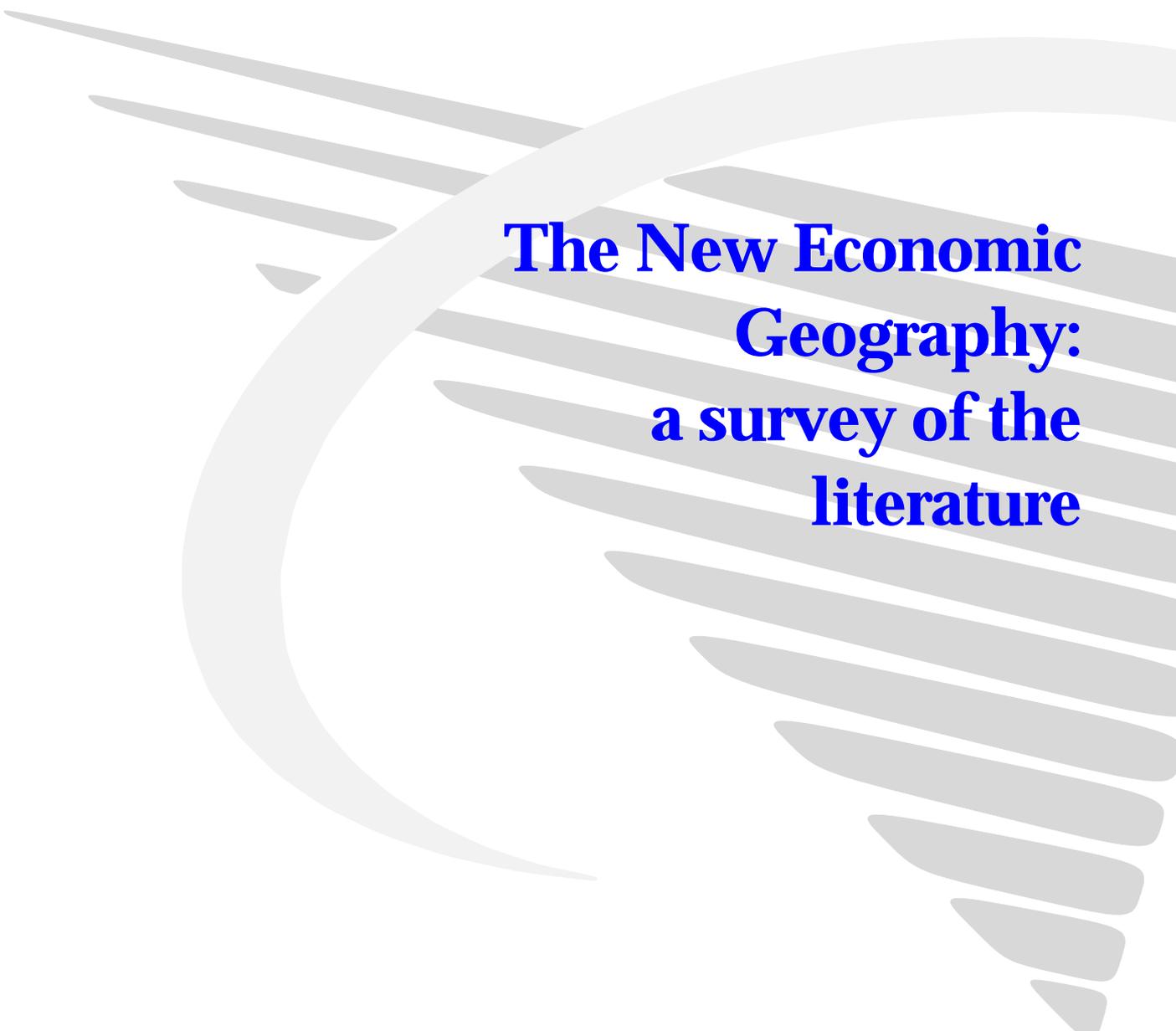


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December 2002



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Federal Planning Bureau

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Executive Summary

This overview of the literature dedicated to the new economic geography intends to highlight the main mechanisms, which contribute to explain the spatial concentration of economic activity, in particular the formation of cities and industrial districts. This should provide some guidelines for an empirical analysis of the determinants of the spatial distribution of economic activity in urban areas in Belgium and for suggestions of economic policy instruments capable of influencing location choices.

The main contribution of the new economic geography is to deal with some of the classic questions of regional and urban sciences related to location in a coherent theoretical framework, and to explain the endogenous mechanisms driving geographic concentration of economic activity and leading to core-periphery patterns. In a pioneering text, Krugman (1991a) has shown that these forms of concentration are linked to the existence of agglomeration economies, according to which the spatial concentration itself creates a positive economic environment.

According to the new economic geography, the self-reinforcing process deriving from the spatial concentration of economic activity arises from the interplay of various factors: scale economies, transport costs, backward-forward linkages of firms, which determines the location of economic activity. In the presence of increasing returns to scale, each producer is inclined to concentrate its production in a single location. In order to minimise the transport costs, the producer will have a tendency to locate where the local demand is the most important. But demand concentrates precisely where other firms have already located. If a specific economic activity develops particularly in a given region, due to history, this region will attract the firms of the other regions, thus reinforcing the advantage deriving from the size of its own market. This circular process of cumulative causality leads in the end to the concentration of the industry in a single area.

The effects from the concentration of economic activity can be reinforced by the existence of externalities such as technology and knowledge spillovers through the improvement of information flows (informal contacts facilitated by proximity), access to a diversified range of intermediate goods and complementary services to industrial activity, and the benefits from specialised high-skilled labour availability. The economic literature also makes a distinction between location economies associated with the firms belonging to a same sector and the urbanisation economies associated with the firms from all sectors being located in a same place. The accounting for the interactions between technological, sectoral and geographical proximity comes from the research work on endogenous growth, which considers these externalities as the engine of growth.

