Clustering of multinational and national firms: evidence from Italy[i]

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ABSTRACT

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Abstract:

This paper aims at understanding whether national and multinational firms have different agglomeration patterns. By using the Figueiredo *et al.* (2007) version of the Ellison and Glaeser (1997) index to analyze the agglomeration of 78 Italian manufacturing industries in 2001, we find that competition is an industry specific centrifugal force, since it discourages the agglomeration regardless of the category a firm belong to. Conversely, information costs and skilled labor are firm-specific drivers of agglomeration, since they push only multinational enterprises to cluster together. Transportation costs and spillovers from patents are not significant determinants of agglomeration, while spillovers that arise from tacit knowledge discourage the clusters of national enterprises and the co-agglomeration between multinational and national companies, since a leak of knowledge may occur from the most to the less advanced firms.

Key words: Firm-specific and Industry-Specific Determinants of Agglomeration, Multinational and National Firm, Spillovers and Information costs.

JEL classifications: F23, L11, R12, R30

INTRODUCTION

The distribution of economic activities within a geographic area is a widely debated topic. Indeed, location choices made by firms are not random and often converge towards the same location. The concentration of economic activities in a geographic unit gives birth to the phenomenon of agglomeration. According the “dartboard theory” (Ellison and Glaeser, 1997), an industry can be defined agglomerated when the distribution of firms is much more geographically concentrated than an ideal situation where firms choose randomly their location. Agglomeration occurs because of the presence of centripetal forces such as spillovers and natural resources, which drive the location choices of firms and whose intensity may change across countries, industries and firms. At the same time, centrifugal forces, such as transportation costs, may act against the agglomeration and, hence, the output can be the dispersion of economic activities across the geographic units.

However, the determinants of agglomeration may have different signs and intensities according to the type of firm that make the location choice. In particular, some differences may arise by comparing Multinational Enterprises (MNEs) to national firms. Indeed, MNEs investing in a country can choose among the following options: not to cluster, to agglomerate with other MNEs or to agglomerate with national firms. If the centripetal and the centrifugal forces of agglomeration are industry-specific, which means that they change in sign and intensity across industries but not across categories of firms within the same industry, MNEs should replicate the location choices made by national firms and, hence, to co-agglomerate with them. At the same time, provided that MNEs are significantly less numerous than national firms, the agglomeration within MNEs would be less intensive than the agglomeration within national firms, for statistical reasons. Conversely, if the drivers of agglomeration are firm-specific, which means that they have different signs and intensities

within the same industry according to the category of firms, we would observe that MNEs follow a different agglomeration pattern with respect to national firms, and that the two categories of firms agglomerate within them and do not co-agglomerate between them.

The reasons why the drivers of agglomeration of MNEs may be different from the drivers of agglomeration of national firms are explained in section 2, which revises the literature on the determinants of agglomerations for different categories of firms. In the third section we will briefly discuss our choice concerning the measure of agglomeration, while in the next paragraph we will provide some descriptive statistics in search of evidence of firm-specific characteristics of agglomeration in Italy. The fifth section presents the equations and the data used to test whether the determinants of agglomeration are firm or industry-specific. The sixth paragraph shows the results of our econometric analysis, while the last part concludes and proposes future points for the research agenda.

2. THEORETICAL BACKGROUND AND HYPOTHESES

The theoretical and empirical literature has identified several drivers affecting the agglomeration. Some of them are widely recognized as being either a centripetal or a centrifugal force. Transportation costs and competition, for instance, typically act as dispersion forces. Conversely, information costs, which arise when firms have to invest in a new country or sector, push firms to cluster with other firms that have already supported such costs and, hence, they act as centripetal forces. The role of other drivers of agglomeration is more controversial, since they are found to be both centripetal and centrifugal forces. This is the case of knowledge spillovers and skilled labor. These controversial results might depend on the idiosyncratic characteristics of the firms, which are likely to affect the direction and intensity of the drivers of agglomeration. MNEs and national companies display several

different features that may have a strong impact on the agglomeration forces. Therefore it is worth analyzing each driver of agglomeration in the light of the two categories of firms that have been identified, i.e. MNEs vs. national companies.

2.1 - Competition.

Competition has been identified as a centrifugal force both theoretically and empirically. According to the Core-Periphery models of New Economic Geography (Krugman, 1991a,b; Krugman and Venables, 1990, 1995; Venables 1996; Puga, 1999), competition implies a decrease of profits because firms must cut their prices in order not to be crowded out from the market. This explains why competition push firms not to agglomerate.

The effect of competition on the agglomeration has been found to have a negative impact on agglomeration also in the empirical literature both when MNEs and national firms are considered together (Alsleben, 2005) and when they are analyzed separately (Co, 2002). Furthermore, there are no arguments to believe that competition has a different impact on the agglomeration according to the category of enterprises. Therefore we formulate our third hypothesis:

- *Hypothesis n. 1:* Competition is an industry-specific dispersion force.

2.2 - Transportation costs

Transportation has been emphasized by the New Economic Geography (Krugman, 1991a,b; Krugman and Venables, 1990, 1995; Venables 1996; Puga, 1999) as one of the main centrifugal forces: if transportation costs are high, firms prefer to locate next to the market and, hence, dispersion occurs. The empirical literature confirms the negative correlation between agglomeration and transportation costs, both when the firms are considered together (Rosenthal and Strange, 2001; Alsleben, 2005) and when only MNEs are taken into account

(Figueiredo *et al.*, 2000). Also in this case there are no arguments to believe that transportation costs have a different impact on the agglomeration of enterprises according to the category they belong to. This explains why transportation costs are expected to be an industry-specific determinant of agglomeration, with a negative sign. Hence we formulate the following last hypothesis:

- *Hypothesis n. 2:* Transportation costs are an industry-specific dispersion force.

2.3 - Information Costs.

Information costs are supported by firms that undertake the first investment in a given industry or geographic unit. Piscitello and Mariotti (1995), Shaver (1998) and He (2002) find that information costs have a positive impact on the agglomeration of MNEs investing in Italy, U.S.A. and China, respectively. This happens because MNEs, in order to minimize information costs, tend to adopt a strategy of "herd behavior", which consist in imitating the location choices previously made by other MNEs that have already entered the market and, hence, have already supported the information costs. This strategy pushes MNEs to cluster together; therefore information costs can be considered a centripetal force of the agglomeration of MNEs.

Conversely, national firms are expected to be much less concerned about information costs, because they know their home country and can choose more consciously whether to enter an industry and where to locate. Therefore we expect that information costs do not act as centripetal force for the agglomeration within national firms.

Finally, we do not expect even that information costs push MNEs to cluster with national firms: indeed, as stated by Shaver (1998), MNEs prefer to replicate the location choices made by other MNEs, since they are more similar and face the same problems of information asymmetries that national firms do not support.

We can therefore summarize our conclusions on the role of information costs in the agglomeration in the following hypothesis:

- *Hypothesis n. 3:* Information costs are a firm-specific determinant of agglomeration, because they promote the agglomeration within MNEs but not the agglomeration within national firms nor the co-agglomeration between MNEs and national firms.

2.4 - Spillovers.

