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Local productivity differences through thick and thin: market size, entry costs and openness to trade

Antonio Accetturo, Valter Di Giacinto, Giacinto Micucci e Marcello Pagnini

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LOCAL PRODUCTIVITY DIFFERENCES THROUGH THICK AND THIN: MARKET SIZE, ENTRY COSTS AND OPENNESS TO TRADE

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Antonio Accetturo (Bank of Italy, Rome),
Valter Di Giacinto (Bank of Italy, L'Aquila),
Giacinto Micucci (Bank of Italy, Ancona),
and Marcello Pagnini (Bank of Italy, Bologna) *

Abstract

Firms and workers are more productive in denser areas. Two main hypotheses have been put forward to explain the higher productivity found in larger cities: the existence of agglomeration economies (which foster productivity of firms located in a same area) and the effect of firm selection (the exit of less efficient firms due to a tougher competition). To distinguish between these hypotheses, a model has recently been proposed by Combes, Duranton, Gobillon, Puga and Roux (2010). In this paper, we extend their model along three directions: first, we allow for the existence of asymmetric entry costs, as land prices are usually higher in densely populated areas; second, we introduce heterogeneous market potentials across regions; third, we differentiate the spatial scale at which the effects of agglomeration (limited spatial scale) and selection (larger scale) may operate.
Using a large dataset of about 48,000 Italian manufacturing firms, we show that productivity advantages are largely due to agglomeration economies; moreover, when introducing the hypothesis that market access to foreign markets is different across locations and that agglomeration and selection may impact at differentiated scales, a significant selection effect appears to emerge.

Key words: agglomeration economies, firm selection, market size, entry costs, openness to trade.

JEL classification: c52, r12, d24.

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1. Introduction

It is well established empirically that firms and workers are more productive in more populated areas (see the seminal work of Ciccone and Hall, 1996, and the reviews of Rosenthal and Strange, 2004, and Melo, Graham, and Noland, 2009). Estimates of the elasticity of productivity with respect to city population range between 0.02 and 0.10, depending on the country, sector and estimation procedure. In a recent analysis on Italy, Di Giacinto et al. (2011) detect local productivity advantages for both types of agglomerated areas they take into consideration, that is urban areas, which typically display a huge concentration of population and host a wide range of economic activities, and industrial districts, which exhibit a strong concentration of small firms producing roughly the same products; the authors also find that advantages are much larger for urban areas.

If the existence of productivity differences in favor of larger cities seems to be undisputed, the debate on the mechanisms originating such differences is still open. Two main hypotheses have been put forward in order to explain the higher average productivity of firms and workers in larger cities: the existence of agglomeration economies and the effect of firm selection.

For a long time, the explanation based on agglomeration economies has prevailed. Duranton and Puga (2004) show that agglomeration economies arise due to the possibility for firms to share suppliers, the existence of thick labor markets facilitating matching between firms and workers, the learning-by-doing promoted by the concentration of firms and workers in the same location.

However, more recently, the alternative explanation based on firm selection has gained consensus. This explanation is mainly built on works by Melitz (2003) and Melitz and Ottaviano (2008), suggesting that larger markets attract more firms and make competition tougher, thus leading less productive firms to exit from the market in a process of Darwinian selection of firms.

With the purpose to distinguish between agglomeration and firm selection in explaining local productivity differences, Combes et al. (2010) nest a generalized version of a firm selection model in a standard model of agglomeration. In assessing the relative importance of agglomeration and firm selection using French data, they resort to a new non parametric empirical methodology that is totally grounded on theory and that allows for a simultaneous estimation of the different forces shaping productivity distributions at local level. According to their evidence, local productivity differences are almost entirely explained by agglomeration while selection effects do not have any role.

The aim of this paper is to extend both theoretically and empirically the work by Combes et al. (2010) by introducing three possible alternative explanations for the disappearance of the selection effect.

First, we allow for the existence of asymmetric entry costs for firms in the local markets. In the original model Combes et al. (2010) assume that these costs are the same across areas. However, land prices are generally higher in densely populated areas and this may create an anti-competitive effect that reduces the strength of firm selection.

In the second extension we consider the case of different trade costs across regions. Combes et al. (2010) assume perfect symmetry in the trade costs across locations. This implies that the intensity of the selection process solely depends on local population. However, we show that whenever the market access for some regions is better, the selection effect is much stronger factoring out for local population size.

In the third extension, we also analyze the case of differentiated spatial scales at which the effects of agglomeration (narrow spatial scale) and selection (larger scale) operate; in fact, while agglomeration economies emerge within a limited spatial range, trade costs - that are crucial for the identification of the relevant market where selection effects take place - only differ at broader spatial scales.

Our paper is therefore related to the theoretical literature that propose a unified analysis of agglomeration and selection forces within the same model and also to the empirical contributions trying to measure the strength of the two effects.[1] While agglomeration economies have been widely analyzed, the empirical literature on selection is still in its infancy. Syverson (2004a) investigates whether local market size influenced productivity dispersion varying inversely with the intensity of selection effects. For the concrete industry where trade costs contribute to geographically segment markets, he finds that local market size reduces productivity dispersion and increases the strength of selection effects. In another paper, Syverson (2004b) examines again the relationship between selection and productivity dispersion but this time using data at industry level. Del Gatto, Ottaviano and Pagnini (2008) resort to a similar empirical setting and show that industries that are more opened to external trade display a lower dispersion in productivity and hence more intense selection effects.

[1] Other theoretical contributions nesting selection and agglomeration effects as well as firm sorting include Behrens and Nicoud (2008) and Behrens, Duranton and Nicoud (2010).

Using a large dataset of more than 48,000 Italian manufacturing firms observed during the period 1995-2006, we test the predictions of our three theoretical extensions. Results show that, although theoretically important, the effects of differentiated entry costs on selection seem quite negligible from an empirical point of view. The second and third extensions, instead, have more support in the empirical analysis, that is a significant selection effect is detected when introducing the hypothesis that market access to foreign markets depends on locations and that agglomeration and selection may impact at differentiated scales. However, as in Combes et al. (2010), we find that productivity advantages of larger cities are mainly attributable to agglomeration economies.

The rest of the paper is organized as follows. In section 2 the theoretical model is illustrated, starting from the baseline version of Combes et al. (2010) and then introducing further hypothesis on entry costs, market potential, and spatial scale. Section 3 presents the data. Section 4 discusses the econometric results for the baseline model. Section 5 discusses the evidence for the extended version. Section 6 concludes.

2. The extended model

In this section we present an extended version of the Combes et al. (2010) model of agglomeration and selection along three different lines: (i) asymmetric entry costs; (ii) differences in market access across regions and (iii) the problem of the spatial scale.

2.1 The basic setup

The basic setup relies on Melitz and Ottaviano (2008) compounded with a model of agglomeration economies (Fujita and Ogawa, 1982; Lucas and Rossi-Hansberg, 2002).

An individual consumer utility is given by:

$$U = q^0 + \alpha \int_{k\in\Omega} q^k dk - \frac{1}{2}\gamma \int_{k\in\Omega} \left(q^k\right)^2 dk - \frac{1}{2}\eta\left(\int_{k\in\Omega} q^k dk\right)^2 , \qquad (1)$$

where q^0 indicates the consumption of a homogeneous nummeraire good, that is freely traded across locations, and q^k is the consumption of a variety *k* of a set Ω of differentiated goods. Parameters α and γ are assumed to be both positive and indicate a higher preference for the differentiated good with respect to the nummeraire. Parameter $\eta > 0$ represents consumer preferences for variety, the higher η the larger the love for variety in the differentiated goods set.