However, congestion effects exist besides these agglomeration economies. According to these effects, concentration brings about an increase in the prices of the immobile local factors (land, natural resources, agricultural workers), and of goods that can lead to an inverse process of dispersion of economic activity. These dispersion forces, which allow to explain the existence of several concentration places, are linked to transport costs, land use costs, labour market competition and competition on the market of goods and services, and to negative externalities (congestion in transport, pollution).

From an economic policy point of view, it is very important to understand the processes underlying the location decisions of firms and their possible impact on industrial structure and the dispersion of economic activity within a given geographical area, because the predominance of agglomeration forces could create inequalities between the core and the periphery. The central idea of the new economic geography is that the spatial distribution of economic activity results from the interaction between centripetal forces and centrifugal forces, whose nature can vary according to the spatial scale considered: local, regional or international. While the role of pecuniary externalities, emphasised by the new economic geography, is especially relevant to explain agglomeration effects at the European scale, empirical studies tend to show that the existence of technology and knowledge spillovers, encouraged by specialised high-skilled labour availability, may well prove to be a better explanation of agglomeration at the local level. Thus, this mechanism is very important to understand, for example, the impact of information and communication technology on the spatial configuration of cities.



Introduction

The “New Economic Geography” deals with some of the classic questions of regional and urban sciences. Why does economic activity tend to concentrate geographically? How has the spatial distribution of economic activity evolved and how can it be expected to evolve in the future? What is the appropriate role of government in influencing this evolution? However, it tends to revisit these questions using a new approach where increasing returns to scale are the driving force behind increased concentration of economic activities.

An obvious explanation for the uneven distribution of economic activity across space is that certain regions enjoy natural advantages over others, such as endowments with natural resources or the presence of rivers or harbours. However, additional arguments have to be introduced in order to understand the advantages of concentration, which are unrelated to natural endowments. The new economic geography relies on the concept of “agglomeration economies”, i.e. economies arising from the interplay of transport costs¹, increasing returns to scale and factor mobility, in order to explain the clustering of firms, workers and consumers.

By introducing the concept of “circular causation”, i.e. the idea that dominance of regions is a self-reinforcing process, the new economic geography models try to explain how core-periphery patterns can arise endogenously. They help understand how historical accident² can shape economic geography, and how small changes can produce discontinuous changes in spatial structure.

From an economic policy point of view, it is very important to understand the processes underlying the location decisions of firms and their possible impact on industrial structures and the dispersion of industrial activities within a geographical area. The central idea is that the population and production patterns result from the interaction between centripetal forces (forward-backward linkages) and centrifugal forces (immobility of factors of production). The new economic geography can be useful to define the conditions under which a movement of firms toward the core can be expected and when this trend can reverse. The predominance of agglomeration forces could extend the imbalance between a core and a periphery and create spatial inequalities.

The geographic concentration of economic activity is a characteristic of the economic landscape. Agglomerations can be observed at different scales.

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1. In the new economic geography, as in international trade models, the term “transport costs” covers all sorts of costs that arise in international transactions apart from genuine transport costs: tariffs, quotas, and information costs due to national regulations, culture, language, etc.
 2. More generally, the idea that there is a “path dependency” and that “history matters” has been previously developed by David (1985) and Arthur (1989, 1994).

- At the broader scale, the new economic geography analyses the factors, which lead to the clustering of economic activities in regions such as the US "manufacturing belt" (area between Green Bay, Saint Louis, Baltimore and Portland) or the European manufacturing core, the so-called "Blue Banana" (area between South East England, Ruhr Valley, South East France, Southern Germany and Northern Italy). This deepening integration can lead to the strengthening of the core regions, attracting new production sectors, at the expense of the peripheral regions retaining only traditional activities.
- At the intermediate level, within particular countries, the existence of cities is treated as evidence of the role played by increasing returns to scale. The new economic geography examines whether the changes in the interaction of centripetal and centrifugal forces will tend to promote the development of metropolitan areas or foster their fragmentation.
- Small scale agglomerations are also observed through the existence of technological or industrial districts (Silicon Valley, the City in London, the North East Central Italy or "Third Italy"). These agglomerations result from a particular process of cumulative causation linked to the nature of development. In consequence, the location of particular industries often reflects the lock-in of transitory advantages.

The idea behind this working paper is to give some elements for an economic interpretation of urban phenomenon, referring to the main results of the New Economic Geography. Section II of the paper presents the main concepts used in the theoretical approach of the new economic geography. Section III describes the standard Core-Periphery model and its extensions. Section IV focuses on the growth of cities, discussing the complementarities between growth and location theories and looking at the role of information and communication technologies on the determinants of location decisions by firms.



The New Economic Geography: background and main features

A. The resurgence of geography

In the 1990s, the issues of space and location started to get increasing attention in the economic literature, aiming at explaining the spatial concentration of economic activity and regional growth disparities. This research was mainly initiated by the work of Krugman (1991a, 1991b), who contributed to the development of a general equilibrium approach to study geographic agglomeration, industrial clustering and the evolution of cities.

The framework proposed by the new economic geography (NEG) integrates various elements derived from traditional theory about the location of economic activity¹. However, the traditional theory said very little about the causes of agglomeration. The new economic geography proposes general equilibrium models in which the spatial distribution of economic activities can be explained by endogenous location decisions. The interactions between the different markets, between the firms and their suppliers and customers, the role of workers as production factors and consumers are the key elements of these models.

Regional economics and urban economics have already analysed the potential advantages from geographical concentration of economic activity. The centripetal forces favouring agglomeration of firms within industries have already been put forward by Marshall (1920) who distinguishes the advantages of having a large local market, a large labour pool and knowledge spillovers.

Harris (1954) and Pred (1966) studied the emergence of large regional concentration of economic activity, such as the “manufacturing belt” in America's northeast and inner Midwest. Harris (1954) emphasized the role of access to markets in the location of economic activities. He measured the market access of each region using a measure of “market potential” defined as a weighted sum of purchasing power across locations, with the weights for each location depending inversely on its distance. Harris concluded that the heavily industrialised regions of the United States were in general also locations with exceptionally high market potential. He also noted that the concentration of production was self-reinforcing. Pred (1966) was interested in the dynamics of regional growth and in the conditions for a regional economy to take off in a cumulative process of growth.

