The firm-specific determinants of agglomeration: a comparison between multinational and national firms

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Abstract

This paper deals with the agglomeration of economic activities in Italy. By using the Guimaraes *et al.* [2004] version of the Ellison & Glaeser [1994] index, we test the hypothesis that the determinants of agglomeration differ in significance, intensity and sign between multinational and national firms. The data concerning the agglomeration of 112 manufacturing and mining industries, computed over the 686 Italian Local Labor Systems (SLL) in the year 2001, show that some agglomeration forces are industry-specific while some others are firm-specific. Indeed, on the one hand the industrial concentration and the inter-industry externalities seem to act as centripetal forces for all types of enterprises, on the other hand the intra-industry spillovers appear to favor the agglomeration of only multinational firms, while acting as centrifugal force both for the clustering of national firms and for the co-agglomeration between foreign and domestic enterprises. This result suggests that the possibility of knowledge transmission between firms belonging to the same industry may discourage the most advanced enterprises to co-locate with the less innovative firms. The main policy implication is that a high Intellectual Property Regime (IPR) is preferred to a low protection of intellectual property, since in the latter case the co-agglomeration does not occur and multinational and national firms do no interact and do not exchange knowledge, while in the former scenario domestic and foreign enterprises co-locate, and even if the high IPR limit the transfer of knowledge, other mechanisms, such as the labor turnover, may occur and promote knowledge spillovers between firms.

Key words: Firm-specific and Industry-Specific Determinants of Agglomeration, Multinational and National Firm, Intra-industry Spillovers and Inter-Industry Externalities, IPR regimes.

JEL classifications: F23, L11, R12, R30

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Introduction

The distribution of economic activities within a geographic area is one of the most debated topic of Industrial Economics. Indeed, the comprehension of the forces that drive the co-location of firms in the same geographic unit is a very strategic issue, since it allows to set up policies that are capable of attracting a high number of firms in a certain area. As Shaver [1998] notices, to understand the determinants of agglomeration is useful not only for policy makers, but also for firms that have to decide where to open a new plant, and for researchers, who can better analyze the linkage between geographic clustering and performance of enterprises.

When dealing with the agglomeration issue several different aspects can be taken into account. A first concern may be to find the best way to gauge this phenomenon, since the final output can be very different and sometimes conflicting according to the methodological choices made to build the agglomeration index. These indexes are used to measure the agglomeration of economic activities in different countries, in order to understand whether there are country-specific characteristics of agglomeration or, conversely, industries cluster in the same way across all countries. Another very debated issue concerns the determinants of agglomeration: the aim is to understand what are the centripetal and the centrifugal forces that drive the location choices of the economic activities, in order to provide useful advises to policy makers who want to attract firms in a given area. Finally, within this last section few other papers try to disentangle the dissimilarities between the agglomeration patterns of different typologies of firms, such as multinational vs. national enterprises: these authors argue that the agglomeration forces can be not only industry or country specific, but also firm-specific, that is they are related to the characteristics of the group which the firm belong to[1].

Our article aims to give a contribution to this latter issue of the agglomeration literature. Indeed we believe that the strategic choices that bring different types of firms to differ in terms of economic and innovation performance also affect their location choices through the determinants of the agglomeration. In other words, we may think that some of the variables that explain the clusters of firms can act either as centripetal or as centrifugal forces according to typology of enterprises. The two groups of firms that we will take into account to test our hypothesis that the agglomeration patterns differ according to characteristics of the enterprises are the multinational and the national plants, which we may think of as clustering in different ways because of several reasons that will be shown in the review of the literature.

The article is organized as follows. In the first paragraph we present a review of the literature, by discussing three of the four mainstreams that are related to the topic of agglomeration: the description of the clusters across different industries and different countries, the analysis of the determinants of agglomeration, and the analysis of firms-specific determinants of agglomeration by distinguishing between multinational and national enterprises. In the second paragraph we will briefly discuss the fourth topic concerning the agglomeration, that is the measure of this phenomenon, and we will show how we decide to gauge the agglomeration in our paper and why we made that choice. In the third part we provide some descriptive statistics to see whether there is evidence of different location choices between foreign and domestic plants. The fourth section describes the data and the equation used in our econometric analysis. Finally, the last paragraph shows the results of our regressions, whose aim is to understand the agglomeration determinants both within and between each group of firms, by using two different agglomeration indexes for multinational and national plants, and a co-agglomeration index between foreign and domestic plants.

[1] In the following sections we will provide more detailed pieces of information concerning the authors who dealt with the different issues of agglomeration.

The agglomeration in the literature.

The literature concerning the agglomeration of economic activities can be grouped into four main categories, according to the purpose of the articles, that is:

- to find the most correct index to gauge the agglomeration;
- to describe the agglomeration patterns of different countries and industries;
- to understand what are the determinants of agglomeration;
- to highlight the differences between industry-specific and firm-specific determinants of agglomeration, with a special attention to the dissimilarities between multinational and national firms.

The first topic will be discussed in the next paragraph. We will now focus on the other three.

The agglomeration of countries' industries.

In this group we find those authors who use the different measures of agglomeration to depict the distribution of economic activities in different industries and countries.

Ellison and Glaeser [1994, 1997] study the co-location pattern of manufacturing firms in the Silicon Valley at 2, 3 and 4 digit and at country, county and zip-code levels. Nearly all the sectors turn out to be more agglomerated than their counterfactual ideal situation based on the "dartboard approach", even if only half of the sectors seems to have a high agglomeration (more than 0.5 points). According to EG, the intensity of agglomeration rises with the desegregation of the digits and with the aggregation of the geographic units, but the rank of the sectors' agglomeration does not change.

Maurel and Sedillot [1999] focus on French industries and find that three groups of sectors can be considered very clustered: the mining industry, whose agglomeration determinants are natural advantages, the traditional sectors, whose agglomeration pattern depends on past static externalities, and the technology industries, which cluster because of the presence of spillovers. By comparing their results with those of EG, they find that U.S.A. and France share a similar pattern of agglomeration.

Guimaraes *et al.* [2004] look at the agglomeration of 103 sectors at 3-digit level in the 275 "concelhos" of Portugal, and they find results very close to that of EG.

Deveraux *et al.* [1999] study the agglomeration of economic activities in England at 4-digit level and for three different spatial aggregation of the data (Local Authority, Post-code and County). The most clustered industries turn out to be the traditional ones and the agglomeration pattern of UK results to be close to that of USA and France, at least as regards the industries that show higher values of the index, while it differs for the less agglomerated industries.

Finally, Pagnini [2002] use three different indexes to measure the agglomeration of 100 industries at 3-digit level in Italy in 1996, and finds that they all agree as far as the most agglomerated sectors are concerned, while they give different responses for the lower agglomerated industries. As Deveraux *et al.* [1999], he uses three different levels of aggregation of the data (counties, regions and Local Labor Systems) and finds that the traditional sectors are still the most agglomerated.

From these studies, it seems therefore that there are strong industry-specific determinants of agglomeration, since the most agglomerated sectors always turns out to be the traditional ones. However, there are also some country-specific dissimilarities, since the patterns of agglomerations also differ across countries.

The determinants of agglomeration

A second bunch of authors that deal with the agglomeration issue look for the determinants of this phenomenon, with the aim of giving useful advises to the policy makers who want to attract firms in certain area.

From a theoretical point of view, there are three mainstreams in the literature dealing with the determinants of agglomeration, that are the Traditional Trade Theory, the Urban and Spatial Economics and the New Economic Geography.

In the traditional trade theory, which is based on the assumptions of constant returns to scale and perfect competition, the determinants of agglomeration derive from the determinants of trade once that the hypothesis of immobility of capital is removed. Indeed, in the framework of Heckscher-Ohlin, the main determinant of trade is the different endowments between countries, which bring firms to locate (and to agglomerate) close to the raw materials source as soon as they can move. In Ricardo the differences in endowments has to be intended as technology differences, but the conclusions are the same. Therefore the presence of natural advantages is considered the first main force of agglomeration.

The New Economic Geography, as developed by Krugman [1991], Venables [1995], Krugman & Venables [1995] Ottaviano & Puga [1998], and Puga [1999], move from opposite assumptions with respects to the Traditional Trade Theory, since it considers increasing returns to scale and identical endowments across countries. Therefore the main agglomeration force becomes the exploitation of scale economies, which derives from the concentration of economic activities in the same area. On the other hand, transportation costs act as a dispersion force, even if with a non-monotonic relationship. Indeed, a decrease in transportation costs increases the agglomeration up to a certain threshold where the congestion economies begin to prevail and generate a new wave of dispersion. Hence the final output depends on the equilibrium among these three forces.

Finally the Urban and Spatial Economics emphasizes the importance of external economies that derive from the co-location of several firms in the same areas. These agglomeration or location externalities might be intended either as knowledge spillovers, which originate from a cluster of enterprises belonging to the same industry, or as pecuniary externalities, which arise when firms belonging to different industries or vertically integrated share common services (e.g. infrastructures, administrative services etc.) that make it possible to reduce the production and transaction costs.

Both types of externalities are seen as agglomeration forces, while transportation costs, congestion economies and product varieties (that is an increase in the competition) act as dispersion forces.

The empirical papers that tested the hypotheses developed by the theoretical literature confirm the validity of the main conclusions of all the three mainstreams.

The importance of natural advantages is demonstrated by several authors, such as Co [2002], who finds a positive relationships with a proxy defined as *raw material usage per production value added*. Rosenthal and Strange [2001] find that all the proxies used for raw materials, for energy and for water have a positive impact on agglomeration in U.S.A., even if with different intensities according to the spatial unit of the data (zip-codes, county and state levels). Also Alsleben [2005] finds that the dummy for the extractive industries is positively correlated with the agglomeration of economic activities in Germany, which is measured through the EG index. Guimaraes *et al.* [2000], and Pagnini [2002] use other proxies to account for other natural advantages of a given sector, such as the low cost and the high education of workers, which all turn out to be positively correlated with the agglomeration of firms respectively in Portugal and in Italy.

The positive impact of scale economies, which is complementary to the negative impact of an high degree of competition, has been tested by not many authors. Co [2001] uses the variable *Scale* defined as value added per plant, while Alsleben [2005] makes use of the Herfindahl index to account for the concentration of each sector. Both these authors find evidence of a positive relationship of concentration with respect to the agglomeration: therefore the level of competition acts as a centrifugal force, while the possibility of exploiting scale economies and concentrating the market increases the agglomeration. Alsleben [2005] and Combes and Duranton [2003] explains this phenomenon by tying it both to the profits compression caused by the product market competition, and to the so-called labor-poaching phenomenon, namely the competition in the input-market that brings firms to pay high salary in order to keep their workers (or to attract the workers of the opponents) and to avoid the turnover costs.