Spillovers are another crucial force of agglomeration that have been identified by Urban and Spatial Economics, which emphasizes the importance of external economies that arise from the co-location of several firms in the same areas.

According to the theory, knowledge and technological spillovers act as a centripetal force, since the possibility of absorbing knowledge attract firms. However, the evidence concerning the impact of knowledge spillovers on agglomeration of economic activities is controversial. Indeed, some authors (Figueiredo, Guimaraes and Woodward, 2000; Rosenthal and Strange, 2001; He, 2002; Hogenbirk & Narula, 2004; Hilber and Voicu, 2006) find that firms are attracted by spillovers, while some others (Flyer and Shaver, 2000; Alsleben, 2005; Alcácer and Chung, 2007) find that spillovers are a centrifugal force of agglomeration. The explanation provided by the authors who find a negative correlation between agglomeration and spillovers is that, when a MNE locate next to other firms, it may not only absorb but also transfer knowledge, with a final possible negative balance where the quantity and the quality of spillovers transferred are higher than the quality and the quantity of knowledge absorbed.

Co (2002), who compares the determinants of the agglomeration of foreign-owned and domestic-owned enterprises, finds that knowledge spillovers have a high positive impact on the agglomeration of national firms and a low influence on the clustering of multinational firms.

Our hypothesis on the role of spillovers in the agglomeration and co-agglomeration of MNEs and national firms stems from the following considerations. First of all, it is worth noting that spillovers may arise both from tacit and from codified knowledge. The former refers either to the knowledge that is protected by the firm through secrecy or to the knowledge embedded in the strategic, organizational and managerial innovations that have been undertaken by the firm and that are not visible outside. Conversely, the latter refers to the knowledge that has been registered by the firm on official documents, such as patents, in order to protect it from competitors. While tacit knowledge require a high interaction between the source and the receiver of spillovers in order to be transferred, codified knowledge is publicly available and do not require strong interactions to be absorbed. Furthermore, while tacit knowledge, once transferred, can be used without being prosecuted by the law, codified knowledge is protected and, hence, not usable. This means that firms are driven mainly by tacit and not by codified knowledge in their agglomeration patterns. Hence the following first hypothesis can be formulated:

- *Hypothesis n. 4-a*. Spillovers that arise from codified knowledge are a not significant determinant of agglomeration for any type of firm.

Conversely, as regards spillovers that arise from tacit knowledge, we believe that they affect the agglomeration pattern of all types of firms. Indeed, tacit knowledge is the key of competitiveness of firms, since it involves not only the innovations that are kept secret, but also the organizational, marketing and managerial strategies that allow a company to outperform its competitors. Therefore, firms are highly afraid to lose their tacit knowledge, and, hence, they aim at defending it rather than acquiring tacit spillovers from other firms. This is true especially for firms that have a high competitive advantage, which therefore prefer not to agglomerate regardless of their nationality. However, the negative relationship

between tacit spillovers and agglomeration may be mitigated or even offset when either firms are similar and, hence, they have the same probability to acquire and to release tacit spillovers, or when they are able to acquire tacit knowledge without transferring it.

This might be the case of MNEs. Indeed, this type of firms are typically the most competitive and, hence, are expected not to agglomerate within them nor to co-agglomerate with national firms, in order to avoid to lose tacit knowledge. However, when MNEs invest in a country, they can choose to adopt either a competence exploiting or a competence exploring strategy (Cantwell, 1995; Fors, 1997; Kuemmerle, 1999; Cantwell and Mudambi, 2005). A recent OECD document on intellectual assets and international investments by Belderbos and Sleuweaegen (2007) has shown that most of MNEs make use of FDIs to exploit their intellectual assets developed at home, by adapting the products and technologies to the host country market. Provided that our data refer to the year 2001 and that Italy is not one of the most technologically advanced country among the OECD, we can state that also most of MNEs that invested in Italy have used a strategy of "adaptive innovation", by keeping the core of their innovative activities at home and by exploiting their knowledge and adapting their technologies in the Italian market. This means that MNEs might be willing to locate next to other firms that are technologically advanced, since they may be able to absorb tacit knowledge spillovers without running the risk to transfer their own strategic knowledge. Indeed, their core intellectual assets are kept at home while the innovation that is undertaken in the host country is only adaptive. Therefore on the one hand, some MNEs prefer not to cluster with any type of firms in order not to transfer their tacit knowledge and to keep their competitive advantage, especially if they undertake their main innovative activities in the host country instead of simply using an adapting strategy; on the other hand, some others MNEs aim at clustering with other international firms because they display a similar level of technology and because they may absorb spillovers without transferring their own tacit

knowledge, especially if they use an adaptive innovation strategy in the host country. Therefore tacit spillover may act both as centrifugal and as centripetal force: the final impact on the agglomeration within MNEs is likely to be not significant, unless one of these two opposite forces prevail on the other.

Conversely, as regard the co-agglomeration with national firms, MNEs are likely to prefer not to cluster with them because of the technology gap. Indeed, MNEs are typically more advanced and more productive than most of national firms, therefore not only the former have no advantages to cluster with the latter, but also MNEs may run the risk to transfer some tacit knowledge spillovers, even if their innovation is only adaptive. This transfer may help the national competitors lagging behind to catch-up with MNEs.

Finally, as regards the agglomeration within national enterprises, we believe that the level of technological heterogeneity among these firms is so high that the same mechanism operating between MNEs and national firms occurs also within national firms. In other words, the most technologically advanced national firms are more afraid of a possible leak of tacit knowledge than attracted by a possible absorption of spillovers with respect to other less advanced national firms. Therefore we expect that spillovers are negatively correlated with the agglomeration of national firms.

Summarizing, the following hypothesis can be stated:

Hypothesis n. 4-b: Tacit knowledge spillovers are a firm-specific determinant of agglomeration. Specifically, the effect on the agglomeration within MNEs is likely to be on average not significant, while the effect on the agglomeration within national firms and on the co-agglomeration between multinational and national enterprises is negative.

2.5 – Skilled labor

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), for instance, find that the number of managers over total employment, which is used as proxy of skilled labor, is positively correlated with the agglomeration of U.S. firms. However, labor pooling implies also high turnover costs for the firms competing for best workers. Furthermore, 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 ad Duranton, 2001 and 2003).

MNEs typically attract the best workers because of their international prestige and because they are able to pay the highest wages. Therefore they share a similar labor market made of high skilled workers. Since most of skilled labor can be found in other MNEs, a new multinational investor should locate next to other MNEs in order to be sure to attract the best workers. Furthermore, even if in the future the MNE may run the risk to be subject to labor poaching, it can support high turnover costs to hire new skilled workers and to undertake labor pooling from others MNEs. Therefore we expect that skilled labor positively affect the agglomeration within MNEs.

MNEs may also locate next to national firms, since they are able to attract skilled labor without running the risk to lose their own best workers, provided that they can afford to pay the highest wages and that they are more attractive. Nevertheless, , a national investor is likely not to be willing to locate next to a MNE to attract their workers since a national firm cannot pay higher wage than the a MNE; furthermore, in the future, the national firm might by subject to labor poaching from the MNE. Therefore, two opposite forces work in the coagglomeration of national and multinational enterprise: the first one, which come from the MNEs, is centripetal, while the second one, which originate from the national firms, is

centrifugal. We expect therefore that the final effect is zero and that skilled labor do not significantly affect the co-agglomeration between national and multinational enterprises, unless one of the two forces overwhelms the other.