The advantages of concentration resulting from interactions between different sectors and many of the underlying ideas about cumulative causation through

1. For an overview of traditional theory (e.g. von Thünen, Weber, Christaller, Lösch), see Fujita et al. (1999).

forward and backward linkages were also familiar to development economics in the 1950s (Myrdal, 1957; Hirschman, 1958).

B. Increasing returns to scale

The reason why mainstream economic theory rediscovered economic geography only recently is mainly because increasing returns to scale, associated with indivisibilities in production, are crucial in the explanation of agglomerations. Under constant returns to scale, firms can locate anywhere. It is the presence of increasing returns that induce firms to concentrate operations in one location rather than in several locations in order to work more efficiently.

Therefore, a distinctive feature of the new economic geography is that it makes use of the analytical tools provided by industrial organisation theory and developed in the fields of international trade theory¹ and economic growth theory² in order to model increasing returns and imperfect competition³. The new economic geography draws heavily on a spatial Dixit-Stiglitz monopolistic competition model. The inclusion of transport costs and space requires a certain number of modelling devices, as will be described in the next section.

The key elements of the NEG models are the explicit consideration of space due to transport costs, the accounting for economies of scale, the microeconomic foundation of centripetal and centrifugal forces and pecuniary externalities, which are the endogenous outcome of market forces. Economies of scale and transport costs cause imperfect competition, which is captured by the Dixit-Stiglitz monopolistic competition approach.

The NEG considers that the geographic concentration of economic activity reflects the interaction between the presence of increasing returns to scale and transport costs. In such a world, increasing returns activities are predicted to locate in the larger market, giving rise to a “home-market effect”⁴. When transport costs matter, attractive locations for production of goods subject to economies of scale are those locations, which are close to markets (backward linkages) and suppliers of intermediate goods (forward linkages), other things being equal. Then, concentration of production in some location tends to attract the mobile factors of production. Workers have better job and consumption opportunities where production is concentrated. The resulting concentration of the labour force leads to more demand for consumption goods in that location, which makes the region more attractive for producers. Some centrifugal forces work against these centripetal forces. Concentration of population and economic activities in one region may drive land rents and housing prices up and lead to congestion and environmental problems. Moreover, as immobile factors remain in peripheral areas, firms from the centre may want to move there to supply these areas.

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1. See Helpman and Krugman (1985) for a survey of the “New International Economics”.
 2. The “New Growth Theory” goes back to the work of Romer (1986, 1990). See Barro and Sala-i-Martin (1995) for a survey of the literature.
 3. If increasing returns are external to firms (unit costs depend on the size of the industry), the tools of competitive analysis can still be used. If increasing returns are internal to firms (unit costs depend on the firm's size), the model has to introduce imperfect competition.
 4. The home-market effect, predicted by models of trade based on increasing returns to scale, is the tendency for large countries to be net exporters of goods with high transport costs and strong scale economies (Hanson, 1998).

C. Agglomeration economies

The new economic geography starts from the observation that economic activity is unevenly distributed across space. The concentration of economic activity can be only partly attributed to differences in underlying characteristics (geography, technology, endowments). In fact, a main explanation of the spatial concentration of firms and consumers/workers is related to the existence of externalities, the so-called 'agglomeration economies', which means that spatial concentration itself creates a favourable environment for the location of economic activity (Fujita et al., 1999), enhancing productivity and growth.

The new economic geography distinguishes between pecuniary and non-pecuniary externalities in reference to Scitovsky (1954), as mentioned by Fujita and Thisse (2002).

Pecuniary externalities refer to the effects of interactions mediated by markets. These interactions, which contribute to the formation of agglomeration economies, can be divided into two types:

- Interactions between firms and households: these externalities relate to employment or consumption of goods and services. The proximity between firms and households facilitates the matching process in terms of skills on the labour market and the access to a larger variety of goods and services.
- Interactions between firms: the proximity between firms facilitates forward-backward inter-industry and intra-industry linkages such as the access to a larger variety of intermediate goods and business services, as well as intra-firm relations between front office and back office.

Non-pecuniary externalities, such as “knowledge spillovers” (or technological externalities), refer to the effects of non-market interactions due to proximity. Non-pecuniary externalities are realised through processes directly affecting the utility of an individual or the production function of a firm. Non-pecuniary externalities are thought to be an important factor in the creation of agglomerations. But, by their nature, they are difficult to measure empirically. Such concepts as informational and technological externalities between firms, or in general informational exchanges between agents explain why households and firms want to cluster together. The reason for clustering is the fact that these externalities between firms are assumed to decline rapidly with distance. Knowledge spillovers are channelled through face-to-face communication and casual diffusion of information between firms. These non-market mechanisms matter most for small scale agglomerations.

In the literature (Duranton, 1997; Fujita and Thisse, 1996), another distinction is made between “location economies” associated to firms of a same sector (intra-industry externalities) and “urbanisation economies” associated to firms located in a same area (inter-industry externalities). Some authors have demonstrated the positive impact of a diversified sectoral environment on the results in terms of innovation (Audretsch and Feldman, 1999; Duranton and Puga, 2001).

D. Cumulative or circular causation mechanism

The new economic geography considers that the concentration of economic activity in a location creates a favourable economic environment that supports further concentration. The interaction of demand, increasing returns and transport costs creates a circular causation process. In the presence of increasing returns and transport costs, firms tend to agglomerate in a single place and to choose a location with a large local demand. But the presence of more firms in a single place then creates an incentive for other firms to locate in the same place. The location decisions of firms and consumers/workers form a self-reinforcing process.

The circular relationship, in which the location of demand determines the location of production, and vice-versa, can be a deeply conservative force. Circular causation reinforces small differences in the production structure and can differentiate similar markets into large and small. Locations with large population will tend to specialise in the production of goods for which scale economies, product differentiation and transport costs are significant. With a large home market, producers of highly differentiated products can potentially obtain enough local demand to exploit economies of scale. Locations with small home markets will tend to specialise in standard products, or products for which transport cost or scale economies are insignificant.