The transportation costs turns out to be always significant in the equations that test the determinants of agglomeration, with a negative sign. Rosenthal and Strange [2001] use as proxy the *inventories per $ of shipment*, since they assume that industries producing highly perishable products face higher shipping costs and have less inventories. Pagnini [2002] and Alsleben [2005] relate their proxy to the imports and exports of a each industry, and they confirm the negative relationship between transportation costs and agglomeration.

The congestion economies are seldom considered within the agglomeration analyses, since they are not very easy to be measured. Pagnini [2002] and Guimaraes *et al.* [2000] propose to use the cost of land as proxy, since a high price of lands is associated to an high demand of investments and therefore to a high congestion.

Finally, the intra-industry spillovers and the inter-industries externalities have been the most tested variables in the analysis of the determinants of agglomeration. The former are generally intended as knowledge spillovers, and are measured as *innovation per $ of shipment* in Rosenthal and Strange [2001] and as *R&D intensity* of each industry in Pagnini [2000], Alsleben [2005] and Co [2002]. All the authors confirm the positive relationship with agglomeration, except Alsleben [2005] who justifies his result in terms of fear of knowledge transfer: indeed, when knowledge spillovers occur in an area, the less innovative firms gain while the most innovative suffer a leak of knowledge. This happens through several mechanisms such as the labor poaching, which implies not only turnover costs but also the transmission of knowledge among firms, the backward and forward linkages between enterprises and the imitation of competitors. All these mechanisms can be avoid by not agglomerating: this is the interesting explanation given by Alsleben [2005] and Combes and Duranton [2003] for the negative relationship they found between spillovers and agglomeration, which will be also tested in our paper.

To account for other intra-industries spillovers different from knowledge spillovers, such as the input sharing that generate pecuniary advantages, Rosenthal and Strange [2001], Guimaraes *et al.* [2000] and Alsleben [2005] introduce a variable called *manufactured inputs,* which is positively correlated with agglomeration since the higher the costs for inputs the more the advantages from sharing them.

Finally, the inter-industry externalities are more difficult to be measured. Rosenthal and Strange [2001] as proxy the *non-manufactured inputs,* which is very close to *manufactured input* as meaning but accounts for inter-industries externalities, while Co [2002] makes use of a proxy for business services. On the other hand, Bronzini [2003, 2004] computes a diversity index, which is a sort of Herfindahl index calculated as if all the sectors, except the one that is being analyzed, were a single big industry: in other words it is like to measure the concentration (or the level of competition) of all the other sectors, hence a negative sign of the index means a positive influence on the agglomeration. The inter-industry externalities always turn out either to favor the agglomeration or not to be significant, and this shows that the inter-industry externalities mainly act as centripetal forces since they allow to gain pecuniary advantages.

The comparison between multinational and national firms

Most of the articles do not disentangle the dissimilarities of the agglomeration patterns across different typologies of firms, such as multinational and national enterprises. As Shaver [1998] claims, there are both reasons for location similarities and reasons for location differences between national and international firms.

A similar pattern of agglomeration can be observed whenever the drivers of agglomeration are industry-specific, that is when they push firms to cluster just because they belong to that industry, regardless of the typology of the enterprise: according to Shaver [1998], both the natural advantages and the agglomeration economies (intra-industries spillovers + inter-industries externalities) act as industry-specific determinants of agglomeration.

On the other hand, the multinational and national enterprises might follow different patterns of agglomeration both within and between each group, and this happens when the determinants of firms' clustering are firm-specific. For instance, Shaver [1998] observes that foreign firms are more import intensive and technologically advanced than national firms, and therefore they might look for locations that have easy access to imports or that guarantee the presence of specific assets that fit to their technology. At the same time, multinational firms that enter a country face some disadvantages compared to the U.S.-owned enterprises, since they do not know the market; therefore they cluster with other multinational firms by taking their location choices as a demonstration effect and by exploiting the high knowledge spillovers that arise from the co-location of international enterprises. Furthermore, the location patterns may also differ because national firms clustered in the past, while multinational enterprises enter in a second time and are driven by new forces.

Shaver [1998] finds evidence of differences in agglomeration patterns between multinational and national firms, since it turns out that foreign firms prefer the U.S. countries that are on the coast, offer low salaries and have low unionization rate. Therefore he concludes that foreign firms should look at the location of the other multinational firms, ad not of the domestic enterprises, when they enter a market, while national firms should not necessarily follow the foreign enterprises in their location choices since the agglomeration drivers might be very different. The policy makers also should set up different policies according to what typology of firms they want to attract.

Co [2002] compares the determinants of the agglomeration of all the U.S. firms with the clustering pattern of foreign-owned and domestic-owned enterprises. The only agglomeration driver that is found to be *industry-specific* are the scale economies. On the other hand natural advantages and business services seem to be more important for foreign firms, while knowledge spillovers have a high positive impact on the agglomeration of national firms and a low influence on the clustering of multinational firms. This might mean that the inward foreign direct investments of U.S.A. are driven not by technological spillovers, but rather by the backward linkages that foreign firms fix with the local suppliers of raw materials.

Finally, Duranton & Overman [2003], by using a point-pattern methodology for some descriptive statistics, do not find significant differences between the distribution of foreign and domestic owned enterprises in UK. Conversely, Hogenbirk & Narula [2004] use a location choice model and find not only that the pattern of multinational and national firms are dissimilar, but also that the location choices of foreign-owned enterprises differ per home country. Indeed, European foreign direct investments favor border regions, which allow to decrease transportation costs and which turn out to be more familiar and more culturally similar to the home country, whereas Japanese ad U.S. multinational firms follow more simplistic location patterns, by choosing the "obvious" regions that offer agglomeration and urbanization economies. However, both MAR and Jacobians externalities increase the probability of attracting foreign direct investments.

Other papers just focus on the location drivers of foreign direct investments. Shaver [2000] finds evidence that the proxy used to account for agglomeration economies[2] is negatively correlated with the probability of attracting foreign direct investments in U.S.A.. The explanation provided for this evidence is that firms (especially the large ones) not only capture benefits that arise from the agglomeration economies, but also contribute to them. Hence the more advanced firms, which generally are multinational, prefer not to cluster when the spillovers are too high.

Conversely, Guimaraes *et al.* [2000] find that multinational firms are attracted in the Portuguese "*concelhos*" by agglomeration and urban economies in terms both of intra-industry spillovers and inter-industries externalities (especially in the service sectors,). Hilber and Voicu [2006] look at the distribution of multinational enterprises in Romania, and also conclude that the

[2] The proxy used by Shaver [2000] to account for the agglomeration externalities is the proportion of industry establishments that are in the state where foreign plant locates.

probability of a region to attract foreign firms depends on intra-industry spillovers and on the agglomeration economies in the services sector; labor market conditions also matter.

De Propis *et al.* [2005] classify the inward foreign direct investments of Italy according to the Pavitt [1984] taxonomy[3], and find that while the agglomeration externalities matter for all types of multinational firms, the urbanization economies are not important at all (except those that arise from Milan). Furthermore, the specialization of a region in a given industry, which implies intra-industry spillovers, acts as centripetal force only for the *science based* firms and the *specialized suppliers*, whereas the diversified regions, namely the districts, only attract the *specialized suppliers* industries. In general it seems that the intra-industry spillovers attract a multinational firm only when they embed codified knowledge, which is more transferable through the linkages with local firms compared to the tacit knowledge.

A similar result is found by Bronzini [2003], who confirms that the inward foreign direct investments of Italy are not attracted by districts, because they represent closed systems based on tacit knowledge and social relationships that are not easy to enter. Indeed he finds that only the intra-industry spillovers attract multinational firms in a region, while the inter-industry externalities, that are typical of many districts, are insignificant for foreign direct investments. Bronzini [2004] also finds evidence that the specialization of an area is significant for the location choice of all types of multinational firms, whereas the diversified regions attract foreign enterprises only in the manufacturing industries.

In the following section we will show some different measures of agglomeration used in the literature and we will provide some arguments to justify our choice concerning how we gauged the agglomeration.

The measure of agglomeration

The analysis and the comprehension of the agglomeration requires the employ of a specific measure able to identify the phenomenon. The measure of agglomeration still represents a very controversial subject, since the use of different indexes might give different meanings to the concept of geographic distribution of economic activities. In this section we will show our choice concerning the measure of agglomeration and the arguments that justify it.

One of the most used variable are the Location Quotient (LQ) and the Gini Coefficient. The LQ defines a region specialized in a sector when the pattern of the regional employment in that industry, compared to the pattern of regional employment in all industries, overcomes the pattern of national employment in that sector compared to the pattern of national employment in all sectors. However, this index yields a result for each pair of industry-region and does not allow either to have only one measure of agglomeration for each industry nor to make comparisons across countries.

The Gini Index allows to solve this problem by internalizing the geographic dimension inside the index and by yielding one measure of agglomeration for each industry. The index, which is based on a cumulative sum of the number of employees working in a given sector compared to total employment within each region, can assume a value between 0 and 1 respectively in case of dispersion or agglomeration of economic activities. However, this index does not account for the concentration of the industry, that is, given a certain number of employees in an industry, it can

[3] Pavitt [1984] taxonomy classify the manufacturing industries in four different groups, each of which share the same features in terms of sources, patterns and appropriation of innovations, and in terms of entry barriers and average dimension of enterprises. The groups are:

- *Supplier dominated industries*: textiles, food and beverages, paper and printing, wood.
- *Scale intensive industries*: basic metals, motor-vehicles, trailers and semitrailers
- *Specialized suppliers:* machinery and equipment, office, accounting and computing machinery, medical, precision, and optical instruments
- *Science based:* chemicals, pharmaceuticals and electronics.

yields the same output both if the industry is composed of two plants and if the industry is composed of N plants[4].

Ellison & Glaeser (EG) [1994, 1997] face this problem with a sophisticated model that not only accounts for the concentration of industries through the use of the Herfindahl index, but also takes into consideration what are the determinants of agglomeration and how much randomness there is in location choices. In other words, they construct an index that is able to compare the observed agglomeration pattern with an ideal situation where the distribution of economic activities is made randomly, without driving forces, "*as if locations are chosen by throwing darts at a map*" (Ellison e Glaeser, [1994]). This comparison is useful to understand how much the determinants of co-location are significant to explain the agglomeration in excess with respect to that generated by a situation where firms co-locate nearby not because of special agglomeration forces but randomly, e.g. by choosing the region where the manager resides. The agglomeration determinants considered in the model are the presence of natural advantages and the knowledge spillovers.