Standard maximization under budget constraint (for further details, see Ottaviano, Tabuchi and Thisse, 2002; Melitz and Ottaviano, 2008; Combes et al., 2010) leads to the following Marshallian demand for the differentiated good:

$$q^k = \frac{1}{\gamma + \eta\omega}\left(\alpha + \frac{\eta}{\gamma}\omega P\right) - \frac{1}{\gamma}p^k \quad \text{if} \quad p^k \leq \bar{h} \equiv P + \frac{\gamma(\alpha - P)}{\gamma + \eta\omega} \tag{2}$$

and zero otherwise. ω is the measure of the set of varieties $\tilde{\Omega}$ actually produced in the economy. $P \equiv \frac{1}{\omega}\int_{j\in\tilde{\Omega}} p_j dj$ is the average price faced by a consumer. $\bar{h}$ is the price threshold that immediately follows from the restriction $q^k \geq 0$. It should be noted that varieties with a price higher than a certain threshold $\bar{h}$ will not be consumed in this economy. This is due to the utility function (1), in which marginal utility is bounded.

The production of the numeraire good is obtained under constant returns to scale with a one-to-one technology; this implies that one unit of labor is needed to produce one unit of this kind of good.

Differentiated products are produced under monopolistic competition. Upon paying a sunk cost *s*, firms can start the production process, by using *h* units of labor to produce one unit of output. This implies that *h* is the marginal cost. Firms are heterogeneous in terms of *h*, the latter being randomly drawn by a known distribution function *G(h)* common to all locations (*g(h)* denotes the continuous density function). As usual in this literature we assume that firms decide first whether to enter the market and then they are able to observe their true productivity (*1/h*). All firms with a marginal cost above the price threshold pay the fixed cost and then exit.

The economy is made of *R* locations (cities) in which production may take place. Firms may be created and shut down in each city, but they cannot relocate. [2] Whenever a firm is set in a city, it can export its differentiated good to other locations upon paying an iceberg trade cost $\tau \geq 1$. This implies that an exporting firm should ship τ units of its good to deliver one unit to another city. We assume that the trade cost matrix is symmetric and constant, that is, given two locations *i* and *j*, $\tau_{ij} = 1$ if *i*=*j* and $\tau_{ij} = \tau$ if $i \neq j$. Since all varieties enter symmetrically in the utility function, we can index firms by their marginal cost realization *h*.

[2] For models respectively combining firm relocation choices with Melitz (2003) and Melitz and Ottaviano (2008) setups, see Baldwin and Okubo (2006) and Okubo, Picard and Thisse (2010). Nocke (2006) pursues a similar line of research however moving from the tenets of oligopoly theory.

The equilibrium operating profits that a firm located in city *i* is able to extract in region *j* are:

$$\pi_{ij}(h) = \frac{N_j}{4\gamma}\left(\bar{h}_j - \tau_{ij} h\right)^2 \qquad (3a)$$

where N_j is the population in city *j*.

Due to free entry in each market, ex-ante firm profits are driven to zero. This implies that expected operation profits before entry must equalize the sunk cost:

$$\frac{N_i}{4\gamma}\int_0^{\bar{h}_i}\left(\bar{h}_i - h\right)^2 g(h)dh + \sum_{j\neq i}\frac{N_j}{4\gamma}\int_0^{\bar{h}_j/\tau}\left(\bar{h}_j - \tau h\right)^2 g(h)dh = s \qquad (3b).$$

Let us now turn to the agglomeration component of the model and its idiosyncratic effects on firms. Each worker is endowed with one unit of labor, inelastically supplied to firms. Individual productivity, however, is positively influenced by the face to face interactions with other workers, the positive externalities generated through them are subject to a spatial decay (Fujita and Ogawa, 1982; Lucas and Rossi-Hansberg, 2002). This implies that the effective labor supply by a worker located in city *i* is equal to $a\left(N_i + \sum_{j\neq i}\delta N_j\right)$, where $a(0)=1$, $a'>0$, $a''<0$ and $\delta \in [0,1]$, which represents the strength of cross-city interactions. Since workers are mobile across sectors, per capita labor income is equal to $a\left(N_i + \sum_{j\neq i}\delta N_j\right)$. In anticipation of the empirical part, this *Agglomeration* effect will be measured by $A_i \equiv \ln\left[a\left(N_i + \sum_{j\neq i}\delta N_j\right)\right]$. A firm in city *i* with a unit labor requirement *h* hires $l_i(h) = \sum_j \frac{Q_{ij}(h)}{a\left(N_i + \sum_{j\neq i}\delta N_j\right)}$ workers at a total cost $a\left(N_i + \sum_{j\neq i}\delta N_j\right) l(h) = \sum_j Q_{ij}(h)$, where $Q_{ij}(h)$ is the total production of firm *h* located in city *i* and sold to market *j*.

Agglomeration effects could be also heterogeneous across firms. Combes et al. (2010) suppose that while agglomeration economies raise the productivity for all firms in larger cities, they can have a stronger effect on more productive firms (*Dilation* effect). In order to introduce this idea in a tractable way, they suppose that the Agglomeration effect is stronger in more efficient firms (i.e. those with a lower *h*). Analytically, the effective labor supply for an employee living in city i and hired by firm h is $a\left(N_i + \sum_{j\neq i} \delta N_j\right) h^{-(D_i - 1)}$, where $D_i \equiv \ln\left[d\left(N_i + \sum_{j\neq i} \delta N_j\right)\right]$ and $d(0) = 1$, $d' > 0$ and $d'' < 0$.

The natural logarithm of the productivity of a firm with marginal cost h and located in city i is $\phi_i(h) = \ln\left(\frac{\sum_j Q_{ij}(h)}{l_i(h)}\right) = A_i - D_i \ln(h)$.

In anticipation of the empirical part, we can now write the cumulative density function of the log of productivities:

$$F_i(\phi) = \max\left\{0, \frac{\tilde{F}\left(\frac{\phi - A_i}{D_i} - S_i\right)}{1 - S_i}\right\} \tag{4}$$

where $\tilde{F}(\phi) \equiv 1 - G(e^{-\phi})$ is the underlying cumulative density function of the log productivities in absence of agglomeration, dilation and selection effects. $S_i \equiv 1 - G(\bar{h}_i)$ denotes the proportion of firms that fail to survive competition in city *i*.

We can now turn to the core results of this paper, by looking at the (heterogeneous) effects of city size on the Agglomeration, Dilation and Selection components. Combes et al. (2010) show that, if cities are ranked in terms of population: $N_1 > N_2 > ... > N_{R-1} > N_R$:

1. The agglomeration and the dilation effects are stronger for larger cities, i.e. $A_1 > A_2 > ... > A_{R-1} > A_R$ and $D_1 > D_2 > ... > D_{R-1} > D_R$;
2. The selection effect is stronger in larger cities, i.e. $\bar{h}_1 < \bar{h}_2 < ...\bar{h}_{R-1} < \bar{h}_R$.

We refer to their paper for a formal proof. A remarkable feature of this demonstration is that it is obtained without making any parametric assumption about *G*.

