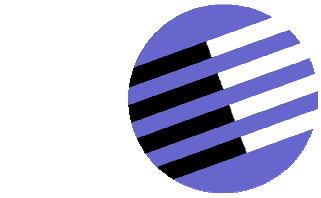

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# Trade, growth and geography: A synthetic approach

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# Trade, growth and geography: A synthetic approach

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**Abstract**

Economic integration affects economic development through two main channels : growth and localization of the economic activities. The theories of endogenous growth and economic geography enable us to understand these mechanisms. We study in this paper their similarities and specificities before suggesting their useful combination within a single model. Indeed, both theories are based on the same Spence-Dixit-Stiglitz monopolistic competition framework. However, they suggest two different approaches to deal with the impact of economic integration. We consider that a third path, by proposing a synthetic approach, better answers the issues raised in terms of economic convergence and divergence by these two sets of models.

*Keywords*: regional economic integration, endogenous growth, economic geography

*JEL classification*: F12, F15, F43, O18, O30, O41, R11, R12, R13

## 1 Introduction

The question that new growth and new geography theories are trying to answer is the following : How (new growth) and where (new geography) new goods and new firms are created ? Our answer goes through the construction of a model of synthesis between new growth and new geography theories to answer the how and where since the two are connected and interdependent. Our objective is indeed to show that the combination of growth and geography theories allows us to better understand the linkages between growth and location.

Indeed, a clear geographical dimension is present in growth theories through spillovers and likewise a growth dimension is present in geography theories through ad hoc dynamics (comparative static). As a result, it appears that

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economic concentration explains growth through the innovation and production process. Not only are the questions connected, the assumptions are also similar (Section 2). However, there still remains some clear specificities for both sets of theories (Section 3) that allow us to propose a synthetic framework (Section 4).

# 2 The similarities between new geography and new growth theories

New trade, new growth and new geography theories all rely on a common framework based on economies of scale and monopolistic competition. The existence of increasing returns to scale (IRS) and imperfect competition seems to be a rather realistic view of the structure of many industries and play a major role in the explanation of trade, location and the creation of knowledge. For instance, trade between similar countries can be explained if we allow for country-specific economies of scale, since these can foster specialization (even if countries have identical relative factor endowments). (IRS) also explain intra-industry trade (Helpman and Krugman, 1985). Moreover, the possibility of profiting from imperfect competition to invent new goods and the existence of public good features for knowledge contribute to explain economic growth.

As soon as we introduce positive externalities in trade, we have to depart from the traditional trade theory and rely on models allowing scale economies to trade in differentiated goods. Not until scale economies and imperfect competition had been incorporated into static theory could dynamic theories of the relationship between trade and technology evolve. Since externalities emerge as a consequence of market interactions involving economies of scale at the level of the individual firm, thus we must model an imperfectly competitive market structure : the workhorse is the Dixit-Stiglitz (1977) model of monopolistic competition and the particular formalization of Ethier (1982). Basically, this framework shows that the more differentiation, the more varieties, the more intense the specialization into a set of varieties, the more IRS (Section 2.1).

In a dynamic setting, the impact of external effects and of capital accumulation and the existence of differentiated goods in presence of economic integration has been analyzed by Rivera-Batiz and Romer (1991a and 1991b) and Grossman and Helpman (1991a and 1991b) combining new trade and new growth theories. These authors show that since most of the costs of developing a new technology occur before production begins and do not vary with the intended scale of output, innovation normally gives rise to dynamic scale economies. And since firms typically cover the costs of their up-front investments by exploiting market power generated by their inventions, innovation gives rise to imperfect competition (Section 2.2).

## 2.1 Increasing returns to scale

IRS [1] provide an interesting mechanism linking integration and growth. Indeed, trade openness, by increasing the size of the market for the producers, leads to greater specialization and - in the average - to a higher scale of production. The trade literature suggests then that trade is beneficial if it brings an expansion of the IRS sector. For instance, we expect that the smaller the country, the more it gains from trade due to international economies of scale. Ohlin (1933) had already recognized the complementary effect of IRS to differences in factor endowments in explaining trade. Another approach, relying more on dynamic economics, considers that trade in intermediate inputs raises both the level and rate of economic growth. In both sets of theories, free-trade fosters growth.

There are two main types of externalities. With external economies of scale, the doubling of the production factors by one firm doubles its production, but the doubling of the production factors by all the firms more than double the global production (Section 2.1.1). With internal economies of scale, the doubling of the production factors by one firm more than double its production (Section 2.1.2).

### 2.1.1 External economies of scale

There could be external economies of scale resulting from the inability of firms to appropriate knowledge completely. Here, the question of the diffusion of knowledge and of its extent is crucial. If we accept that goods contain ideas and that these ideas can be decrypted by importers, then diffusion can become international even in the case of private knowledge. Indeed, most of the sources of the economies of scale (and of imperfect competition) will depend on a dynamic process implying knowledge diffusion. The introduction of knowledge in the framework points towards dynamic models. Indeed, in Helpman-Krugman (1985), the wish to bring the analysis of trade at the dynamic level is mentioned and will be completed by Grossman-Helpman (1991a). Even if we keep the external economies of scale without considering the role of internal economies, we still need to determine the scope of these economies : national or international. As Ethier (1979) pointed out, if these scale economies arise in the production of intermediate goods that are tradable, then these economies apply also at the international level.

### 2.1.2 Internal economies of scale

When IRS are occurring at the firm level, a larger firm can take advantage of more specialization to become more efficient. Moreover, some costs are independent of the scale of production and will thus fall per unit as production increases. The persistence of internal economies of scale is then inconsistent with competitive equilibria. With IRS, marginal cost pricing implies losses since price-taking

[1] Pecuniary externalities describe benefits from interactions through market transactions whereas technological externalities deal with the effects of interactions outside the market (e.g. information flows) that appear in an invisible fashion.

behavior is inconsistent with non-negative profits and thus market cannot be perfectly competitive. Therefore, IRS require a market structure that allows for prices above marginal cost. Internal scale economies must involve imperfectly competitive markets where monopoly profits may be earned by firms unless they are eliminated by entry.

Likewise, technical change is not easily modelled in the traditional neoclassical framework due to its incompatibility with the usual hypothesis of perfect competition. Technical change assumes new ideas, whose exclusivity is only partial, and that possess some features of public goods. This is however correct to assume that the traditional factors such as capital and labor display CRS since they are exclusive (divisible). However, when we consider ideas as factors of production, returns to scale tend to be increasing. The problem is that IRS contradict perfect competition. Due to the invention of new ideas, older ideas are thus replaced because of their obsolescence and their value becomes nil (as their marginal cost of production). Then, there is no incentive to pursue research and create new ideas. Monopolistic competition will provide the necessary incentives.