Finally, as regard the agglomeration within national firms, the heterogeneity among the enterprises is so high that some of them can afford high turnover costs and undertake labor pooling, while some others cannot support high turnover costs and, hence, are subject to the risk of labor poaching. Hence, also in this case both centripetal and centrifugal forces operate. Therefore, if the two forces have a similar entity, we expect that the average effect of skilled labor on the agglomeration within national firms is zero. The following last hypothesis can be then formulated:

- *Hypothesis n 5:* Skilled labor is a firm specific driver of agglomeration. Specifically, it promotes the agglomeration within MNEs, while it is not significant for the co-agglomeration between national and multinational enterprises and for the agglomeration within national firms.

3. THE MEASURE OF AGGLOMERATION

The analysis and the comprehension of the agglomeration requires the employment of a specific measure that is able to identify the phenomenon. Ellison & Glaeser (1997) (henceforth, EG) elaborate a sophisticated model that discounts the industrial concentration (measured by the Herfindahl index) from the agglomeration, in order to avoid to identify an industry as agglomerated even if all the employees work only in one plant.

However, Holmes and Stevens (2002) show that, since the EG index is employment-based and depends on the Herfindahl index, it is affected by the dimension of the plants. In

other words, given the same number of employees and plants, it yields a higher agglomeration index for industries whose average dimension of plants is bigger.

Therefore Figueiredo, Guimaraes and Woodward (2007) (henceforth, FGW) suggest to use a plant-based instead of an employment-based index, in order to give the same weight to all the plants regardless of their dimension. The final agglomeration index that Figueiredo *et al.* (2007) propose, which is similar to the EG original index but with plants instead of workers, is:

$$\gamma_{FGW} = \frac{\frac{G_{FGW}}{\left(1-\sum_i x_i^2\right)} - \frac{1}{N}}{1-\frac{1}{N}}$$

where $G_{FGW} = \sum_i \left(\frac{n_i}{N} - x_i\right)^2$ is the "raw" agglomeration index, n_i is the number of plants of a given sector operating in region *i* over the total number of plants N that compose that industry, x_i is the ratio of employees of region *i* over the national employment and $\frac{1}{N}$ is the plant-based Herfindahl index, which accounts for the industrial concentration.

In order to measure the co-agglomeration between national firms and MNEs, we employed the following Barrios, Bertinelli & Strobl (2003) variant of the EG co-agglomeration index

$$\gamma_s^{Co} = \frac{G_s - H_s - \sum_k \gamma_{s,k} \cdot \omega_{s,k}^2 \cdot \left(1 - H_{s,k}\right)}{1-\sum_k \omega_{s,k}^2}$$

where *s* expresses the industry and *k* the typology of firm, e.g. multinational vs. national enterprises. This index turns out to be a measure of how firms belonging do different groups cluster together, by subtracting the intra-group agglomeration indexes ($\gamma_{s,k}$) to the total raw agglomeration index (G_s), which is computed as if all plants belonged to the same

group. The effects of industrial concentration is always discounted by the Herfindahl index, which is computed both for the totality of firms (H_s) and for each group ($H_{s,k}$)[ii]. The firm-specific agglomeration indexes are weighted by $\omega_{s,k}^2$, which represents the share of employees of each group of firm k in each industry s. A high value of the index means that the agglomeration of all the plants, computed as if all the firms belonged to the same group, is higher than the sum of the agglomeration of each group of firms, hence MNEs and national firms cluster together. The opposite holds if the index is low or negative.

4. DESCRIPTIVE STATISTICS

The FGW agglomeration indexes have been computed for 78 Italian manufacturing industries at three-digit level. The industries range from number 151 (Production, processing and preserving of meat and meat products) to number 366 (Miscellaneous manufacturing n.e.c) of classification NACE-CLIO. For each industry we obtained two indexes, one for MNEs and the other for national firms.

The indexes have been computed by looking at the distribution of national and multinational plants across the 686 Italian Local Labor System (LLS) in 2001, where the LLS are geographic units similar to the industrial districts. Each LLS, whose map has been designed by the Italian National Statistics Institution (ISTAT, 2001), is composed of a set of "*comuni*", which are the smallest administrative Italian entities. The idea behind the LLS is to account for the economic and social relationships among the Italian smallest administrative units. Such relationships are shaped mainly along the trajectories of commuters' flows, regardless of the counties and regions each "*comune*" belong to. In this way we are able to catch the effects of spillovers on the agglomeration more in depth, since knowledge flows are

not confined into the artificial boundaries but follow the social relationships that occur across administrative units. (Feser, 2000).

To compute the FGW indexes for MNEs we employed the Reprint-ICE database, which is provided by Politecnico di Milano. The database contains detailed data about the location of the plants of each MNE in every year in Italy. The total amount of foreign plants for the year 2001 is equal to 3,622 units and the nationality is mainly European (67%), followed by North America (28%), South America (0,5%), Asia (2,9%), Africa (0,2%) and Australia (0,2%). The types of direct investments considered are both green-field (28%) and brown-field (72%).

Data about the distribution of national plants across the LLS in 2001 come from the ISTAT, (2001). Since the database provides only data about the total plants regardless of the nationality of the firm, the national dataset has been obtained as difference between the total plants and the foreign-owned plants. The resulting amount of domestic plants, upon which we have computed the national agglomeration indexes, is equal to 595,865 units.

Some first considerations can be drawn by looking at the values of the indexes[iii] for each industry by type of firm. Table 1 and 2 display the 20 most agglomerated industries for national firms and MNEs, respectively. It is clear from table 1 that for national firms the most agglomerated industries appear to be the traditional sectors, such as ceramic, textile, jewellery, leather and food. This outcome reflects the typical Italian production structure: indeed, most of economic activities, especially in traditional industries where Italy enjoy a competitive advantage, are organized in districts, which can be identified as specialized LLS. The only advanced industry that appears among the most agglomerated sectors for national firms is pharmaceuticals. This table is line with the analysis of Pagnini (2002), who found that, in 1996, the most agglomerated industries in Italy were the same traditional sectors that we find to be the most agglomerated in 2001.

(Table 1 goes about here)

As regards MNEs, we observe from table 2 much more heterogeneity among the most agglomerated industries. Indeed, next to the traditional industries, which turn out to be still highly agglomerated, we also find some advanced industries such as pharmaceuticals, chemicals, electronics, treatment of metals and mechanical engineering. This picture suggests that national firms and MNEs present different agglomeration features, at least as regards the 20 most agglomerated industries.

(Table 2 goes about here)

Table 3 compares the mean, the median and the standard deviation of the FGW indexes computed for MNEs and national firms. It is clear that the mean and the standard deviation of the indexes computed for MNEs are higher than those of the indexes computed for national firms. This outcome confirms that the two typologies of firms seem to have different agglomeration patterns. This intuition is strengthened by the coefficient of the Pearson correlation, which is reported at the end of the table. Indeed, the two set of indexes are correlated only at 27.56%. The Spearman correlation, which compares the ranks of agglomeration of the two categories of firms, definitely confirm that MNEs and national firms are differently distributed among the Italian LLS, since the value of the coefficient is only about 10%, as reported at the end of table 3.

