Spatial agglomeration of MNEs:

The role of information externalities and knowledge spillovers

Abstract

This study suggests a model for the agglomerative behaviour of MNEs with local competitors. Relying on foreign MNEs' spatial distribution across 686 Italian *Local Labor Systems*, we find that MNEs' locational behaviour is influenced by (i) informational externalities, giving rise to locational cascades and imitation of other foreign MNEs, and (ii) potential knowledge spillovers, which might act both as a centrifugal and a centripetal force, depending on the nature of local counterparts. Specifically, foreign MNEs tend not to agglomerate with local domestic companies as they perceive potential knowledge inflows to be lower than potential leakages, unless local companies enjoy some comparative advantages. Conversely, foreign MNEs' are willing to agglomerate with other foreign MNEs, as they bet on a positive balance between knowledge inflows and outflows.

Key words: MNEs' location choice, agglomeration, information externalities, knowledge spillovers

JEL classifications: F23, L11, R12, R30

1. Introduction

The spatial behaviour of MNEs has significant implications for regional and local development because of the scale of FDI operations undertaken by MNEs in all industrial and commercial sectors. According to the latest World Investment Report 2008 (Unctad, 2008), global FDI inflows has reached the level of $1,833 billion in 2007, and policy makers are continuing in their efforts to make the investment climate more attractive so that the overall trend to inward FDI remains one of great openness. Within this contexts, it becomes crucial to understand and predict the spatial decisions of MNEs.

The study of the concentration of economic activity in geographical space has long intellectual roots, leading back to Marshall (1920). Traditional location theory was mainly concerned with the firm's need to achieve economies of scale, while simultaneously minimising cross-border and other transportation costs. However, advances in transport and communication technologies, the rapid developments in the global economy (Dunning, 2009) as well as the evolution of capabilities and strategies of MNEs towards asset-augmenting and competence creating investment (Cantwell and Mudambi, 2005) require adjustments to be made to these explanations. In particular, partly because of the shift in the global environment, firm-specific advantages have to be considered increasingly interconnected with location-specific ones (Cantwell, 2009) so that in order to analyze the MNE location problem properly, it is necessary to consider both the organizational and the locational choices together (McCann and Mudambi, 2004). Indeed, while receiving knowledge spillovers, firms may also serve as potential knowledge sources, depending on the local context and local companies relative characteristics (Alcacer and Chung, 2007).

Within this context, we propose a model for interpreting the location behaviour of MNEs as respect to the local (either foreign or domestic) competitors, at the industrial level. Extending the traditional approach à la Ellison and Glaeser (1997), where firms locate near one another

as proximity reduces transportation costs for goods, people and ideas, we claim that (i) geographical proximity alone does not suffice to generate agglomeration economies, and therefore, interaction between actors; and (ii) interaction does not necessarily lead to positive spillovers. Specifically, foreign MNEs' locational behaviour is influenced by two types of externalities and spillovers (Vicente and Suire, 2007). On the one hand, informational externalities and observational learning give rise to locational cascades leading MNEs to imitate (and therefore, agglomerate with) other foreign MNEs, which have already faced the problems related to their being unfamiliar with the local context. On the other hand, potential knowledge externalities and spillovers, associated to interactive learning, might act both as a centrifugal and a centripetal force. In fact, a number of recent studies have recognized that individual firms interact differently with local networks, as well as experiencing different degrees of knowledge inflows and outflows with these networks, and they have stressed that local competitive interaction may offset the potential attractions of knowledge spillovers (Shaver and Flyer, 2000; Chung and Kalnins, 2001; Aharanson et al., 2007; Alcacer and Chung, 2007). Therefore, to study the overall impact of potential spillovers on the locational behaviour of MNEs it is necessary to examine knowledge inflows and knowledge outflows (leakages) simultaneously.

In particular, MNEs' subsdiaries might undertake a range of roles (McCann and Mudambi, 2007) going from competence exploitation to competence creation (Cantwell and Mudambi, 2005; Belderbos and Sleuweaegen, 2007; Cantwell and Piscitello, 2007). Specifically, competence exploiting subsidiaries simply adapt to the local context lines of capabilities already existing within their parent companies; hence, they have little to gain and much to lose from co-locating with local firms. Conversely, competence creating subsidiaries aim at creating new sources of competitive advantage for their parent companies, and are normally located in countries/local contexts close to the innovation frontier where domestic firms and

specific domestic sectors are likely to possess valuable knowledge also for foreign MNEs (Singh, 2007). However, the majority of MNEs' subsidiaries continue to focus on incremental adaptation of their parent firm's products for the local markets (Kuemmerle, 1999; Frost et al., 2002), they particularly suffer the risk of technological leakages, i.e. that their technology will fall into the hands of local competitors (Sanna Randaccio and Veugelers, 2007). However, knowledge outflows (leakages) might be smoothed (or even counterbalanced) whenever local companies do perform a comparative international advantage in that sector. If this is the case, as in Singh (2007), knowledge outflows from host domestic firms to MNE subsidiaries exceed knowledge inflows from MNE subsidiaries to host country firms.

In order to assess the role of information and knowledge spillovers on the agglomerative behaviour of foreign MNEs with other foreign MNEs and/or local domestic companies, we develop and empirical analysis that focus on foreign MNEs in Italy, as in 2001. Namely, we analyze foreign MNEs' spatial behaviour and location choices across 686 Italian territorial units named *Local Labor Systems,* by relying on the agglomeration indexes originally developed by Ellison and Glaeser (1997).

This work is original in various respects. First, although previous studies have already assessed that firms' agglomerative behaviour might differ according with their heterogeneity/productivity (Ottaviano et al., 2002; Baldwin and Okubo, 2006; Saito and Gopinath, 2009), we show that heterogeneity concerns not only "who" agglomerates but the whole set of actors involved. In other words, explaining agglomeration requires taking into account "who agglomerate with whom". In an earlier paper, Alcacer and Chung (2007) distinguish foreign firms between technological leaders and laggards relative to the host country, thus allowing for firm heterogeneity. Instead, we allow for a different dimension of heterogeneity that refers to the distinction between foreign and domestic companies. Second, we attempt to provide a direct measure for information externalities, while the previous

literature has insofar indirectly inferred their role from the observation of spatial agglomeration. Third, we provide a measure of (intra- and inter-industry) knowledge spillovers that allow for the fact that spillovers are not simply "in the air" but they do imply on the one hand, the generation of tacit knowledge and, on the other, the ability and the opportunities to absorb it. Fourth, we assess the overall impact of potential spillovers on the locational behaviour of MNEs by examining knowledge inflows and knowledge outflows (leakages) simultaneously.

The paper is organized as follows. Section 2 presents our conceptual framework and develops the testable propositions on the role of information externalities and knowledge spillovers on the industrial location of foreign MNEs and their co-location with other foreign MNEs and local domestic companies. Section 3 describes the index adopted for measuring agglomeration and coagglomeration, and presents the data as well as some descriptive statistics. The econometric model and the variables employed are reported in Section 4, while Section 5 illustrates and discusses the results. The last Section summarizes the main contribution and implications of the paper and indicates directions for future research.

2. Conceptual background and propositions

Location of MNEs' investments has been widely investigated both theoretically and empirically by economic geographers and IB scholarls. Relevant influencing factors have been recently summarized in three broad categories as follows (Crozet *et al.*, 2004; Dunning and Lundan, 2008): (i) endowment effects, that explain why particular economic activity would be "naturally" drawn to a given location; (ii) agglomeration effects, referring to the Marshallian availability of labour, to the easy and cost-effective access to specialised inputs and to knowledge spillovers; and (iii) policy-induced effects.

Therefore, the attractiveness of some locations lie not only in the fact that they can provide firms with valuable resources in the form of good physical and human infrastructures but also valuable opportunities for learning from other firms through intentional and unintentional knowledge inflows and spillovers (McCann and Mudambi, 2004).

Borrowing from some recent studies on the formation of high tech clusters (Vicente and Suire, 2007; 2009), we add to this framework the suggestion that MNEs' location decision-making is influenced by two types of externalities and spillovers and, namely, the distinction between informational externalities and knowledge externalities.

Specifically, it has been already widely shown that MNEs' location decision-making process is considerably affected by the market and event uncertainty mainly due to their suffering from the so called "liability of foreigness" dating back to Hymer (1960). Hence, foreign firms have a poor knowledge of, and ability to forecast, the economic events in the host country, thus suffering from a condition of adverse asymmetry in information costs, especially those related to *location-specific observation costs* needed to investigate the local endowment of factors (Casson, 1994)[1]. Consequently, MNEs' location choices will be inherently influenced by their rational response to the existence of information costs (Mariotti and Piscitello, 1995; Shaver, 1998; He, 2002).