## 2.2 Monopolistic competition

The monopolistic competition model considers that there are sectors consisting of many products produced with the same production function. In a sector whose product is differentiated and where each variety is produced with IRS (these are relatively small so that the industry can accommodate many producers, each one producing a different variety) intraindustry trade is possible [2]. Then, following Chamberlin (1933), it is natural to expect in this industry a market structure known as monopolistic competition where every firm chooses a variety and its pricing so as to maximize profits, taking as given the variety of choice and pricing strategy of the other producers in the industry. In this case, every firm ends up producing a different variety of the product. We will see in more details how monopolistic competition is built in the Spence-Dixit-Stiglitz framework (Section 2.2.1) and then, adapted to a growth setting, in the Romer-Grossman-Helpman framework (Section 2.2.2).

### 2.2.1 Spence-Dixit-Stiglitz modelling

Spence (1976) and Dixit and Stiglitz (1977) developed a formalization of Chamberlin's concept of monopolistic competition, becoming the most used model of competition in the presence of IRS, first in new trade, then in new growth and finally in new geography, implying that these three theories are, in terms of their market structure, indeed very closely related. When preferences are of the Spence-Dixit-Stiglitz type, a single producer competes equally with every other

[2] Indeed, comparative advantage drives specialization at the aggregative, sectorial international level but economies of scale cause specialization at the level of individual products. So we have the Heckscher-Ohlin interindustry specialization and a scale economy intraindustry trade.

producer, and he derives the same profit level for any variety choice that is not supplied by others. If he were to choose a variety that is already supplied by another firm, he would have to share the market for this variety, thereby ending up with profits lower than those he could attain by adopting some other variety. Therefore, no variety will be produced by more than one firm.

If there are no impediments to entry and exit in the differentiated goods sector, then the number of firms is endogenously determined. If the number of firms is large enough, then we expect entry and exit to lead to zero profits (at the aggregate). In this case, the degree of monopoly power equals the degree of economies of scale [3]. Ethier (1979, 1982) has insisted that, when dealing with product differentiation at the international level, we shall rather consider the case of intermediates than the one of final goods. The taste for variety and the range for specialization would in that case be even more fundamental for intermediates than for final goods. The main restriction being the tradable features of these intermediates.

Dixit-Stiglitz's model assumes that many differentiated goods enter perfectly symmetrically into demand; the individual utility function takes a rather particular form (CES) [4]. However, it offers a way to respect the effects of IRS at the level of the firm, is readily suitable for an analysis in terms of general equilibrium and thanks to its use of a large number of firms in a continuum space (there is a very large number of potential manufactured goods, so many that the product space can be represented as continuous, enabling us to side-step integer constraints on the number of goods), we can respect the integer nature of individual choices under IRS (each good is typically produced in only one location) while representing the aggregate of such choices with continuous variables (such as the share of production carried out in a particular location).

The size of the market affects neither the mark-up of price over marginal cost nor the scale at which individual goods are produced. As a result, all scale effects work through changes in the varieties of goods available. Manufacturing involves economies of scale that arise at the level of the variety (there are no economies of scope). Normally, we think that larger markets mean more intensive competition, and that one of the ways the economy takes advantage of the extent of the market is by producing at larger scale. The Dixit-Stiglitz model says, however, that all market-size effects work through changes in variety (see Fujita-Krugman-Venables, 1999, p. 52). Strategic interactions between firms' location decisions (Weber, 1909; Hotelling, 1929) are not addressed since Hotelling treats the geographical distribution of demand and resources as exogenous and analyzes the strategic interactions of firms. In our analysis, strategic interactions are not central and the Dixit-Stiglitz framework allows us to focus on the implications of endogenous location of demand and resources.

In Dixit-Stiglitz's framework, the industrial good is symbolized by an index of consumption that imposes a constant and equal elasticity of substitution between every pair of goods as usual in context of product differentiation.

[3] See Helpman-Krugman (1985, chapter 7) for further details.

[4] See Krugman (1995a and 1995b) and Neary (2000) for an account of the limitations of the Dixit-Stiglitz model.

However, as in Ethier (1982), the index can also be composed of differentiated intermediate inputs and households consume a single homogenous consumption good. New goods substitute imperfectly for old so that there is increasing diversity in consumption [5]. Total factor productivity (TFP) raises with the number of available varieties due to the increasing degrees of specialization in production (Ethier, 1982) or the larger number of finer production processes. This approach of monopolistic competition is based on Bertrand competition : each firm takes competitor's prices as given. Furthermore, firms can differentiate their products so that they are not perfect substitutes for either the products of existing competitors or the products of potential entrants. Each firm acts as a monopolist facing a downward-sloping demand curve.

One of the main interests of the Dixit-Stiglitz framework for the models of new growth and new geography is that it allows to introduce vertical linkages by assuming that manufacturing uses itself (in addition to labor) as an input. Therefore, the same aggregate of manufacturing varieties demanded by consumers is also an input into the production of each variety. Thus, the same industry is both downstream, producing output for final consumption, and upstream. Likewise, in the growth models of Rivera-Batiz and Xie (1992, 1993), the manufacturing sector produces two types of goods : a consumer good and a producer good. However, for mathematical tractability, they consider that the production function is the same in both cases so that there is possible conversion into one another on a one-for-one basis. In that sense, the manufacturing sector is both a supplier and customer from itself.

### 2.2.2 Romer-Grossman-Helpman modelling

These three authors provide an understanding of the importance of monopolistic competition in growth theory. In their models, population growth is nil and returns to scale for the reproducible factors are constant in each sector. R&D requires the use of high-skilled labor (human capital) and of the stock of knowledge but not of physical capital. Knowledge is non-rival and partially non-exclusive. The non-rivalry implies that the production and dispersion of knowledge cannot be strictly managed by the private sector. Once the discovery is made, the marginal cost to spill it over to a new user is nil. Hence, the return for the inventor is also nil. In that sense, the wish to obtain a private benefit cannot be at the origin of the R&D activity. The only way would be to sell these products at a higher price than the marginal cost or that the public sector for instance would subsidize knowledge. In any case, perfect competition is not the most appropriate framework to discuss such issues.

The non-exclusivity stems from the relative difficulty for inventors to protect their inventions through patents or copyrights and prevent others to use it without their consent. The degree of exclusivity is essential in influencing the production and dispersion of knowledge. Without any exclusivity, private benefits are impossible. Conversely, exclusivity, even partial, allows inventors to

[5] Homogeneity implies perfect substitutability (elasticity tends to infinity) and vice-versa for differentiation.

patent their inventions and get a positive return. The first case of no exclusivity denotes pure research usually financed by the public sector. However, since this type of research can be useful to the production, it forms a positive externality. The other type or partial exclusivity allows inventors to capture some market power. An easy way to model this activity is to consider that the inventor has the exclusive control over the use of his idea and grants licenses to producers of the goods made from his idea.