(Table 3 goes about here)

This dichotomy also arises from the distributions of frequencies, which display more dispersion for MNEs than for national firms, as it is shown by figures 1 and 2.

(Figure 1 and 2 go about here)

Finally, we also computed the co-agglomeration indexes[iv], which are useful to understand whether and how much national firms and MNEs agglomerate between them. The number of industries over which we were able to compute the co-agglomeration index is 72,

because 6 industries out of 78 do not display co-agglomeration between national and MNEs. The 20 most co-agglomerated sectors, which are shown in table 4, still appear to be the traditional industries. This means that MNEs and national firms do not agglomerate in advanced industries, which are intensive of spillovers. A possible explanation lies in our second hypothesis: MNEs do not agglomerate with national firms in order to avoid the unintentional transfer of their superior technology and tacit knowledge to the national competitors.

(Table 4 goes about here)

5. METHODOLOGY AND DATA

To understand whether different categories of firms imply different patterns of agglomeration, we correlated the agglomeration indexes with those variables that have been identified by the literature as main drivers of this phenomenon. In particular, in order to be able to distinguish between firm-specific and industry-specific determinants of agglomeration, we employed three different equations. The first one makes use of the agglomeration index computed for national firms as dependent variable; the second one uses the agglomeration index computed for MNEs, and the third one makes use of the co-agglomeration index. If some determinants of agglomeration show different signs or significances among the three equations, this means that the determinants are firm-specific and change its effect within the same industry according to the category of firm considered.

The standard equation that we used to reach our goal is the following:

$$\log \gamma_s^k = \beta_0 + \beta_1 \log X_s + \varepsilon_s$$

where γ_s^k identifies the agglomeration index of sector *s* for the group of firm *k*, i.e. national (*Nat*) vs. multinational (*MNE*) enterprises, X_s are the variables that express the

determinants of agglomeration, and ε_s is the error term. In the third equation we used a co-agglomeration index (γ_s^{co}), which has been correlated with the same explicative variables. All the three indexes have been normalized between 0 and 1 in order to be able to use the logarithms. The agglomeration depicted by the indexes refers to the year 2001, as well as the explicative variables: the choice of this year as benchmark is due to the huge amount of data on plants provided by the ISTAT census taken in that year.

The independent variables have been computed for each industry. Their values changes across industries within each equation but are the same for each industry across the three equation, because they reflect the drivers of agglomeration of Italian industries. Such determinants may be either industry-specific, if they keep their sign and significance across the equations, or firms-specific, if they are centripetal force for a category of firm and centrifugal force for the other category, or if they lose their significance across the equations.

The determinants of agglomeration that we take into account in our analysis are those centripetal and centrifugal forces identified in section 2:

$$\log \gamma_s^k = \beta_0 + \beta_1 \log C_s + \beta_2 \log T_s + \beta_3 \log I_s + \beta_4 \log P_s + \beta_5 \log S_s + \beta_6 \log L_s + \beta_7 D + \varepsilon_s$$

where *C* is the level of competition of the industry, *T* are the transportation costs of the industry, *I* are the information costs, *P* are spillovers that arise from codified knowledge, *S* are spillovers that arise from tacit knowledge and *D* is a dummy variable to control for those sectors that displays very high levels of agglomerationbecause of the presence of districts.

According to our hypothesis n. 1, competition (*C*) is an industry-specific centrifugal force of agglomeration. A common proxy used in the literature for competition (see e.g. Alseben, 2005) is the Herfindahl index, which accounts for the industrial concentration of each sector. The index has been computed for each industry according to the following formula:

$$H_s = \sum_j z_j^2$$

where z_j is the share of employees of each plant *j* within the industry s^v. This index differs from the plant-based Herfindahl index that we used in to compute the FGW agglomeration index, since in the this case we make use of the employees of the plants, whereas in the agglomeration index we use the number of plants and the Herfindahl index turns out to be equal to 1/N.

A high value of the Herfindahl index identifies a concentrated industry, i.e. a not competitive sector: therefore we expect that the Herfindahl index is positively and significantly correlated with all the three agglomeration indexes.

Transportation costs (T) are the another dispersion force according to our hypothesis n. 2. In order to find a good proxy we used the input-output tables. Transportation costs are computed as the flows of input that each industry receives by all the three transportation sectors (Nace 60: land transport; transport via pipelines; Nace 61: water transport; Nace 62: air transport). Since the level of aggregation of the data of the input-output tables is 2-digit, we distributed the flows of transportation costs among the 3-digit industries by weighting the data, when possible, through the weight of the goods produced by each 3-digit industry, and through the amount of production of each sub-industry when data about weight were not available[vi]. Because of the arguments discussed in hypothesis n. 2, we expect a negative correlation between the proxy accounting for transportation costs and all the agglomeration indexes.

Hypothesis n. 3 states that information costs (*I*) are a firm-specific determinant of agglomeration, which positively affects only MNEs. In order to test such hypothesis we need to gauge information costs. However, it is hard to quantify the expenditures in terms of

money and time that firms must sustain in order to collect information about an industry or a location they want to enter. Generally speaking, literature on spatial distribution of firms makes use of agglomeration as a proxy for information costs, which means that authors use the effect (agglomeration) to measure the cause (information costs) (e.g. Mariotti and Piscitello, 1995; Head, Ries and Swenson, 1999; He, 2000).

Obviously this approach cannot be used in our analysis, because agglomeration is our dependent variable. Therefore we decided to make use of a new proxy, which accounts for the share of expenditures in external services over total sales of each industry in the year 2001. This variable has been obtained by aggregating the single data on sales and expenditures in services contained in the balance sheets of all the firms operating in Italy in 2001. The data come from Aida database, which is part of the Bureau van Dijk database. The idea is that, if an industry displays high expenditures in external service, it means that its firms require an external support to undertake their activities and their investments. This support consist mainly of financial and consulting activities, which allow the firms to collect a large amount of information about the industry they want to enter. Our proxy does not allow to catch the information collected internally by the firm, however this type of data is very difficult to quantify and can be collected only through a survey analysis. Therefore we believe that our variable is able to embed a good part of the phenomenon concerning information costs, which are expected to be positively and significantly correlated only with the agglomeration index of MNEs.

Spillovers are another important determinant of agglomeration that we discussed in section 2.4. The most used proxies in the literature are either R&D expenditures (Alsleben, 2005) or the number of patents (Co, 2002). However, our first aim is to distinguish between spillovers that arise from tacit knowledge and spillovers that arise from codified knowledge,

in order to be able to test hypothesis 4a. As regards the latter, similarly to Co (2002) we employed a proxy that account for the number of firms owning at least a patent over the total amount of firms operating in each sector between 1998 and 2000. These data come from CIS (Community Innovation Survey) database, which is held by ISTAT. Patents are the most representative proxy for spillovers that arise from codified knowledge, because they are a written and public document that is by far the most used non tacit method of protecting innovation. As stated by hypothesis n. 4a, we expected that this variable is never significant across the three equations, since no agglomeration is required to absorb spillovers that are publicly available through the patents.