Informational externalities refer to the firm's observational learning and give rise to locational cascades that lead MNEs to co-locate with companies that already experienced and solved the same problems with the local environment. Knowledge spillovers are instead associated to interactive learning and, therefore, they might act both as a centrifugal and a centripetal force depending on their prevailing outflow vs inflow component.

[1] These costs include also *market and event observation costs*, which are relevant to the acquisition of information on economic and environmental events affecting general production and market conditions, and *information costs* related to the communication, monitoring and control of the internal activities of the multinational enterprises (Casson 1994).

Foreign MNEs' location behaviour might then be driven by the presence of other companies and by the latters' characteristics. Namely, we refer to MNEs' agglomeration whenever foreign MNEs are driven by the presence of other foreign MNEs that have already faced the same "liability of foreigness", and to MNEs' co-agglomeration when they are led by local domestic companies' choices.

Informational externalities

Industry level agglomeration has been already widely shown to significantly occur and to play an important role in MNEs' location decisions (e.g. Head et al., 1995). Within this context, models of informational cascades have been used to explain business agglomeration (Caplin and Leahy, 1998) and clusters formation (Vicente and Suire, 2007, 2009). Informational cascades are based on the role played by informational externalities (Manski, 2000), which can be defined as the benefits agents can obtain from the observation of others (Banerjee, 1992; Bikhchandani and Hirshleifer, 1998). Hence agents converge rapidly towards a same strategy.

When entering a foreign country, MNEs suffer from the liability of foreigness (Zaheer, 1995; Zaheer and Mosakowski, 1997), which is composed by different barriers of a more or less permanent nature associated to foreign exchange risks and unfamiliarity with the local business conditions (nature of the competition, local suppliers and customers, etc.) and the other specific location factors (availability of infrastructures and services, tax incentives, etc). Thus, MNEs face high uncertainty about the payoff of their action that, however, might at least overcome through engagement in learning (Petersen and Pedersen, 2002). In particular, MNEs confront their individual expectation to the collective choice already undertaken by firms that have already faced the same issues and, therefore, are more informed about and

more embedded in the local context (Hymer, 1960). Thus, foreign MNEs learn from the other foreign MNEs' sequence of past actions and simply adopt the same mimetic behaviour.

Such phenomena can be explained basically by an informational problem, and accurately by an arbitrage between private information and public information (the latter has the externality property because of the economies of information searching costs it induces). In this context, behaviour convergence appears as the result of a sequential and cumulative process in which agents decide on the basis of both their own private and probabilistic informational signal and the aggregate actions of predecessors facing a similar decision problem (Vicente and Suire, 2007). Therefore, the public signals firms receive from their predecessors are integrated in their decision as relevant information on the quality of the area. This information reduces the uncertainty and increases the probability for firms to locate themselves in an area selected by other firms previously.

We claim that the higher the private cost MNEs should sustain for gathering information about the unfamiliar foreign locational factors, the more they will rely on public information embodied in the previous location choices by other foreign MNEs. Namely, MNEs tend to adopt a strategy of "herd behavior", which consists in imitating location choices previously made by other MNEs that have already entered the market and, hence, have already supported the needed information costs. Conversely, that does not hold for local domestic firms, whose decisions are strongly driven by historical factors such as the region where an entrepreneur already lives and the region where the original resources conducive to an industry are located (Sorenson and Audia, 2000).

Hence, the need for information costs does impact positively on the MNEs' agglomerative behaviour. Our first proposition is the following:

Proposition 1: Foreign MNEs are more likely to agglomerate with other foreign MNEs the higher the uncertainty on the local context and the relevant information costs.

Knowledge spillovers

According to both the regional science and economic geography literatures as well as to the IB approaches, knowledge and technological spillovers do crucially impact on the co-location of firms in the same areas, i.e. firms locate near one another to learn and "to speed the flow of ideas" (Ellison et al., 2007). However, although spatial proximity is important to generate knowledge spillovers it does not suffice as (i) proximity does not necessarily imply interaction and (ii) interaction does not necessarily mean positive spillovers. Indeed, firms may absorb knowledge but they may also lose it, and the net balance is not necessarily positive as it is instead assumed by most of the regional economics literature. Firms are indeed neither equally equipped to receive knowledge nor homogeneously willing to serve as a source of spillovers; hence, firms' location choice is sensitive to their perception of the benefits of spillovers (McCann and Mudambi, 2005).

Knowledge spillovers are not unidirectional, as they may correspond to either inflows or outflows of knowledge and, while the former are universally perceived as positive, the latter may be perceived either positive or negative depending on the local industrial structure and the relevant competitive scenario, as well as on their being leaders or laggards in the sector (as compared to the local companies). Knowledge outflows may be regarded from the public good aspect of knowledge point of view (d'Aspremont et al., 1998), which therefore contributes to a virtuous cycle by strengthening the knowledge base of the region and making it a more attractive location for other knowledge-bearing firms, that in turn will generate larger future knowledge inflows to all the firms in the group (McCann and Mudambi, 2007). However, the unintentional knowledge leakages of the MNE's valuable intellectual capital is

normally seen negatively by the firm (Grindley and Teece, 1997) and this is true especially in a context of oligopolistic competition, as it is normally the case for MNEs. In fact, any information outflows from the MNE might be more valuable to its competitors than any potential information outflows from these competitors to the MNE, so the overall effect of the knowledge outflows is perceived to be negative. Hence, knowledge spillovers and the foreign MNEs' perception depends on the industrial structure and competitive context (McCann and Mudambi, 2004; Rosenthal and Strange, 2003), but also on the relative position of foreign MNEs towards local domestic as companies would strategically choose locations to gain exposure to others' localised knowledge while reducing leakage of their knowledge to competitors (Alcacer and Chung, 2007). Indeed, when foreign MNEs behave as leaders, as they exploit existing capabilities and adapt existing products and processes to local environments, leakages towards local companies are likely to be higher than possible inflows. Thus, foreign MNEs would not co-locate with local domestic companies, which are laggards and have therefore something to gain from them. Hence, as foreign MNEs are typically more technologically advanced and more productive than local domestic firms (Castellani and Zanfei, 2006), they do not normally perceive any advantage from coagglomeration with local companies as they fear potential knowledge inflows to be lower than potential leakages. Conversely, whenever local companies are technological leaders or enjoy some comparative advantages in the relevant sector, foreign MNEs might perceive as positive the net balance of knowledge flows, thus being possibly willing to co-locating with them.

Instead, foreign MNEs' are more likely to agglomerate with other foreign MNEs, as knowledge inflows would be at least as relevant as knowledge outflows. Indeed, MNEs perceive as likely the chance of benefiting from knowledge spillovers generated by their "peers", thus betting on a positive balance of knowledge spillovers. This is likely to be even truer the more the MNEs' local subsidiary is competence exploiting, i.e. whenever it

constitutes a rather weak source of knowledge spillovers for the international competitors co-located in the host country.

Therefore, our second proposition is articulated as follows:

Proposition 2a: Foreign MNEs tend to not agglomerate with local domestic companies, the higher the potential knowledge spillovers as they expect potential knowledge outflows (leakages) to be higher than inflows.

Proposition 2b: Proposition 2a does not hold if local domestic companies enjoy a comparative advantage in the relevant sector.

Proposition 2c: Foreign MNEs tend to agglomerate more with other foreign MNEs, the higher the potential knowledge spillovers. Indeed, they expect the balance between inflows and outflows to be positive.

Possibly due to the absence of such a distinction between foreign and domestic companies on the one hand, and between advantaged vs. non advantaged local domestic companies, on the other, previous empirical evidence concerning the impact of knowledge spillovers on agglomeration of economic activities is controversial. Indeed, some authors (Figueiredo et al., 2000; Rosenthal and Strange, 2001; He, 2002; Hogenbirk and Narula, 2004) find that foreign firms are attracted by potential local spillovers, while others (Flyer and Shaver, 2000; Alsleben, 2005; Alcácer and Chung, 2007) find that the latter act as a centrifugal force.