Ottaviano and Puga (1998) distinguish three kinds of cumulative mechanisms through which economic activities can agglomerate: (1) migration-induced demand linkages, (2) input-output cost and demand linkages, (3) endogenous growth, factor accumulation, and intertemporal linkages.

E. Centripetal and centrifugal forces

The spatial distribution of economic activity is very uneven. Many activities are highly concentrated geographically, although not in a single location. This is a consequence of the interaction between agglomeration forces and dispersion forces formalised in economic geography models.

The centripetal (agglomeration) forces, i.e. forces that pull economic activity towards existing locations of economic activity, have already been put forward by Marshall (1890). Following the exposition of Marshall's ideas in Krugman (1998b), and in Fujita and Thisse (2002), the firm faces three potential sources of centripetal forces:

- Backward and forward linkages: the large size of the local market creates both backward linkages (large markets are preferred locations for production of goods subject to economies of scale) and forward linkages (large markets support the local production of intermediate goods, lowering costs for downstream production).
- Pooling of skilled workers: the concentration of economic activity favours the availability of specialised labour skills.
- Externalities: the concentration of economic activity creates externalities, such as “knowledge spillovers” (technological spillovers), i.e. an improvement of the diffusion of information due to proximity (face-to-face contacts).

Empirical studies tend to show that the effects of knowledge spillovers and the availability of specialised labour skills are more relevant for explaining small scale agglomeration (e.g. Silicon Valley, the City of London), while the effects of forward and backward linkages are more relevant for large scale agglomeration (e.g. pattern of location in Europe).

Besides agglomeration forces, the presence of dispersion forces explains the existence of various concentration places. The centrifugal forces, i.e. forces that push economic activity away from existing centres, are due to the existence of transport costs in the face of immobile factors (land, natural resources, agricultural workers and consumers), and negative externalities. In a survey of the literature, Ottaviano and Puga (1998) mention models with congestion externalities, according to which high concentration produces a rise in the price of immobile local factors (land rents and wages) and goods, which can induce dispersion effects.

Competition between firms can also represent a dispersion force (Duranton, 1997). There is a trade off between a location in proximity of consumers at the price of a higher degree of competition and a location more distant from the centre in order to benefit from a lesser degree of competition, at the cost of losing access to a large concentrated market

TABLE 1 - Forces affecting geographical concentration

Centripetal forces	Centrifugal forces
Market-size effects (backward-forward linkages)	Immobile factors
Thick labour market (availability of specialised labour skills)	Land rents
Pure external economies	Pure external diseconomies

Source: Krugman (1998b).

In the real world, all these centripetal and centrifugal forces affecting geographical concentration are at work. Theories, however, tend to focus on a limited set of forces. If the aim of empirical work is to understand better why economic activity tends to concentrate geographically, a distinction has to be made between competing theories that highlight the different mechanisms through which scale economies contribute to agglomeration.

The simple model developed in Krugman (1991a, 1991b) suggests that agglomeration is the result of demand linkages between firms, which are created by the interaction of transport costs and fixed costs in production. Scale economies are internal to the firm. The presence of immobile factors acts as an opposite dispersion force. Other models introduce scale economies in producing non-traded intermediate inputs (Rivera-Batiz, 1988) or vertical stages of production, in which firms produce both consumer and industrial goods (Venables, 1996). In these models, cost and demand linkages between industries (inter-industry interactions) foster agglomeration. Alternative models suggest that agglomeration economies are the result of positive spillovers between firms in the same location (intra-industry interactions), i.e. location-specific externalities (Henderson, 1974). Scale economies are external to the firm. The source of these intra-industry externalities is not specified. However, following Marshall (1920), agglomeration occurs because the proximity of firms in one same industry facilitates learning and the exchange of ideas.

In a dynamic model of city formation, Black and Henderson (1999) combine location-specific industry externalities with location-specific human-capital externalities according to which the accumulation of human capital generates positive spillovers (Lucas 1988), so that the concentration of labour in a given location makes all local workers, regardless of industry, more productive. Congestion costs associated with the limited local availability of housing or other non-traded goods or factors act as a centrifugal force. As cities develop, the price of housing increases in urban areas relative to peripheral areas. To attract workers to cities, firms must compensate them for the relatively high costs of urban living and commuting. The higher productivity of labour in agglomerated regions justifies these higher wages. If agglomeration economies are sufficiently strong, most production occurs in industry clusters where wages and housing prices are relatively high.



The Core-Periphery model

Economic geography models rely on the interaction of increasing returns to scale (imperfect competition), transport costs, and factors mobility. The NEG models use a common set of tools involving the Dixit-Stiglitz monopolistic competition framework and the so-called “iceberg” transport costs (see *infra*). These particular tools are considered the best available for dealing with increasing returns, transport costs and backward-forward linkages in an analytically tractable general equilibrium framework.

A. The spatial impossibility theorem

The spatial impossibility theorem of Starrett (1978) tells that: if space is homogeneous and transport is costly, there does not exist any competitive equilibrium with trade between distant locations (Ottaviano and Thisse, 2001). A model with mobile agents on a closed, homogeneous space, facing a production technology with constant returns to scale (no indivisibility), can never explain the occurrence of agglomerations. In such a framework, economic activity will disperse without any countervailing force, because dividing up production over many locations leads to no loss in efficiency. With the removal of constant returns to scale, the assumption of imperfect competition is needed to capture the main source of agglomeration: indivisibility.

B. The modelling tools

1. Dixit-Stiglitz monopolistic competition framework

The monopolistic competition model presented by Dixit and Stiglitz (1977) can be used to circumvent the problems deriving from the introduction of market structures consistent with the presence of increasing returns to scale. This model, known for its applications to a new class of growth and trade theories, is based on a convenient assumption on market structure (monopolistic competition) to avoid the problems due to price-taking behaviour in the presence of increasing returns to scale. The model also disregards the complex mechanisms of strategic interactions, as firms ignore the effects of their actions on prices and income.