Indeed, if you consider that new ideas require a voluntary effort in R&D and spread slowly to other producers, then the imperfect competition framework shall be more suitable. In that framework, first proposed by Romer (1987, 1990) and then Grossman and Helpman (1991a) and Aghion and Howitt (1992), technological change stems from a voluntary R&D effort. The R&D activity is financed by ex-post monopoly power. However, in order to encourage R&D, innovators shall be rewarded. Since new ideas are costly but can be shared without strict exclusivity, this implies that other firms can use the idea of another firm without having to pay for it. Then, there is no ex-ante incentive without a system of patents. Thus, this requires that the inventor obtains a monopoly power over the production and sale of the invented good. Thanks to these profits, protected by patents or secrecy, inventors have an incentive to create [6].

Deliberate investments in knowledge require an environment where intellectual property rights are protected. Without such protection, investors cannot appropriate the fruits of their labor. A patent or trade secret typically gives an innovator the ability to exercise monopoly power in the product market. That is, a firm with proprietary access to an innovative technology usually can price above marginal cost without losing all of its sales. And the more unique and superior the innovator's technology, the greater will be the monopoly power and the larger the reward (Arrow, 1962). This explains why imperfect competition features prominently in these models.

Profits must recover in response to the exit of firms to provide proper entry signals. In the static theory of monopolistic competition, the existence of a traditional fixed cost is sufficient to guarantee stability : entry of new firms crowds out labor supply per firm, thus raising the share of fixed cost in total cost and reducing profits until they are wiped out. In a dynamic model of monopolistic competition, total fixed cost per firm is not exogenous but can be reduced by diminishing research efforts. Crowding out of labor supply per firm by the entrance of new firms needs not lead to a reduction in instantaneous profits if firms decide to reduce research employment to offset the larger burden of the fixed management expenditures. Such a decision will not be taken if the intertemporal gains from research are relatively high.

[6] The period of monopoly is in any case reduced by obsolescence or imitation.

# 3 The specificities of new geography and new growth theories

Although based on similar characteristics, new geography and new growth theories still display specific features. One feature of new geography is its reliance on internal IRS, comparative statics and partly numerical results. New geography uses comparative static or ad hoc dynamics where one of the variables (the location of labor or of firms) moves over time. Moreover, it does not rely on inter-temporal decisions based on rational expectations by individual agents. Conversely, new growth provides a dynamic framework with analytical solutions and external IRS.

Another distinction between the two sets of theories is their point of departure : the first Marshallian explanation of economic concentration (the diffusion of knowledge through technological externalities) for new growth, whereas Krugman (1991) and Venables (1996), in their geographic models, are interested in the two other explanations : the pooling of labor and the variety of differentiated goods through forward and backward linkages (e.g. pecuniary externalities). We will first review some specific features of the new economic geography (Section 3.1) and then some particular characteristics of the new growth theory (Section 3.2).

## 3.1 Economic geography and agglomeration economies

Economic geography is the study of where economic activity takes place and why. Agglomeration is the clustering of economic activity, created and sustained by some sort of circular cumulative causality. Economic geography tries to derive spatial concentration from the interactions among economies of scale, transportation costs and factor mobility. The geographical distribution of economic activities is indeed determined by the interaction between economies of scale, which support the concentration of production in large markets, and trade costs, which also imply its presence in small markets. Concentration of economic activity prospers because of agglomeration economies and its self-reinforcing process.

Despite the fundamental contributions of Lösch (1940), Harris (1954) or Pred (1966), this is only recently that a proper analytical framework for market structure has been built. According to Krugman (1991, 1995a, 1995b, 1997, 1998), this is due to the lack of models associating IRS and imperfect competition as suggested by Hotelling (1929), Lösch (1940) or Koopmans (1957) [7]. We will first review the learning of the older theories (Section 3.1.1), then of the new theories (Section 3.1.2), and finally provide some elements on the role of transaction costs as a proxy for trade liberalization on the spatial structure of the economy (Section 3.1.3).

[7] Hotelling (1929) proposed a model where space and localization were considered as strategic factors in firms behavior. A detailed presentation of theories of economic geography can be found in Fujita-Krugman-Venables (1999), Neary (2000) and Fujita and Thisse (2002).

### 3.1.1 Old geography learning

Most of the concepts currently used in new economic geography were elaborated by several economists over the last century. Among others, we shall note the works concerned with :

- The central-place of Christaller (1933) and Lösch (1940) : The trade-off between scale economies and transportation costs leads to the emergence of a lattice of central-places, each serving the surrounding farmers.

- The market potential of Harris (1954) : Producers prefer sites with good access to consumers, but also access to markets tend to be good in regions in which many firms chose to produce. Linkages stories work only if there are increasing returns to production at the level of the individual firm; otherwise, the firm would not concentrate production where the market is largest, but rather establish a separate facility to serve each market. But if there are IRS, competition must be imperfect.

- The base-multiplier of Pred (1966) : The export activities are a region's economic base, whereas the non-base activities are derived from that base's performance. As the region expands, local income grows. A cumulative process begins when underlying parameters cross some critical value. Although these break and sustain points are not always the same.

- Henderson (1974) : There is a tension between external economies associated with geographic concentration of industries and diseconomies (such as congestion costs and pollution) associated with large cities. The net effect of this tension is that the relationship between the size of an economy and the utility of a representative resident is an inverted U curve. External economies tend to be specific to particular related industries, but diseconomies tend to depend on the overall size of a city, whatever it produces.

- When we assume external economies to decline with distance, we obtain a von Thünen-type trade-off between a centripetal force due to the external economies that pulls employment into concentrated districts and a centrifugal force where business locates in low-rent locations away from the concentrated centres and attracts workers at lower wages.

### 3.1.2 New geography learning

New geography has drawn from these previous studies and benefited from new tools and modelling tricks from industrial organization and new trade theories. The set of studies that interests us has been focusing on the interaction between concentration and dispersion forces along the varying level of transaction costs [8].

**Sustain point and break point** New geography tries to answer the two following questions :

[8] Empirical contributions on this issue include among others : Brülhart (1996, 1998), Brülhart and Torstensson (1996), Davis and Weinstein (1999) and Hanson (1996, 1997a, 1997b, 1998a, 1998b).

- When is a spatial concentration of economic activity sustainable ? If all manufacturing is concentrated in one region, a worker who defects to the other region might find that doing so improves his real wage; if it does, the concentration of manufacturing is not an equilibrium. This is what defines the sustain point. More explicitly : does, in a core-periphery framework, a small group of workers moving from the North to the South receive a higher real wage than received by the workers remaining behind ? If so, a core-periphery is not an equilibrium : manufacturing will shift over time to the peripheral region. If not, a core-periphery pattern is an equilibrium : the concentration of manufacturing will be self-sustaining.