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

Therefore both Maurel and Sedillot (MS) [1999] and Guimaraes *et al.* (FGW) [2004] 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 Guimaraes *et al.* [2004] propose, which is similar to the EG original index but with plants instead of workers, is:

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

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 number of total employees in region *i* and $\frac{1}{N}$ is the plant-based Herfindahl index, which accounts for the industrial concentration. The denominator is used as normalization. The MS plant-based index differ only in the construction of the raw agglomeration index, since $G_{MS} = \sum_i \left(\frac{n_j}{N}\right)^2 - \sum_i x_i^2$

Guimaraes *et al.* [2004] demonstrate that $Var(\gamma_{FGW}) < Var(\gamma_{EG})$, since the use of the plants instead of the employment allows to obtain an unweighed index, not affected by dimension of the firms locating in the geographic units. Given these properties, the FGW and the MS variants of the agglomeration index is preferred to gauge the phenomenon with respect to the EG original version, and will be used inside this paper to detect the determinants of the geographic concentration.

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4 The Gini coefficient for each sector is: $Gini^s = 1 - \sum_{i=1}^{M} \left(X_i - X_{i-1}\right)\left(S_i^s - S_{i-1}^s\right)$, where X_i is the total employment of the region *i*, while S_i is the employment of the same region in sector *s*.

However, the plant-based agglomeration indexes makes it possible to compute the agglomeration either among all typologies of firms or within different groups of firms, e.g. within multinational and within national enterprises. Conversely, it does not allow to account for the co-agglomeration between the two different typologies of firms. In order to be able to study what are the determinants of the co-agglomeration between foreign and domestic enterprises, we employed the Barrios, Bertinelli & Strobl [2003] variant of the EG co-agglomeration index. Indeed, Ellison and Glaeser [1994] show that the EG index computed at 2-digit level is a weighted sum between the intra-industry agglomeration, given by plants belonging to the same 3-digit group, and the inter-industry co-agglomeration, given by plants that belong to different 3-digit groups but to the same 2-digit classification. Therefore they develop an index that is able to account for the co-agglomeration between plants belonging to different industries. Barrios *et al.* [2003] rearrange this index by considering different typologies of firms instead of different industries. The co-agglomeration index they obtain is:

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

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 with different characteristics cluster together, by subtracting the intra-group agglomeration indexes ($\gamma_{s,k}$) to the total agglomeration (G_s) computed as if all plants belonged to the same group, with the effects of industrial concentration being always discounted by the Herfindahl index both for the total (H_s) and for firm-specific ($H_{s,k}$) values[5]. 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.

The co-agglomeration index can be read in the following way: a high value means that the agglomeration of all the plants, without distinguishing the typology they belong to, is higher than the group-specific agglomerations, therefore the industry that is being analyzed is mainly driven by industry-specific determinants of agglomeration, which affect the firms regardless of the group they are part of. Conversely, a low or negative level of the index means that the total agglomeration is as high as or lower than the specific agglomerations, hence multinational and national firms do not cluster between but within them. In this case we will say that the industry is driven by group-specific agglomeration forces.

Data and descriptive statistics

Our databases allowed us to compute the agglomeration index of Italian industries both for the totality and for different typologies of firms, and to make a first comparison by analyzing the dissimilarities among the ranks of agglomeration associated to each type of enterprise.

In the first step we took into account all the firms and we calculated the plant-based FGW and MS indexes, in order to assess how similar they are. The computation has been made over 112 industries by looking at the distribution of the plants across the 686 Italian Local Labor System (SLL) in 2001, where the SLL are geographic units similar to the industrial districts. The data come from the Italian National Statistics Institution (ISTAT) and refers to manufacturing and mining industries, aggregated at 3-digit level.

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[5] 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.

The choice of SLL as geographic unit for the calculation of the indexes has been driven by the critics that several authors, such as Feser [2000] and Iuzzolino [2004], have moved to the EG index. Indeed the spillovers, which are considered to be one of the main agglomeration force in the EG model together with the natural advantages, can not been confined into the artificial administrative boundaries of the countries, regions and counties, but rather they are linked to the social relationships of people, which overcome the administrative borders. The EG index, whose construction implies the use and the formalization of knowledge spillovers, appears therefore to be biased by the geographic unit chosen. Indeed, the rank of the agglomeration of industries is different according to the geographic unit used, because of the different intensities exerted by the knowledge spillovers in the different geographic units. The use of the SLL appears to be most coherent with the basic assumptions of the EG (and FGW and MS) index: indeed the map of the Italian SLL has been shaped by Sforzi according to the movements of the commuters, which are considered to be one of the main vehicle of spillover exchange within the broader mechanism of the employment turnover. The starting geographic units from which SLL have been mapped by Sforzi are the smaller administrative Italian entities, which are called "*comuni*": these units have been aggregated into SLL according to the trajectories of commuters flows, and regardless of the counties and regions they belong to. Therefore the SLL appears to be a better geographic unit to account for agglomeration of economic activities given that spillovers are not delimited by administrative boundaries by they follow the relationship among people. Figure 1 shows the distribution of SLL in Italy.

If we compare the FGW and MS indexes[6] for the totality of firms, we find that they agree in assessing that the most agglomerated sectors are the traditional ones, as also Pagnini [2002] do find. On the other hand, as regards the less agglomerated industries, the indexes are discordant. Indeed, if wee look at table 1, we see that the Spearman correlation, which is computed by comparing the ranks provided by the two indexes, is not so high. However, since the mean, the median and the standard deviation of the two indexes are very similar, and since the Pearson correlation is very high, we can conclude that the two indexes are equivalent and we can make use of only one of them. We decided to employ the FGW index since its "raw" agglomeration index discounts the share of employment from the share of firms for each SLL, instead of discounting it at the end in terms of total sum of all SLL. We think that the first approach yields a measure of agglomeration which is more precise than the second one.

Therefore we will focus on the FGW index. If we look at the distribution of frequency, which is reported in figure 2, we see that most of the industries show a value of the agglomeration close to zero, while only 10-15% of the sectors displays values higher than 0.05, which is considered by Ellison & Glaeser [1994] the threshold above which an industry can be considered agglomerated. The most agglomerated sectors are shown in figure 3: as we have already said, they result to be mainly traditional industries. In order to assess whether this result is affected by the level of aggregation of industries, we also computed the FGW agglomeration index at 2-digit level. Figure 4 show that the most agglomerated industries turn out to be again the traditional ones. Furthermore, it results that the 2-digit indexes are lower than the medium value of the 3-digit indexes that compose each 2-digit industry. This happens because the 2-digit level of analysis implies the assemblage and homogenization of industries that are still quite different, hence the agglomeration forces are weaker and the firms appear to be much more scattered. However, the correlation between the 2-digit indexes and the means of the 3-digit indexes that compose each 2-digit sectors is 0.827, therefore even if the level of analysis in terms of digits changes, the rank of agglomeration is very similar.

In a second step we computed the FGW index for different typologies of firms, by distinguishing between multinational and national enterprises.

[6] The FGW indexes are displayed in the appendix, while the MS indexes are available upon request

Data about multinational firms come from Reprint-ICE, which is a database provided by Politecnico di Milano concerning all the inwards (and outwards) foreign direct investments occurred in Italy since the end of the XIXth century. The database is firm-based and not plant-based, therefore it does not allow to assess the distribution of the plants of each firm across the SLL. In order to be able to obtain this information we used the R&S (*Ricerche e Studi Mediobanca* – Madiobanca Researches and Studies) volumes, which contain detailed data about the location of the plants of each multinational firm operating in Italy in every year, since 1994. By using these volumes we where able to expand our database and to employ 3622 foreign plants to compute the agglomeration index for multinational firms. The nationality of these plants is mainly European (67%), followed by North America (28%), South America (0,5%), Asia (2,9%), Africa (0,2%) and Australia (0,2%). The main investors are U.S.A. (27%), followed by France (17%), Germany (14%) and UK (10%). The types of direct investments considered are both green-field (28%) and brown-field (72%): we will account for this issue when dealing with the determinants of agglomeration of multinational firms.

Data about the distribution of national plants across the SLL in 2001 come from the Italian National Statistics Institution (ISTAT). Since the database provides only data about the total plants regardless of the nationality of the firm, the national data-set has been obtained as difference between the total plants and the multinational plants. The resulting amount of domestic plants upon which we have computed the national agglomeration indexes for the 112 manufacturing and mining sectors are 595865.

The values of the indexes are reported in the appendix, together with the value of the FGW index computed for the totality of firms. Table 2 compares the mean, the median and the standard deviation of the indexes computed for different typologies of firms: what we can immediately notice is that the mean and the standard deviation of the FGW index of Multinational firms are higher with respect to the values of the index computed for national enterprises. This is a first hint suggesting that the two typology of firms might have a different agglomeration pattern.

This intuition is strengthen by the coefficients of the Pearson correlation, which are reported in table 3. Indeed, we see that the coefficient of multinational firms is very low both with respect to national firms and with respect to the totality of firms. On the other hand, the domestic enterprises seem to have the same pattern of agglomeration of the totality of firms, but this result is basically due to the fact that the national firms represent more than 99% of the totality of firms.

Differences between multinational and national firms in terms of agglomeration pattern also arise from the different distribution of frequencies, which are displayed in figures 5 and 6: as we can see, the distribution of the domestic agglomeration index is much more homogeneous and centered around its mean with respect to the multinational agglomeration index, which is more skewed on the right with a much longer tail.

In order to avoid bias due to the choice of SLL as geographic unit, the agglomeration indexes have been computed also at regional and county level both for the totality of firms and for each typology of firm. As we can see from table 4, the wider the geographic unit, the higher the value of the index: this result is straightforward, since the use of a broader geographic unit allows to take into account a higher number of firms, hence the values of agglomeration turn out to be higher. Table 5 displays the Pearson and Spearman correlation between different geographic units for different typologies of firms. We can see a very high correlation between SLL and counties both for national and multinational firms, while the coefficients decrease when considering the region with respect to counties and provinces, since the former is a much wider geographic unit than the latter. Hence it seems that the choice of the geographic unit slightly affects the index of agglomeration: we consider our choice of SLL the most correct because of the reasons explained above. However, the other two geographic dimensions also will be taken into account in the econometric analysis.