Conversely, in order to test hypothesis n. 4b a more complex index has been computed. The core variable of this index is a proxy that we will call tacit innovation intensity. This proxy accounts for the percentage of firms that, between 1998 and 2000, either used tacit methods to protect their innovation (such as secrecy, increase of complexity of operations and increase of required competences) or undertook innovations in the following fields: strategy, management, organization, esthetic, design, training and marketing. These types of innovation, indeed, are not codified by the firms in any official public document.

However the tacit innovation intensity cannot account by itself for the spillovers generated by each industry, because on the one hand, absorptive capacities are required in order to be able to understand the tacit knowledge, on the other hand, interaction between the source and the receiver of spillover is necessary in order to be able to transfer the tacit knowledge.

As regards the first issue, it is known that spillovers are not a spontaneous process but require some abilities to be understood, which can be developed only by undertaking the same type of innovation that must be absorbed. In other words, the more a firm develops tacit knowledge the more it is able to absorb it from other firms. Therefore the tacit innovation

intensity of the sectors accounts not only for the spillovers that arise from tacit knowledge, but also for the absorptive capacities of each industry. This explains why in the spillover index, given the industry *s*, we crossed its tacit innovation intensity, which accounts for the potential spillovers produced by that sector, with the tacit innovation intensity of all other sectors (including *s* itself), in order to account for the possibility that such industries can absorb the spillovers produced by *s*.

However, the presence of high absorptive capacities is still not sufficient to guarantee the transfer of tacit knowledge among firms. Indeed, a strong interaction between the source and the receiver of spillover is required in order to enable such a transfer. Therefore it is necessary to include in the spillover index a measure that accounts for the intensity of the relationships of the firms not only within each industry, but also between each pair of sectors. Indeed, both intra-industry and inter-industry spillovers, which occurs through backward and forward linkages, can act as a centripetal or centrifugal force for a given industry. This happens because the knowledge that flows from a firm that belong to industry *s* to its supplier or its customer that belong to another industry can be absorbed by a competitor that operate in the industry *s* and that share the same supplier or customer. This possibility may either promote or discourage the agglomeration among firms. Therefore backward and forward linkages must also be taken into account in order to define a more complete picture of the total amount of spillovers produced by a given industry. In order to account for such linkages we used the Input-Output table provided by ISTAT, which is organized as a matrix where the same industries are reported both on the lines (*i*) and on the columns (*j*). Each record represents the flows of goods that *i* supply to *j* (or that *j* receive from *i*). Starting from these tables, it is possible to compute the intensity of the relationship between each pair of industries through the following ratio:

$$q_{i,j} = \frac{x_{i,j}}{\sum_j x_{i,j} + \sum_i x_{i,j}}$$

where $x_{i,j}$ are the flows of goods (in millions of Euros at current prices) exchanged between industries *i* and *j*, while the denominator is the sum of all the flows of sector *i* towards all other industries (including *i* itself) and all the flows of sector *j* towards all the other industries (including *j* itself). The higher the ratio the more intensive is, of course, the relationship between sector *i* and sector *j* and, hence, the more inter-industry spillovers are likely to flow.

The final index we built to account for the spillovers that arise from tacit knowledge for each single industry derives from the combination of the tacit innovation intensity, the absorptive capacities and the intensity of relationships. In particular, we computed, for each industry *s*, an index by interacting the tacit innovation intensity of *s*, which accounts for the spillovers produced by the industry *s*, with both the tacit innovation intensities of all the other industries (including *s* itself), which account for their absorptive capacities, and the intensity of the relationships within and between sectors, given by the ratio $q_{i,j}$:

$$S_s = TII_s \sum_{j \neq s} q_{s,j} TII_j + TII_s \sum_{i \neq s} q_{i,s} TII_i + (TII_s)^2 q_s$$

where TII_s is the tacit innovation intensity of sector *s*, which is multiplied (i) by the absorptive capacities of all the backward industries (TII_j) and the intensity of relationship between *s* and each backward industry ($\sum_{j \neq s} q_{s,j}$) (ii) by the absorptive capacities of all the forward industries (TII_i) and the intensity of relationship between *s* and each forward industry ($\sum_{i \neq s} q_{i,s}$) (iii) by the absorptive capacities of the industry *s* itself (TII_s) and the intensity of relationship of *s* with itself (q_s),which is built by using as numerator the records $x_{i,i} = x_{j,j}$ that lie on the diagonal of the input-output tables. Hence, the final spillover index is

composed of three parts, one accounting for backward spillovers, one for forward spillover and the third one for spillover that are generated within the same sector[vii]. According to hypothesis n. 4b, we expect that the spillover index is not significantly correlated with the agglomeration index of MNEs and negatively correlated with both the agglomeration index of national enterprises and the co-agglomeration index.

Hypothesis n. 5 states that skilled labor is a firm specific centripetal force only for MNEs. Following Rosenthal and Strange (2001), we employed as proxy the number of managers over the total employment for each industry in 2001. Data about the number of managers in each Italian Industry come from the database Mediocredito Centrale - Unicredit.

Finally, a dummy has been employed to control for the most agglomerated sectors whose index is more than 0.2, which is either more than ten times higher than the mean of national firms or more than eight times higher than the mean of MNEs. The industries that have been included in the dummy variable are seven: 171 (Preparation and spinning of textile fibres), 172 (Textile weaving), 173 (Finishing of textiles), 192 (Manufacture of luggage, handbags and the like, saddlery and harness), 244 (Manufacture of pharmaceuticals, medicinal chemicals and botanical products), 263 (Manufacture of ceramic tiles and flags), 296 (Manufacture of weapons and ammunition). The activities of these industries are typically organized in districts, i.e. in highly specialized clusters of firms that work in different stages of the supply chain. Except for pharmaceutical industry (244), which displays a strong cluster of MNEs, all the other sectors are traditional industries, whose districts are composed mainly of small-medium national enterprises. The dummy aims at controlling for these industries that are highly agglomerated because of the presence of districts. Therefore it is expected to display a positive sign both for MNEs and for national firms. Specifically, the

dummy will control for the cluster of MNEs in the pharmaceutical industry and for the districts of national firms that operate in traditional industries. As regards the co-agglomeration, we also expect a positive sign, provided that six out of seven industries that are controlled by the dummy are traditional sectors where Italian firms have a strong competitive advantage with respect to foreign firms (Pyke, Becattini and Sengemberger, 1990; Cossentino, Pyke and Sengenberger, 1996; Helg, 2003; Becattini, 2004, De Benedictis, 2005). This means that the latter are willing to join the district of national firms in order to acquire their same competitive advantage.

Table 5 summarizes the determinants of agglomeration we used in our analysis and their proxies, with some descriptive statistics and the expected output, while table 6 shows the correlations.

(Table 5 and 6 go about here)

6. RESULTS

A first OLS[viii] regression has been performed to test our hypotheses. However, the plot of residuals has immediately shown a correlation between the errors and the X matrix, which give birth to problems of heteroskedasticity. The Breusch-Pagan test has confirmed that data are not omoskedastic, by rejecting the hypothesis of constant variance. We decide therefore to employ a Weighted Least Square (WLS) regression, which allows controlling for heteroskedasticity by ascribing less weight to the observations with the highest variance.