However, it is worth specifying that this framework refers to knowledge spillovers occurring both within the firm's own industry (i.e. intra-industry spillovers) and in other more or less related industries (inter-industry spillovers). Intra-industry spillovers are associated with the

presence of a wide-ranging collection of firms within a given industry or sector, all concentrated in the same geographical area (Baptista and Swann, 1998). They relate to specialisation externalities and can be associated with the contribution of Marshall (1920), and to what geographers call "localisation economies". The kinds of linkages that grow up between competitors, suppliers and customers in any regional district or area are also, to some extent, peculiar to that location, and imbue the technology creation of its firms with distinctive features. For these reasons, other MNEs often need to be on-site with their own production and their innovatory capacity if they are to properly benefit from the latest advances in geographically localised technological development, to feed their innovation (Cantwell, 1989). Inter-industry spillovers are associated with the co-presence of firms from different industries, and working in different fields of research. Indeed, the more diverse is the R&D conducted in a region, the more the firm could potentially benefit (Feldman and Audretsch, 1999). Such spillovers relate to diversity externalities, which favor the creation of new ideas across sectors, and go back to the concept of "urbanisation economies" originally suggested by Jacobs (1969). Thus, inter-industry spillovers exert an indirect effect upon foreign firms' agglomeration. Indeed, if MNEs in sector *i* tend to agglomerate with other companies in sectors *j*s to capture and benefit from vertical (or, more generally, inter-industry) spillovers, they predictably will end to agglomerate together.

3. Location and agglomeration

3.1. The index adopted

Any assessment of the importance of clustering must rest on the counterfactual position that is adopted, i.e. what one assumes would have happened in the absence of clustering (Dunning and Lundan, 2008). Accordingly, we rely on the framework suggested by Ellison and Glaeser

(1997) that adopted the idea that in the absence of either natural advantages or spillovers (i.e. in the absence of agglomeration) location choice could be reduced to throwing darts at a map. As the issue we want to investigate is the foreign MNEs's locational approach relative to other foreign MNEs and/or domestic companies, we adopted both an index for agglomeration and an index for coagglomeration. Specifically, as far as agglomeration is concerned, we relied on the traditional agglomeration index suggested by Ellison and Glaeser (1997) and, namely, on its revised version suggested by Figueiredo et al. (2007), which replaces employment with plant count data. In other words, this index takes into account that, since the EG index provides an employment-weighted measure that is affected by the dimension of the plants, i.e. given the same number of employees and plants, it yields a higher agglomeration index for industries whose average dimension of plants is bigger (Holmes and Stevens, 2002). Specifically, while the original Ellison and Glaeser (1997) agglomeration index is:

$$\gamma_{EG} = \frac{G_E - \left(1 - \sum_{j=1}^{J} x_j^2\right) H_E}{\left(1 - \sum_{j=1}^{J} x_j^2\right)\left(1 - H_E\right)}$$

Where:

$$G_E = \sum_{j=1}^{J} \left(s_j - x_j\right)^2$$

s_j denotes area *j*'s share of employment in that industry, x_j denotes area *j*'s share of total manufacturing employment in the same industry, and H_E is the employment Herfindhal index for that industry.

The index suggested by Figueiredo et al. (2007) is the following:

$$\gamma_{GFW} = \frac{nG_{GFW} - \left(1 - \sum_{j=1}^{J} x_j^2\right)}{\left(n-1\right)\left(1 - \sum_{j=1}^{J} x_j^2\right)}$$

where $G_{GFW} = \sum_{j=1}^{J}\left(\frac{n_j}{n} - x_j\right)^2$ is the "raw" concentration index, n_j is the number of plants in area *j*, n is the total number of plants that compose that industry, and x_j denotes again area *j*'s share of total manufacturing employment in the same industry.

Thus, the GFW index is very similar to the EG index. It only replaces the Herfindhal index by $\frac{1}{n}$ and the "raw concentration index" is replaced by its counterpart expressed in terms of counts of plants, G_{GFW}.

As far as whether foreign MNEs tend to locate close to domestic companies, we resorted to the coagglomeration index originally put forward by Ellison and Glaeser (1997), as in Barrios et al. (2006). Accordingly, coagglomeration between foreign MNEs and domestic firms occurs whenever they co-locate more than it would happen randomly, which constitute the counterfactual for the absence of coagglomeration. Therefore, one should expect zero when foreign and domestic firms are exactly as co-located with one another as random chance should make them. Negative values of the index arise when foreign and domestic firms are agglomerated in different areas[2].

Specifically, considering the divide between foreign and domestic plants, and measuring the degree of coagglomeration between these plant groups across regions, for a given industry i the index can be written as follows:

$$\gamma_i^{Co} = \frac{\left[G_i / \left(1 - \sum_j x_j^2\right)\right] - H_i - \sum_k \gamma_{i,k} \cdot w_{i,k}^2 \cdot \left(1 - H_{i,k}\right)}{1 - \sum_k w_{i,k}^2}$$

where G_i is the "raw concentration" of employment in the group as a whole, i.e. an approximation of the Gini index defined as the sum of square deviations of s_{ij} (the share of

[2] The authors wish to thank Glenn Ellison, Edward Glaeser, William Kerr and Luisito Bertinelli for their suggestions and clarifications on the correct use and interpretation of the coagglomeration index.

industry *i*'s employment in area *j*) to x_j (the share of aggregate manufacturing employment in area *j*):

$$G_i = \sum_j \left(s_{ij} - x_j\right)^2$$

The term $H_i = \sum_k w_{ik}^2 H_{ik}$ represents the group's plant Herfindhal index for the industry. Subscripts k = f, d refer to other foreign MNEs or domestic plants, respectively, and w_k represents their relevant shares of total employment of industry *j*. The term γ_i is the agglomeration index calculated previously.

Therefore, we believe these measures of agglomeration are particularly appropriate to investigate the locational behaviour of foreign MNEs. Indeed, due to the inclusion of Herfindhal indexes, they allow for the industrial structure of each considered sector that has been shown to influence firms' perception of the benefit of information spillovers[3] (McCann and Mudambi, 2007).

3.2. Data and descriptive statistics

Agglomeration indexes have been computed using information on foreign MNEs in Italy from the Reprint-ICE database, which contains detailed yearly information about both Italian affiliates of foreign firms (in terms of number of employees, location and sales) and the foreign affiliates of Italian firms, in manufacturing and service industries, since 1986 (for further details, see Mariotti and Mutinelli, 2009). Data on the spatial and industrial distribution of national plants come from the 2001 Economic Census (Italian Office for National Statistics, 2001a). However, as the Economic Census provides information on the

[3] Namely, firms might perceive a potential positive effect associated to knowledge leakages in a competitive market structure, where they may contribute to local virtuous cycles, and the public aspect of knowledge dominates. Conversely, firms negatively see leakages of their valuable capital (e.g. Co, 2002; Alsleben, 2005) when the market structure is oligopolistic, and the private aspect of knowledge dominates.

total number of plants regardless of their nationality, we subtracted foreign-owned plants (as in 2001) in order to obtain the population of the local domestic ones.

As our focus is here on manufacturing, we refer only to the 101 three-digit Nace - rev.1 sectors where at least one foreign MNE is present, as in 2001 (see Annex 1). However, as our aim is to explain agglomeration, we need to consider only sectors hosting at least two foreign MNEs' plants. Hence, we eliminated 9 sectors thus reducing the total number to 92. Additionally, we also excluded sectors that represented outliers possibly distorcing the estimation, thus obtaining 85 relevant sectors[4].

As far as the territorial level, agglomeration indexes have been calculated at the Local Labor System (LLS) level in Italy. Namely, we relied on the 686 LLSs identified from the 2001 Census of Population[5]. The Italian Office for National Statistics identifies LLSs on the basis of commuters' patterns and they correspond to geographic areas wherein the bulk of the resident population both live and work (Italian Office for National Statistics, 2001b). Thus, LLSs correspond to territorial units constituted by several municipalities[6] that are geographically intertwined, and they may therefore be considered an instrument to investigate the socio-economic structure of the country more appropriate than the administrative units (reprensented by regions or provinces). Especially, they costitute a proper unit of analysis to capture the effects of spillovers on agglomeration as knowledge flows have been extensively shown to cross administrative boundaries (Anselin et al. 1997; Paci and Usai, 2000; Autant-Bernard, 2001). Indeed, being identified by means of commuters' movements, SLLs'

[4] Namely, we left out from the analysis publishing and related activities, as they actually refer to services rather than to manufacturing activities (see the latest revision of the Nace classification), and those sectors where a lion share of the total foreign-owned plants (80 percent or more) is constituted by units co-located in the same municipality and referring to a single MNE. Indeed, this multi-plant structure is exclusively due to administrative and legal reasons, thus introducing a substantial distortion in the value of the agglomeration indexes.

[5] For a similar approach based on the Italian LLSs, see Pagnini (2002).