The final step has been the computation of the co-agglomeration index[7]. Indeed, until now we have considered only the agglomeration patterns of each typology of firm. It is useful to calculate also the index that is able to account for the co-agglomeration between multinational and national enterprises, in order to understand what are the agglomeration forces that drive the co-location of different typologies of firms. The most co-agglomerated sectors, which are shown in figure 7, still appears to be the traditional industries.

The comparison among the agglomeration of national firms, the agglomeration of multinational enterprises and the co-agglomeration of domestic and foreign firms, seems to disclose at least two important phenomena. On the one hand, there seem to be agglomeration and co-agglomeration drivers which are highly industry-specific, that is they affect the localization choices of all the firms regardless of their nationality: this is true for the traditional industries, since they always turn out to be the most agglomerated sectors for all typologies of enterprises. On the other hand, the differences between multinational and national patterns of agglomeration seem to reveal that there are some agglomeration forces that are firm-specific, which affect in different ways the different typologies of enterprises. In the following sections we will try to understand what determinants can be considered industry-specific and what drivers, conversely, act as firm-specific agglomeration forces. The analysis will try also to assess what are the centripetal forces that drive the co-agglomeration of different typologies of firms.

The equation and the data

In order to understand what are the firm-specific and the industry-specific determinants of agglomeration, and what drivers promote the co-agglomeration between foreign and domestic enterprises, we employed three different equations. The first has the agglomeration index of national firms as dependent variable, the second one focuses on the agglomeration index of multinational enterprises, and the third one makes use of the co-agglomeration index.

The standard equation form is the following:

$$\log(\gamma) = \beta_0 + \beta_1 H_s + \beta_2 Trans_s + \beta_3 Spill_s + \beta_4 Ext_s + \beta_5 Wage_s + \beta_6 Big_s + \beta_6 Small_s + \beta_7 dummy\_trad + \varepsilon_s$$

where γ is, from time to time, the agglomeration index of national firms (γ^{NAT}), the agglomeration index of multinational enterprises (γ^{MNE}) and the co-agglomeration index (γ^{Co}), while *s* is the industry. On the right of the equation we find the explicative variables that have been considered to be the main determinants of the agglomeration and co-agglomeration of firms and that will be explained in a while. These variables have been computed for the each industry and are the same across the three equations, since the aim is to understand how the location choices of different typologies of firms are affected by the characteristics of the Italian industries. All the explicative variable, as well as the dependent variable, refer to the year 2001: the choice of this year as bench mark is due to the huge amount of data provided by the Istat-census, which is made at the beginning of each decade. All the dependent variables have been standardized.

H is the Herfindahl concentration index computed for each sector and can be read both as proxy for the level of the competitiveness and as proxy for the importance of economies of scale. A low level of the Herfindahl index means that the industry is highly competitive, which implies, as Alsleben [2005] claims, not only a compression of the profits, but also an increase of probability of

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

labor-poaching. Furthermore, since the concentration of a sector is driven by the presence of economies of scale, the Herfindahl index can also be seen as a proxy for the scale intensity of the industry, which acts as centripetal force as we know from the New Economic Geography. Hence we expect a positive correlation between the Herfindahl and the agglomeration index.

The Herfindahl index of the each sector has been computed not by using the numbers of plants as we did in the plant-based FGW agglomeration index, but by using the number of employees of each plant[8]. However, the ISTAT database provides, for every SLL, not the number of employees of each plant, but the number of firms that belongs to each class of employees[9]. As Ellison and Glaeser [1994] 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.

The variable *trans* stands for transportation costs, which are traditionally considered dispersion forces. In order to find a good proxy for the transportation costs for each industry we used the input-output tables, which are provided by Istat and make it possible to see the flows of each industry's goods used by the other industries as input, by using a matrix. Therefore, to obtain a good proxy of the transportation costs, we used the inflows of each industry provided by the three transportation sectors identified by Istat (Nace 60: land transport; transport via pipelines; Nace 61: water transport; Nace 62: air transport). Since the level of aggregation of the data is 2-digit, we distributed the inflows among the 3-digit industries by weighting the data, when possible, through the weight of the goods of each 3-digit industry, and through the amount of production of each sub-industry when these data were not available[10].

The intra-industry spillovers have been measured in terms of knowledge spillovers of each sector (*Spill*). The most used proxy for spillovers (see Pagnini [2000], Alsleben [2005] and Co [2002]) is the R&D intensity, measured as R&D expenditures weighted by the value added or the number of employees of each industry. In our paper we employed not only the R&D intensity, which gauge the R&D inputs, but also the Patents, which is considered a rough measure of the R&D output.

The R&D expenditures used for the R&D intensity index come from the Istat database and are provided at 2-digit level. The distribution of the data across the sub-industries has been done according to value-added of each 3-digit sector, while the normalization has been done through the number of employees of each industry. The patents used to gauge the R&D output come from the Crenos (Centro Ricerche Economiche Nord-Sud – Economic Researches Center North-South) database, which is provided by Cagliari and Sassari Universities. Also in this case the data were available at 2-digit level, therefore they have been allocated across the sub-industries according to the value added of the industries, as we did for R&D expenditures. Since the patents are subject to a great variance from year to year, we decided to employ the cumulated sum of the inventions patented from 1997 to 2001, and to normalize them through the value added of each industry. However, the variable of reference to account for the intra-industry spillovers will be the R&D intensity. The expected sign of the coefficient of the intra-industry spillovers is generally positive, but it might be negative if firms are more scared by the leak of their own knowledge than eager to gain advantages from spillovers of other enterprises.

The inter-industry externalities (*Ext*) are the most difficult variable to gauge, since they should account for the spillovers that arise from the co-location of firms belonging to different industries. Following Henderson *et al.* [1995], Bronzini [2003, 2004] and Paci & Usai [2006], we

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[8] $H = \sum_j z_j^2$, where z_j is the share of employees of each plant j within the industry.

[9] 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

[10] The only industries for which it was not 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.

employed the so-called Diversity index, also known as Inverse Herfindahl index, which is a special Herfindahl index constructed as if all the other sectors except the one that is being analyzed were only one big industry. The formula is:

$$Ext_s = Div_s = \sum_{r,r \neq s} \sum_{j, j \in r} z_j^2$$

where *r* represents all the industries different from *s*, and z_j the share of employees of each plant within its 3-digit sector *r*. The index is employed-based as the Herfindahl index is, and the method through which it has been computed always relies on the classes of employees. The inter-industry externalities are likely to act as centripetal forces, since the firms belong to different industries and hence there is no risk of a leak of knowledge.

Following Pagnini [2002], we also introduced the variable *wage*, which derives from the Istat databases and represents the mean of the wage of each sector weighted for the number of employees. The salary is one of the instruments used by firms to contrast the turnover of workers, which is one of the main vehicle through which spillovers spread. A high salary might reflect a strong lock-in strategy implemented by firms, and therefore might have a positive impact on agglomeration, since the workers are unlikely to change job because the income effect prevail on the substitution effect when the salary is high.

To account for the size of firms, whose location choice might be affected by their dimension, we introduced the variables *Big* and *Small,* which has been used separately because they are highly correlated. Following a procedure similar to that of Bronzini [2003, 2004], we computed the variable *Small* as share firms that have less than 50 employees in each industry, while the variable *Big* is the share of firms that have more than 1000 employees in each sector. The sign of these variables either positive or negative: indeed, we see in the literature that some authors, such as Alsleben [2005], finds that small firms agglomerate more than big ones since they employ more creative workers that are difficult to replace, while some others, such as Holmes and Stevens [2002] find that there is a positive correlation between the agglomeration and the dimension of firms. Coversely, Bronzini [2003, 2004] finds that the size has no importance in explaining the location choice of firms.

We finally employed a dummy for traditional industries[11], because of two reasons. The first one is that the traditional sectors always appear to be the most agglomerated in every country, therefore they must be driven by strong industry-specific determinants of agglomeration, which need to be controlled for if we want to disclose the firm-specific agglomeration forces. The second reason is that, as Maurel and Sedillot [1999] claim, the agglomeration of traditional industries have been driven by forces that depend on past static externalities, which might have completely changed at the present time, therefore they require to be controlled for. We expect a positive sign of the coefficient of this dummy.

Results

The first analysis refers to the domestic firms: the national agglomeration index has been regressed on the independent variables, in order to understand what are the determinants of co-location of Italian plants in the SLL. Results are reported in table 6, where the first two columns measures the intra-industry spillovers in terms of R&D intensity, while the other two as patents. The number of industries for which it was possible to run the analysis in the first column and 98 in the second. The Herfindahl index and the salary have been squared both to reduce their correlation with other regressors and to detect possible non-linear relationship of these variables with

[11] The industries that have been considered in the *dummy_trad* are the Textile (171, 172), the Leather (191 and 192), the Ceramic tiles (263) and the Jewellery (362).

agglomeration: indeed it turned out that the coefficients and the significance of the squared Herfindahl index and Wage are much better than those (not reported) of the same variables not squared, therefore we decided to employ only the squared proxies.

As we can see, the significance and the R-Squared of the model are satisfying. All the coefficients, except the intra-industry spillovers and the size of firms, have the expected sign. Indeed the concentration index is positively correlated to the agglomeration, meaning that competition act as centrifugal force because of the reasons reported by as Alsleben [2005], while economies of scale promote the clustering. Transportation costs are confirmed to be a centrifugal forces, whereas the wage turns out to be an instrument that lock-in the workers and raises the probability of agglomeration. The strong and positive significance of *dummy_trad* confirms the existence of a special pattern of agglomeration for the traditional sectors, whose cluster might depend on past externalities. Finally the inter-industry externalities confirm their positive impact (given by the negative sign of the coefficient) on the agglomeration, since they provide inter-industry externalities without any risk of leak of knowledge. The positive impact of inter-industry externalities may also be due to presence of backwards and forwards linkages between firms that belong to different stages of the production chain, which brings them to cluster.

The curios result turns out to be the coefficients of intra-industry spillovers, which is robust with respect to the different measures of spillovers (R&D intensity vs. Patents). As we can see, the sign is negative, meaning that the spillovers act as a centrifugal force for the agglomeration of national enterprises. The result is different from Pagnini [2002], who finds a positive impact of the R&D intensity on the agglomeration of the totality of plants in Italy, regardless of the nationality of firms. The explanation of such a difference might lie either in the better measure of agglomeration provided by the plant-based index, whose variance and reliability is higher than the employment-based index, or in the nature of intra-industry spillovers, which might be a group-specificity agglomeration force by having a different impact according to the nationality of firms. For national plants, it seems that the hypothesis of Alsleben [2005], who finds that firms in Germany are more scared than attracted by the presence of spillovers because of the risk of a leak of knowledge, is confirmed also for Italy.