2.2 Asymmetric entry costs

In this section we provide the first extension of the baseline model. In particular, we allow for the existence of differentiated entry costs, which are increasing with the resident population in the city. The idea is quite simple. The entry cost can be imagined as a physical setting up cost, like buying a lot and building an establishment. Land prices are usually higher in densely populated areas, this implies that entry costs can be ordered as follows: $s(N_1) > s(N_2) > ... > s(N_{R-1}) > s(N_R)$.

Consider now city *i* and *j*, characterized by different population size. Equation (3b) can now be rewritten, respectively, as:

$$\frac{N_i}{4\gamma}\int_0^{\bar{h}_i}(\bar{h}_i - h)^2 g(h)dh + \frac{N_j}{4\gamma}\int_0^{\bar{h}_j/\tau}(\bar{h}_j - \tau h)^2 g(h)dh + \sum_{\substack{k\neq i\\ k\neq j}}\frac{N_k}{4\gamma}\int_0^{\bar{h}_k/\tau}(\bar{h}_k - \tau h)^2 g(h)dh = s(N_i) \qquad (5)$$

$$\frac{N_j}{4\gamma}\int_0^{\bar{h}_j}(\bar{h}_j - h)^2 g(h)dh + \frac{N_i}{4\gamma}\int_0^{\bar{h}_i/\tau}(\bar{h}_i - \tau h)^2 g(h)dh + \sum_{\substack{k\neq i\\ k\neq j}}\frac{N_k}{4\gamma}\int_0^{\bar{h}_k/\tau}(\bar{h}_k - \tau h)^2 g(h)dh = s(N_j) \qquad (6)$$

By subtracting (6) from (5) we obtain:

$$N_i\upsilon(\bar{h}_i, \tau) - N_j\upsilon(\bar{h}_j, \tau) = s(N_i) - s(N_j) \qquad (7)$$

where $\upsilon(\bar{h}_x, \tau) = \int_0^{\bar{h}_x}(\bar{h}_x - h)^2 g(h)dh - \int_0^{\bar{h}_x/\tau}(\bar{h}_x - \tau h)^2 g(h)dh \quad \forall x = i, j$.

Similarly to Combes et al. (2010), we can now state the conditions for the agglomeration, dilation and selection effects.

<u>Proposition 1.</u>

If $N_i > N_j$ and $s(N_i) > s(N_j)$:

1. The agglomeration and the dilation effects are stronger for the larger city, i.e. $A_i > A_j$ and $D_i > D_j$;
2. If productivities are Pareto distributed, the selection effect is stronger in the larger cities, i.e. $\bar{h}_i < \bar{h}_j$, if and only if $s'(N) < \frac{s(N)}{N}$.

<u>Proof (see Appendix a1)</u>

In the Appendix we provide a similar condition on $s'(N)$, when firm marginal costs are drawn from a generic distribution function *G(.)*.

Point 2 of Proposition 1 states that the effects of population size on selection can be attenuated and, in some cases, reverted when the entry cost, expressed as a function of the local population size, is steep enough. The intuition is quite simple: when the entry cost sharply increases with population size, more crowded cities experience an anti-competitive effect, thus allowing the survival of more inefficient firms. We will test this prediction in the empirical part.

2.3 Asymmetric trade costs and the spatial scale problem

The second extension relates to the role that differences in terms of market access across regions might have on the intensity of competition at local level. As it will become clearer in a while, this question is also linked to the topic of the definition of the relevant market for manufacturing products.

In their model, Combes et al. (2010) assume that trade costs are the same across regions. In what follows, we will remove this assumption. Specifically, start again from the case in which there are R regions. Two of them, say i and j, are located within the same country, the rest of the regions belong to different countries (for the sake of simplicity let us assume that one region corresponds to one country). Assume that in order to ship one unit of a good from region i to region j , a producer has to send $\tau_{ij} > 1$ units of the same good. We also assume that $\tau_{ij} = \tau_{ji}$, $\tau_{ii} = 1$ and $\tau_{jk} \neq \tau_{ik}$.

Now compare the free entry conditions for the two domestic regions i and j for which we assume that $N_i = N_j = N_d$. It follows:

$$\frac{N_d}{4\gamma}\int_0^{\bar{h}_i}(\bar{h}_i - h)^2 g(h)dh + \frac{N_d}{4\gamma}\int_0^{\bar{h}_j/\tau_{ij}}(\bar{h}_j - \tau_{ij}h)^2 g(h)dh + \sum_{k\neq i,j}\frac{N_k}{4\gamma}\int_0^{\bar{h}_k/\tau_{ik}}(\bar{h}_k - \tau_{ik}h)^2 g(h)dh = s \quad (8)$$

$$\frac{N_d}{4\gamma}\int_0^{\bar{h}_j}(\bar{h}_j - h)^2 g(h)dh + \frac{N_d}{4\gamma}\int_0^{\bar{h}_i/\tau_{ij}}(\bar{h}_i - \tau_{ij}h)^2 g(h)dh + \sum_{k\neq i,j}\frac{N_k}{4\gamma}\int_0^{\bar{h}_k/\tau_{jk}}(\bar{h}_k - \tau_{jk}h)^2 g(h)dh = s \quad (9)$$

Subtracting (9) from (8) it yields:

$$N_d\left[\upsilon(\bar{h}_i,\tau_{ij}) - \upsilon(\bar{h}_j,\tau_{ij})\right] = \sum_{k\neq i,j}\frac{N_k}{4\gamma}\int_0^{\bar{h}_k/\tau_{jk}}(\bar{h}_k - \tau_{jk}h)^2 g(h)dh - \sum_{k\neq i,j}\frac{N_k}{4\gamma}\int_0^{\bar{h}_k/\tau_{ik}}(\bar{h}_k - \tau_{ik}h)^2 g(h)dh$$

(10)

If the expression on the right hand side of this equation is negative, that is region i has a better market access to other countries than region j, this will imply that $\upsilon(\bar{h}_i,\tau_{ij}) < \upsilon(\bar{h}_j,\tau_{ij})$ and hence, given that $\frac{\partial \upsilon}{\partial h} > 0$, $\bar{h}_i < \bar{h}_j$. In words, selection effects will be stronger in the region with better market access to the foreign markets despite the assumption that local market size is the same in the two domestic regions. Thus, differences in market access may contribute together with market size to shape productivity distributions at local level.

Another related issue concerns the spatial scale at which agglomeration and selection effects operate. In their model, Combes et al. (2010) implicitly assume that the spatial scale for the effects of agglomeration, dilation and selection is the same. This assumption seems questionable for different reasons. As far as agglomeration effects are concerned, both the theoretical and empirical literature seems to suggest that they operate at a very local level, i.e. they exert their effects within a very limited spatial scale.[3] On the contrary, trade costs, that are crucial for the identification of the relevant market where selection effects take place, may significantly differ at a broader spatial scale, for instance at country level.

Following these remarks, we show how the basic model can be reinterpreted as one in which agglomeration, dilation and selection effects operate at different spatial scales. Assume that space is partitioned in two macroregions or countries. Each macroregion hosts a different number of localities (or regions) inside its borders. Define total population in the two macroregions as $P_1 = \sum_i N_{1i}$ $P_2 = \sum_j N_{2j}$, where *i* and *j* denote the different localities, and assume that $P_1 > P_2$. Within each macroregion, agglomeration and dilation effects exert their effects at the level of individual localities. At the same time, from the point of view of trade, each macroregion is assumed to represent a unified market, hence trade costs between localities belonging to the same macroregion will be zero. On the contrary, by assumption, the two large regions are not perfectly integrated through trade. In order to export one unit of the good from 1 to 2 a producer in macroregion 1 has to ship $\tau \geq 1$ units of the same good. Finally, we assume that entry costs are the same across all locations.