[6] It may be worth observing that, referring to the Eurostat scheme of territorial classification - the Nomenclature of Territorial Units for Statistics (NUTS), Italian municipalities correspond to the NUTS5 level.

boundaries are more likely to capture the spatial dimension of tacit knowledge spillovers, which are mainly based on localized interactions among people, firms and social entities.

Tables 1 and 2 report the 15 highest and lowest values of agglomeration indexes for foreign MNEs with other foreign MNEs and local domestic companies, respectively. Interestingly, the observations of sectors appearing in the two rankings seem to provide a preliminary confirmatory evidence for our propositions. First of all, foreign MNEs significantly agglomerate with other foreign firms in several high tech sectors (i.e. aerospace, pharmaceuticals, consumer electronics, medical equipment, scientific instruments). Apart from pharmaceuticals, none of these is included in the list of most coagglomerated industries, i.e. those in which foreign MNEs agglomerate with local domestic firms (see Table 2). On the contrary, the same or other high tech sectors are in the opposite list of least agglomerated sectors (i.e. consumer electronics, aerospace, electronic components, optical instruments). This evidence is coherent with the idea that high tech industries are the first candidates to be both more sensitive to information costs and a source of important knowledge spillovers. In the same vein, it is worth noting that three of the four scale intensive sectors (tabacco, motor vehicles, man-made fibers, motor cycles and bycicles) in which foreign MNEs tend to agglomerate with other foreign MNEs do appear among the ones in which foreign MNEs do not agglomerate with local companies. Second, traditional sectors do not record the agglomeration of foreign MNEs with other foreign firms, while recording that with local domestic companies, whenever the latter enjoy a comparative advantage (i.e. manufacture of ceramic tiles, textiles, footwear and furnitures). This evidence gives some descriptive support to Proposition 2b.

(Tables 1 and 2 go about here)

4. The econometric analysis

4.1. The model and the variables

As already widely acknowledged (Barrios et al. 2006; Ellison et al., 2007), the index suggested to measure agglomeration and coagglomeration do not allow neither to make the distinction between natural advantages due to site-specific characteristics and potential spillovers nor to assess their relative importance. Therefore, we adopt a simple OLS regression model aiming at explaining the role of these explanatory variables on the agglomeration of foreign MNEs, and their coagglomeration with domestic firms. Specifically, according to our conceptual framework and propositions, we consider variables related to both information esternalities and knowledge spillovers, other than traditional variables associated to the reliance on natural resources and transportation costs. Specifically, the models are the followings:

$$\gamma_i^{MNC} = \beta_0 + \beta_1 Info\_extern_i + \beta_2 Know\_spill_i + \beta_3 Controls_i + \varepsilon_i$$

$$\gamma_i^{Co} = \delta_0 + \delta_1 Info\_extern_i + \delta_2 Know\_spill_i + \delta_3 Controls_i + \eta_i$$

where γ_i^{MNC} is the agglomeration index for foreign MNEs with other foreign MNEs in sector *i*; γ_i^{Co} is the agglomeration index for foreign MNEs with local domestic firms in sector *i*, *Info_extern* is the variable related to information externalities, and *Know_spill* refers instead to knowledge spillovers; *Controls* accounts for control variables.

The explanatory variables have been built as follows (the detailed description of the variables, the source of data and the year considered are reported in Table 3). However, it may not be out of place here observing that in the operationalisation of our variables we followed the recent empirical innovation put forward by Ellison et al. (2007) to rely on instruments for the characteristics of industries in order to rule out possible endogeneity. Specifically, they observe that the I/O tables that are normally employed to proxy interactions amongst

industries and agents may be endogenous to agglomeration as they may indeed reflect the industries' geography. In fact, I/O relationships might also mirror agglomeration, and not only influence it. Hence, according with the procedure adopted in that paper, where they instrument the US I/O tables through the UK one, we also rely on the UK I/O table obtained from the UK Office for National Statistics, and referring to 1995. Additionally, UK I/O tables allowed us to adopt detailed information at the three digit level[7].

(Table 3 goes about here)

Informational externalities (Info_extern)

In order to allow for the informational effect, we suggest a proxy for information costs, i.e. those costs firms should sustain in order to gather information on the local industrial and territorial context. Specifically, we refer to each industry's firms' resort to external local services, the rationale being that higher expenditures for external services mean greater need of external supports to undertake activities and investments[8]. Hence, industries displaying high need for a wide range of diversified external services correspond to those in which firms sustain high costs for gathering private information about the qualititative and quantitative availability of services for different locational choices. Alternatively, firms might react by relying on public information embodied in the others' behaviour, i.e. they tend to coagglomerate in order to reduce information costs and to benefit instead from informational externalities.

Namely, the variable *Info_extern* is measured by the degree of dependence on external services for each industry *i* calculated as the incidence of the total flows each sector i receives in input from the service sectors, on the total output. Specifically, the variable *Info_extern*

[7] Instead, the Italian I/O tables are not available at the three-digit sectoral level.

relies on the UK input-output tables and includes the following sectors: 99 (Telecommunications), 100 (Banking and finance), 102 (Auxiliary financial services), 107 (Computer services), 108 (Research and development), 109 (Legal activities), 110 (Accountancy services), 111 (Market research, management consultancy), 112 (Architectural activities and technical consultancy), 113 (Advertising), and 114 (Other business services). In line with our propositions, we expect a positive role in the explanation of agglomeration of foreign MNEs with other foreign MNEs.

Knowledge spillovers (Know_spill)

Potential knowledge spillovers are hard to identify. In fact, they have been normally inferred either indirectly by estimating the change in productivity of domestic firms as a result of investment by foreign MNEs (starting from the pivotal contribution of Caves (1974) and Griliches (1979)) or by tracing knowledge flows directly using citations between patents (Jaffe et al., 1993; 2000; Almeida, 1996; Frost, 2001; Singh, 2007) or by relying on the technology flows between sectors stemming from the Scherer's matrix (Ellison et al., 2007).

Our proxy for spillovers occurring within (intra) and between (inter) sectors takes into account that spillovers imply on the one hand, the generation of knowledge and, on the other, the ability and the opportunities to absorb it (for a related approach, see also Kafouros and Buckley, 2008). Therefore, we consider the following three dimensions:

(i) The sector *i*'s ability/potential of generating spillovers refers only to tacit knowledge, which cannot be codified and requires personal contacts, interaction and spatial proximity to be transmitted (Alsleben, 2005). Namely, the Tacit Innovation Index has been measured by the share of firms (in sector *i*) that

[8] Instead, previous empirical studies on spatial distribution of firms has traditionally considered agglomeration itself as a proxy for information costs (e.g. Mariotti and Piscitello, 1995; Head et al., 1999; He, 2000), thus using the effect (agglomeration) to measure the cause (information costs).

undertook innovations in the following fields: strategy, management, organization, esthetic, design, training and marketing, and/or used tacit methods to protect their innovation (such as secrecy, increase of complexity of operations and increase of required competences), in the period 1998-2000. Data come from the Italian chapter of the Community Innovation Survey (CIS3), which is maintained by the Italian Office for Statistics.

(ii) The ability of the other sectors *j* to absorb/capture spillovers generated by sector *i*, i.e. their absorptive capacity. According with the previous empirical literature (e.g. Griffith et al., 2003; Lehay and Neary, 2007), sector *i*'s absorptive capacity has been proxied by the sector's R&D intensity (R&D expenditures/sales). Data come again from the Community Innovation Survey (CIS3).

(iii) According with previous studies (e.g. Smarzinska Javorcik, 2004; Haskel et al., 2007; Kafouros and Buckley, 2008), the opportunities to absorb technology are likely to proportionally depend on the frequency and the intensity of contacts occurring between the relevant sectors (*i* and *j*). Relying on the UK I/O table, we used the total I/O flows between sector *i* and sector *j* in order to proxy the contacts. Specifically: ($x_{i,j}$ + $x_{j,i}$), where $x_{i,j}$ represents the flows of goods (in millions of Euros at current prices) that industry *i* supply to industry *j*, and $x_{j,i}$ the amount that industry *i* receives from *j*).

Therefore, the proxy employed for total (i.e. both intra- and inter-industry) knowledge spillovers involving sector *i* is the following:

$$Know\_spill\_tot_i = TII_i \sum_j (x_{i,j} + x_{j,i}) * R\&D_j + R\&D_i \sum_i (x_{i,j} + x_{j,i}) TII_j$$

where i, j = 1, …, 85.