Results of the WLS estimation for all the three equations are reported in table 7. The output is reported in three columns, where the first one displays the results of the

agglomeration within national firms, the second one the output of the agglomeration within MNEs, and third one the results concerning the co-agglomeration between MNEs and national firms.

The first hypothesis turns out to be almost fully confirmed. Indeed, competition appears to be an industry specific centrifugal force, since the higher the concentration the higher the agglomeration regardless of the category of firms that is taken into account. Hence both MNEs and national firms are afraid to cluster in high competitive industries because of the negative externalities that derive, such as profit compression. Competition seems to discourage also the co-agglomeration between MNEs and national firms, but the coefficient is not significant. A possible explanation is that MNEs do not fear the competition of most of national companies because the former are generally more competitive than the latter, hence MNEs may be willing to cluster with national firms even if the industry is highly competitive. Furthermore MNEs and national firms often compete in different markets or different geographic areas and, hence, they may cluster even if the competition in the industry is high.

Hypothesis n. 2 is not confirmed: indeed, we expected that transportation costs are an industry-specific centrifugal force, with a negative and significant sign for all categories of firms. Conversely, we found that they do not affect at all either the agglomeration nor the co-agglomeration.

The third hypothesis is fully verified. Indeed, information costs are positively and significantly correlated with the agglomeration of MNEs, while they have a not significant effect on the agglomeration of national firms. Therefore, in line with the literature on MNEs, it is confirmed that MNEs face high information costs that push them to replicate the location choices previously made by other MNEs. Our further result with respect to the literature is that information costs are a firm-specific determinant of agglomeration, since they do not play a significant role in the agglomeration of national firms. Furthermore, information costs do

not have any role even in promoting the co-agglomeration between MNEs and national firms. This is a further confirmation that MNEs, in order to minimize their information costs, prefer to replicate the location choices made by other MNEs, which are more similar to them and which face the same type of problems, and not by national firms, which display different features and do not face high information costs.

Hypotheses n. 4a and 4b also turn out to be fully verified. As regards the former, spillovers that originate from codified knowledge are never significant either for the agglomeration nor for the co-agglomeration. Therefore agglomeration seems not to be required in order to absorb the knowledge that is embedded in patents. The opposite seems to be true for the spillovers that arise from tacit knowledge. Indeed, hypothesis n. 4b is almost fully confirmed: tacit spillovers are a centrifugal force both for the agglomeration within national firms and for the co-agglomeration between national and multinational enterprises. This happens because the technological differences within national firms in the first case, and between national and multinational companies in the second case, make the probability of a leak of strategic tacit knowledge higher than the probability of absorbing useful tacit knowledge for the most advanced firms.

As regards spillovers that arise from tacit knowledge, as stated by hypothesis 4a they are not significant for the agglomeration within MNEs while they negatively affect both the agglomeration within national firms and the co-agglomeration between national and multinational enterprises. Our results are consistent with those found by Flyer and Shaver (2000), Co (2002) and Alcacer and Chung (2002) for MNEs investing in U.S.A., which appears not to be particularly attracted by knowledge spillovers. The explanation provided by Flyer and Shaver (2000) is that MNEs are typically the most advanced firms and, hence, are more concerned of leaks of knowledge than attracted by the gain deriving from the absorption of knowledge. Co (2002) adds a further explanation by stating that MNEs investing in U.S.A.

are not driven by the sourcing of U.S. technology and that they tend to adapt their products and know-how to U.S. conditions. Conversely, MNEs investing in U.S. seem to be driven more by economies of scale and by the research of resources, since the proxies used for concentration and natural resources appears to be positively and significantly correlated with the agglomeration of foreign plants. Alcacer and Chung (2002) explain their result by disentangling the heterogeneity of U.S. industries: indeed, most of investments occur in low-tech sectors, where MNEs are not attracted by spillovers, while the opposite is true for investments occurring in high-tech industries.

Similar arguments can be used for the Italian case besides the explanation that we provided for the hypothesis 4b. Indeed, Italy is not one of the most technology advanced countries among the OECD and, hence, it is not the most preferred destination for MNEs looking for technology source. Therefore MNEs are likely not locate next to other MNEs to absorb technology, but they rather locate next to other foreign firms either to decrease their information costs or to look for rents and economies of scales in concentrated industries, as it is shown by the positive and significant coefficient of Herfindahl index. In other words, MNEs try to invest in those Italian industries with a low presence of other MNEs in order to be able to exploit the gains that derive from economies of scales and from oligopolistic markets.

Hypothesis n. 5 turns out to be fully verified. Indeed, only MNEs can support high turnover costs and can afford to undertake labor pooling without suffering from labor poaching. Therefore they locate both next to other MNEs and to national firms. However, the latter prefer not to locate next to MNEs because they cannot attract the best workers and they may run the risk to be subject to labor poaching from MNEs. This explains why skilled labor is positively and significantly correlated only with the agglomeration of MNEs, while the coefficient of the co-agglomeration is not significant. . As regards national enterprises, they

are so heterogeneous that some of them can afford labor pooling with other national firms and some others cannot, hence some firms are attracted by skilled labor and some others are not. The consequence is an average not significant net final impact of skilled labor on the agglomeration within national firms.

Finally, the dummy that controls for the districts is always positive and very significant. The coefficient is particularly high for the agglomeration of national firms and for the co-agglomeration of national and multinational enterprises. These results confirm that the districts are still a strong source of agglomeration for national enterprises in those traditional industries where Italy display a high competitive advantage with respect to foreign firms, and that MNEs are attracted by these clusters because they aim at acquiring the same competitive advantage.

CONCLUSIONS

In this paper we tried to assess whether multinational and national firms differ in their agglomeration patterns. In order to reach this goal, we first describe the agglomeration of national and multinational firms through the FGW index, and then we try to correlate such a measure to the determinants of agglomerations. The issue of co-agglomeration between national firms and MNEs is taken into account too.

We find that competition is the only industry-specific driver of agglomeration, while transportation costs do not seem to be a significant determinant of agglomeration, as well as spillovers that arise from codified knowledge, which can be absorbed without agglomerating. Conversely, information costs, skilled labor and spillovers from tacit knowledge are firm specific determinant of agglomeration. Specifically, the two first driver promote the agglomeration of only MNEs, while the last one discourage the agglomeration within national

firms and the co-agglomeration between national and multinational enterprises without significantly affecting the agglomeration within national firms.

These results give a useful contribution to the literature on agglomeration, since the evidence on the firm-specific and industry-specific determinants of agglomeration is still scanty. However, both policy makers and firms may also be interested in this output.As regards the former, the distinction between firm-specific and industry-specific determinants of agglomeration may help policy makers dealing with the territorial distribution of economic activities to target their policies according to the categories of firms that they want to move. As regards firms, they may also be interested in better understanding and deeper disentangling the firm-specific and the industry-specific drivers of agglomerations, in order make more consciously their location choices according to the category of firms they belong to.