The size of firms also matters for the agglomeration of national enterprises, even if this is true only as far as the big industries are concerned. Indeed, the proxy *Big* is always negatively and significantly correlated with the agglomeration, meaning that the bigger the dimension of firms the lower the level of cluster. This result might be due to the same explanation provided for the output of Herfindahl index and intra-industry spillovers: the big firms are generally more technologically advanced and more subject to the labor poaching with respect to small enterprises, therefore they may prefer not to co-locate because they fear more the possible leak of knowledge rather than being attracted by the possible acquisition of new knowledge.

In order to better understand whether the agglomeration pattern of domestic and foreign firms are really different, especially with respect to knowledge spillovers, we run a second regression by taking into account only the multinational plants. Results are reported in table 7: the data available allowed us to use only 72 industries. The coefficients of the regressions containing the proxy for small firms have been omitted, since the results did not change but the variable always turned out to be not significant.

In the first column all multinational plants are considered, without distinguishing between green-field and brown-field investments. This analysis might appear to be incorrect, since only green-field investments involve a real location choice, while brown-field investments are made to acquire new firms and new assets and does not allow the choice of location. Nonetheless, brown-field investments are undertaken not only to acquire specific assets, but also to enter new markets: hence, given a certain number of firms operating in that market, their location might become one of the main determinants of the acquisition choice of the multinational firm, *coeteris paribus*. However, to avoid possible bias due to the presence of both green-field and brown-field investments, we decided to control for this difference in the second column: since it was no possible to use only the green-field investments, due to their low number with respect to brown-field investments, we decide to employ a proxy to account for the number of green-field over the total investments for each industry. A positive correlation between the number of green-fields and the agglomeration, without any change of the other coefficients, might mean that the forces that drive multinational firms to cluster together have a stronger effect when the location choice is "pure", that is not driven by an acquisition but by the decision to open a new plant.

As we can see from table 2, the Herfindahl index is still positive and strongly significant, meaning that also multinational firms are afraid of the competitiveness (and look for agglomeration economies), as well as national firms do: therefore we may conclude that the level of concentration is an industry-specific centripetal force.

The transportation costs seem to be less important for foreign firms, since the lose their significance. Hence transportation costs appear to be a group-specific agglomeration force, since only national firms take them into account in their location choices. A possible explanation for this result is that the multinational firms consider the transportation costs relevant as location determinants when they choose in what country to invest, whereas they attach less importance to this variable once that they have chosen the country and they have to decide where to settle the plant inside this country.

The wage loses completely its significance, hence it also can be considered a firm-specific determinant of agglomeration., since it affects only the pattern of agglomeration of national enterprises.

The dummy for the traditional sectors still shows a positive and highly significant coefficient, meaning the determinants that drive the agglomeration of these kind of industries are the same across the different typologies of firms.

Conversely, both the inter-industry externalities and the intra-industry spillovers have a different impact on the agglomeration pattern of national and multinational firms. Indeed, the inter-industry externalities exhibit a negative sign but lose their significance: this means that the multinational firms are not interested in clustering with other foreign enterprises that belong to different sectors, or that they do not establish strong backwards or forwards linkages with other multinational firms.

On the other hand, the intra-industry spillovers[12] show a positive and significant coefficient, which means that multinational firms are attracted by the presence of knowledge spillovers deriving from other international enterprises. This result does not clash with the negative impact that competitiveness has on agglomeration: indeed, in this specific case competitiveness act as centrifugal force not because of the leak of knowledge, but because of the other aspects such as the profit compression and the labor poaching, which have been described by Alsleben [2005] and Combes and Duranton [2003]. The impact of knowledge spillovers is conversely captured by the coefficient of the *R&D intesity*, which turns out to be positive. A similar result was found by Bronzini [2003], who claims that multinational firms tends to locate in the highly specialized areas that provide knowledge spillovers. Hence, both intra and inter-industries externalities can be considered firm-specific agglomeration forces, since their impact on agglomeration changes between multinational and national firms.

The positive, even if not significant, sign of the proxy that account for the dimension of firms can also be used to strengthen the result that we found for intra-industry spillovers. Indeed, the biggest firms are the most technologically advanced and, even if they might suffer a leak of knowledge when they agglomerate, the gain in terms of spillovers acquired from other big multinational firms might be so high that firms prefer to cluster and to run the risk of a leak of knowledge instead of not agglomerating and not receiving any transfer of knowledge. However the

[12] The intra-industry spillovers have been measured in terms of R&D intensity, since this variable is considered to be more reliable. However the same results are confirmed by using the patents.

dimension of firms does not seem to be so important as determinant of agglomeration of multinational enterprises, since the coefficient of the proxy is not significant.

Finally, the positive and significant coefficient of the proxy used to account for the greenfield investments, without any change as regards the other coefficients, confirms that the agglomeration pattern of multinational firms is further strengthened when the location choice is pure and not affected by other motivations that are typical of brown-field investments.

The analyses concerning the national and multinational agglomeration have also been run by using the index computed at regional and county level, in order to verify whether the results are affected by the choice of the geographic unit, even we consider the SLL the geographic dimension that better fits with the hypotheses of the EG model. As it shown by tables 9, the main results concerning the role of spillovers and externalities do not change for national firms. As far as multinational firms are concerned, the number of industries upon which we were able to compute the agglomeration indexes were only 66, hence the regressions turned out to be not significant.

The last regression concerns the co-agglomeration between national and multinational firms: the aim is to see whether and how they cluster together. The results of the regression are reported in table 8. As we can see, the Herfindahl index still exhibits a positive and significant coefficient, meaning that the competitiveness act as an industry specific dispersion force (and that the economies of scale act as an industry-specific agglomeration force). Also the dummy for traditional sectors confirm its industry-specific nature: indeed both multinational and national enterprises that belong to these sectors follow a particular pattern of agglomeration, which bring them to cluster within and between each group.

The transportation costs and the wage definitely lose their significance: this confirms that they are group-specific determinants of agglomeration, since they count only for national enterprises.

The most interesting results turn out to be the intra-industry spillovers and inter-industry externalities: indeed their coefficients are both significant and the signs confirm the firm-specific nature of these different kind of spillovers. In particular, the intra-industry spillovers affect negatively the co-agglomeration between national and multinational firms. A possible explanation for this result is that foreign enterprises are attracted by spillovers produced only by other multinational firms, because they are technologically advanced and generate advantages despite the risk of a leak of knowledge. On the other hand, the spillover produced by domestic firms are less advanced and do not attract multinational enterprises since they would report a loss (in terms of leak of knowledge) bigger than the advantage gained by the acquisition of new but less skilled knowledge. Nevertheless, the opposite explanation is also possible: domestic firms might not to want to agglomerate with multinational firms to avoid the transfer of local knowledge, which would allow the foreign enterprises to better integrate in the market and to become more competitive. Our analysis is not able to assess the direction of the causality.

The inter-industry externalities appear to be a centripetal force for the co-agglomeration of domestic and foreign enterprises. This result shows that multinational (national) enterprises do not fear to cluster with national (multinational) firms when they belong to different sectors, since there is no risk of a transfer of specific knowledge. Another possible explanation is that multinational firms establish backwards and forwards linkage with domestic enterprises rather than with foreign firms, and this explain why the coefficient of inter-industry externalities is not significant for the agglomeration within multinational firms while it is for the co-agglomeration between domestic and foreign firms.

The final interesting result is the negative and significant coefficient of the proxy used to account for the presence of big firms: as we said for the national firms, the big dimension of enterprises increases the loss associated to a possible leak of knowledge, without being offset by an increase of advantages associated to the acquisition of new knowledge because of the high technology gap between the two typologies of firms.

Conclusions and policy implications

In this paper we tried to assess whether multinational and national firms differ in their agglomeration patterns. There are several reasons to believe that these two typologies of firms are driven by different location choices: for instance, Shaver [1998] observes that foreign firms are more technologically advanced than domestic firms, therefore they may be attracted by the presence of *high-quality* knowledge spillovers provided by other multinational firms, whereas they might be not attracted by spillovers provided by national and lagging firms because they fear a leak of knowledge. Furthermore, multinational firms face some disadvantage with respect to domestic enterprises when entering a new market, hence they might want to follow the location choice of other multinational firms by considering it as a demonstration effect. Finally the distribution of national firms might have been shaped by past determinants, which do not play any longer an active role as agglomeration forces at the moment of the entrance of multinational enterprises in the country.

Given these considerations, we tested the existence of different patterns of agglomeration between foreign and domestic plants over the 686 Italian SLL in 2001, and we attempted to understand what determinants of agglomeration can be considered to be industry-specific, that is related to the fact that firms belong to an industry regardless of its nationality, and what forces on the contrary appear to be firm-specific, namely connected to the typology of enterprise. In order to do that, we used data about 595865 domestic plants, provided by the Istat database, and 3622 multinational plants, coming from the Reprint database of Politecnico di Milano. All the firms operate in the mining and manufacturing industries; the total amount of industries for which we had enough data to run our regressions is 98 for national enterprises and 72 for foreign plants, while in the descriptive statistics we were able to draw conclusions for 112 industries.

Before testing our hypothesis of different agglomeration patterns, we presented a review of the literature that dealt with the agglomeration issue, by showing the previous empirical works concerning the agglomeration of economic activities in different countries, the determinants of agglomeration, and the differences between the location choice of national and multinational firms. Then we discussed about the measures of agglomeration provided by the literature during the past years. We decided to use the plant-based FGW variant of the EG index, since it allows to decrease the variance of the results. We also chose to employ the Barrios *et al.* [2003] co-agglomeration index to account for the agglomeration between the two typologies of firms, since the agglomeration index makes it possible to compute only the clustering within each group.

The descriptive statistics already provides evidence of different agglomeration patterns between foreign and domestic plants. The econometrics results confirm our hypothesis. Indeed, the variables that we decided to take into account as being explicative of the agglomeration act differently according to the typology of firms. Only the level of competitiveness, measured by the Herfindahl index, is found to be an industry-specific dispersion force. Transportation costs and wages appear to be important, respectively with a negative and positive sign, only for the agglomeration of national plants. The inter-industry externalities also can be considered a firm-specific centripetal force, since they affect only the national firms. However, their significance is high also for the co-agglomeration between foreign and domestic enterprises: this results may be due to the fact that multinational firms establish backwards and forwards linkages with national firms and not with other foreign enterprises. Finally, the most interesting results is provided by the intra-industry spillovers, which act as centripetal force for multinational plants, while they are negatively correlated both with the agglomeration within national enterprises and with the co-agglomeration between foreign and domestic plants. This confirm our initial hypothesis that firms are afraid of a leak of knowledge when they cluster together other enterprises that are technologically lagging: this explains why knowledge spillovers act as centripetal forces within multinational firms, that are all technologically advanced, while they become a centrifugal force for the co-agglomeration between foreign and domestic plants. This result is also confirmed by the sign of proxy for the dimension of firms: indeed, the presence of big firms, which produce more spillovers than the small enterprises, act as centrifugal force for national plants, which fear the transfer of knowledge, whereas it acts as centripetal force (even if not significant) for multinational firms, which prefer to cluster rather than scattering when the spillovers are high.