Namely, we can distinguish between intra- and inter-industry components as follows:

$$Know\_Spill\_\text{int}ra_i = TII_i * x_{i,i} * R\&D_i$$

and

$$Know\_spill\_inter_i = TII_i \sum_{j \neq i} (x_{i,j} + x_{j,i}) * R\&D_j + R\&D_i \sum_{i \neq j} (x_{i,j} + x_{j,i}) TII_j$$

As in Ellison et al. (2007) our measures of knowledge spillovers are undirectional and, according to our propositions we expect a positive impact of spillovers on the MNEs' agglomeration while a negative sign for the coagglomeration of MNEs with local companies unless the latter enjoy a comparative international advantage that make the former more interested in sourcing local competences and resources.

In order to allow for the relative international advantage (or disadvantage) of Italian industries and firms, we rely on the revealed comparative advantage (Balassa, 1965). Specifically, RCA_{ij} is defined as follows:

$RCA_{ij} = (X_{ij}/\Sigma_j X_{ij})/(\Sigma_i X_{ij}/\Sigma_{ij} X_{ij})$

where X_{ij} are exports in sector *i* (i = 1, .., 85) from country *j*.

The numerator represents the percentage share of a given sector *i* in national exports and the denominator represents the percentage share of the same sector in the world export. Where *RCA* is above 1 the country is said to be specialised (i.e. comparatively advantaged) in that sector and vice versa where *RCA* is below 1.

Data employed to build the index come from the Italian National Institute for Foreign Trade (ICE) and refers to 1998 (ICE, 2008). The variable RCA is reported in Annex 2 where traditional sectors, in which Italian firms enjoy a strong competitive advantage (De Benedictis, 2005), show the highest RCA values (the maximum value is 11.525, in the Manufacturing of ceramic tiles and flags).

In order to identify those sectors in which Italian companies are more likely to be leader, and foreign MNEs are therefore more confident about the potential knowldge inflows as a

counterbalancing force against the natural disadvantages related to the unfamiliar environment, we adopted a threshold equal to 2. Thus, our variable D_RCA2 takes the value one when RCA>2, and zero otherwise.

Human capital

Besides mechanisms related to interaction and imitation among people, knowledge spillovers are also vehicled by workers, especially highly educated ones (Blomstrom and Kokko, 1998; Moretti, 2004; Rosenthal and Strange, 2004). However, although foreign MNEs may count on their ability to offer higher wages to attract best workers, they may also lose them. According with the traditional trade-off between labour pooling and labour poaching (Ellison et al., 2007), one may expect that foreign MNEs tend to colocate with domestic companies the higher the share of highly educated workers, but also the opposite may be true. The concentration of skilled employment in a given area or industry represents a strong centripetal force for any type of firms, since it allows to undertake labor pooling. Indeed, by agglomerating and by offering the best wages it is possible to attract high skilled workers, which positively affect the productivity of the firm and which contribute to the transfer of tacit knowledge (Rosenthal and Strange, 2001). However, it can also assume a negative connotation when it becomes labor poaching. Indeed, firms may also lose their best workers and, hence, decrease their productivity and suffer a leak of tacit knowledge (Combes and Duranton, 2001).

As in Rosenthal and Strange (2001), we proxied human capital with the share of managers on the total employment in each industry[9] (*Skilled_labour*). Data come from the database Mediocredito Centrale-Unicredit[10] and refer to year 2001. We expect this variable to

[9] It is worth mentioning that we also tried the share of graduated workers over the total employment. However, as the latter did not come out significant, we decided to not report it in the paper.

[10] We wish to thank Alessandro Arrighetti and Andrea Lasagni for providing us with the relevant data.

positively influence the agglomeration of foreign MNEs with local domestic companies, while we do not have any a priori expectation on the impact on the agglomeration of foreign MNEs with other foreign MNEs.

Control variables

Transportation costs (Transport)

According to Marshall (1920), the costs of moving goods and people could be reduced by industrial agglomeration (Ellison and Glaeser, 1997). Therefore, firms tend to concentrate within the same region when transportation costs decrease. Indeed, low costs allow the firm to serve proximate and distant markets from a single central location without substantial disadvantage. But as transportation costs climb, the profitability of such a configuration diminishes; if transportation costs are high enough, the firm would prefer to have facilities distributed geographically (Chung and Song, 2004).

Our proxy relies on the UK I/O tables and refers to the degree of dependence on Transportation costs for each sector *i* calculated as the incidence of the total flows each sector i receives in input from the transportation sectors, on the total output. Specifically, our variable *Transport* includes the following sectors: 93 (Railway transport), 94 (Other land transport), 95 (Water transport) and 96 (air transport). In line with results obtained by previous studies (Krugman, 1991; Figueiredo et al., 2000; Alsleben, 2005), we expect high transportation costs to constitute a dispersion force that, therefore, does negatively impact on agglomeration.

Natural resources (Natural_resources)

It has long been recognized that natural advantages can affect the location decisions of firms, as they explain why particular economic activities would be naturally drawn to a given

location (Dunning and Lundan, 2008).

According with Rosenthal and Strange (2001) we rely on the I/O tables to control for the importance of natural advantages associated with proximity to inputs. Specificially, our variable *Natural_resources* is the incidence of the total flow each sector *i* receives in input from the natural resource sectors, on the total output. Sectors included are: 1 (Agriculture) ,2 (Forestry), 3 (Fishing), 4 (Coal extraction), 5 (Oil and gas extraction), 6 (Metal ores extraction), 7 (Other mining and quarrying). To the extent that firms desire to locate close to natural resources, we expect the coefficient of this variable to be positively related to agglomeration of foreign MNEs with both other foreign MNEs and local domestic companies. Descriptive statistics and correlation coefficients are reported in Table 4.

(Table 4 goes about here)

5. Results of the econometric analysis

Results from the robust OLS estimation for the agglomeration of foreign MNEs with other MNEs (γ^{MNC}) and with local domestic companies (γ^{Co}) are reported in Table 5. Variables have been standardized in order to make it easier to interpret estimated coefficients and make them easily comparable.

(Table 5 goes about here)

The first two columns reveal that the proxy employed for information externalities (*Info_extern*) turns out to be positive and significant different from zero (at $p<.05$), thus confirming our first proposition on the MNEs' herding behaviour towards other foreign MNEs' locational choices, allowing them to reduce the costs for gathering information on the context specific locational factors. In fact, information externalities do not seem to influence the agglomeration of foreign MNEs with local domestic companies (*Info_extern* is never

significant in the models for γ^{Co}) that have different characteristics and by their very nature face different problems and local and issues.

As far as our second propositions, i.e. the role of knowledge spillovers, our results seem to confirm them. Namely, knowledge spillovers do impact positively on the agglomeration of foreign MNEs with other foreign MNEs (*Know_spill_tot* is positive and significantly different from zero, at p<.01 in Model 1), thus confirming Proposition 2c. However, this holds especially for the intra-industry component, as indeed, Model 2 reveals that both *Know_spill_intra* and *Know_spill_inter* are positive and significant (at p<01) but the former presents a coefficient that is 5-folds the latter's one. Proposition 2a is also confirmed as looking at results for foreign MNEs' agglomeration with local domestic companies, it emerges a strongly significant negative effect both for total knowledge spillovers (*Know_spill_tot* is significantly different from zero at p<.01, in Model 3) and their intra- and inter-industry components (Models 6 and 7). However, these negative effects, due to the foreign MNEs' fear of outward knowledge leakages to local competitors, seem to be counterbalanced by the MNEs' hope to accessing local sources of knowledge, whenever local companies enjoy a comparative international advantage, thus confirming Proposition 2c. As a matter of fact, the moltiplicative variable *Know_spill_tot_rca* turns out to be positive and significantly different from zero (at p<.01) in Model 4, although the estimated coefficient does not allow to overcome the negative one obtained for *Know_spill_tot.* However, the counterbalancing effect becomes clearer when distinguishing between intra- and inter-industry knowledge spillovers. *Know_spill_intra_rca* is positive and significantly different from zero (at p<.05), while *Know_spill_intra* remains negative but not significant, in Model 8, thus revealing that foreign MNEs perceive a net positive balance for knowledge inflows vs. outflows, only when local competitors in the same sector do enjoy a comparative advantage.

As far as the availability of skilled labour, the proxy employed does not come out significantly different from zero in any of the specifications adopted. However, it is always positive and almost significant when considering the agglomeration of foreign MNEs with local domestic companies as, if this is the case, they may perceive a positive trade-off between labour pooling and labour poaching (Ellison et al., 2007). Indeed, foreign MNEs might count on their ability to offer higher wages to attract best workers (Brown et al., 2004), with a low risk of losing them. The scant significance of the proxy employed might be associated to the territorial unit used in the analysis. Indeed, as LSSs are constituted by clusters of municipalities characterised by the self containing of labour demand and supply, they already might capture most of the agglomeration due to the local labour market.