- When is a symmetric equilibrium, without spatial concentration, unstable ? Starting from an equilibrium in which manufacturing is equally divided between the two regions, a movement of a small number of workers from one region to the other raises or lowers the relative wage in the destination; if it raises it, the symmetric initial situation is unstable against small perturbations. This is what defines the break point. Note that sustain point occurs before break point.

We see that the answers to both of these questions hinge on the balance between centripetal forces that tend to promote spatial concentration of economic activity, and centrifugal forces that oppose such concentration.

**Concentration and dispersion forces** We display the opposite forces along the following repartition. 1) Concentration or centripetal forces are : vertical linkages, thick markets, local knowledge spillovers and intermediate transportation costs. 2) Dispersion or centrifugal forces are : immobile factors, land rent / commuting, congestion costs, wage differentials, global knowledge spillovers and high and low transportation costs. We shall also introduce an important distinction. At the regional level, core-periphery is possible because labor is mobile. However, at the national level, core-periphery is less possible because labor is immobile [9].

**a) Concentration force :** A larger manufacturing labor force makes a region more attractive both because the larger local market leads to higher nominal wages (backward linkage) and because the larger variety of locally produced goods lowers the price index (forward linkage). If a region gains a slightly larger manufacturing sector, that sector would grow overtime while the other region's manufacturing sector shrank, leading eventually to a core-periphery pattern with all manufacturing concentrated in one region (the symmetric equilibrium is unstable for medium trade costs but stable for high trade costs).

Agglomeration of manufacturing in the North causes a discontinuous upward jump in real wages in the North and a fall in the South. The labor demand generated by manufacturing raises North's wage, measured relatively to agricultural goods. And the country with manufacturing has a lower cost-of-living index, because it does not have to pay $\tau$ on imported manufactures. This effect

[9] In this literature, the distinction between regional and national levels depends on the mobility of labor. National borders are associated with barriers to labor mobility.

amplifies North's gain and also drives the decline in real wages in the South. A firm in the South, the small market, experiences a transport cost disadvantage in supplying the North, the large market, so that it cannot afford to pay a nominal wage as high as in the North. The size of the wage gap between the two countries may continue to increase over some interval of trade costs. Eventually, however, the wage gap declines with transport costs; in the limit, as these costs go to 0, factor prices are equalized (the value of proximity to customer and supplier firms vanishes as transport costs fall) and the symmetric equilibrium becomes stable once again.

Income growth increases demand for manufactures relative to agriculture, and this manufacturing growth is concentrated in the North. This has two effects on the sustain condition. Because it increases North's wage, it makes it more attractive for manufacturing to set up in the South. But, precisely because the North is manufacturing more and paying higher wages, the share of the North in world manufacturing expenditure rises, and this strengthens backward linkages and reinforces the existing agglomeration.

**b) Dispersion force :** We have seen that agglomeration results from pecuniary externalities associated with increasing returns to scale and transportation costs. Firms locating in densely populated areas save money in terms of fixed costs by concentrating production in a single factory, and on transportation costs by locating close to the big market. However, agglomeration creates congestion costs, since firms in concentrated areas have to compensate workers by paying them with higher wages than in peripheral regions (Krugman and Livas, 1996).

Likewise, agglomeration requires that workers live in a confined area, this increases pollution, rents and necessary extra infrastructure to face congestion constraints. While firms in the center pay their workers at a higher fee, firms in the periphery have to pay their own workers at a lower fee in order to compensate for the transportation costs. Fortunately, these workers may accept these lower wages since they are confronted with lower congestion costs. One of the dispersion force is indeed that firms move towards regions that offer low wages and away from regions that offer high wages. So that the distribution of manufacturing evolves over time to the extent that wages differ across regions.

Finally, it appears that at high transportation costs (high $\tau$), the symmetric equilibrium is unique, because each country must have manufacturing to supply its local consumers. The dominant force in determining location is the need to be close to final consumption, preventing any strong geographical concentration of manufacturing. At low $\tau$, the dominant determinant of location is wage costs, again urging dispersed manufacturing to keep labor costs down.

**c) The life-cycle of development** Countries that industrialize first do so by developing industries that are especially labor-intensive or that are weakly linked to other sectors. Technical progress (exogenous) steadily augments all primary factors. If linkages between industries (so-called Jacobs linkages) are

stronger than within, concentration is never sustainable and nations tend to develop a diversified mix. Conversely if MAR linkages (so-called Marshall-Arrow-Romer linkages or linkages within industry) apply, concentration is sustainable for low $\tau$. After relocation, the industry in the South can build its own linkages and the catch up process goes on and accelerates.

Successful industrialization, however, raises manufacturing employment in the South and raises wages and thus eventually prepares the way for the spread of industry to yet another country. The most labor-intensive industry or the one with low intermediate input requirements (since it is less dependent on supply from other firms) is the first to leave the North, because they are more responsive to high wages that cause the relocation of industry. The less labor intensive will follow suit at an increasing pace due to the dynamic of vertical linkages in the new location [10].

### 3.1.3 The role of transportation costs

According to new economic geography, very high as well as very low transaction costs favor dispersion forces and intermediate transaction costs favor concentration forces [11]. At sufficiently high transport costs, there is a unique stable equilibrium in which manufacturing is evenly divided between the regions. An increase in one region's industrial labor force reduces the real wage there, because it increases the supply of manufactures that cannot be exported. When transport costs fall below some critical level, new stable equilibria emerge in which all manufacturing is concentrated in one region. The forward-backward linkages associated with the relocation of workers raise the real wage in the location to which workers are moving and the symmetric equilibrium is unstable (sustain point). When they fall below a second critical level, the asymmetric equilibrium becomes unstable (break point). Chronologically, we go from asymmetry (sustain point) to symmetry (break point).

At high and low trade costs, each country employs half its labor force in each industry: at high $\tau$ because of the need to serve final consumers, and at low $\tau$ because of factor supply considerations. At high trade costs, the demand-side centrifugal force created by immobile consumers outweighs concentration forces, causing manufacturing to be spread out. Likewise, at low trade costs, the supply-side centrifugal force created by the need to import agricultural goods also outweighs concentration forces. This is the non-monotonic effect of trade costs on the pattern of agglomeration. In between there is a range in which agglomeration is sustainable, and a narrower range in which the diversified equilibrium is unstable. At intermediate $\tau$, there is an intermediate range between sustain and break points, at which there are three stable equilibria. Therefore

[10] See FKV (1999) for a detailed analysis.

[11] The larger the share of manufacturing workers in the economy, the greater the range of $\tau$ in which the symmetric equilibrium is unstable (because of vertical linkages). A high degree of product differentiation and large price cost mark-ups, and hence strong forward-backward linkages all this conduct to a higher specialization and greater IRS. The range of transport costs in which the core-periphery geography occurs is greater the larger the share of manufactures in the economy, and the larger are firms' price cost mark-ups.

the linkage forces that can cause agglomeration are strongest relative to other forces at intermediate values of $\tau$. Thus, there is an inverted-U relationship between $\tau$ and the geographic concentration of industry [12].