However, as regards the output of co-agglomeration, it might be also the case that national enterprises escape from foreign firms and not vice-versa, for instance because the former want to avoid to transfer the latter some local knowledge that would increase their competitiveness: we are not able to establish the direction of the causality.

Our results may have several implications, since different policies might be drawn according to what types of firms one wants to attract. For instance, policies who favor the transfer of knowledge, may promote the agglomeration within multinational firms but not the co-agglomeration between domestic and foreign enterprises. In this case the inward foreign direct investments would lose some of their potential appeal as vehicle of transfer of knowledge, since local and international firms that operate in the same industry would not co-agglomerate and spillovers, that tend to be geographically bounded, would not occur. On the other hand, policies that pursue the protection of knowledge might promote the co-agglomeration between the two typologies of firms, even if the transfer of knowledge would be difficult as well because of the high protection of the intellectual property regimes (IPR). However, in this last scenario, even if spillovers appears to be a weak vehicle of transmission of knowledge, other mechanisms might occur, such as the turnover of workers, which also allow the transfer of knowledge. This alternative mechanism mainly operates when firms are close, that is when national and multinational enterprises co-agglomerate, which happens, according to our results, when the spillovers are low or are kept low. Hence, strong intellectual property regimes may trigger other mechanisms of transfer of knowledge different from spillovers.

Policies that favor the backward and forward linkages between national and multinational enterprises also promote the co-agglomeration, and this confirms the prominent role of linkages as mechanism of transfer of inter-industry knowledge. On the other hand, policies that increase the competitiveness of an industries decrease the agglomeration and co-agglomeration of plants regardless of the typology of firms.

Also enterprises may be interested in these results when deciding where to open a new plant, by taking the location choices of the previous firms as bench mark. For instance, a multinational firm that want to enter a new market might take the location choice of other multinational firms as demonstration effect. Therefore, if multinational firms locate within them and do not agglomerate with national plants, this might be a sign that there is a high risk of a leak of knowledge. On the other hand, the presence of co-agglomerated area might be a sign that the IPR regime works well in that country and therefore the multinational firm might become willing to co-locate with other national plants since there is no risk of a transfer of knowledge, even if other mechanisms, such the labor turnover, may occur.

The opposite can also be truth: a national enterprise might prefer not to cluster with international firms by taking the absence of co-agglomerated areas as a sign the presence of high spillovers, which imply the risk of a transfer of local knowledge that would increase the competitiveness of foreign firms.

Finally, these results shed further light on the issue concerning the existence of firm-specific patterns of agglomeration, which has been not enough explored until now. A future line of research might be the comparison between the patterns of agglomeration of multinational firms according to their countries of provenience, for instance by distinguishing among Europe, Usa and Japan, as Hogenbirk and Narula [2004] did. Another possible future development is to look at the different patterns of agglomeration related to other characteristics of firms different from their nationality, such as the sizes of enterprises.

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Figures

Figure 1 – Local Labor Systems in Italy

Source: Istat – 8th General Census of manufacturing and services

Figure 2 – Distribution of frequency of the FGW index – Totality of firms

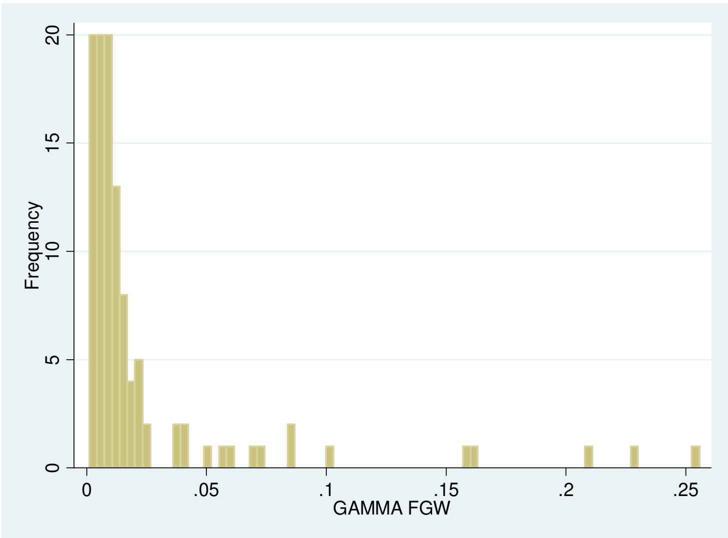


Figure 3 – Agglomeration indexes of the most agglomerated industries in Italy - Totality of firms.

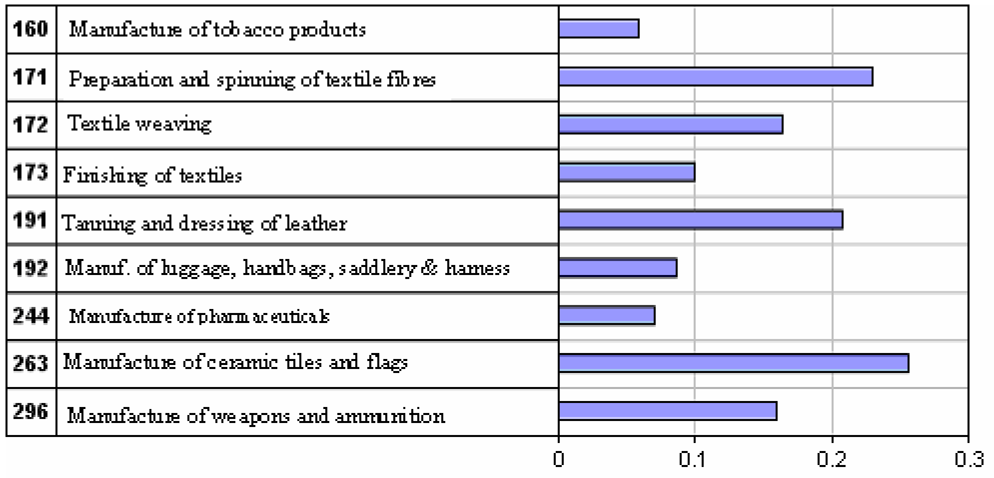
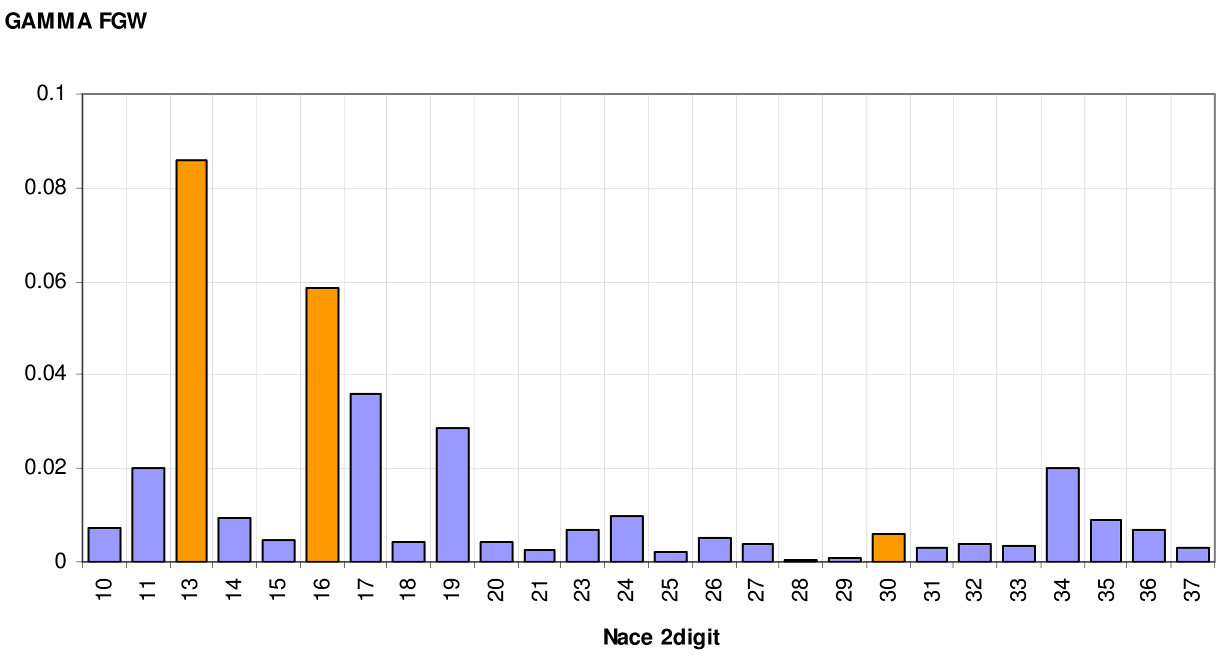


Figure 4 – Agglomeration of Italian Industries computed at 2-digit level - Totality of firms.



Note: The orange industries should not be considered, since they are composed of one industry also after being disgregated at 3-digit level. Indeed the value of the agglomeration index at 2 and 3 digit level is the same. The Nace code are the following: 10 - Mining of coal and lignite, extraction of peat; 11 - Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction excluding surveying; 12 - Mining of uranium and thorium ores; 13 - Mining of metal ores; 14 - Other mining and quarrying; 15 - Manufacture of food products and beverages; 16 - Manufacture of tobacco products; 17 - Manufacture of textiles; 18 - Manufacture of wearing apparel; dressing and dyeing of fur; 19 - Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear; 20 - Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials; 21 - Manufacture of pulp, paper and paper products; 23 - Manufacture of coke, refined petroleum products and nuclear fuel; 24 - Manufacture of chemicals and chemical products; 25 - Manufacture of rubber and plastic products; 26 - Manufacture of other non-metallic mineral products; 27 - Manufacture of basic metals; 28 - Manufacture of fabricated metal products, except machinery and equipment; 29 - Manufacture of machinery and equipment n.e.c.; 30 - Manufacture of office machinery and computers; 31 - Manufacture of electrical machinery and apparatus n.e.c.; 32 - Manufacture of radio, television and communication equipment and apparatus; 33 - Manufacture of medical, precision and optical instruments, watches and clocks; 34 - Manufacture of motor vehicles, trailers and semi-trailers; 35 - Manufacture of other transport equipment; 36 - Manufacture of furniture; manufacturing n.e.c.; 37 – Recycling.

