1 Introduction

The "New Economic Geography" literature, which has flourished in the last decade, describes how the interactions of centripetal and centrifugal forces determine the locational decisions of firms and workers between two or more regions involved in trade. The interactions of these forces endogenously determine the size and the productivity of the regional economies. The market outcome is typically affected by the degree of integration among regions.

Increasing returns play a major role in these models that assume decreasing costs of production within each firm. Moreover, pecuniary externalities arise because of the assumptions of increasing returns at the firm level and trade costs in the manufacturing (or modern) sector. Pecuniary externalities induce mobile agents, workers or firms, to move towards regions where the size of the manufacturing sector is bigger. In this way, either consumers (if they demand goods produced in the modern sector) or firms (if they use these goods as production factors), may reduce the share of goods on which trade costs should be paid, if they did not move, and agents had to import them from other regions. However, each manufacturing firm (or consumer) that moves where pecuniary economies are larger, increases the incentive for its customer firms and workers to move in the same direction. These movements, in turn, increase the size of the region of destination and, therefore, the incentive for other firms and consumers to move towards the same region. Hence, concepts such as "backward and forward linkages" (Hirshman, 1958) or "cumulative causation" (Myrdal, 1957) turn out to be fundamental in this body of literature.

Centripetal forces, which favor cumulative causation and, therefore, a spatial concentration of the sector with increasing returns, are generated by three main factors: (1) workers' mobility when the final sector exhibits increasing returns (Krugman, 1991b); (2) backward and forward linkages between firms producing intermediate and final goods, when intermediate goods are produced under increasing returns (Venables, 1996);[1] (3) technological advantage of production in a

[1] Fujita and Thisse (2000a) point out that the assumption of the existence of an imperfectly competitive intermediate sector is sufficient to lead to a core-periphery structure.

particular region (Baldwin and Forslid, 2000). On the contrary, centrifugal forces are generated by: (1) immobile demand sources (such as that generated by immobile workers); (2) stronger competition for limited productive factors, and in good markets for firms that operate in core regions; (3) technological knowledge spill-overs from regions with a more productive modern sector towards less developed regions. Whenever centripetal forces are stronger than centrifugal forces, the modern sector tends to be completely agglomerated in one region, while a uniform distribution of the economic activity emerges when centrifugal forces are stronger.

Moreover, the interest in location and economic growth issues has recently led many economists to investigate how the main conclusions of the New Economic Geography literature can be affected when pecuniary externalities interact with the dynamic and external economies of scale introduced in New Endogenous Growth models by Romer (1990) and Grossman and Helpman (1991). Waltz (1996), Martin and Ottaviano (1999) and Fujita and Thisse (2000b), introduce dynamic economies of scale in New Economic Geography models by means of R&D activities, while Baldwin and Forslid (2000) introduce them by means of capital formation processes.[2] The general result of this kind of model is that the dynamic economies of scale tend to strengthen centripetal forces. Nevertheless, as Fujita and Thisse (2000b) point out "even those that stay put in the periphery are better off than under dispersion provided that the growth effect triggered by the agglomeration is strong enough".

Puga and Venables (1999, p. 292) observe that the "economic development may not be a gradual process of convergence by all countries, but instead involve countries moving sequentially from the group of poor countries to the group of rich countries". They show that an exogenous productivity increase of all primary factors strengthens centripetal forces in developed countries by

[2] Moreover, Martin and Ottaviano (1996) analyze the effects of pecuniary externalities arising among firms producing manufacturing goods under increasing returns that are costly traded, and innovative firms that use manufacturing goods to produce new patents. New patents are then acquired by manufacturing firms with a fixed cost. Hence, Martin and Ottaviano (1996) show that growth is more sustained, and agglomeration is stronger when the market size is wider, the share of the differentiated good demanded by consumers is higher and when labor demand, the elasticity of substitution between any pair of varieties, trade costs, innovation costs and the subjective rate of discount are smaller.

increasing immobile workers' wages. In turn, this may lead some firms to start their production in a less developed country, where wages are lower. Besides, Puga and Venables assume that firms that start their production in newly industrialized countries may adopt the same technology as that used by firms in the leading countries. In other words, they do not focus on technological differences. By contrast, in this paper we want to stress that when there are technological differences, the lagging regions may not always be able to catch up with the leading ones, even though there are "potential" technological knowledge spill-overs. In fact, we will see that some conditions must be satisfied before there can be a process of catching up, while *potential technological knowledge spill-overs do not take place automatically towards firms in a lagging region.* In this respect, we concur with Verspagen (1991, p. 361) when he claims:

> "The basic (implicit) intuition behind the convergence hypothesis seems to be that international knowledge spill-overs take place automatically. In the (economic) literature dealing with the nature of technological change in more detail (e.g. Dosi, 1988) it is argued that this assumption is indeed a heroic one. Since the process of (international) technology spill-over is essentially a process of adoption of new techniques at the microeconomic (firm) level, the capabilities of the "receiving" country (firm) to "assimilate" (foreign) technological knowledge are critical to the success of diffusion. If countries (firms) do not have the relevant capabilities to assimilate new knowledge, spill-overs may not take place at all."

The purpose of this paper is threefold. First, we want to show how the above-mentioned forces can interact when workers have different employment opportunities. Specifically, two types of workers are considered: skilled and unskilled. Skilled workers are interregionally mobile and employed by the manufacturing (also called modern) sector characterized by increasing returns at the firm level; unskilled workers are not interregionally mobile but are intersectorally mobile because they can be employed in both the modern and the traditional sectors. Backward and forward linkages exist between manufacturing firms producing final and intermediate goods.

Second, we want to show that a richer analysis of the interactions of all the above-mentioned forces can be conducted when the regional levels of the technological development of the modern sector may differ and change over time. As a consequence, in our model we allow explicitly for differences in the regional levels of the technology.

Third, we want to account for the fact that the lagging regions are not always able to catch up completely with the leading regions. Here, a complete catch up can be achieved when (i) the technological gap between the two regions is not too wide and (ii) firms in the lagging region have enough opportunities to *learn by interacting* (e.g. watching) the technologies used by firms in the leading region. In particular, this may occur only if the lagging regions' learning capabilities to assimilate potential technological spill-overs are sufficiently large. The chances of benefiting from these spill-overs depends on the opportunity to interact with firms operating in the leading regions. Since this opportunity is higher when regions are more integrated, *our work stresses the relevance of trade costs levels - as a proxy for the difficulty of interacting - in allowing a successful process of catching up.* More precisely, we represent trade costs by iceberg costs that are particularly suitable to describe the cost of the "distance" between any two regions, as well as the cost of all other natural and artificial barriers to trade. Therefore, while knowledge spill-overs may take place from a leading region towards a neighbouring lagging region, they fail to occur if the lagging region is very far, because its firms have less opportunities to interact with firms in the more developed region.

The model is presented in section 2, while section 3 deals with the necessary conditions for a complete process of catching up to occur. In section 4, the equilibria for given levels of the technology in the two regions are analyzed. More precisely, agglomeration equilibria are studied in 4.1, while the symmetric equilibrium is analyzed in 4.2. Using new dynamics based on technological spill-overs, we discuss the different equilibria in section 5, where it is shown that the level of trade costs is critical in determining whether a catching up process can be successfully completed or not. Section 6 gives the conclusions.