## 3.2 Economic growth and technical change

Since Solow (1956), neoclassical growth theory had dominated the way economists dealt with long-term growth in the sense of a capital accumulation process. New growth theories have suggested new insights inside the accumulation process whether through learning-by-doing (Romer, 1986; Stockey, 1988; Young, 1991), human capital accumulation (Romer, 1986; Lucas, 1988; Stockey, 1991) or knowledge capital accumulation (Romer, 1990; Grossman and Helpman, 1991a; Aghion and Howitt, 1992). This is essentially this third path we will follow in our analysis. The new theory of growth analyzes the circumstances for which capital (physical, human or knowledge) is not subject to decreasing returns and allows for continued growth. In that framework, growth is determined endogenously and a change in economic policy that modifies the return on capital accumulation may have permanent growth effects.

Growth proceeds deterministically through the creation of new durables that increase the productivity of the production process. Growth is defined as the development of new differentiated intermediate products conducting to permanent gains in productivity in the production of the final goods. Growth depends thus on knowledge that increases marginal product of labor and decreases innovation cost in creating new products. This technological progress (the Solow residual) is in fact not a purely random exogenous process but rather one guided by market forces, that results from intentional industrial innovation, that is, from the allocation of resources to R&D in response to perceived profit opportunities [13]. We will first review the theoretical foundations of the growth theories (Section 3.2.1), then we will discuss the role of innovation in the growth process (Section 3.2.2) and finally the relationship between trade and knowledge spillovers as an engine for growth (Section 3.2.3).

### 3.2.1 Model of Ramsey, Cass and Koopmans

This model is based on microeconomic foundations as proposed by Ramsey (1928), Cass (1965) and Koopmans (1965). Changes in capital stock depend on the confrontation between optimal choices of households and firms that interact on competitive markets. Firms produce and sell to households and other firms an homogenous good by using labor and capital inputs. Households offer the labor, own the capital, consume the good and save. Firms maximize profits

[12] If transport costs are nil or low enough, trade is, in terms of welfare, unambiguously beneficial. However, a lowering of transport costs has three effects : a direct gain from reduced transport costs, a gain from that part of increased exports which represents a net addition to production, but also a loss due to that part of imports which substitutes for domestic shipments. The sum of the three effects is ambiguous (see Dion, 2003).

[13] A detailed presentation of endogenous growth theories can be found in Grossman and Helpman (1991a), Barro and Sala-i-Martin (1995) and Aghion and Howitt (1998).

considering that households are the owners of the firms. Firms have access to a technology that allows them to transform factors of production into goods.

In this model, households earn wages for their work and interest rates on their assets. They buy and consume goods and accumulate savings as new assets. There is interaction between generations in the sense that current households maximize their utility subject to a budget constraint whose horizon is infinite. Although households are mortal, their family is immortal. We thus assume that parents are partly altruistic and make transfers to their children.

If we consider that capital accumulation (even if human capital is included) faces decreasing returns and thus does not allow long-term growth, we have to look for another factor to help us understand what empirics show : long-term growth. Our main culprit may well be technological change (improvement in the methods of production and rise in the quantity and quality of new varieties of products) as a way to avoid decreasing returns over the long run. Endogenous growth theorists have tried to determine the origin of technological progress and thus help to understand how other factors such as trade could positively influence long term growth.

The models dealing with product diversity study the increase in variety for production goods or consumption goods. The more varieties, the more industries: this is the way innovation is taken into account. Arrow (1962) and others have shown that knowledge can be approached in terms of know-how and learning-by-doing (LBD) and is thus composed of positive externalities carried out under market conditions. In that sense, it allows increasing returns to scale at the aggregate level, whereas at the firm level we will still have constant or decreasing returns to scale. In that framework, it was still possible to rely on the traditional neo-classical theory with perfect competition. However, new growth theory or endogenous growth theory relies on the idea that investment in the form of R&D expenditure generates knowledge and innovation and hence products of higher quality and quantity and eventually higher productivity.

### 3.2.2 Innovation and growth

There exist two different ways to introduce new goods : the accumulation of experience through learning-by-doing (LBD) (Stockey, 1988, 1991; Young, 1991, 1995, 1998) and technological innovation through R&D (Romer, 1990; Grossman and Helpman, 1991a; Aghion and Howitt, 1992). LBD is a type of product useful for production processing and external from the economic decision taking (perfect competition still applies). Innovation, however, considers R&D as an investment highly profitable. Although an initial fixed cost has to be paid, it will be compensated later (if research succeeds). New products may then be commercialized at a fixed price above marginal cost. Since we assume that knowledge is infinite, growth can keep on going.

However, due to the distortions created by the production of innovative products, growth and inventive activity are sub-optimal. Obviously, since this economy is working in a non-competitive framework, we shall expect it to be also non-optimal. We may even expect a sub-optimal allocation of resources

between the R&D sector and the goods sector [14]. We will first review the role that externalities play in new growth theories. We will then present the two types of outputs (private and public goods) provided by the R&D activity.

**The externalities** Three different externalities have usually been noted due to the R&D sector : the effect of the consumer surplus, the effect of the rent diversion and the R&D effect. The first two externalities are pecuniary since they are obtained through the normal functioning of the market and not from exogenous factors. These externalities in a perfect competition framework do not generate any inefficiency and the competitive equilibrium is pareto optimal.

The first externality is positive since the consumers and other users of the idea profit from the difficulty that the inventors have to practice perfect price discrimination. The second externality is negative since it represents the idea that new technologies lead to the obsolescence of former technologies affecting their owners. The last externality is positive and comes from the fact that inventors profit from the use of their ideas in the production of goods but not in the production of knowledge. The production of a particular idea profits to all other would-be inventors.

Usually, it seems the global effect is positive although it is difficult to prove it formally. Another externality can appear when exclusivity is partial and allows for instance for imitation. In that case, private return of R&D will be lower than its social return. Conversely, the reality of patent races exemplifies the case where the first inventor, overtaking his competitors, gets exclusive rights over its invention. In that sense, the incitation to be the first may conduct to a private return over the social return.

In order to model these ideas, we cannot rely on the decreasing returns of the neo-classical model. Two possibilities exist to escape them : learning-by-doing or LBD (Arrow, 1962) and R&D (Romer, 1990). LBD fosters productivity through experience and diffusion to other producers. The higher the global stock of capital, the higher the level of technology of each producer. At the aggregate level, decreasing returns may be avoided. R&D expenditures can also raise productivity and permit to avoid decreasing returns at the aggregate level. The lack of rivalry that characterizes new ideas is obvious in the case of fundamental research.