Figure 5 – Distribution of frequency of the domestic agglomeration index.

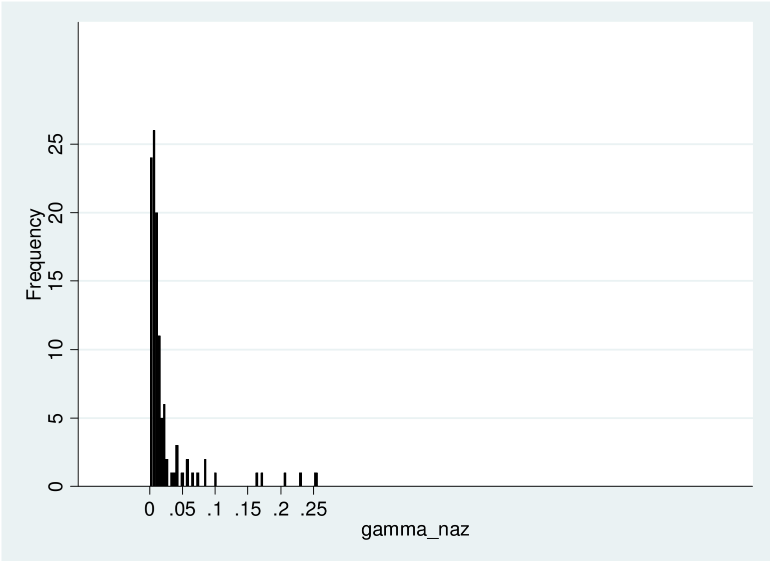


Figure 6 – Distribution of frequency of the multinational agglomeration index.

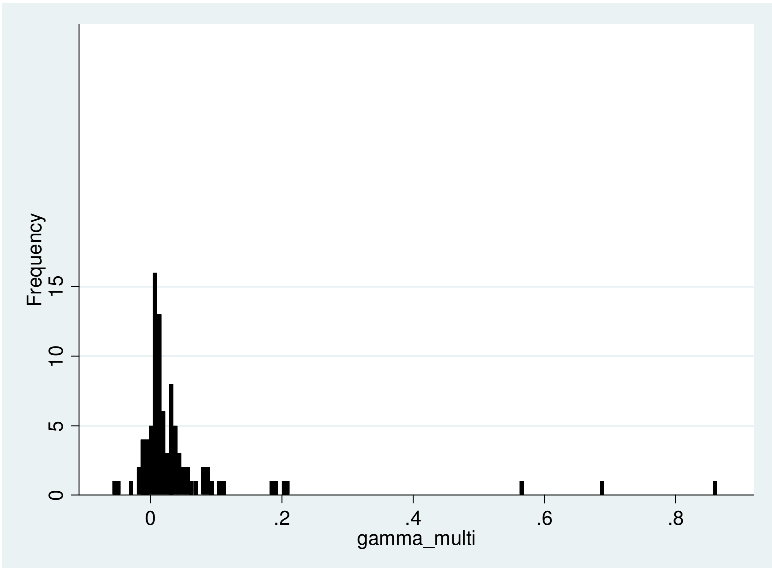
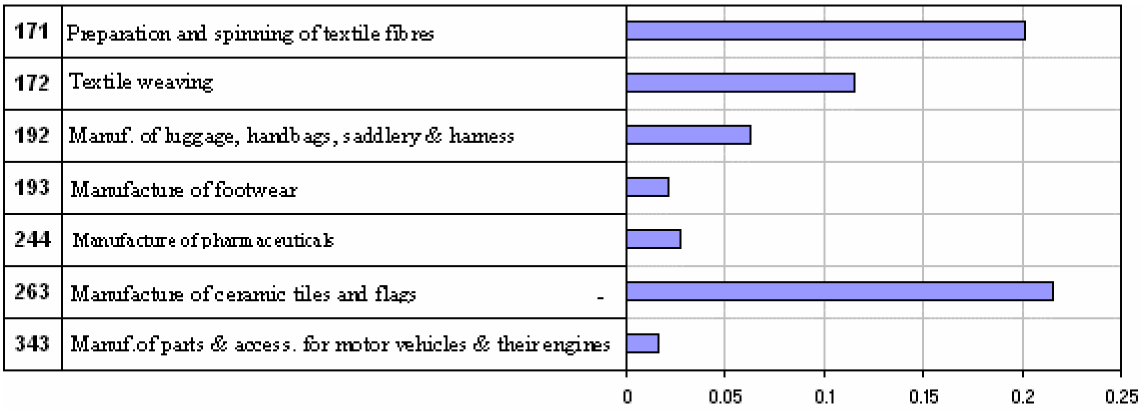


Figure 7 – Co-agglomeration indexes of the most co-agglomerated industries



Tables

Table 1 – Comparison between the FGW and the MS indexes – 109 industries, all firms

	FGW Index	MS Index
Mean	0.02413	0.02268
Median	0.00984	0.00996
Standard Deviation	0.00194	0.00194
Pearson Correlation	0.96685	
Spearman Correlation	0.60959	

Table 2 - Comparison between the FGW agglomeration indexes of different type of firms

	Totality	National firms	Multinational firms
Mean	0.02413	0.02420	0.05139
Median	0.00984	0.01008	0.01608
Standard Deviation	0.04393	0.04438	0.13118

Table 3 - Pearson correlation among the FGW agglomeration indexes of different type of firms

	TOTALITY	DOMESTIC	MULTINATIONAL
TOTALITY	1	-	-
DOMESTIC	0.9988	1	-
MULTINATIONAL	0.2020	0.1889	1

Table 4 –Mean of the FGW index for each typology of firm and for different geographic units

	TOTALITY	DOMESTIC	MULTINATIONAL
SLL	0.02413	0.02420	0.05139
COUNTY	0.02830	0.02834	0.06197
REGION	0.04957	0.04980	0.07506

Table 5 – Pearson (Spearman) correlation among different geographic units for each type of firm

DOMESTIC	SLL	County	Region
SLL	1	-	-
County	0.9529 (0.9363)	1	-
Region	0.8445 (0.7868)	0.8575 (0.8794)	1
MULTINATIONAL			
SLL	1	-	-
County	0.9573 (0.834)	1	-
Region	0.7281 (0.7433)	0.7711 (0.8265)	1

Table 6: Determinants of agglomeration of national firms: OLS results

	Gamma FGW National (Spill. as R&D intensity - Big)	Gamma FGW National (Spill. as R&D intensity - Small)	Gamma FGW National (Spill. as Patents - Big)	Gamma FGW National (Spill. as Patents - small)
Herfindahl_Square	24.72415 ***	25.22925 ***	27.7812 ***	28.21143 ***
Transportation costs	-0.2780957 **	-0.2708494 **	-0.2981975 ***	-0.3006405 **
Spillovers	-0.1480344 **	-0.1421682 **	-0.2077415 ***	-0.2070355 ***
Externalities	-0.4208288 ***	-0.2926963 ***	-0.3713089 ***	-0.2332945 **
Wage_Square	0.3410405 **	0.3643497 **	0.2914197 **	0.2882443 *
Dummy traditional	2.746897 ***	2.784325 ***	2.843641 ***	2.864792 ***
Big	-0.2027954 *	-	-0.1929035 *	-
Small	-	0.0547061	-	-0.1148863
Cons.	-0.9060733	0.8041744	-2.274011	-2.106191
n. of obs.	97	97	98	98
F-Test	0.0000	0.0000	0.0000	0.0000
Adj.R-squared	0.4986	0.4775	0.5069	0.4875

Notes:***Significant at 1%, **Significant at 5%, *Significant at 10%

Table 7: Determinants of agglomeration of multinational firms: OLS Results

	Gamma FGW MNE	Gamma FGW MNE with greenfield variable
Herfindahl_Square	96.95273 *	105.336 **
Transportation costs	-0.2599864	-0.2274273
Spillovers	0.2626657 ***	0.2912732 ***
Externilities	-0.0620649	-0.0183695
Wage_Square	-0.1800914	-0.159746
Dummy traditional	3.497585 ***	3.677916 ***
greenfield quota	-	0.3618008 ***
Big	0.0476216	0.1208318
cons.	-13.76746	-15.38838
n. of obs.	72	72
F-Test	0.0000	0.0000
Adj.R-squared	0.3789	0.4507

Notes:***Significant at 1%, **Significant at 5%, *Significant at 10%

Table 8: Determinants of co-agglomeration between multinational and national firms: OLS Results

	Coagglomeration index between National & MNE
Herfindahl_Square	35.0686 **
Transportation costs	-0.1788861
Spillovers	-0.3283204 ***
Externalities	-0.5387326 ***
Wage_Square	0.2612254
Dummy traditional	-4.86866 ***
Big	-0.5459184 *
cons.	1.5459184
N.obs.	76
F-Test	0.0000
Adj.R-squared	0.4342

Notes:***Significant at 1%, **Significant at 5%, *Significant at 10%

Table 9: Determinants of agglomeration of national firms at Regional + County level: OLS Results

	Gamma FGW National (Spill. as R&D intensity - Region)	Gamma FGW National (Spill. as R&D intensity -County)	Gamma FGW National (Spill. as Patents - Region)	Gamma FGW National (Spill. as Patents - County)
Herfindahl_Square	20.83691 **	22.76852 **	27.3233 ***	27.1422 ***
Transportation costs	-0.1023821	-0.196981	-0.1580213	-0.2335295 *
Spillovers	-0.2168305 ***	-0.1609977 **	-0.4151176 ***	-0.2827195 ***
Externalities	-0.2690771 *	-0.4011915 ***	-0.1909903	-0.345988 ***
Wage_Square	0.2843183	0.2833519 *	0.2825449 *	0.2694156 **
Dummy traditional	1.918376 ***	2.289761 ***	2.030009 ***	2.377243 ***
Big	-0.0967393	-0.1650846	-0.0790564	-0.1548182
Cons.	-0.2883629	-0.6753821	-2.274011	-2.556793
n. of obs.	97	97	98	98
F-Test	0.0000	0.0000	0.0000	0.0000
Adj.R-squared	0.2647	0.4239	0.5069	0.4696