However, a remark must be taken into account. These results have been found by using the Italian case to run the empirical analysis. It would be interesting to understand whether the same output is found in other countries. In particular, it is worth understanding whether the sign and the significance of the coefficients accounting for tacit spillovers change across countries, according to the technology intensity of the host country. Indeed, MNEs investing in a advanced country for technology sourcing reasons may be willing to locate next to other MNEs or to national enterprises in order to absorb their tacit knowledge. However, provided that our results are consistent with those found by Flyer and Shaver (2000), Co (2002) and Alcacer and Chung (2002), who study the agglomeration patterns in one of the most advanced countries such as U.S.A. and who find that knowledge spillovers do not drive the agglomeration of MNEs, it is likely that our output is valid beyond the country-specificity of our analysis.

Finally, another possible extension of our paper may derive from the analysis of agglomeration patterns based on the distinction of other categories of firms different from multinational and national enterprises, e.g. by considering large vs. small firms.

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FIGURES

Figure 1 – Distribution of frequency of the FGW indexes for national firms

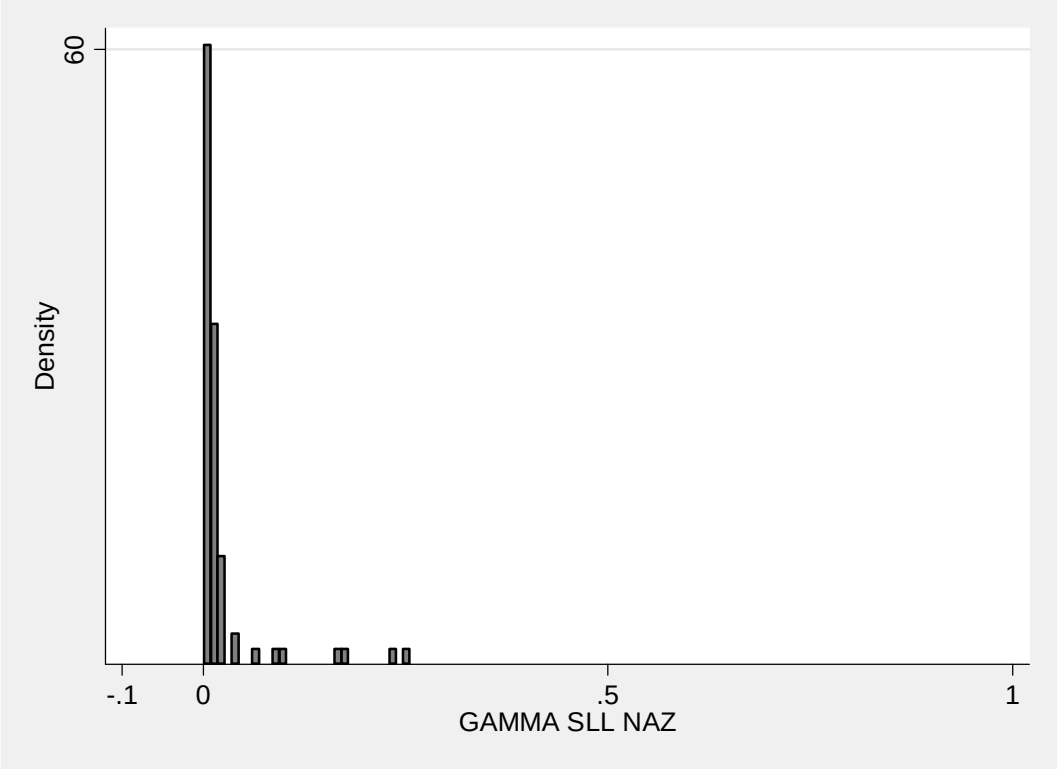
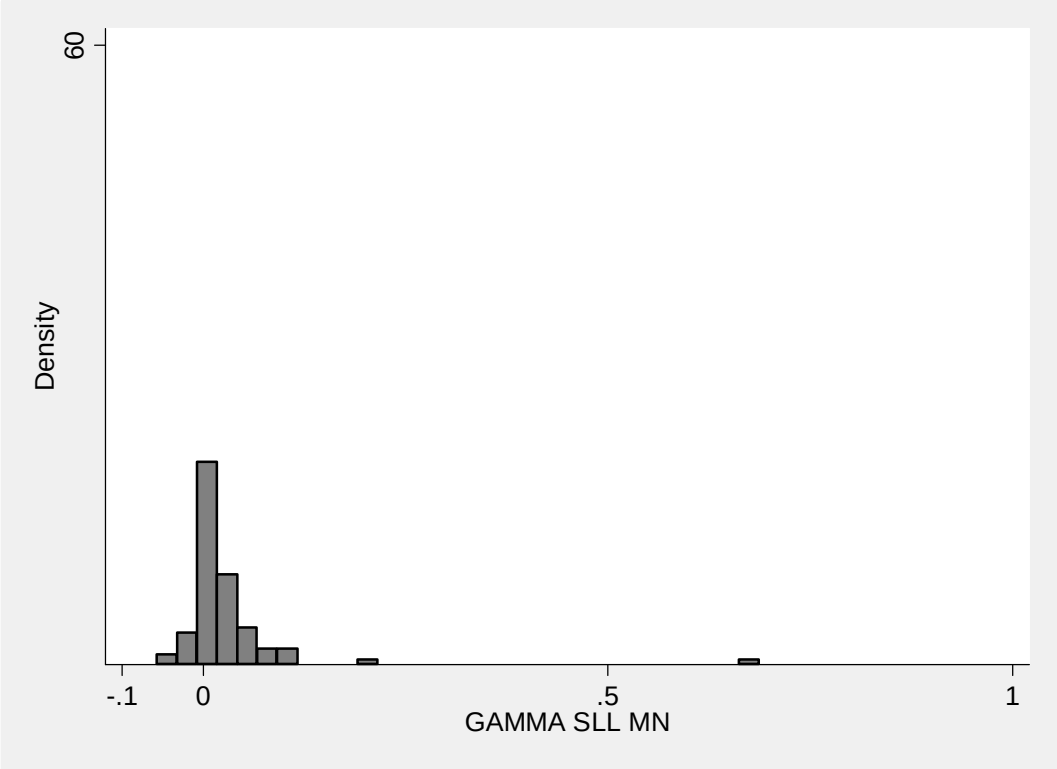


Figure 2 – Distribution of frequency of the FGW indexes for MNEs



TABLES

Table 1 – The 20 most agglomerated industries for national firms.

Number	Industry	Description of the industry
1	263	Manufacture of non-refractory ceramic goods other than for construction purposes; manufacture of refractory ceramic products
2	171	Textile fibre preparation; textile weaving
3	296	Manufacture of weapons and ammunitions
4	172	Textiles weaving
5	173	Finishing of textiles.
6	192	Manufacture of luggage, handbags and the like, saddlery and harness
7	244	Manufacture of pharmaceuticals, medicinal chemicals and botanical products.
8	362	Manufacture of jewellery and related articles
9	193	Manufacture of footwear
10	242	Manufacture of pesticides and other agro-chemical products
11	343	Manufacture of parts and accessories for motor vehicles and their engines
12	152	Processing and preserving of fish and fish products
13	334	Manufacture of optical instruments and photographic equipment
14	351	Building and repairing of ships and boats
15	262	Manufacturing of ceramic products
16	175	Manufacture of other textiles
17	251	Manufacture of rubber products
18	154	Manufacture of vegetable and animal oils and fats
19	271	Manufacture of basic iron and steel and of ferro-alloys (ECSC)
20	352	Manufacture of railway and tramway locomotives and rolling stock

Table 2 – The 20 most agglomerated industries for MNEs.