<u>Proposition 2</u>

Consider 2 regions: *r* belongs to macroregion 1 and *s* to macroregion 2. *r* and *s* have the same population ($N_r = N_s$), but macroregion 1 is bigger than 2.

1. The agglomeration and the dilation effects are the same in the two regions, i.e. $A_r = A_s$ and $D_r = D_s$;

[3] See Rosenthal and Strange (2003 and 2008) for evidence on the rapid spatial decay of information and human capital spillovers and Puga (2010) for a survey on the same topic.

2. The selection is stronger in region *r*.

Proof (see Appendix a2)

Two implications from this result are that (a) looking at the relation between market size and selection can be misleading when the analysis is carried out at a very detailed spatial scale; (b) in the case for instance of manufacturing goods selection effects can be properly detected only when geographical units like entire countries and their interactions in the context of the international trade are considered. We will investigate these issues in the empirical section.

3. Data and Descriptive statistics

The empirical analysis presented in this paper was carried out on a large panel of more than 48,000 Italian manufacturing firms, observed over the period 1995-2006.

The panel was built as follows (see also Di Giacinto et al., 2011, that used the same dataset for mapping local productivity advantages in Italy). Yearly balance-sheet figures on value added, fixed investments, and capital stock were drawn from the Chamber of commerce-Company Accounts Data Service database (Centrale dei Bilanci / Cerved). Additional firm level data, including the sector of economic activity, firm location (municipality where the firm is established) and number of employees were also included as auxiliary information in the database.

Only one third of the firms in the database report employment data. To overcome this shortcoming, missing employment figures were imputed by means of a statistical procedure, using total labor cost as the main auxiliary information in order to recover missing data on the number of employees. In fact, unlike the information on the number of employees, data on total labor costs are available for all the firms in the sample. Average unit labor cost measured on the sub-sample of firms for which employment counts information is available provides the information needed to recover missing labor input data. To allow for possible heterogeneity in mean wages, the sample was stratified according to a number of relevant firm characteristics. In particular, mean wages are allowed to vary across sector, geographical area and type of local labor market. Additional firm-level wage heterogeneity is also controlled for by stratifying the sample according to firm size, measured by value added, and profitability. Larger firms may feature a different skill composition of the labor force, and consequently different mean wages. At the same time, more profitable firms are more likely to pay wage premiums, thus sustaining higher total labor cost for given number of employees. In each stratum the median of observed firm-level average labor cost was computed, and these estimates were subsequently used to impute missing employment data by taking the ratio of total firm labor cost to the median wage of the stratum in which the firm is classified.

The capital stock at firm level has been estimated from the book value of investment using the permanent inventory method and accounting for the sector-specific depreciation rates from the Italian National Accounts data. The capital stock in the initial year has been estimated using the deflated book value, adjusted for the average age of capital calculated from the depreciation fund (for more details, see Di Giacinto et al., 2011). Nominal value added and consumption of intermediate goods figures were deflated by using industry specific price indexes.

Firms with less than 5 employees were removed from the sample since data were very noisy for that size class. Given that our sample is not balanced, our final dataset includes about 345,000 observations and 48,000 firms (Table 1): this means that on average we dispose of 7 yearly balance-sheet figures for each firm over the 12-years period 1995-2006.

The information about the municipalities where firms are located allows us mapping them into Local Labor Markets Areas (LLMA). LLMA are built departing from data on daily commuting flows from place of residence to place of work available for the 8,100 municipalities in Italy. Contiguous locations are then aggregated into LLMA. Through this procedure, within LLMA labor mobility is maximized while mobility across LLMA is minimized. The outcome of this procedure mapped the Italian territory into 784 LLMA in 1991 (686 in 2001)[4]. LLMA represent an ideal partition to analyze many agglomeration effects, provided that most of them are conveyed though the interactions taking place within the local labor market. However, this zoning system can be sometimes problematic as far as the definition of the relevant market for manufacturing products is concerned.

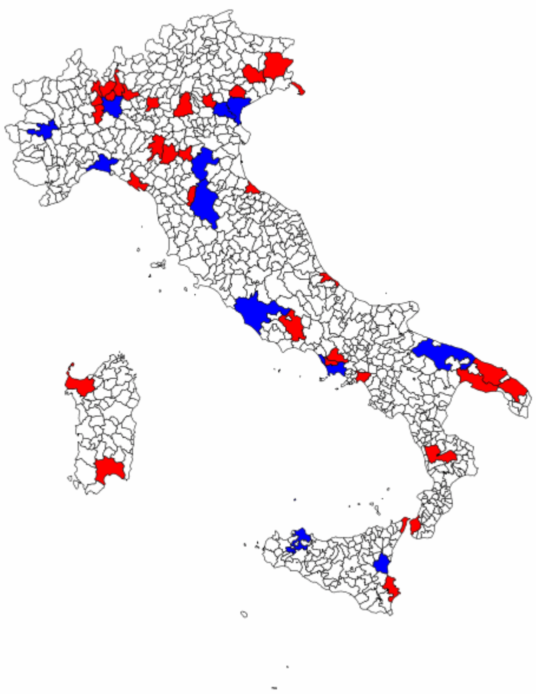
LLMA are further classified into Urban areas (UA) and other non-urban areas. As for the mapping of the urbanization phenomenon in Italy, UA are those LLMA for which the resident population is above the threshold of 200,000 inhabitants (see the map in figure 1). Although Italy was historically known as the "country of one hundred cities", it did not see the development of the urban giants featuring the economies both of several developed and underdeveloped countries. Hence, setting a relatively low threshold level to define UA seems to be consistent with

[4] In the following, the empirical analysis is carried out on the basis of the 1991 map of LLMA. The choice is motivated by the opportunity of using a classification that is predetermined with respect to the sample period considered in the analysis.

the low degree of urbanization in the Italian economy. However, in what follows, we will also check the robustness of our results using a higher threshold (500,000 inhabitants).

About a half of the firm-level observations refer to firms in UA (Table 1). The sectoral distribution reveals that about 45 per cent of the observations are related to the metal and metal products, mechanical and machinery, textiles and apparel industries.

Fig. 1 - Map of LLMA in 1991: Urban Areas with population > 500,000 (in blue),Urban areas with population between 200,000 and 500,000 (in red), non urban areas with population below 200,000 (in white)



4. The estimations for the baseline model

4.1 TFP estimation

In order to allow for a comparison of productivity across firms and areas, unobservable total factor productivity (TFP) levels have to be first estimated. Following a standard approach, we obtain TFP estimates at firm-level as the residual of an estimated production function.

The following standard Cobb-Douglas production function was considered:

$$Q_{i\in(r,s)t} = \Phi_{it} L_{it}^{\alpha_s} K_{it}^{\beta_s} \qquad (11)$$

where L and K denote labor and capital inputs used to produce the amount of output Q in the year t by firm i belonging to sector s and located in LLMA r;[5] α_s and β_s are the production function coefficients, that are allowed to vary across sectors. We do not impose constant returns to scale technology.