Finally, as far as our control variables, we observe that, interestingly, transportation costs do not come out significantly different from zero in any of the specifications. However, this result may be not only a sign of changes in transportation technologies that altered the perception of space, but also to the admittedly irrelevant role of transport costs in influencing firms' locational choice in a relative small-sized country like Italy. Likewise, the coefficient of the variable *Natural resource* is never significantly different from zero, as in most of the previous empirical investigation on firms' agglomeration patterns (e.g. Rosenthal and Strange, 2001). However, our result might also stem from the exclusion of the mining sectors and energy products where natural resources certainly play a more relevant role (see also Pagnini, 2002).

6. Conclusion

This paper investigated factors explaining MNEs' agglomeration behavior at the subnational level. Specifically, by distinguishing between foreign MNEs' agglomeration with other

foreign MNEs on the one hand, and with local domestic companies on the other, we assess the relative importance of factors used to explain agglomeration in traditional studies.

In particular, we believe our results provide some contributions to the dialogue now taking place between industrial geographers, economics and business analysts. Specifically, our results confirm the presence of isomorphism in MNEs' location decisions. However, while most of previous empirical studies document this phenomenon at the country level for the same company (e.g. Arregle et al., 2009), we show the same occurs at the subnational level among foreign MNEs. Additionally, previous studies have already recently shown that MNEs' attitude towards knowledge spillovers is not deterministically positive (as instead implicitly hypothesised in the traditional regional economics) but it may vary according to the market structure. Here we make a step further as we show that MNEs' perceptions on the net effects of outward vs. inward knowledge spillovers crucially depends also on the nature of the companies MNEs locate close to.

We find that MNEs' locational behaviour is influenced by (i) informational externalities, giving rise to locational cascades and imitation of other foreign MNEs, and (ii) potential knowledge spillovers, which might act both as a centrifugal and a centripetal force, depending on the nature of local counterparts. Specifically, foreign MNEs tend not to agglomerate with local domestic companies as they perceive potential knowledge inflows to be lower than potential leakages, unless local companies enjoy some comparative advantages. Conversely, foreign MNEs' are willing to agglomerate with other foreign MNEs, as they bet on a positive balance between knowledge inflows and outflows.

Our proposed model can be expanded in several directions. For instance, one may distinguish foreign MNEs by nationality in order to assess whether their imitation approach in location choices is stronger for companies originating from the same home country. Indeed, companies

migth find it easier to trust and imititate other companies' choices whenever the latter share the same cultural background and institutional system of values (Lu, 2002; Chan et al., 2006).

Along the same line, one could try to distinguish foreign MNEs' subsidiaries according to their motivations and/or mandate. Indeed, motives for FDI have been increasingly characterised by competence creating attitude over the last decades (Cantwell and Piscitello, 2008) and "the geography of international business activity is not independent of the competitive advantages of the investing firms, and this interdependence is particularly apparent when one examines the dynamics of knowledge-intensive MNE activity" (Dunning, 2009, p. 5).

These modifications would allow to account for several dimensions of MNEs' heterogeneity. Unfortunately, the small numbers involved in the Italian case, as well as the lack of information on the very nature of motivations justifying foreign entries, currently hinder such empirical extensions. The opportunity of replicating the study across other countries would certainly provide a promising step forward in advancing our understanding of the relationship between MNEs' heterogeneity and locational choices.

Other possible modifications may be to allow for the dynamics of the location processes rather than referring only to the observed spatial configuration of MNEs in a certain point in time. Another route in which our model can be expanded is adding service sectors to the manufacturing ones in order to investigate differences, if any, in MNEs location choices. Such modifications require considerable additional gathering of data, and are beyond the scope of the current paper.

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Table 1 – Agglomeration of foreign MNEs with other foreign MNEs: Most and least agglomerated industries

Nace Code		γ
		15 most agglomerated industries
160	Manufacture of tobacco products	0.2119
263	Manufacture of ceramic tiles and flags	0.2056
353	Manufacture of aircraft and spacecraft	0.1874
244	Pharmaceuticals, medicinal chemicals and botanical products	0.1112
267	Cutting, shaping and finishing of ornamental and building stones	0.1056
341	Manufacture of motor vehicles	0.0941
247	Manufacture of man-made fibres	0.0890
323	Manufacture of television and radio receivers, sound or video recording or reproducing apparatus and associated goods	0.0839
354	Manufacture of motorcycles and bicycles	0.0807
331	Manufacture of medical and surgical equipment and orthopaedic appliances	0.0687
351	Building and repairing of ships and boats	0.0646
284	Forging, pressing, stamping and roll forming of metal; powder metallurgy	0.0563
332	Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment	0.0553
156	Manufacture of grain mill products, starches and starci products	0.0507
177	Manufacture of knitted and crocheted articles	0.0491
		15 least agglomerated industries
271	Manufacture of basic iron and steel and of ferro-alloys	-0.0573
362	Manufacture of jewellery and related articles	-0.0511
342	Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers	-0.0285
296	Manufacture of weapons and ammunition	-0.0184
372	Recycling of non-metal waste and scrap	-0.0180
315	Manufacture of lighting equipment and electric lamps	-0.0128
174	Manufacture of made-up textile articles, except apparel	-0.0104
366	Miscellaneous manufacturing n.e.c.	-0.0091
314	Manufacture of accumulators, primary cells and primary batteries	-0.0087
152	Processing and preserving of fish and fish products	-0.0071
352	Manufacture of railway and tramway locomotives and rolling stock	-0.0069
264	Manufacture of bricks, tiles and construction products, in baked clay	-0.0055
297	Manufacture of domestic appliances n.e.c.	-0.0035
232	Manufacture of refined petroleum products	0.0006
158	Manufacture of other food products	0.0020

Table 2 – Agglomeration of foreign MNEs with local domestic companies: Most and least agglomerated industries

Nace Code		γ
		15 most agglomerated industries
263	Manufacture of ceramic tiles and flags	0.2151
171	Preparation and spinning of textile fibres	0.2013
172	Textiles weaving	0.1107
244	Pharmaceuticals, medicinal chemicals and botanical products	0.0271
193	Manufacture of footwear	0.0212
343	Manufacture of parts and accessories for motor vehicles and their engines	0.0161
361	Manufacture of furniture	0.0072
262	Manufacture of non-refractory ceramic goods other than for construction purposes; manufacture of refractory ceramic products	0.0049
173	Finishing of textiles	0.0041
291	Manufacture of machinery for the production and use of mechanical power, except aircraft, vehicle and cycle engines	0.0035
159	Manufacture of beverages	0.0031
175	Manufacture of other textiles	0.0008
261	Manufacture of glass and glass products	0.0006
251	Manufacture of rubber products	0.0004
252	Manufacture of plastic products	0.0000
		15 least agglomerated industries
271	Manufacture of basic iron and steel and of ferro-alloys	-0.2513
296	Manufacture of weapons and ammunition	-0.2447
323	Manufacture of television and radio receivers, sound or video recording or reproducing apparatus and associated goods	-0.1683
232	Manufacture of refined petroleum products	-0.1208
353	Manufacture of aircraft and spacecraft	-0.1019
351	Building and repairing of ships and boats	-0.0972
341	Manufacture of motor vehicles	-0.0896
314	Manufacture of accumulators, primary cells and primary batteries	-0.0821
151	Production, processing and preserving of meat and meat products	-0.0764
342	Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers	-0.0755
160	Manufacture of tobacco products	-0.0741
321	Manufacture of electronic valves and tubes and other electronic components	-0.0691
334	Manufacture of optical instruments and photographic equipment	-0.0682
354	Manufacture of motorcycles and bicycles	-0.0652
365	Manufacture of games and toys	-0.0607