The Dixit-Stiglitz model uses specific functional forms for consumer preferences allowing for a 'preference for variety'. This means that the utility of a consumer will be positively related to the number of goods available. To completely eliminate every producer's market power, it is often assumed that the range of goods

is continuous, and each producer is infinitely small. With full competition, the good is assumed to be homogeneous, and its price the only criterion of selection. With monopolistic competition, consumers discern different varieties, and products from different producers are imperfect substitutes. Even if each individual producer faces increasing returns to scale in production, the largest producer is not always able to eliminate smaller competitors because substitution between products is limited.

According to Quigley (1998), the NEG models based on the Dixit-Stiglitz approach can be particularly useful in the context of urban economics, to explain why diversity in consumer goods and in production inputs can produce external scale economies. The intuition behind this result is that the size of the city and its labour market will determine the number of specialised local goods and producer inputs given the degree of substitutability among these goods and among these inputs. A larger city will have a greater variety of these goods and inputs and this greater variety increases utility and output. On the consumption side, greater differentiation among goods means that variety has greater effect on utility. On the production side of the economy, in a similar way, output will be related to the number of inputs available. Greater differentiation among inputs means that variety has greater effect on output. Thus, larger cities will offer a broader range of products and the well-being of their inhabitants will increase with size, up to a certain limit.

2. Transport costs

Economic geography models involve the assumption of iceberg-type transport costs. This assumption first introduced by Samuelson (1954) in international trade means that a fraction of any good shipped simply “melts away” in transit - usually at a constant rate per distance covered. So, transport costs are incurred in the good itself and one needs not model the price of transport separately.

C. The standard Core-Periphery model¹

The basic model provided by Krugman (1991a, 1991b) combines a monopolistic competition model and pecuniary externalities associated with forward-backward linkages to show how large-scale agglomerations can emerge. Fundamental for the emergence of industrial concentration are economies of scale due to which the profit maximising manufacturing firms only locate in one region. Under certain assumptions backward and forward linkages promote a self-reinforcing industrial concentration process. The driving force behind this is the mobility of workers and firms, which locate where the market is relatively large. The immobility of the farmers acts in the opposite direction. Therefore, the spatial equilibrium structure, which results from the relative weight of the centripetal and centrifugal forces, crucially depends on the level of the transport costs, the manufactures' share of total expenditure and the elasticity of substitution among the differentiated manufacturing goods.

1. The following model is the version of the core-periphery model of New Economic Geography presented in Fujita M., Krugman P., Venables A. (1999). For convenience the same notation as in the book is used.

1. Assumptions

The model considers two regions and two sectors. Agriculture tied to land is perfectly competitive and produces a homogeneous good under constant returns to scale. The total quantity is C_A . Manufacturing that can be located in either region is monopolistically competitive and produces differentiated products ($i = 1, \dots, I$) under increasing returns to scale.

Aggregate utility from consuming both types of goods is a Cobb-Douglas function of agricultural product and of a CES sub-utility function derived from consuming manufactures.

$$(1) U(C_A, C_M) = C_M^\mu C_A^{1-\mu}$$

where $\mu \in [0, 1]$

Let “ c_i ” be the quantity consumed of manufactured product i . The utility of the consumer derived from (c_1, \dots, c_I) is given by a CES function that captures symmetry and preference for variety.

$$(2) C_M = \left[\sum_{i=1}^I c_i^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}$$

where $\sigma > 1$

With this specification of utility, it results from the household's maximisation problem that the share of consumer expenditures devoted to manufacturing goods in household equilibrium is μ and the elasticity of substitution between different manufactured products is constant (σ).

There is a single production factor in the economy, but each sector uses a specific type of labour: farmers in agriculture, workers in manufacturing. The supply of labour is given exogenously. To simplify, the model assumes that the share of manufacturing workers in the population equals μ , the share of manufacturing in consumer expenditures.

Consumers maximize their utility given their budget constraint. There is free entry for firms and firms maximize profits.

2. Conditions for agglomeration

The economy consists of two regions. The scope of the model is to show how manufacturing is distributed across regions and under what conditions the entire manufacturing population will concentrate in one region.

Krugman supposes first that both types of labour are immobile, so that the distribution of workers and farmers across regions is fixed. The transport costs for manufactured goods between regions are introduced in the model by iceberg transport costs. This means that of any unit of the good transported from a region to the other one, only $1-\tau$ units arrive at the destination, with the parameter τ a positive constant between 0 and 1. The model assumes that transport costs for agricultural goods are non-existent.

Several intermediate results, given this set-up, are worth noting (Schmutzler, 1999). First, producers are usually assumed to face a fixed cost “F” and a variable cost “a” per item produced. As the fixed cost per product declines with total production, they are subject to an increasing returns technology. However, because of the downward sloping consumer demand, output cannot grow indefinitely. Instead, producers maximize profits by setting marginal benefit equal to “a”. Facing demand generated by the utility function (1), this pricing strategy results in a constant mark-up over marginal costs. Second, because of increasing returns to scale, each firm produces only one product. Third, free entry sets pure profits equal to zero. Fourth, each firm produces at the same output level in equilibrium.

The equilibrium output of each firm is a positive function of the fixed costs and the elasticity of substitution, and a negative function of the marginal costs. The number of firms in a region is a positive function of its manufacturing labour supply, and a negative function of both fixed and marginal costs.

Then, Krugman introduces labour mobility in the model and analyses the confrontation of centripetal and centrifugal forces. While agricultural labour continues to be immobile, manufacturing population moves towards the region that offers the higher present real wage. In equilibrium, both regions must either offer the same manufacturing wage or the manufacturing population will be concentrated in the region offering the higher real wage. Such a concentration of the entire manufacturing activity in one location in equilibrium can only occur if no firm has an incentive to locate at the periphery. With transport costs, it is convenient for workers to stay in the centre because the cost of living is higher in the periphery, since most consumption goods have to be imported from the centre. It is also cheaper for firms to serve from the centre the majority of customers living in the centre. But, it is cheaper to serve the agricultural population in the periphery if firms produce in the periphery. An agglomeration equilibrium results when this latter centrifugal effect is small relative to the other two centripetal effects.