In the case of R&D, knowledge in each firm is a collective good each other firm can access at zero cost. In that sense, once discovered, new ideas diffuse instantaneously in the economy. This also means that any change in the level of the technology of the firm is similar to the acquisition of new ideas by the economy as a whole, and hence, proportional to the change in the aggregated

[14] Empirical contributions include among others Backus et al. (1992), Kremer (1993) and Jones (1995a, 1995b). Whereas Kremer acknowledges most of the conclusions of the new growth theories, Jones attempts to weaken some of their assumptions. However, Barro and Sala-i-Martin (1995) have shown that the critics of Jones rejecting the assumption of proportionality between the stocks of human capital, knowledge and new goods, even when taken into account, did not prevent the assumptions and conclusions of endogenous growth theories to hold.

knowledge capital stock. However, at the same time, firms try to protect their discoveries with patents. Thanks to this limited and temporary protection, technical diffusion is not immediate and innovators can keep their competitive lead for a while. In this decentralized framework, this is indeed the single incentive to pursue research. But then, the usual models of perfect competition do not account appropriately for these interactions among firms.

**The two products of R&D** R&D is both a public and private good and that makes it specific comparatively with other inputs. There is indeed a clear distinction between knowledge and human capital. Human capital is both rival and exclusive. Human capital and technology are two distinct inputs, since human capital does obtain a market return in the research sector whereas technology can be acquired free of charge from a publication. So that technology has the features of a public good when used in the R&D sector. There are no diminishing returns in R&D activities with respect to the level of knowledge capital. This implies that it is possible to sustain infinite growth in quality or productivity by allocating a fixed amount of skilled labor to R&D activities.

This absence of diminishing returns with respect to reproducible factors of production is central in allowing endogenous growth. However, in the manufacturing sector, the use of designs is subject to patents. Patents are infinitively lived and carry a positive value because the attached durables can be sold or rented for a profit to be used in the manufacturing sector. Patenting provides the incentives for innovation and makes technology partially a private good. The role of patents as a partially exclusive way of protecting inventions is central in the analysis.

Innovation can follow a self-perpetuating process without interruption. Indeed, thanks to non-rivalry, knowledge stock, associated with other traditional factors, generate IRS, so that the marginal product of knowledge needs not decrease as more knowledge is accumulated. The technological spillovers combine to form a stock of public knowledge, thereby lowering the cost of future invention. This cost reduction compensates the tendency for the private returns to invention to decrease as a result of increases in the number of competing technologies.

Long-run growth can thus be sustainable since the increasing returns of public knowledge offset the diminishing returns of private research. Moreover, the partial non-excludability of knowledge implies that investment incentives can be preserved thanks to partial protection. Product designs are proprietary information because they can be kept partly secret or protected through patents or copyrights. Inventors put a patent on the new good and thus retain monopoly profits on its production.

In the models of product variety proposed by Romer (1990) or Grossman and Helpman (1991a, 1991b, 1990a and 1990b), innovation permits to expand the range of goods available in the market. Firms allocate resources to R&D in order to invent new goods that substitute - but imperfectly - for existing brands. Most importantly, technology results from investment made by forward looking,

profit-seeking agents : this "endogenizes" technological change. The complete mechanism is as follows : producers of unique products earn monopoly rents, which serve as the reward for their prior R&D investments. The innovative products may be either final (as in Grossman and Helpman) or intermediate (as in Romer) goods. In the latter case, then, innovation contributes to TFP in the final goods sector.

The innovation process is set in motion as soon as each firm requires a new idea (or the creation of a new unit of human capital) through R&D. Ideas do not become exhausted since their potential stock is assumed unlimited and there are thus no diminishing returns in the creation of knowledge. However, there still exists incentives for innovators of doing research. Innovators can indeed appropriate the returns to product-specific information which enables them to manufacture new products, even if the returns to general information which serves as an input in the inventive activity are impossible to capture. In that sense, endogenous innovation is self-sustaining [15].

Each R&D project generates some additional knowledge that is potentially useful to subsequent inventors and that enters the public domain. The contributors to the stock of knowledge cannot monitor the use of this public knowledge nor enforce any property rights. Thus, knowledge capital is a public input into R&D. An important assumption is that the knowledge capital stock is to be proportional, at every moment, to the economy's cumulative experience at R&D. In particular, the stock of knowledge is to be proportional to the number of R&D projects previously undertaken (so there are no diminishing returns to learning). Finally, the cost of innovation is to be proportional to the stock of knowledge. Eventually, capital accumulation occurs as a response to knowledge accumulation, as technological innovations raise the marginal productivity of capital and so make investment in machinery and equipment more profitable.

Since human capital is used intensively in R&D, a country with more from it will innovate faster (and vice-versa for a country largely endowed in low-skilled labor). An economy endowed with a larger stock of human capital allocates more of this resource to R&D, the most human capital intensive of the economic activities, and as a consequence its rate of innovation is higher (and vice-versa). How to avoid the centre-periphery pattern then ? Thanks to the knowledge spillovers through trade liberalization.

### 3.2.3 Trade and spillovers

The disparities among revenues over the world may be due to long delays of knowledge diffusion between rich and poor countries. They may also be due to the difficulty for poor countries to appropriate such knowledge because of barriers to trade or lack of human capital able to translate these ideas into products. However, the progressive location of multinationals into poor countries attracted by lower costs shall help the diffusion of knowledge and the gradual catching-up. Technology shall then spread to other countries thanks for instance

[15] There is no product obsolescence in this approach, contrary to the model of quality ladder (Aghion-Howitt, 1992).

to imitation (cheaper than innovation) and allow for conditional convergence. The geographical spread of the diffusion is an essential element when we will deal with knowledge spillovers and their impact on international development. Indeed, the empirical applications of these theoretical models shall try to model these geographical features.

We have seen in the previous part that when the investment in R&D - at the origin of technical change - has constant returns, long term growth becomes possible. We might wonder how fast new discoveries spread to other countries. In our view, this is an important factor to permit convergence and the catching up process of developing countries. Thanks to imports, countries may use implicitly foreign technology. Laggard-countries (so-called followers) can also catch-up with the advanced countries (so-called leaders) thanks to imitation. In any case, trade provides an opportunity to take advantage of knowledge spillovers at the international level and symbolizes the benefits of economic integration [16]. We will first review the features of knowledge spillovers before studying their impact in the context of economic integration.

**Knowledge spillovers** Diffusion of knowledge allows to build a higher domestic stock of knowledge partly based on foreign-originated knowledge. This stock helps to raise the productivity levels of each factor and of total factor productivity (TFP). The latter being a clear indicator of development and competitiveness. Knowledge diffusion aims at sharing ideas through diverse ways of communication such as the spreading of new ideas thanks to journals (public knowledge) or goods and services (private knowledge).