Table 3 – Description of variables, data sources and expected sign

	Description	Data source	Year
Dependent variables			
γ^{MNC}	Agglomeration index for foreign MNEs with other foreign MNEs	Data set Reprint	2001
γ^{Co}	Agglomeration index for foreign MNEs with local domestic companies	Italian National Office for Statistics	2001
Explanatoryvariables			
Info_externalities	The incidence of the total flow each sector i receives in input from the external services sectors, on the total output. Sectors included are: 99 (Telecommunications), 100 (Banking and finance), 102 (Auxiliary financial services), 107 (Computer services), 108 (Research and development), 109 (Legal activities), 110 (Accountancy services), 111 (Market research, management consultancy), 112 (Architectural activities and technical consultancy), 113 (Advertising), and 114 (Other business services).	UK I/O	1995
Know_spill	$Know\_spill\_tot_i = TII_i \sum_{j=1,..,85}(x_{i,j} + x_{j,i}) * R\&D_j + R\&D_i \sum_{i=1,..,85}(x_{i,j} + x_{j,i}) TII_j$	UK I/O CIS3 (Italian National Office for Statistics)	1995 1998-2000
Rca	Revealed comparative advantage	Italian Institute for the International Trade	
Skilled_labour	The share of managers over the total employment in each industry.	Mediocredito Centrale-Unicredit	2001
Control variables			
Transport	The incidence of the total flow each sector i receives in input from the transport sectors, on the total output. Sectors included are: 93 (Railway transport), 94 (Other land transport), 95 (Water transport) and 96 (Air transport).	UK I/O	1995
Natural_resources	The incidence of the total flow each sector i receives in input from the natural resource sectors, on the total output. Sectors included are: 1 (Agriculture) ,2 (Forestry), 3 (Fishing), 4 (Coal extraction), 5 (Oil and gas extraction), 6 (Metal ores extraction), 7 (Other mining and quarrying).	UK I/O	1995

Table 4 - Descriptive statistics and correlation matrix

	γ^{MNC}	γ^{Co}	Info_extern	Know_spill_tot	Know_spill_intra	Know_spill_inter	Rca	Skilled_labour	Natural resource	Transport
Mean	0.0269	-0.0228	7.4639	1.3106	0.0905	1.2201	1.4874	1.9290	3.496	2.1770
Std. Dev.	0.0449	0.0615	2.8272	3.0088	0.3065	2.8128	1.6274	1.0378	8.964	1.6959
Min	-0.0573	-0.2513	2.8250	0.0024	0	0.0023	0	0.1250	0	0.3860
Max	0.2119	0.2151	18.3190	22.5935	2.3945	21.6370	11.5250	6.0798	40.192	8.4880
No. Obs.	85	85	85	85	85	85	85	85	85	85
γ^{Co}	0.132									
Info_extern	0.366	-0.007								
Know_spill_tot	0.373	-0.161	0.052							
Know_spill_intra	0.313	-0.155	0.079	0.669						
Know_spill_inter	0.365	-0.155	0.047	0.996	0.607					
Rca	0.274	0.450	0.064	-0.183	-0.117	-0.183				
Skilled_labour	0.051	0.161	0.160	-0.097	-0.067	-0.097	-0.063			
Natural resource	0.012	-0.068	-0.056	-0.139	-0.082	-0.140	-0.113	0.155		
Transport	-0.087	0.071	-0.045	-0.145	-0.113	-0.143	0.304	-0.036	0.079	

Table 5 – Results of the robust OLS regressions (standardized variables)

	γ^{MNC}		γ^{MNC}		γ^{Co}		γ^{Co}		γ^{Co}		γ^{Co}		γ^{Co}		γ^{Co}	
	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7		Model 8	
Info_extern	.0156	**	.0155	**	-.0018		-.0014		-.0016		-.0017		-.0019		-.0012	
	(2.13)		(2.09)		(-0.31)		(-0.23)		(-0.27)		(-0.26)		(-0.32)		(-0.18)	
Know_spill_tot	.0164	***			-.0092	***	-.0097	***								
	(5.42)				(-2.72)		(-2.95)									
Know_spill_intra			.0523	**					-.0055		-.0088	**			-.0055	
			(2.14)						(-1.17)		(-2.59)				(-1.17)	
Know_spill_inter			.0129	***					-.0056				-.0089	**	-.0055	
			(3.33)						(-1.01)				(-2.48)		(-0.99)	
Know_spill_tot_rca							.0068	***								
							(2.67)									
Know_spill_intra_rca															.0053	**
															(2.60)	
Skilled_labour	.0007		.0008		.0107		.0111		.0106		.0108		.0108		.0108	
	(0.15)		(0.16)		(1.38)		(1.43)		(1.37)		(1.44)		(1.38)		(1.39)	
Natural resource	.0037		.0036		-.0075		-.0070		-.0075		-.0070		-.0075		-.0071	
	(0.95)		(0.93)		(-1.31)		(-1.20)		(-1.29)		(-1.23)		(-1.31)		(-1.22)	
Transport	-.0011		-.0010		.0039		.0042		.0039		.0043		.0040		.0045	
	(-0.19)		(-0.18)		(0.57)		(0.60)		(0.55)		(0.63)		(0.57)		(0.63)	
Constant	-.0269	***	-.0269	***	-.0228	***	-.0227	**	-.0228	***	-.0228	**	-.0228	***		
	(6.27)		(6.25)		(-3.42)		(-4.42)		(-3.41)		(-3.42)		(-3.42)			
R-squared	0.2681		0.2658		0.1105		0.0773		0.0688		0.0637		0.0637		0.0759	
F	10.90	***	11.50	***	4.75	***	5.31	**	2.85	**	2.85	**	2.69	***	5.06	***
No. obs	85		85		85		85		85		85		85		85	

Legenda: ***: p<.01; **: p<.05; *: p<0.10. T statistics in brackets

Annex 1 - Foreign MNEs and local domestic plants in Italian sectors, as in 2001

3-digit Nace-rev1 code	Description	Foreign MNEs' plants		Local domestic plants	
		(No.)	(%)	(No.)	(%)
151	Production, processing and preserving of meat and meat products	8	0.227	4294	0.738
152	Processing and preserving of fish and fish products	4	0.114	486	0.083
153	Processing and preserving of fruit and vegetables	17	0.483	2216	0.381
154	Manufacture of vegetable and animal oils and fats	5	0.142	4768	0.819
155	Manufacture of dairy products	28	0.796	4789	0.823
156	Manufacture of grain mill products, starches and starch products	7	0.199	2196	0.377
157	Manufacture of prepared animal feeds	22	0.626	765	0.131
158	Manufacture of other food products	55	1.564	50470	8.670
159	Manufacture of beverages	63	1.791	3487	0.599
160	Manufacture of tobacco products	6	0.171	163	0.028
171	Preparation and spinning of textile fibres	25	0.711	4252	0.730
172	Textiles weaving	10	0.284	4698	0.807
173	Finishing of textiles	2	0.057	1861	0.320
174	Manufacture of made-up textile articles, except apparel	6	0.171	5627	0.967
175	Manufacture of other textiles	21	0.597	4507	0.774
177	Manufacture of knitted and crocheted articles	7	0.199	6829	1.173
182	Manufacture of other wearing apparel and accessories	27	0.768	42520	7.304
193	Manufacture of footwear	20	0.569	13944	2.395
203	Manufacture of builders' carpentry and joinery	2	0.057	33782	5.803
211	Manufacture of pulp, paper and paperboard	11	0.313	304	0.052
212	Manufacture of articles of paper and paperboard	120	3.412	4740	0.814
232	Manufacture of refined petroleum products	71	2.019	839	0.144
241	Manufacture of basic chemicals	228	6.483	1278	0.220
242	Manufacture of pesticides and other agro-chemical products	10	0.284	64	0.011
243	Manufacture of paints, varnishes and similar coatings, printing ink and mastics	107	3.042	1268	0.218
244	Pharmaceuticals, medicinal chemicals and botanical products.	133	3.782	777	0.133
245	Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations	54	1.535	1810	0.311
246	Manufacture of other chemical products	100	2.843	1821	0.313
247	Manufacture of man-made fibres	11	0.313	60	0.010
251	Manufacture of rubber products	69	1.962	1979	0.340
252	Manufacture of plastic products	212	6.028	12855	2.208
261	Manufacture of glass and glass products	74	2.104	5622	0.966
262	Manufacture of non-refractory ceramic goods other than for construction purposes; manufacture of refractory ceramic products	32	0.910	4521	0.777
263	Manufacture of ceramic tiles and flags	6	0.171	724	0.124
264	Manufacture of bricks, tiles and construction products, in baked clay	17	0.483	654	0.112
265	Manufacture of cement, lime and plaster	35	0.995	500	0.086

Annex 1 - Foreign MNEs and local domestic plants in Italian sectors, as in 2001 (ctd)