In this model, agglomeration depends on the level of transport costs, the size of the manufacturing sector and the consumer preference for variety. Reasonably high transport costs are a condition for agglomeration, so that serving the periphery from the centre is a feasible alternative to local production. The size of the manufacturing sector reinforces agglomeration since the wage premium necessary to compensate workers in the periphery will increase, since a large quantity of goods has to be delivered from the centre. The preference for variety also matters, because a small elasticity of substitution goes along with high economies of scale, which favours firms’ location in the centre.

An interesting feature of the model is that minor initial differences between regions may lead to a core-periphery structure. So “history matters” (Arthur, 1989). Supposing that region 1 has a slightly larger share of agricultural population, Krugman investigates how transport costs influence the distribution of manufacturing between the two regions. With relatively high transport costs, an equilibrium will emerge such that both regions have some manufacturing, but region 1 has a higher manufacturing share than region 2. The larger market is more attractive. As transport costs come down it is worth moving to the larger market to ship products out to region 2. At some point, a new equilibrium emerges where all manufacturing is concentrated in region 1. The advantages of concentrating production dominate the advantage of being close to the market.

D. The extensions of the Core-Periphery model

The core model developed by Krugman (1991a, 1991b) is in general not suited for empirical validation. The main reason is that for an intermediate range of trade costs it produces only one location with manufacturing economic activity. This result does not correspond, obviously, to the facts about the spatial distribution of manufacturing activity in the US or in Europe. Moreover, the core model lacks some of the spatial characteristics of agglomerations, which have been found to be very relevant empirically, such as the tendency of prices of local goods to be higher in agglomerations.

Krugman and other authors modified the prototype NEG model in various respects. In some model extensions, different factors in favour of industrial dispersion like non-tradable goods and congestion costs are introduced. But also elements reinforcing industrial clustering, such as vertical linkages between industries, are considered. But neither the fundamental structure of the basic model nor its key mechanisms are modified by those extensions. A common feature of most of the model extensions is that they do not deliver analytical solutions and exhibit multiple equilibria. In general, numerical examples illustrate the model mechanisms. They contribute to support that the new economic geography provides general and robust insights about the interactions of various forces and their impact on the geographical distribution of economic activities.

Krugman and Venables (1995) present a model in which they assume, in contrast with Krugman (1991a, 1991b), no inter-regional labour mobility. In consequence, when a sector expands the labour supply must come from other sectors in that region. Cumulative causation and the emergence of agglomeration in this model come from input-output linkages between firms, which are now assumed to use each others’ outputs as its inputs. In this model, firms benefit from being close to each other by avoiding transport costs on factors of production. This model produces two types of equilibria. For high trade costs of manufactures, a symmetric equilibrium, and for low trade costs a core-periphery solution. For intermediate transport costs, asymmetric but unstable equilibria are possible (Fujita, Krugman and Venables, 1999).

Krugman and Venables (1996) extend this model by assuming two manufacturing sectors, each of which trades more with firms in the same sector than with firms of the other sectors. Complete agglomeration is less likely, because reduced costs and demand linkages benefit to firms in the same sector while

competition in product and labour markets applies to all firms in all sectors equally. For low trade costs, this leads regions to specialise in one sector only.

An extension of this Krugman-Venables model consists in introducing an additional dispersion force into the model, assuming increasing-returns to scale in agriculture (Puga, 1999; Fujita, Krugman and Venables, 1999). In this model, agglomeration raises wages in the core region, making it attractive for firms to relocate to a peripheral region where labour costs are lower. The result is a *W*-type relationship between the share of industry in each region and trade costs. For high trade costs, there is equal distribution of industrial activity, for intermediate levels of trade costs full as well as partial agglomeration results, and for low trade costs there is a return to equal distribution of industrial activity.

Given the observation that full agglomeration is not in accordance with the facts, geographical economics models based on forward and backward linkages and with no interregional labor mobility (Venables, 1996; Krugman and Venables, 1996; Puga, 1999) seem therefore useful models for empirical testing. Unfortunately, direct testing of this class of NEG models is rather problematic because it requires detailed information on input-output linkages between firms on a regional level. The model developed by Helpman (1998), with its empirical applications by Hanson (1998, 1999) is a useful alternative for empirical research. It combines elements of the core model such as demand linkages with the introduction of a non-tradable consumption good (i.e housing). The price of housing, which increases with agglomeration, acts as a dispersion force in this model, in the same way as the rising wages in the previous model (Puga, 1999). In fact, it is shown that both models produce similar results in terms of equilibrium outcomes.



Cities and economic growth

The share of population living in cities has tended to increase over the long period. Predicting the evolution of cities requires a framework for understanding the costs and the benefits of urban areas. This section examines what can be said about the agglomeration forces and the dispersion forces in order to assess how changes in these forces will affect the growth of cities.

A. Economic growth and agglomeration

According to the neoclassical growth theory, economic growth was understood as the accumulation of physical capital (Solow, 1956). The inequality between regions was explained by an unequal distribution of physical capital. This view has been challenged by the endogenous growth theory, where total factor productivity (TFP) is considered the engine of economic growth. These new theories relate growth to increasing returns and to technological progress (e.g. Romer, 1986 and 1990; Grossman and Helpman, 1991; Aghion and Howitt, 1998).

Aggregate output Y can be derived by the following production function (Quah, 2001):

$$(1) Y = F(K, AN)$$

where F is increasing and concave, K denotes the stock of physical capital, N denotes the quantity of labour employed, and A the residual factor.

In the endogenous growth theory, A can be interpreted as the level of technology. It is the total factor productivity (TFP)¹.