According to Marshall (1920), information flows are more intensive within a country than between countries because it decreases over distance and borders. These flows of information and ideas are a clear incentive in concentrating economic activity in a single place (at least until congestion costs reverse the trend). Whether communication works through face-to-face interactions (requiring physical presence and possibly concentration) or telecommunication (where physical presence and concentration are not compulsory) both are complements rather than pure substitutes (Gaspar and Glaeser, 1997). National diffusion shall be relatively more intensive in face-to-face interactions than in telecommunication relatively to international diffusion.

Specialization in the Hecksher-Ohlin-Samuelson (HOS) setting is determined by relative differences in factor endowments given equal technology. In a dynamic setting, we shall however envisage that technologies change thanks to innovation. By improving the diffusion of knowledge we may better spread its benefits. However, knowledge seems to be rather concentrated around few locations and there does not exist many efficient ways to force its spillovers into action. Among these means we could think of labor mobility (workers carrying their own knowledge and know-how) or trade in goods, services and capital that

[16] Empirical contributions include among others : Bayoumi et al. (1996), Coe and Helpman (1995), Frankel and Romer (1999), Lichtenberg and de la Potterie (1996, 1998), Nadiri (1993) and Nadiri and Kim (1996).

contain knowledge. Both are limited by distance and all the usual impediments to mobility. If we agree that goods carry knowledge, then the phasing out of barriers to trade through its impact on trade and firm relocation, shall modify the diffusion of knowledge (according to the elasticities at work : see Dion, 2003a). All barriers to diffusion and more especially artificial ones can impede economic growth.

**International spillovers** Traditionally, it is assumed that access to foreign-made intermediate goods can raise productivity in manufacturing even in the absence of international knowledge spillovers. However, if we allow for global knowledge spillovers, then researchers can draw on a common stock of general knowledge. In that case, integration boosts not only manufacturing productivity (by expanding the range of intermediate inputs available to a producer of final goods) but also the long-run rate of productivity growth (by providing access to the general knowledge generated abroad). Moreover, there shall also be a positive effect of trade on the rate of technological progress in each country. It arises because R&D is an activity with dynamic IRS (although its production function is CRS at the internal level of the firm, it is IRS at the external level). Nonetheless, in the case of local spillovers, national research productivity accumulates in proportion to local R&D activity.

The opportunities to draw from the stock of global knowledge disappear in case of isolation such as autarky. The more commercial interactions, the higher the contribution to the local stock of knowledge. Trade in tangible assets facilitates the exchange of intangible ideas (through personal contacts) so that spillovers between two countries increase with the volume of their bilateral trade. However, there may be a limit in terms of incentives to export your knowledge. Indeed, a country that imports human capital-intensive goods finds that international integration reduces derived demand for human capital and thereby lowers the cost of innovation. But it works the other way round for the country that exports these goods, because the exportables sector draws capital away from research activities (cf. Stolper-Samuelson theorem).

**Economic integration** To evaluate the impact of economic integration on growth through knowledge spillovers we shall use the progressive phasing out of trade barriers. It seems that participation in world markets accelerates a country's acquisition of foreign knowledge. Integration thus facilitates the transmission of technical information, encourages entrepreneurs and innovators in each country to compete and pursue new and distinctive ideas and technologies, so that trade alleviates duplication of research effort. Reducing duplication of research effort thanks to economic integration increases the aggregate productivity of resources employed in R&D. Thus, each R&D project contributes fully to the global stock of knowledge capital (Romer, 1990; Rivera-Batiz and Romer, 1991a and 1991b).

Integration also enlarges the size of the market that means more sales and greater profits for a given market share but also facing a greater number of com-

petitors. The more rapid accumulation of knowledge implies a more rapid reduction in the cost of product development in each country, and so entrepreneurs introduce new varieties at a faster pace. Integration increases the available stock of knowledge. With a higher available stock of knowledge, the R&D cost diminishes (the cost of R&D in a location depends negatively on the number of firms located in that location), new ideas and thus new firms are created in each location with a relocation for some from North to South.

Concentration of industries, stock of high-skilled labor, expenditure share of differentiated good, degree of increasing returns to scale (taste for variety) in a region, all have a positive impact on its growth rate. Whereas the cost of innovation and the rate of time preference have a negative impact. In welfare terms, through openness, households have access to a more diversified set of goods, and since they favor variety, this increases their level of utility (these are the so-called static or temporary gains). The increase in the rate of utility (the so-called dynamic or permanent gains) stems from trade in ideas and the consequent higher global stock of knowledge. In addition, growth is increasing in the share of industrial firms in trade partners. This is due to the role of spillover intensity.

# 4 The synthetic framework

What have we learned from the two previous parts ? New growth theory deals essentially with the consequences of economic integration on growth. New economic geography studies mostly the impact of economic integration on the localization of economic activities. Both approaches seem thus complementary. To specify their interdependence, we can either introduce location decisions in growth models or dynamics in geography models. Recently, some authors have noticed several links between the two sets of theories. These authors rely on the circular and cumulative causality that connects growth and geography to address the effects of economic integration on development [17].

Considering the inequalities exemplified by the specialization and concentration of certain activities in a limited number of countries, we may wonder how to reverse them. Liberalization accompanied by technology transfer may spur growth. This could lead to factor price equalization due to a shift in relative factor endowments towards convergence [18]. We are here interested in the way

[17] In both the static and dynamic models, the spread of the spillover benefits across national boundaries eliminates any tendency for the increasing returns activity to concentrate in a single location. Conversely, because of factor price equalization (FPE), a core-periphery pattern is possible : the equilibrium is highly asymmetric. When spillovers are limited, the innovator can better appropriate the benefits of his invention, so that there is a trade-off between global and local spillovers for welfare.

[18] Empirically, we know nowadays that convergence is conditional rather than absolute, since it depends on specific features and different parameters among economies. Economies are heterogenous so that their steady states may differ. The main idea remains, that the further away the economy is from its steady state, the faster it will grow. The hypothesis of a steady state is not only easier to model analytically, it is also confirmed by empirics since growth per capita is positive but has no trend so the assumption that growth rates tend

economic integration affects development in poorer countries, but also how integration affects growth in richer countries. We argue that economic integration may foster growth and reduce inequalities by decreasing the wage differential. One of the main determinants of growth will be the level of transaction costs. In order to model these effects we use the learning of new trade, new growth and new geography theories in a common approach. We first recall the learning from older theories (Section 4.1) before presenting the most recent approaches that have attempted to build a synthetic framework (Section 4.2).

## 4.1 The old theories

Among the first attempts to connect growth and geography, authors such as Marshall, Perroux, Myrdal, Hirschman or Pred have provided very useful frameworks, whose insights lead current research. Indeed, the concept of cumulative and circular causality has been often used to explain the reasons of convergence and divergence between countries that were previously similar but overtime departed and transformed into asymmetric countries.