After log transformation the following estimating equation ensues (lowercase letters denote logs):

$$q_{it} = \alpha_s l_{it} + \beta_s k_{it} + \phi_{it} \qquad (12)$$

from which the firm-level log-TFP can subsequently be computed as the residual:

$$\hat{\phi}_{it} = q_{it} - \hat{\alpha}_s l_{it} - \hat{\beta}_s k_{it} \qquad (13)$$

provided that consistent estimates of parameters α_s and β_s are available.

Equation (13) was estimated by ordinary least squares (LS), individual firm fixed effects (FE) and Levinsohn and Petrin (LP) methods to control for input-output simultaneity, (see Levinsohn and Petrin, 2003). We run distinct regressions for each industry at two digits of the SEC classification[6].

Overall, results obtained according to the three estimation methods do not show large differences, although the LS estimates exhibit slightly larger values of the input coefficients as compared to those resulting from FE and LP methodology, thus confirming the likely presence of the expected positive simultaneity bias. LP estimates show generally larger elasticities for the capital input and correspondingly lower estimates for the labor input as compared to FE, the sum of the two coefficients attaining very close values in the two cases. Decreasing returns to scale (RTS) seem to be the prevalent regime in our estimates, although a formal test of constant RTS did not reject the null for the majority of sectors considered in the analysis. Estimated TFP levels

[5] To avoid cluttering notation, in the following we drop the reference to the LLMA and the sector when indexing variables referring to the individual firm.

[6] Firms with less than 5 employees were dropped from the sample prior to estimation for data reliability issues. Following the same line of reasoning, firms attaining extreme values of the K/L ratio were also excluded. As a result, the final sample dropped to about 28,700 firms per year.

are highly correlated across the three estimation methods, the Pearson correlation coefficient attaining values equal or higher than 0.95.

The results comparing productivity levels across different regions and estimated with the Levinsohn-Petrin method are reported in Table 2. They clearly indicate that the estimated TFP is generally higher in urban areas.

4.2 - Econometric approach

To obtain estimates of the parameters measuring the intensity of selection and agglomeration effects in the theoretical model detailed in section 2, we implement the methodology set forth in Combes et al. (2010), which makes use of non parametric techniques exploiting only the information conveyed by the empirical cumulative distribution of log productivities in each city.

The estimation procedure is developed on the basis of the assumption that in city *i* the cumulative density function F_i of log TFP can be obtained by dilating by a factor D_i, shifting rightwards by A_i and left-truncating a share S_i of the values of some underlying distribution with cumulative density function $\tilde{F}$.

Under this assumption, the authors prove that the cumulative densities of log productivity in cities *i* and *j* are related by the following formulas:

$$F_i(\phi) = \max\left\{0, \frac{F_j\left(\frac{\phi - A}{D}\right) - S}{1 - S}\right\}, \qquad \text{if } S_i > S_j \tag{14}$$

$$F_j(\phi) = \max\left\{0, \frac{F_i(D\phi + A) - \frac{-S}{1-S}}{1 - \frac{-S}{1-S}}\right\}, \qquad \text{if } S_j > S_i \tag{15}$$

where

$$D = \frac{D_i}{D_j}, \qquad A = A_i - DA_j, \qquad S = \frac{S_i - S_j}{1 - S_j}. \tag{16}$$

Only parameters *A*, *S* and *D*, providing a relative measure of agglomeration, selection and dilation effects on productivity in large versus small cities, can be identified and estimated from the empirical cumulative distribution.

Rewriting the above relations in terms of the quantiles of the two distributions yields, after a suitable change of variable, the key relationship that can be exploited to fit the model to the data:

$$\lambda_i(r_S(u)) = D\lambda_j(S + (1-S)r_S(u)) + A, \qquad u \in [0,1] \qquad (17)$$

where $\lambda_h(u) = F_i(u)^{-1}$, $h \in [i, j]$, and $r_S(u) = \max\left(0, \frac{-S}{1-S}\right) + \left[1 - \max\left(0, \frac{-S}{1-S}\right)\right]u$.

Estimation can be carried out on the basis of equation (17) by resorting to the class of estimators introduced in Gobillon and Roux (2010). Letting $\theta = (A, S, D)$, the Gobillon and Roux estimator is defined as

$$\hat{\theta} = \arg\min_{\theta}\left(\int_0^1 [\hat{m}_\theta(u)]^2 du\right) \qquad (18)$$

where $\hat{m}_\theta(u) = \hat{\lambda}_i(r_S(u)) - D\hat{\lambda}_j(S + (1-S)r_S(u)) - A$ and where the theoretical quantiles λ_i and λ_j have been replaced by the corresponding estimators $\hat{\lambda}_i$ and $\hat{\lambda}_j$.

The advantages of this new methodology are manifold. First, it is entirely grounded on theory and allows for a simultaneous assessment of selection and agglomeration effects. Second, it does not impose parametric assumption about the shape of *G*. Third, unlike a traditional quantile regression approach, it is based on a comparison of basically all the quantiles of the two distributions and not only of specific percentiles, thereby improving robustness of the estimated parameters. This degree of generality, however, is achieved at a cost. The procedure actually only allows to compare locations according to a single profile (e.g. urban versus non urban areas). In this sense the methodology can be deemed to implement essentially a univariate approach. Should factors other that agglomeration and firm selection in thick local markets affect the TFP distribution at the city level, it would be difficult to control for such confounding effects when bringing the model to the data. At the same time a discrete classification of cities in agglomerated vs. non-agglomerated has to be enforced a priori in order to estimate the model. Compared to the use of continuous measures of city size or density, this approach inevitably involves some degree of arbitrariness in empirical applications.

4.3 - Econometric results

In this section we first report the estimation results obtained by fitting the baseline Combes et al. (2010) specification to data collected on the sample of Italian manufacturing firms illustrated in section 3.

In order to implement the estimation procedure, a crucial specification step involves the definition of the criteria that allows distinguishing large from small urban areas. Both administrative and functional areas can provide the reference spatial partition to this purpose and, on this respect, we choose to refer to local labor market areas (LLMA) identified on the basis of daily worker commuting flows, as the latter are more likely to represent the areas where agglomeration economies display their effects. More specifically, the employment areas identified by the Italian national statistical institute (Istat) on the basis of the 1991 population census were utilized as reference spatial units in the analysis (see also section 3).

Two alternative criteria were considered in order to separate large and small cities: population count and population density.

Population size represents our preferred gauge, as it more closely identifies large urban areas within Italian LLMA. When we consider density as a measure of local scale we actually find out that a number of relatively small LLMA attain high levels of population density, while they clearly do not qualify as large urban systems according to size or other indicators that denote large urban areas.

A threshold level of 200,000 residents is our baseline choice in order to identify large cities and it is also the value adopted by Combes et al. (2010) in part of their empirical analyses. Finally, consistently with the above mentioned paper we average TFP at firm level across years $\hat{\phi}_i = \sum_{t=1}^{T_i} \hat{\phi}_{it} / T_i$ in order to reduce the noise in the data.

Estimates of parameters *A*, *S* and *D* obtained considering this spatial partition are separately displayed in Table 3 for the 2-digits SEC industries. Our results are largely in line with the evidence reported by Combes et al. (2010). Positive agglomeration effects on TFP levels are found out for most sectors. Based on bootstrapped standard errors, estimates of the *A* parameter are significantly different from zero in all but one sector. The cross-industry average estimate of *A* implies a 5.5 per cent increase in TFP when firms localize within large urban areas compared to other locations. The effect is smaller compared to the estimates obtained by Combes et al. (2010) using French firm panel data (9.5 per cent) but, nonetheless, it provides evidence of a substantial right shift of the TFP distribution in large urban areas.