Writing $y = Y/N$ for labour productivity or output per worker and $k = K/N$ for the capital-worker ratio, and assuming that F satisfies constant returns to scale, equation (1) implies:

$$(2) \dot{y}/y = (1 - s_K)(\dot{A}/A) + s_K(\dot{k}/k) ,$$

$$\text{where } s_K = K \left(\frac{F_K}{F} \right), \text{ and } F_K = \frac{\partial F}{\partial K}$$

1. This view is opposed to the Solow interpretation of A as a mere residual from econometrically fitting the production function, given Y , K , and N .

With competitive markets, the term s_K is physical capital's income share. Equation (2) decomposes growth in output per worker into contributions due to technology and to physical capital. While attention first focused on the contribution of physical capital (second term on the right of (2)), more recent research (Lucas, 1988; Romer, 1994) suggests that the A term is crucial for understanding economic growth.

The new economic growth theories suggest that TFP reflects increasing returns and/or technological progress, i.e. the outcomes of science and research and development (e.g. Aghion and Howitt, 1998; Grossman and Helpman, 1991; Romer, 1986, 1990). Both explanations can be distinguished. However, most researchers follow Romer (1990) and suppose that technological change evolves endogenously due to research and development, an economic activity that involves increasing returns (Quah, 2001). With increasing returns, economic activity can display technological lock-in (David, 1985; Arthur, 1989). Thus, once a technology establishes a benchmark, it tends to last even if preferable alternative technologies become available, because the economic agents find it unprofitable to switch to other technologies.

Interestingly, this reasoning is similar to that followed in the new economic geography, as explained in the previous sections. Krugman (1991a and 1991b) emphasizes the role of increasing returns to explain regional specialisation in specific industries, the evolution of cities and geographical agglomeration. Historical accident can bring a specific industry to a particular location. Then, this industry will find it advantageous to cluster there due to increasing returns to scale and to forces such as technological lock-in.

B. Growth in cities

Some theories of city growth stress the role of dynamic externalities, particularly knowledge spillovers (Glaeser et al., 1992; Black and Henderson, 1999b), therefore converging with the new theory of economic growth, which considers externalities as the engine of growth. Such models argue that the concentration of firms and workers in cities provide an environment in which the free flow of ideas is facilitated. The interactions between people in cities encourage learning and innovation, which create externalities for firms. This occurs because innovations and improvements in one firm improve the productivity of other firms without full compensation. Geographical proximity is a condition of face-to-face communication, which makes externalities particularly large in cities. Therefore, knowledge spillovers might explain why cities survive despite high rents.

1. Knowledge spillovers

Various theories have been proposed to explain the role of knowledge spillovers for city growth. They differ in whether knowledge spillovers come from within the same industry or from other industries, and how local competition affects these externalities with respect to growth.

The first hypothesis, originally developed by Marshall (1890) and later formalized by Arrow (1962) and Romer (1986) (MAR), emphasizes spillovers between

firms in the same industry. This means that the concentration of an industry in a city facilitates knowledge spillovers that arise, for example, through the dissemination of ideas and the movement of skilled labour among neighbouring firms. These spillovers are thought to be most important when local competition is weak. Innovation and growth are encouraged when rents associated with sector-specific knowledge can be internalised.

The second hypothesis, developed by Porter (1990), also argues that knowledge spillovers in a geographically concentrated industry are most important, but insists that their effects on growth are enhanced by strong local competition, which forces firms to innovate in order to survive.

The third hypothesis, developed by Jacobs (1969), emphasizes knowledge spillovers across industries, occurring through the “cross-fertilization of ideas”. Diversity of geographically agglomerated industries promotes innovation and growth in cities. Like Porter, Jacobs supports the view that these externalities are most effective in an environment of strong local competition.

TABLE 2 - Factors favouring knowledge spillovers

Theories	Specialisation vs diversification	Monopoly vs local competition
MAR	Specialisation	Monopoly
Porter	Specialisation	Local competition
Jacobs	Diversification	Local competition

2. Agglomeration forces and congestion forces in cities

The attractiveness of cities can be seen in the quantity of people living in urban areas. It is also reflected by the wage premium paid to workers in those areas. Higher wages in cities can indicate a higher productivity of workers, but this should not underestimate the benefits created by agglomeration.

According to Glaeser (1998), several factors explain why firms are willing to pay to locate in cities. These factors are linked to reduced transport costs for goods, people and ideas.

- Transport costs and increasing returns of some sort play a major role in urban and regional economics to explain cities and locational choices. But while transport costs for goods continue to matter, they have become much less important. There is the relative decline of traditional manufacturing characterised by fixed setup costs and high transport costs and the corresponding rise of services. Transport costs have also declined.
- Another important benefit of cities comes from the elimination of distance between people. The advantage of labour market pooling is to facilitate the access of producers to skilled workers, to improve the division of labour, and to insure workers against firm- or industry-specific shocks.
- The geographical proximity can also enhance the diffusion of ideas across firms by the movement of workers across firms and the exchange of ideas in both formal and informal settings. Urban density also encourages learning

through the interactions between people, which can accelerate human capital accumulation.

While cities are growing, the benefits of agglomeration can, at some point, be overwhelmed by the congestion effects. They include the costs of living, pollution and social problems.

- The costs of living include housing and commuting costs. There is no question that houses in cities cost more and there is a correlation between commuting costs and the city size. These costs are likely to remain despite improvements in building technology and transports.
- The evolution of pollution costs associated with cities could be tempered through better emissions controls, changes in transport technology and the decline of manufacturing industry in cities.
- Cities attract the poor because they have a better access to transport infrastructure and a series of public goods. Basic urban theory implies that the rich leave cities because they have a greater demand for space, which is cheaper outside of cities. Government action is therefore needed to encourage diversified urban areas and attenuate social problems in cities.

3. Optimal degree of concentration

There may well be an optimal degree of concentration, according to Henderson (2000), which should neither be too small relative to the efficient size to reap the benefits from agglomeration, nor too large to avoid the problems of large cities such as high commuting, congestion and living costs, and low quality of urban services.