Number	Industry	Description of the industry
1	192	Manufacture of luggage, handbags and the like, saddlery and harness
2	263	Manufacture of non-refractory ceramic goods other than for construction purposes; manufacture of refractory ceramic products
3	244	Manufacture of pharmaceuticals, medicinal chemicals and botanical products.
4	267	Cutting, shaping & finishing of stone
5	341	Manufacture of motor vehicles
6	247	Manufacture of man-made fibres
7	354	Manufacture of motor vehicles and bicycles
8	331	Manufacture of medical and surgical equipment and orthopedic appliances
9	351	Building and repairing of ships and boats
10	284	Forging, pressing, stamping and roll forming of metal; powder metallurgy
11	332	Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment
12	156	Manufacture of grain mill products, starches and starch products
13	177	Manufacture of knitted and crocheted articles
14	322	Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy
15	172	Textiles weaving
16	151	Production, processing and preserving of meat and meat products
17	242	Manufacture of pesticides and other agro-chemical products
18	245	Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations
19	285	Treatment and coating of metals; general mechanical engineering
20	246	Manufacture of other chemical products

Table 3 – Comparison between the mean and the standard deviation of the FGW indexes computed for national firms and MNEs, with Pearson and Spearman correlations.

Variable	Obs	Mean	Std. Dev.	Min	Max
Gamma FGW National	78	0.0228	0.0467	0.0011	0.2557
Gamma FGW MNEs	78	0.0310	0.0836	-0.0573	0.6868
Pearson correlation: 0.2756*					
Spearman correlation: 0.1095 - Test of Ho: Gamma FGW National and Gamma FGW MNEs are independent. Prob > |t|= 0.3397					

*Significance at 5%

Table 4 – The 20 most co-agglomerated industries.

Number	Industry	Description of the industry
1	263	Manufacture of non-refractory ceramic goods other than for construction purposes; manufacture of refractory ceramic products
2	171	Textile fibre preparation; textile weaving
3	172	Textiles weaving
4	296	Manufacture of weapons and ammunitions
5	192	Manufacture of luggage, handbags and the like, saddlery and harness
6	173	Finishing of textiles.
7	362	Manufacture of jewellery and related articles
8	244	Manufacture of pharmaceuticals, medicinal chemicals and botanical products.
9	193	Manufacture of footwear
10	343	Manufacture of parts and accessories for motor vehicles and their engines
11	152	Processing and preserving of fish and fish products
12	334	Manufacture of optical instruments and photographic equipment
13	262	Manufacturing of ceramic products
14	351	Building and repairing of ships and boats
15	251	Manufacture of rubber products
16	175	Manufacture of other textiles
17	271	Manufacture of basic iron and steel and of ferro-alloys (ECSC)
18	154	Manufacture of vegetable and animal oils and fats
19	314	Manufacture of accumulators, primary cells and batteries
20	242	Manufacture of pesticides and other agro-chemical products

Table 5 – Summary of variables and proxies used to account for the determinants of agglomeration, together with some descriptive statistics.

Variable	Proxy	Obs	Mean	Std. Dev.	Min	Max	Expected output
log_H (Concentration)	Herfindahl index	78	-5.6174	1.4870	-9.1019	-2.4692	Industry specific (+)
log_T (Transportation costs)	Input supplied by transportation industries	78	-2.1194	0.6621	-3.9890	0.0038	Industry specific (-)
log_I (Information costs)	Expenditures in external services over total sales	78	-1.5668	0.2466	-2.1106	-1.0906	Firm specific (+ for MNEs,no impact for national firms and for co-agglomeration)
log_P (Spillovers from codified knowledge)	Percentage of firms owning a patent	78	0.2045	0.1176	0.0000	0.5878	Not significant determinant of agglomeration
log_S (Spillover from tacit knowledge)	Spillover index	78	0.1776	0.0613	0.0899	0.2879	Firm specific (+ for MNEs,negative for national firms and for co-agglomeration)
log_L (Skilled labor)	Managers over total employment	78	0.5256	0.5720	-2.0794	1.8050	Firm specific (+ for MNEs,not significant for national firms and for co-agglomeration)

Table 6 – Correlation matrix of the dependent variables.

	log_H	log_T	log_I	log_P	log_S	log_L
log_H	1					
log_T	0.3099	1				
log_I	-0.2440	-0.2897	1			
log_P	0.3597	-0.0316	-0.0665	1		
log_S	0.0722	0.0107	-0.1947	0.4663	1	
log_L	-0.1459	0.1750	0.0577	-0.0790	-0.0159	1

Table 7 – Results of the WLS regressions

	Agglomeration within MNEs	Agglomeration within National Firms	Co-agglomeration between MNEs and National firms
log_H	0.0046 *	0.0048 **	0.0015
log_T	-0.0072	0.0012	0.0009
log_I	0.0289 *	-0.0058	-0.0106
log_S	0.0746	-0.1283 **	-0.1640 **
log_P	-0.0549	0.0093	0.0171
log_L	0.0158 **	0.0013	-0.0036
Dummy Out.	0.0911 *	0.4126 ***	0.3654 ***
cons	0.1257 ***	0.0743 **	0.0543
N. of obs.	78	78	72
F-Test	2.95	4.15	4.06
P > F	0.0090	0.0007	0.0029
R-squared	0.2280	0.2931	0.1771

Notes: * if $p < 0.10$, ** if $p < 0.05$; *** if $p < 0.01$

ENDNOTES

[ii] Since we used the FGW plant-based version of the EG index, also for the co-agglomeration index we computed the Herfindahl index as H=1/N, as FGW do.

[iii] The whole set of the FGW indexes are available upon request.

[iv] The co-agglomeration indexes are available upon request.

[v] The ISTAT database does not provide the number of employees of each plant, but the number of firms that belongs to each class of employees. The classes of employees defined by ISTAT are: 1, 2, 3-5, 6-9, 10-15, 16-19, 20-49, 50-99, 100-199, 200-249, 250-499, 500-999, more than 1000 employees. As Ellison and Glaeser (1997) claim, in absence of better data, it is reasonable to compute the employment-based Herfindahl index by attributing the medium number of employees of each class to all the plants that belong to that class.

[vi] The only industries for which it was possible to have neither the weight nor the amount of goods produced are Ateco 23 (Production of Coke, oil refinery, nuclear combustible treatment) and 37 (Recycling). In these cases the distribution of the inflows has been made equally across the sub-industries.

[vii] Since the input-output tables are provided by ISTAT at two digit level, we were able to compute our measure of spillovers only at two digit level: we therefore attributed the same index of spillovers to all the three-digit industries belonging to the same two-digit group.

[viii] OLS regression has not been reported because of the econometric problems described afterwards.