At the same time, no evidence of stronger firm selection in larger cities is detected, estimates of *S* being all very close to zero and never statistically significant.

Also for our sample, allowing more productive firms to benefit more from agglomeration, by introducing the dilation term, improves substantially the model fit. Estimates of the *D* parameter are mostly larger than one in size, with a cross-industry average of 1.09, and are statistically significant for five sectors.

The estimated dilation parameter, assuming a value of S=0 (no selection), implies that the TFP surplus in denser areas is equal to 8 per cent at the top quartile and is smaller (4,7 per cent) at the bottom quartile.[7] This evidence is in line with the results of a quantile regression analysis performed on individual TFP estimates by Di Giacinto et al., 2011 showing that the urban productivity premium increases when considering the firms in the upper tail of the TFP distribution.[8] Finally, the results on selection are partially at odds with those in Syverson (2004a) and Arimoto et al. (2009) that found significant selection effects in the case of the concrete industry in the US and in the silk industry in Japan at the beginning of the 20^{th} century.

To check for robustness of the above results with respect to the choice of the population level separating small from large employment areas, we replicated the estimation procedure considering a larger threshold value for the LLMA population (500,000 people).

Estimation results, displayed in Table 4, are qualitatively unchanged, although on average a greater productivity shift due to agglomeration effects is now observed in larger urban areas. The cross-industry average of the estimated *A*'s rises in this case to 0.084. A smaller increase is recorded on average for the dilation parameter (from 1.09 to 1.10), while the estimated *S* coefficient remains very close to zero for all industries.

To provide a further term of comparison the model was estimated also considering a grouping of employment areas according to population density. Table 5 reports the estimation results obtained comparing productivity in employment areas above vs. below mean density. The overall pattern of results is not substantially affected with respect to the baseline case, apart for one sector (Chemicals), where parameter estimates strongly diverge from results obtained when urban scale is measured by population level.

As a final check, in an unreported exercise the model was fitted using as reference spatial units LLMA defined according to the 2001 census, which are on average a bit larger and less

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[7] We exclude the sector "coke, petroleum and nuclear fuel" as we had too few observations to carry out a reasonable analysis.
[8] For similar results obtained through a quantile regression analysis for France, see Braint (2010).

numerous compared to the 1991 definition. No significant deviation appears to stand out compared to baseline estimation results.

5. Econometric results for the extended specifications

In this section we analyze how our baseline empirical findings on the impact of agglomeration and selection on firm productivity are affected when we relax the hypotheses of symmetric entry and trade costs and modify the spatial scale.

In section 2.2 it is shown how heterogeneous entry costs that are increasing with city size may operate as a confounding factor on the observed level of firm selection, possibly reversing the positive effect of a larger market scale on the selection of more productive firms.

In order to control for such confounding factor, we compute new model parameter estimates on the basis of a restricted set of local employment areas. To do so, we first estimate function $s(N)$ for Italian LLMAs (a detailed illustration of the statistical approach that we implemented to obtain empirical estimates of the local entry cost function is given in Appendix a3) and then, following the spirit of Proposition 2 and its extensions to several regions, we exclude all areas with a high $s'(N)$. We adopt two thresholds: in the first we exclude all areas with $s'(N)$ greater than the 75th percentile of the distribution; in the second we drop all LLMAs with $s'(N)$ greater than the 90th percentile.[9] In this way the underlying monotonic relation between urban scale and the intensity of firm selection should be restored.

Estimation results obtained under this empirical strategy are reported in Table 6 and 7 for, respectively, the 75th and 90th percentile thresholds. Overall our baseline results on the importance of agglomeration and dilation effects in shaping the TFP distribution across different locations are confirmed. Although important from a theoretical point of view, our data fail to find a significant effect of differentiated entry costs on selection. Indeed, the estimated selection parameter S turns out to be generally positive but never significant under standard statistical levels. It should be noted, however, that the fact that the selection coefficient appears to be rather imprecisely measured could be also attributed to the reduced sample size.

We turn now to the issue of differences in market access that are not connected to the size of the local employment area and that may uncover a selection process that is not strictly driven by urbanization. In their empirical analysis, Combes et al (2010) address the problem of market

[9] Other thresholds deliver very similar results.

access by dropping from their sample those firms established in local areas with a market potential below the median and show that the main results do not change. Market potential is computed as a distance weighted average of the population density in the other domestic locations. No reference is made to the access to foreign markets, implicitly assuming that either France is a closed economy or that the differences in trade costs with other countries across employment areas are not empirically relevant.

Moving from the theoretical result in equation 10 and from the fact that trade costs with foreign markets can differ at local level, here we explore the alternative hypothesis that TFP distribution can be characterized by a higher truncation point in employment areas with a better access to external trade.

To get a proxy for local market access to foreign markets, we resort to a data set recently made available by Istat. Specifically, for the 684 LLMA defined according to the 2001 census, we have data on the number of employees working in exporting firms (data refer to 2006). We normalize these figures with the total number of employees in the manufacturing activities in the LLMA. The data on the workers employed in exporting plants are available for the entire manufacturing sector only, hence our proxy measures an average market access at LLMA level. The use of this measure has drawbacks and advantages. On the one hand, the use of an average value is likely to reduce the precision of our estimates. Transport costs, indeed, may differ across industries and areas. For example, consider an LLMA that produces both cars and fresh food and it is located close to port but far from motorways. Since cars are more frequently traded by sea and fresh food is transported by truck, this LLMA is likely to have a high foreign market access in the motor industry, while it is much lower in the other sector of specialization. By attributing a single value for all sector, we are likely to underestimate the real market access for cars and overestimate the one for fresh food. On the other hand, the use of averages is likely to limit the potential reverse causality bias due to the fact that productivities are likely to determine the export penetration in foreign markets by local firms.

As our base line estimation we identify areas with a better access to foreign markets as the ones for which the share of employment in exporting firms exceed the third quartile of the distribution of this variable across LLMA.

Estimation results, displayed in Table 8, show how in this case, while the size of agglomeration effects is confirmed, selection effects appear to stand out more neatly, as the estimated S parameter now takes on positive values and is significant for three industries. For many sectors, we also obtain a negative and significant dilation effect (the coefficient is well below one in many occurrences), on this moment we do not have an interpretation for this piece of evidence.

Given that our proxy for market access and local market size can be positively correlated (correlation coefficient with the log of local population is equal to .37 and is significantly different from zero), our results could be at least partially driven by an urbanization effect rather than by the variability across LLMA's of market access to foreign markets. To address this problem, we net out the effects of the local market size by dropping from the sample those firms located in LLMA's with a population below 50,000 people.[10] We have then replicated the estimation for *A*, *S* and *D* for this reduced sample obtaining very similar results to those illustrated in Table 8. To save on space these results are not reported. Thus, these findings confirm that local differences in market access to foreign markets contributes to shaping local tfp distributions beyond the effects of urbanization.