This optimal degree of concentration is also linked to the degree of economic development. At an early stage of economic development, it is rather efficient to have spatially concentrated infrastructure in order to enhance information spillovers and knowledge accumulation. As development proceeds, a greater dispersion of economic activity eventually becomes efficient, because it is possible to spread infrastructure and knowledge resources to the periphery and because congestion locations are less efficient for producers and consumers. Deconcentration occurs by manufacturing moving first from the core cities to nearby cities and then to hinterland cities, where wage and land costs are lower.

Oversized cities, which lead to efficiency losses and a reduction of the urban quality of life, can result from imperfectly working land markets and social marginal costs of increasing city size exceeding marginal benefits. Political institutions can also encourage oversized cities. This result comes from the tendency of national government to invest less in inter-regional infrastructure, so that firms are encouraged to locate in large cities, especially in the national capitals, rather than in the hinterland.

C. ICT in growth and agglomeration

1. Some features of ICT

According to Quah (2001), ICT significantly displays the same features that induce both growth and agglomeration, i.e. increasing returns and knowledge spillovers. On the one hand, ICT is an example of extensive technological progress and represents a factor contributing directly to economic growth. On the other hand, ICT is mainly an industry with increasing returns¹. Therefore, agglomeration and lock-in will characterise ICT while, at the same time, ICT contributes to overall economic growth.

However, ICT has also two important specificities. First, various ICT products are not affected by distance. Their trade implies no transport costs. So, why should ICT industry concentrate geographically. ICT clusters have to be explained². A related question is whether the co-location of diverse industries or the specialisation on a narrow set of activities has the greatest impact on innovation and growth. Second, ICT products are non rival, a characteristic generally displayed by intangible assets. But, ICT products are widely used by consumers directly and they are protected by copyright rather than patents.

2. “The death of distance”

A frequently asked question is about the impact of ICT on the balance between centripetal and centrifugal forces underlying the location of economic activities. Some agglomeration forces are to be weakened by ICT, while other agglomeration forces are likely to be unaffected by new technology.

New technologies will have a mixed effect on the cost of distance (Venables, 2001). transport costs via internet are zero. But, only some activities that can be codified and digitised will be appropriate to distance supply. Thus, some activities will no longer need to be close to consumers and will be in search of lower cost locations. Airline ticketing services, back-room operations of banks and call centres are well-known examples of such activities. As internet and telecommunications infrastructures expand, workers will no longer have to be together to communicate. However, communication in specific matters is better achieved face-to-face. In consequence, knowledge spillovers that firms derive from proximity to other firms will remain important. For many activities, the access to skilled labour and to local networks of specialised suppliers will continue to explain the propensity of economic activity to cluster. The persistence of locations such as Silicon Valley³ reflects not just the specificities of ICT, but the high-skilled nature of that industry.

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1. Quah (2001) distinguishes different parts in the ICT industry and he is well aware that increasing returns are more obvious in certain parts than in others. For example, in the computer industry including software, hardware and services, it is in the software part that increasing returns are mostly expected.
 2. The distinction between ICT industry and ICT products can be part of the explanation. While many ICT products may no longer be affected by distance, it is not necessarily the case for ICT industry.
 3. The activities located in the Silicon Valley are intensive in research and development.

Therefore, the economic landscape will become only progressively less agglomerated as a consequence of the introduction of ICT. Some activities, which are intensive in knowledge, such as research and development, and requiring face-to-face communication will remain geographically concentrated. Other activities less dependent on this kind of communication will be able to relocate to a small number of places.



Conclusion

The main contribution of the “new economic geography” is to explain the cumulative causation process leading to agglomeration in a theoretical framework with solid micro foundations, thereby giving behavioural underpinnings to the insights of previous location theory and regional science. However, no model focusing on a single cause can really capture the complexities of any problem. While Krugman (1991a,1991b) emphasises the role of pecuniary externalities, alternative theories explaining the relevance of location in various issues contest this option. Empirical studies tend to show that knowledge spillovers and the availability of specialised labour skills may well prove to be the determining forces behind small scale agglomeration (Audretsch and Feldman, 1996), while forward-backward linkages are more relevant for patterns of regional location in Europe.

A common objection to the new economic geography is that mathematical formalism leads to a number of simplifying assumptions. In fact, while economic geographers prefer to build bottom-up explanations, most economists prefer using explicit models. Krugman argues that the mechanisms described in the new economic geography are generally consistent with empirical observation. But, according to Neary (2001), no serious attempts are made to compare explanations related to agglomeration with other possible explanations. Moreover, omitting strategic considerations, the new economic geography models based on the Dixit-Stiglitz monopolistic competition approach miss an important aspect of reality developed in games theory.

The empirical research is still at an early stage to draw policy conclusion. However, the availability of new data sets has encouraged the development of a growing body of empirical literature directly based on new economic geography. In Europe, the new economic geography coincided with the debate on the effects of EU deepening through greater economic and monetary integration and the effects of EU widening through enlargement. Thus, the new economic geography served particularly as a conceptual framework for European regional policies since it offered explanations as to why regional integration, by reducing transaction costs, could lead to self-sustaining inequality. However, with its emphasis on the positive effects of local spillovers and on economies of scale, this framework also implies that there are positive effects from agglomeration and hence from regional differences. Martin (1999) shows the existence of a trade-off between equity and efficiency at the spatial level. If economies of scale and localised spillovers explain the self-sustaining agglomeration process, then agglomeration must have some positive efficiency effects. And, because infrastructure financed by regional policies have an impact on transaction costs and therefore on the location decision of firms, the long-term effect of certain regional policies may be sub-optimal in terms of efficiency and growth.

There is also empirical research about the relation between urban concentration and economic growth (Henderson, 2000). This literature shows that urban concentration in many countries appears to be excessive, which is an obstacle to economic growth. It argues that investment in inter-regional transport infrastructure is a key policy instrument to reduce concentration and promote economic growth.



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