266	Manufacture of articles of concrete, plaster and cement	45	1.279	6499	1.116
267	Cutting, shaping and finishing of ornamental and building stone	7	0.199	11217	1.927
268	Manufacture of other non-metallic mineral products	19	0.540	1205	0.207
271	Manufacture of basic iron and steel and of ferro-alloys	4	0.114	128	0.022
272	Manufacture of tubes	23	0.654	243	0.042
273	Other first processing of iron and steel	31	0.881	1289	0.221
274	Manufacture of basic precious and non-ferrous metals	40	1.137	507	0.087
275	Casting of metals	20	0.569	1699	0.292
281	Manufacture of structural metal products	32	0.910	34788	5.976
282	Manufacture of tanks, reservoirs and containers of metal; manufacture of central heating radiators and boilers	41	1.166	1091	0.187
284	Forging, pressing, stamping and roll forming of metal; powder metallurgy	31	0.881	2910	0.500
285	Treatment and coating of metals; general mechanical engineering	28	0.796	34174	5.871
286	Manufacture of cutlery, tools and general hardware	41	1.166	3415	0.587
287	Manufacture of other fabricated metal products	80	2.275	25591	4.396
291	Manufacture of machinery for the production and use of mechanical power, except aircraft, vehicle and cycle engines	174	4.947	3349	0.575
292	Manufacture of other general purpose machinery	178	5.061	22441	3.855
293	Manufacture of agricultural and forestry machinery	23	0.654	4494	0.772
294	Manufacture of machinetools	33	0.938	3447	0.592
295	Manufacture of other special purpose machinery	190	5.402	11026	1.894
296	Manufacture of weapons and ammunition	6	0.171	165	0.028
297	Manufacture of domestic appliances n.e.c.	21	0.597	934	0.160
300	Manufacture of office machinery and computers	23	0.654	1692	0.291
311	Manufacture of electric motors, generators and transformers	49	1.393	2338	0.402
312	Manufacture of electricity distribution and control apparatus	49	1.393	2436	0.418
313	Manufacture of insulated wire and cable	28	0.796	552	0.095
314	Manufacture of accumulators, primary cells and primary batteries	8	0.227	153	0.026
315	Manufacture of lighting equipment and electric lamps	14	0.398	2372	0.407
316	Manufacture of electrical equipment n.e.c.	75	2.132	12208	2.097
321	Manufacture of electronic valves and tubes and other electronic components	22	0.626	1248	0.214
322	Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy	48	1.365	7958	1.367

Annex 1 - Foreign MNEs and local domestic plants in Italian sectors, as in 2001 (ctd)

323	Manufacture of television and radio receivers, sound or video recording or reproducing apparatus and associated goods	4	0.114	397	0.068
331	Manufacture of medical and surgical equipment and orthopaedic appliances	41	1.166	19669	3.379
332	Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment	86	2.445	2318	0.398
333	Manufacture of industrial process control equipment	21	0.597	1141	0.196
334	Manufacture of optical instruments and photographic equipment	23	0.654	2817	0.484
341	Manufacture of motor vehicles	26	0.739	97	0.017
342	Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers	5	0.142	356	0.061
343	Manufacture of Parts and accessories for motor vehicles and their engines	151	4.293	1594	0.274
351	Building and repairing of ships and boats	21	0.597	3322	0.571
352	Manufacture of railway and tramway locomotives and rolling stock	11	0.313	191	0.033
353	Manufacture of aircraft and spacecraft	7	0.199	191	0.033
354	Manufacture of motorcycles and bicycles	15	0.426	1123	0.193
361	Manufacture of furniture	55	1.564	35729	6.138
362	Manufacture of jewellery and related articles	3	0.085	10903	1.873
364	Manufacture of sports goods	9	0.256	630	0.108
365	Manufacture of games and toys	8	0.227	835	0.143
366	Miscellaneous manufacturing n.e.c.	12	0.341	5234	0.899
371	Recycling of metal waste and scrap	2	0.057	1395	0.240
372	Recycling of non-metal waste and scrap	9	0.256	1136	0.195
Total		3517	100.000	582108	100.000

Annex 2 – Revealed Comparative Advantage for the 85 manufacturing industries considered, 1998

3-digit Nace-rev1 code	Description	RCA
263	Manufacture of ceramic tiles and flags	11.525
267	Cutting, shaping and finishing of ornamental and building stone	7.95
282	Manufacture of tanks, reservoirs and containers of metal; manufacture of central heating radiators and boilers	4.025
193	Manufacture of footwear	3.8
361	Manufacture of furniture	3.575
297	Manufacture of domestic appliances n.e.c.	3.5
273	Other first processing of iron and steel	3.225
293	Manufacture of agricultural and forestry machinery	3.2
172	Textiles weaving	2.9
272	Manufacture of tubes	2.675
266	Manufacture of articles of concrete, plaster and cement	2.625
177	Manufacture of knitted and crocheted articles	2.55
294	Manufacture of machinetools	2.375
354	Manufacture of motorcycles and bicycles	2.375
295	Manufacture of other special purpose machinery	2.35
292	Manufacture of other general purpose machinery	2.3
362	Manufacture of jewellery and related articles	2.2
171	Preparation and spinning of textile fibres	2.15
159	Manufacture of beverages	2.125
287	Manufacture of other fabricated metal products	2.1
291	Manufacture of machinery for the production and use of mechanical power, except aircraft, vehicle and cycle engines	2.075
315	Manufacture of lighting equipment and electric lamps	1.725
252	Manufacture of plastic products	1.675
268	Manufacture of other non-metallic mineral products	1.625
153	Processing and preserving of fruit and vegetables	1.6
281	Manufacture of structural metal products	1.6
245	Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations	1.575
296	Manufacture of weapons and ammunition	1.55
261	Manufacture of glass and glass products	1.525
262	Manufacture of non-refractory ceramic goods other than for construction purposes; manufacture of refractory ceramic products	1.525
212	Manufacture of articles of paper and paperboard	1.5
286	Manufacture of cutlery, tools and general hardware	1.5
158	Manufacture of other food products	1.475
175	Manufacture of other textiles	1.475
182	Manufacture of other wearing apparel and accessories	1.45
243	Manufacture of paints, varnishes and similar coatings, printing ink and mastics	1.425
244	Pharmaceuticals, medicinal chemicals and botanical products	1.35
251	Manufacture of rubber products	1.325
247	Manufacture of man-made fibres	1.225
343	Manufacture of Parts and accessories for motor vehicles and their engines	1.225
352	Manufacture of railway and tramway locomotives and rolling stock	1.225
156	Manufacture of grain mill products, starches and starch products	1.2
351	Building and repairing of ships and boats	1.2

Annex 2 – Revealed Comparative Advantage for the 85 manufacturing industries considered, 1998 (ctd)

366	Miscellaneous manufacturing n.e.c.	1.2
342	Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers	1.025
364	Manufacture of sports goods	1.025
155	Manufacture of dairy products	0.975
313	Manufacture of insulated wire and cable	0.975
334	Manufacture of optical instruments and photographic equipment	0.975
264	Manufacture of bricks, tiles and construction products, in baked clay	0.95
311	Manufacture of electric motors, generators and transformers	0.875
154	Manufacture of vegetable and animal oils and fats	0.85
271	Manufacture of basic iron and steel and of ferro-alloys	0.85
312	Manufacture of electricity distribution and control apparatus	0.825
203	Manufacture of builders' carpentry and joinery	0.775
242	Manufacture of pesticides and other agro-chemical products	0.775
232	Manufacture of refined petroleum products	0.7
246	Manufacture of other chemical products	0.7
174	Manufacture of made-up textile articles, except apparel	0.65
211	Manufacture of pulp, paper and paperboard	0.65
241	Manufacture of basic chemicals	0.65
265	Manufacture of cement, lime and plaster	0.625
332	Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment	0.625
341	Manufacture of motor vehicles	0.625
151	Production, processing and preserving of meat and meat products	0.575
316	Manufacture of electrical equipment n.e.c.	0.575
331	Manufacture of medical and surgical equipment and orthopaedic appliances	0.575
322	Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy	0.55
314	Manufacture of accumulators, primary cells and primary batteries	0.525
274	Manufacture of basic precious and non-ferrous metals	0.475
353	Manufacture of aircraft and spacecraft	0.475
365	Manufacture of games and toys	0.425
157	Manufacture of prepared animal feeds	0.4
323	Manufacture of television and radio receivers, sound or video recording or reproducing apparatus and associated goods	0.3
321	Manufacture of electronic valves and tubes and other electronic components	0.275
300	Manufacture of office machinery and computers	0.225
152	Processing and preserving of fish and fish products	0.125
160	Manufacture of tobacco products	0.05
173	Finishing of textiles	0
275	Casting of metals	0
284	Forging, pressing, stamping and roll forming of metal; powder metallurgy	0
285	Treatment and coating of metals; general mechanical engineering	0
333	Manufacture of industrial process control equipment	0
371	Recycling of metal waste and scrap	0
372	Recycling of non-metal waste and scrap	0