As for the spatial scale problem, we reestimate *A*, *D* and *S* using a different zoning system based on the 103 Italian provinces as defined in 1992. Unlike for the LLMA, the borders of these areas were set for political reasons, moreover on average they are much larger than LLMA's both in terms of population and surface. Results are reported in Tables 9 and 10 where we use the mean level of population and the mean population density for the grouping of the provincial markets. Our findings clearly indicate that agglomeration effects still prevail even at this different spatial scale (they are particularly intense when we use the mean population density to discriminate across provinces). Dilation effects basically disappear. But the most important result points to the fact that the parameter *S* is now positive in many industries and in some occurrences is very closed to be significantly different from zero and it is actually different from zero in two industries when adopting the mean population density threshold. Our interpretation is that provincial markets being larger on average than LLMAs could offer a better although still imperfect representation of a relevant market for manufacturing products and hence allow a selection effect to emerge from the data.

As a final extension of our investigation, we change again the spatial scale by assuming that markets are perfectly integrated through trade domestically. Consequently, we analyze the differences of tfp distribution in terms of agglomeration, selection and dilation across industries displaying differences in their openness to trade. In particular, we compare the three most (least) export-oriented industries, where the latter is measured as the ratio of the value of exports to value added at the two digit industry level. The estimated value of the selection effect is 0.008,

[10] When we rule out these small LLMA the correlation coefficient drops to .09 and is not significantly different from zero.

and is significant at the five per cent level. Like the results in Tables 9 and 10, this additional evidence clearly points to the need of having an appropriate definition of the relevant market where manufacturing firms operate for a correct assessment of the selection effects. As for the agglomeration effect, we obtain a positive coefficient (.0009) that is however not significantly different from zero. Finally, as in Table 8 our estimations deliver a negative dilation effect (the coefficient is .77 and is significantly different from one).

The latter results and the findings in Table 8 are at odds with those in Syverson (2004b) who did not find any effect of openness to trade on firm selection in a cross section of US industries while are consistent and generalize those in Del Gatto, Ottaviano and Pagnini (2008) that showed how manufacturing industries in Italy that are more opened to external trade according to several indicators display also a lower TFP dispersion and hence more firm selection. Generalization is attained as the theoretical model nests several forces shaping TFP distribution and does not point only to selection, the empirical methodology consistently allows the simultaneous estimation of these forces and is freed of parametric assumptions about the TFP distribution. Finally, part of the results are obtained exploiting the variability of market access across localities rather than across industries.

6. Final remarks

Agglomeration economies and firm selection in large markets represent two competing explanations for the fact that in urban areas firms are generally more productive than in less densely populated regions are. Combes et al. (2010) introduce a generalized version of a firm selection model nesting a standard model of agglomeration. In assessing the relative importance of agglomeration and firm selection they find that local productivity differences are mostly explained by agglomeration while no significant selection effects are uncovered.

In this paper we extend their model by introducing asymmetric entry costs, heterogeneous market potentials, and by differentiating the spatial scale at which the effects of agglomeration and selection operate.

We subsequently test our theoretical predictions on a large dataset of about 48,000 Italian manufacturing firms per year during the period 1995-2006. Empirical findings obtained by fitting the Combes et al. (2010) model to our data are very close to those reported by the authors using French data. In particular, we find that agglomeration is the main driver of TFP differential even for the Italian economy. When we control for differences in market access or heterogeneity in the spatial scale of agglomeration and selection effects, our estimates appear to provide some support for the existence of a sizeable selection effect. The effects of entry costs, instead, are negligible.

TABLES

Table 1

The sample: number of firms

Sectors	Non urban areas	200,000<pop< 500,000	pop>500,000	Total
Food products, beverages and tobacco	1,884	615	609	3,108
Textiles and textile products	2,845	1,882	859	5,586
Leather and leather products	1,690	230	488	2,408
Wood and products of wood and cork (except furniture)	888	313	205	1,406
Pulp, paper and paper products; recorded media; printing services	1,014	614	1,161	2,789
Coke, refined petroleum products and nuclear fuel	60	27	60	147
Chemicals, chemical products and man-made fibres	534	315	670	1,519
Rubber and plastic products	1,329	619	598	2,546
Other on metallic mineral products	1,759	527	407	2,693
Basic metals and fabricated metal products	5,204	2,572	2,336	10,112
Machinery and equipment n.e.c.	2,977	1,685	1,642	6,304
Electrical and optical equipment	1,736	928	1,589	4,253
Transport equipment	720	289	492	1,501
Other manufactured goods n.e.c.	2,194	945	687	3,826
Total	**24,834**	**11,561**	**11,803**	**48,198**

Source: Elaborations on Centrale dei Bilanci, Cerved.

Table 2

Descriptive statistics: Total Factor Productivity per Firm

Sectors	Average			Median		
	Non urban areas	200,000 <pop< 500,000	pop> 500,000	Non urban areas	200,000 <pop< 500,000	pop> 500,000
Food products, beverages and tobacco	1.033	1.139	1.266	0.931	0.989	1.086
Textiles and textile products	1.031	1.097	1.136	0.960	1.009	1.046
Leather and leather products	1.041	1.050	1.119	1.003	0.960	1.048
Wood and products of wood and cork (except furniture)	1.018	1.033	1.149	0.977	0.988	1.125
Pulp, paper and paper products; recorded media; printing services	0.997	1.029	1.122	0.943	0.980	1.039
Coke, refined petroleum products and nuclear fuel	1.182	1.214	1.131	1.083	1.149	1.006
Chemicals, chemical products and man-made fibres	1.001	1.075	1.188	0.936	0.969	1.070
Rubber and plastic products	1.003	1.044	1.095	0.977	0.997	1.037
Other on metallic mineral products	1.027	1.069	1.099	0.997	1.026	1.058
Basic metals and fabricated metal products	1.011	1.038	1.087	0.975	1.006	1.032
Machinery and equipment n.e.c.	1.012	1.044	1.094	0.968	0.999	1.040
Electrical and optical equipment	0.992	1.021	1.148	0.940	0.963	1.054
Transport equipment	1.020	0.990	1.132	0.976	0.957	1.096
Other manufactured goods n.e.c.	1.016	1.055	1.132	0.974	1.006	1.062

Source: Elaborations on Centrale dei Bilanci, Cerved.
Estimations of Average Total Factor Productivity per firm, by adopting the procedure of Levinsohn and Petrin. Period: 1995-2006.

Table3

Estimates of Agglomeration (A), Selection (S) and Dilation (D).
Urban areas: population > 200,000

Sectors	A *(s.e.)*	S *(s.e.)*	D *(s.e.)*	Obs. for non UA	Obs. for UA	R2
Food products, beverages and tobacco	0.111	0.012	1.143	1,826	1,200	0.967
	*(0.02)**	*(0.01)*	*(0.05)**			
Textiles and textile products	0.058	0.003	1.086	2,781	2,686	0.970
	*(0.01)**	*(0.01)*	*(0.03)**			
Leather and leather products	0.029	0.012	1.121	1,639	704	0.907
	*(0.01)**	*(0.01)*	*(0.07)*			
Wood and products of wood and cork (except furniture)	0.060	-0.002	1.013	872	508	0.937
	*(0.02)**	*(0.01)*	*(0.07)*			
Pulp, paper and paper products; recorded media; printing services	0.069	-0.003	1.150	994	1,735	0.966
	*(0.01)**	*(0.00)*	*(0.05)**			
Coke, refined petroleum products and nuclear fuel	-0.049	-0.006	1.191	60	87	0.895
	(0.30)	*(0.75)*	*(0.41)*			
Chemicals, chemical products and man-made fibres	0.107	0.007	1.160	521	966	0.922
	*(0.04)**	*(0.03)*	*(0.09)*			
Rubber and plastic products	0.047	0.012	1.058	1,288	1,193	0.912
	*(0.01)**	*(0.01)*	*(0.06)*			
Other on metallic mineral products	0.047	0.009	0.994	1,710	916	0.958
	*(0.01)**	*(0.01)*	*(0.05)*			
Basic metals and fabricated metal products	0.046	0.002	0.996	5,090	4,809	0.981
	*(0.00)**	*(0.00)*	*(0.02)*			
Machinery and equipment n.e.c.	0.049	0.000	1.045	2,917	3,261	0.983
	*(0.01)**	*(0.00)*	*(0.03)*			
Electrical and optical equipment	0.085	0,000	1.183	1,702	2,466	0.989
	*(0.01)**	*(0.00)*	*(0.04)**			
Transport equipment	0.045	0.007	1.061	701	767	0.929
	*(0.01)**	*(0.01)*	*(0.06)*			
Other manufactured goods n.e.c.	0.052	0.002	1.118	2,148	1,599	0.961
	*(0.01)**	*(0.01)*	*(0.04)**			