Notes:***Significant at 1%, **Significant at 5%, *Significant at 10%

Appendix

Agglomeration index γ_{FGW} per type of firm, Nace-3, SLL

Nace Code	Industry	Types of firms		
		Total	National	Multinational
101	Mining and agglomeration of hard coal	0.009661559	0.009661559	.
103	Extraction and agglomeration of peat	0.012431671	0.012431671	.
111	Extraction of crude petroleum and natural gas	0.009462065	0.009462065	.
112	Service activities incidental to oil and gas extraction excluding surveying	0.051914591	0.051914591	.
132	Mining of non-ferrous metal ores, except uranium and thorium ores	0.085875529	0.085875529	.
141	Quarrying of stone	0.024089685	0.023997504	0.082395648
142	Quarrying of sand and clay	0.005087735	0.005088936	.
143	Mining of chemical and fertilizer minerals	0.010564488	0.022748656	0.018206336
144	Production of salt	0.073937352	0.073937352	.
145	Other mining and quarrying n.e.c.	0.012718004	0.012749779	0.031790029
151	Production, processing and preserving of meat and meat products	0.011776148	0.011712243	0.040397115
152	Processing and preserving of fish and fish products	0.022833072	0.023076373	-0.007191489
153	Processing and preserving of fruits and vegetables	0.013745139	0.013862408	0.008213306
154	Manufacture of vegetable and animal oils and fats	0.014694834	0.014711134	0.005563541
155	Manufacture of dairy products	0.010910638	0.010958439	0.020059276
156	Manufacture of grain mill products, starches and starch products	0.007463102	0.00744821	0.050744798
157	Manufacture of prepared animal feeds	0.007662348	0.007476932	0.016996374
158	Manufacture of other food products	0.003951327	0.003964265	0.002073595
159	Manufacture of beverages	0.00912258	0.009175388	0.007670963
160	Manufacture of tobacco products	0.058460589	0.058705637	0.211963265
171	Textile fibre preparation; textile weaving	0.229675978	0.231866774	0.008342677
172	Textiles weaving	0.163303503	0.163611383	0.043612418
173	Finishing of textiles.	0.099901633	0.10001401	0.007341927
174	Manufacture of made-up textile articles, except apparel	0.005333052	0.005345979	-0.010469995
175	Manufacture of other textiles	0.017965663	0.018188473	0.00319023
176	Manufacture of knitted and crocheted fabrics	0.021654325	0.021654325	.
177	Manufacture of knitted and crocheted articles	0.012997348	0.012974728	0.049175554
181	Manufacture of leather clothes	0.038326649	0.038326649	.
182	Manufacture of other wearing apparel and accessories	0.00463866	0.004644917	0.011157988
183	Dressing and dyeing of fur; manufacture of articles of fur	0.012983799	0.013000735	.
191	Tanning and dressing of leather	0.208008573	0.207905765	.
192	Manufacture of luggage, handbags and the like, saddlery and harness	0.086752985	0.086457673	0.686766131
193	Manufacture of footwear	0.040611145	0.040661911	0.010853248
201	Sawmilling and planing of wood, impregnation of wood	0.010606276	0.010606276	.
202	Manufacture of veneer sheets; manufacture of plywood, laminboard, particle board, fibre board and other panels and boards	0.014377806	0.01441961	.
203	Manufacture of builders' carpentry and joinery	0.00455448	0.004554232	0.032141487
204	Manufacture of wooden containers	0.003363338	0.003363338	.
205	Manufacture of other products of wood; manufacture of articles of cork, straw and plaiting materials	0.005314885	0.005314726	.
211	Manufacture of pulp, paper and paperboard	0.010090093	0.010189255	0.004173403
212	Manufacture of articles of paper and paperboard	0.002757353	0.002789465	0.004649055
221	Publishing	0.043952677	0.042699049	0.564068483
222	Printing and service activities related to printing	0.006904789	0.006894042	0.188286591
223	Reproduction of recorded media	0.025353273	0.021742423	0.862806658

Agglomeration index γ_{FGW} per type of firm, Nace-3, SLL

Nace Code	Industry	Types of firms		
		Total	National	Multinational
231	Manufacture of coke oven products	0.017578146	0.017578146	.
232	Manufacture of refined petroleum products	0.006675327	0.006982286	0.000674481
241	Manufacture of basic chemicals	0.00515778	0.006085616	0.003447416
242	Manufacture of pesticides and other agro-chemical products	0.02274399	0.02642388	0.040212991
243	Manufacture of paints, varnishes and similar coatings, printing ink and mastics	0.002401015	0.001830508	0.033188132
244	Manufacture of pharmaceuticals, medicinal chemicals and botanical products.	0.069747892	0.064555082	0.111221501
245	Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations	0.007831001	0.007297641	0.039886176
246	Manufacture of other chemical products	0.012877635	0.012071228	0.036836694
247	Manufacture of man-made fibres	0.013997685	0.010202216	0.089075575
251	Manufacture of rubber products	0.016086593	0.016678982	0.00848107
252	Manufacture of plastic products	0.001804456	0.001804132	0.005670579
261	Manufacture of glass and glass products	0.009840493	0.010081809	0.006974443
262	Manifacturing of ceramic products	0.01816799	0.018381768	0.011768131
263	Manufacture of non-refractory ceramic goods other than for construction purposes; manufacture of refractory ceramic products	0.25563938	0.255667911	0.205675941
264	Manufacture of bricks, tiles and construction products, in baked clay	0.011848762	0.012320488	-0.005557058
265	Manufacture of cement, lime and plaster	0.009311124	0.009970559	0.006750757
266	Manufacture of articles of concrete, plaster and cement	0.005293402	0.005389566	0.008046413
267	Cutting, shaping & finishing of stone	0.00987506	0.009865588	0.105696235
268	Manufacture of other non-metallic mineral products, n.e.c.	0.001666351	0.001639555	0.00559779
271	Manufacture of basic iron and steel and of ferro-alloys (ECSC)	0.01420607	0.014438222	-0.057295077
272	Manufacture of tubes	0.003644061	0.003813644	0.01436749
273	Other first processing of iron and steel and production of non-ECSC ferro-alloys	0.005899518	0.00596852	0.006647423
274	Manufacture of basic precious and non-ferrous metals	0.009428306	0.010094911	0.013085367
275	Casting of metals	0.007578045	0.007799815	0.033102614
281	Manufacture of structural metal products	0.002454081	0.00246245	0.011242268
282	Manufacture of tanks, reservoirs and containers of metal; manufacture of central heating radiators and boilers	0.003024948	0.003087895	0.011975213
283	Manufacture of steam generators, except central heating hot water boilers	0.03628293	0.032539593	.
284	Forging, pressing, stamping and roll forming of metal; powder metallurgy	0.007003361	0.006798213	0.056382416
285	Treatment and coating of metals; general mechanical engineering	0.002178931	0.002180185	0.037440607
286	Manufacture of cutlery, tools and general hardware	0.007278943	0.007347848	0.013035842
287	Manufacture of other fabricated metal products, n.e.c.	0.001485671	0.001490945	0.006156684
291	Manufacture of machinery for the production and use of mechanical power, except aircraft, vehicle and cycle engines	0.012012373	0.012499227	0.017844496
292	Manufacture of other general purpose machinery	0.001131684	0.001102524	0.015974465
293	Manufacture of agricultural and forestry machinery	0.008051044	0.008087167	0.014859185
294	Manufacture of machine-tools	0.004623022	0.004584282	0.026292243
295	Manufacture of other special purpose machinery	0.002575686	0.002532163	0.013837765
296	Manufacture of weapons and ammunitions	0.159101903	0.171428928	-0.018461398
297	Manufacture of domestic appliances, n.e.c.	0.006111845	0.006099023	-0.003562076
300	Manufacture of office machinery and computers	0.006131136	0.00610193	0.021171623
311	Manufacture of electric motors, generators and transformers	0.004001176	0.003865317	0.011927744
312	Manufacturing of electricity distribution and control apparatus	0.005604274	0.005396904	0.024228058

Agglomeration index γ_{FGW} per type of firm, Nace-3, SLL

Nace Code	Industry	Types of firms		
		Total	National	Multinational
313	Manufacture of insulated wire and cable	0.010394122	0.010700899	0.016190074
314	Manufacture of accumulators, primary cells and batteries	0.007771917	0.00793822	-0.008711301
315	Manufacture of lighting equipment and electric lamps	0.008174328	0.008296603	-0.012882417
316	Manufacture of electrical equipment, n.e.c.	0.002715926	0.002673853	0.022412549
321	Manufacture of electronic valves and tubes and other electronic components	0.007816075	0.007693691	0.030581546
322	Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy	0.004087431	0.004011135	0.045808913
323	Manufacture of television and radio receivers, sound or video recording or reproducing apparatus and associated goods	0.00791192	0.007393777	0.083985074
331	Manufacture of medical and surgical equipment and orthopedic appliances	0.004165741	0.004164696	0.068752108
332	Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment	0.013930115	0.012862693	0.055312084
333	Manufacture of industrial process control equipment	0.008351555	0.00804364	0.030258201
334	Manufacture of optical instruments and photographic equipment	0.020516817	0.020818634	0.030574804
335	Manufacture of watches and clocks	0.014758055	0.015134755	.
341	Manufacture of motor vehicles	0.022124551	0.012320958	0.094161489
342	Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers	0.006489429	0.006806795	-0.02853026
343	Manufacture of parts and accessories for motor vehicles and their engines	0.026095574	0.026211507	0.029206311
351	Building and repairing of ships and boats	0.019098109	0.019119366	0.064685896
352	Manufacture of railway and tramway locomotives and rolling stock	0.013078596	0.014204329	-0.006972744
353	Manufacture of aircraft and spacecraft	0.0169886	0.017511094	0.187464186
354	Manufacture of motor vehicles and bicycles	0.013686457	0.013778221	0.080769488
355	Manufacture of other transport equipment, n.e.c.	0.004829726	0.005281949	.
361	Manufacture of furniture	0.01165034	0.011663006	0.010109047
362	Manufacture of jewellery and related articles	0.042327748	0.042329273	-0.051112249
363	Manufacture of musical instruments	0.056583063	0.056688542	.
364	Manufacture of sports goods	0.002946349	0.002796091	0.045466001
365	Manufacture of games and toys	0.002221427	0.002297468	0.002761942
366	Miscellaneous manufacturing n.e.c	0.005045654	0.005058276	-0.009103773
371	Recycling of metal waste and scrap	0.004674227	0.004683554	0.026743566
372	Recycling of non-metal waste and scrap	0.0035443	0.003634867	-0.018038309