### 4.1.1 Marshall

According to Marshall's classification (1920), industrial districts arise because of : knowledge spillovers (geographic proximity facilitates the spread of information), advantages of thick markets for specialized skills (a concentration of firms employing workers of the same type would offer labor market pooling : workers would be less likely to remain unemployed if their current employer did badly, and firms would be more likely to find available labor if they did well), and the backward-forward linkages associated with large markets (a geographically concentrated industry could support specialized local providers of inputs). We note that whereas the first factor (the technological external economies or pure spillovers) figures prominently in new growth models, the last two (pecuniary externalities) are major contributors to new geography theories.

### 4.1.2 Perroux

Theories of polarization (Perroux, 1955) concentrated on factors that could foster the transmission of growth. In that framework, economies of scale are frequently invoked as an important cause of spatial polarization. The complementarity between investment effects and pecuniary externalities (Scitovsky, 1954) rely on the effects of economies of scale. More generally, economies of scale are at the core of any kind of polarization (Kaldor, 1970).

The relationship between industrialization and agglomeration is a famous aspect of development theories. Industrialization allows the collection of resources in human, physical and knowledge capital in a specific location. The resulting agglomeration will spur growth. However, this correlation between growth and

towards a constant over the long run is acceptable.

agglomeration, also called circular and cumulative causality, does not say which one causes the other.

### 4.1.3 Myrdal and Hirschman

The idea of cumulative causality and vertical linkages as factors of inequalities in regional development goes back to the fifties (Myrdal, 1957; Hirschman, 1958). According to Myrdal and Hirschman, economies of agglomeration trigger a process of cumulative and circular causality that encourages economic activity to concentrate in certain places. Regional inequalities - in the industrial structure as well as in income levels - may then occur and display a (developed) core - (developing) periphery setting.

Producers want to choose locations that have good access to large markets and to supplies of goods that they or their workers require. However, a place that for whatever reason already has a concentration of producers tends to offer a large market (because of the demand the producers and their workers generate) and a good supply of inputs and consumer goods (made by the producers already there). These are the backward and forward linkages of development theory [19]. Because of these linkages, a spatial concentration of production, once established, may tend to persist, and a small difference in the initial economic size of otherwise equivalent locations may grow over time implying a process of circular cumulative causality. Theses ideas have benefited from the recent renewal of economic geography and endogenous growth theories.

## 4.2 The new models

As soon as we acknowledge that the spatial distribution of economic activity and economic growth are interconnected dynamics, the wish to associate them within the same framework is tempting. The question then is from which setting shall we depart ? From economic geography or from endogenous growth ?

### 4.2.1 From economic geography

Several empirical studies have underlined the benefit of combining growth and geography framework to discuss development. The results of Jaffe (1989), Jaffe and Trajtenberg (1999), Jaffe et al. (1993), Feldman (1994), Audretsch (1998) or Audretsch and Feldman (1996, 1999) suggest that R&D not only spurs externalities but also that knowledge spillovers tend to be geographically localized in the very same region where knowledge was created in the first place. Recognizing that the location of the innovative activity is central in explaining long-term growth, some authors have been trying to insist on the geographic component of growth. Building on new economic geography theories, Baldwin (2001), Baldwin

[19] We have seen earlier how Venables (1996) and Krugman and Venables (1995) had formalized these links between downstream and upstream industries. The complementarity between the decisions of localization of these firms leads to their agglomeration in a single (or limited number of) concentrated location(s).

and Forslid (2000a, 2000b) or Fujita and Thisse (2002) have proposed several ways of introducing dynamic growth within a geographic setting. However, a more promising path may be to introduce geographic features within a growth framework.

### 4.2.2 From endogenous growth

Indeed, authors such as Martin and Ottaviano (2001, 1999), Baldwin et al. (2001), Engelmann and Walz (1995) and Walz (1995, 1996, 1998) [20] have formalized the link between growth and geography by building models where the geographic dimension helps explain the growth dynamics. What we suggest is to pursue that path, by linking even closer the connection between the two while introducing a new dimension thanks to the role of imitation into the model as a supplementary factor of convergence.

Since we wish to deal with the effects of economic integration, we might first wonder whether economic integration may affect the spatial distribution of economic activity. It may do so through the modifications that the decrease in transportation costs could introduce in terms of trade volumes. The latter being often a metaphor for knowledge spillovers through knowledge contained in traded goods. Policies seeking to increase volume or quality of trade may all contribute to a new geography of economic activity.

### 4.2.3 A synthetic approach

Economic integration implies an increase in trade of goods, services, capital and ideas (directly through people communicating and indirectly through goods, services and capital). Economic integration usually has ambiguous effects : less profit (more competition) and more profit (bigger market shares).

A synthetic approach (Dion, 2004b) builds on the "new trade theory" (Helpman and Krugman, 1985) which allows for IRS and imperfect competition. It relates to the "new economic geography" (Fujita et al., 1999) which formalizes that, as trade barriers go down, one should expect firms in IRS sectors to relocate to the biggest markets (home market effect) and the "new growth theory" (Grossman and Helpman, 1991), that suggests that economic integration through knowledge spillovers can avoid a core-periphery pattern.

In a synthetic model, we can indeed consider that in autarky or with rather high trade costs, there exists vertical industry linkages that prevent a symmetric equilibrium. This is due to the geographical concentration of the modern sector itself caused by the linkages between research firms and producers of intermediate goods. The first link (cost linkage) comes from the high number of intermediate goods producers that helps decreasing the innovation costs. This shall attract research firms towards these intermediate goods industries. In the same time, the presence of research firms that design new goods shall encourage the demand for intermediates. This creates a second link (demand link) that

[20] Empirical contributions include among others: Eaton and Kortum (1995), Feldman (1999), Keller (1998, 2000a, 2000b).

attracts intermediate goods producers. The combination of these two links creates centripetal forces that lead to the agglomeration of the economic activity in a single location [21].

The modern sector operating under IRS and being both a supplier and customer of itself, we have vertical linkages that lead to agglomeration at least for determined levels of trade costs. Indeed, if we consider that the North has more intermediate goods than the South or the East, then its innovation costs shall be lower. This implies that it should attract most of the research firms (cost linkage). Moreover, the country endowed with the most research firms shall also obtained the highest demand for its innovative products (demand linkage). There is then a conflict between these opposite forces : centripetal forces leading to concentration and centrifugal forces (such as congestion costs and global spillovers permitted by liberalization) leading to deconcentration.

However, in Dion (2004a, 2004b) we show that making the economy more open makes its internal structure less geographically concentrated. By opening the economy, centripetal forces (the benefice of proximity to suppliers and consumers) are weakened and centrifugal forces (proximity to final consumer demand) are reinforced [22].

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[21] However, such an agglomeration can generate too high a competition and subsequent congestion costs.

[22] The models of geography miss the growth dimension and are thus unable to see the positive impact of integration on both locations thanks to the spreading of knowledge to the poorer locations.

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