Source: elaborations on Centrale dei Bilanci, Cerved.
Estimations of Average Total Factor Productivity per firm, by adopting the procedure of Levinsohn and Petrin. Period: 1995-2006. The t statistics are obtained from 50 bootstrapped replications. *: for A and S significantly different from 0 at 5%, for D significantly different from 1 at 5%.

Table 4

Estimates of Agglomeration (A), Selection (S) and Dilation (D).
Urban areas: population > 500,000

Sectors	A *(s.e.)*	S *(s.e.)*	D *(s.e.)*	Obs. for non UA	Obs. for UA	R2
Food products, beverages and tobacco	0.136	0.004	1.158	2,444	600	0.970
	(0.11)	*(0.57)*	*(0.12)*			
Textiles and textile products	0.041	-0.001	1.193	4,635	842	0.889
	*(0.02)**	*(0.01)*	*(0.05)**			
Leather and leather products	0.046	0.015	1.109	1,854	480	0.891
	*(0.02)**	*(0.02)*	*(0.08)*			
Wood and products of wood and cork (except furniture)	0.112	-0.002	1.092	1,178	201	0.969
	*(0.04)**	*(0.06)**	*(0.14)*			
Pulp, paper and paper products; recorded media; printing services	0.089	-0.010	1.159	1,599	1,131	0.979
	*(0.01)**	*(0.01)*	*(0.05)**			
Coke, refined petroleum products and nuclear fuel	0.092	-0.252	0.916	87	48	0.791
	(0.32)	*(0.60)*	*(0.44)*			
Chemicals, chemical products and man-made fibres	0.135	-0.012	1.134	833	651	0.961
	*(0.04)**	*(0.04)*	*(0.09)*			
Rubber and plastic products	0.068	0.003	1.047	1,905	589	0.891
	*(0.02)**	*(0.02)*	*(0.08)*			
Other on metallic mineral products	0.042	0.011	1.069	2,219	399	0.925
	(0.03)	*(0.04)*	*(0.09)*			
Basic metals and fabricated metal products	0.055	0.001	1.069	7,616	2,293	0.948
	*(0.01)**	*(0.00)*	*(0.03)**			
Machinery and equipment n.e.c.	0.057	-0.001	1.107	4,572	1,611	0.973
	*(0.01)**	*(0.00)*	*(0.03)**			
Electrical and optical equipment	0.120	-0.001	1.157	2,612	1,560	0.988
	*(0.01)**	*(0.00)*	*(0.04)**			
Transport equipment	0.108	-0.003	1.028	989	483	0.911
	*(0.04)**	*(0.07)*	*(0.11)*			
Other manufactured goods n.e.c.	0.071	0.004	1.176	3,067	675	0.985
	*(0.03)**	*(0.05)*	*(0.10)*			

Source: elaborations on Centrale dei Bilanci, Cerved.
Estimations of Average Total Factor Productivity per firm, by adopting the procedure of Levinsohn and Petrin. Period: 1995-2006. The t statistics are obtained from 50 bootstrapped replications. *: for A and S significantly different from 0 at 5%, for D significantly different from 1 at 5%.

Table 5

Estimates of Agglomeration (A), Selection (S) and Dilation (D).
Urban areas: population density above the mean level

Sectors	A *(s.e.)*	S *(s.e.)*	D *(s.e.)*	Obs. for non UA	Obs. for UA	R2
Food products, beverages and tobacco	0.081	-0.002	1.116	1,216	1,836	0.967
	*(0.02)**	*(0.01)*	*(0.05)**			
Textiles and textile products	0.064	0.006	1.101	1,230	4,241	0.946
	*(0.01)**	*(0.01)*	*(0.04)**			
Leather and leather products	0.047	0.013	0.919	343	2,014	0.962
	*(0.02)**	*(0.01)*	*(0.07)*			
Wood and products of wood and cork (except furniture)	0.043	-0.010	1.049	581	793	0.881
	(0.02)	*(0.04)*	*(0.08)*			
Pulp, paper and paper products; recorded media; printing services	0.108	0.001	1.063	478	2,262	0.955
	*(0.02)**	*(0.02)*	*(0.08)*			
Coke, refined petroleum products and nuclear fuel	0.037	0.013	1.146	42	103	0.402
	(0.29)	*(0.93)*	*(0.42)*			
Chemicals, chemical products and man-made fibres	-0.012	0.128	1.423	235	1,223	0.782
	(0.09)	*(0.08)*	*(0.21)**			
Rubber and plastic products	0.072	0.009	0.970	660	1,833	0.948
	*(0.02)**	*(0.01)*	*(0.07)*			
Other on metallic mineral products	0.062	0.013	0.997	986	1,643	0.910
	*(0.02)**	*(0.01)*	*(0.06)*			
Basic metals and fabricated metal products	0.028	0.001	0.973	2,841	7,074	0.947
	*(0.01)**	*(0.00)*	*(0.02)*			
Machinery and equipment n.e.c.	0.027	-0.002	1.005	1,488	4,687	0.870
	*(0.01)**	*(0.00)*	*(0.03)*			
Electrical and optical equipment	0.822	0.011	1.189	943	3,221	0.965
	*(0.11)**	*(0.01)*	*(0.04)**			
Transport equipment	0.052	0.002	1.025	379	1,094	0.841
	*(0.02)**	*(0.04)*	*(0.10)*			
Other manufactured goods n.e.c.	0.038	0.005	1.057	1,251	2,497	0.861
	*(0.02)**	*(0.03)*	*(0.06)*			

Source: elaborations on Centrale dei Bilanci, Cerved.
Estimations of Average Total Factor Productivity per firm, by adopting the procedure of Levinsohn and Petrin. Period: 1995-2006. The t statistics are obtained from 50 bootstrapped replications. *: for A and S significantly different from 0 at 5%, for D significantly different from 1 at 5%.

Table 6

Estimates of Agglomeration (A), Selection (S) and Dilation (D).
Urban areas: population > 200,000, excluding LLMA with s'> 75th percentile

Sectors	A *(s.e.)*	S *(s.e.)*	D *(s.e.)*	Obs. for non UA	Obs. for UA	R2
Food products, beverages and tobacco	0.076	0.013	1.091	1346	671	0.905
	(0.08)	*(0.48)*	*(0.10)*			
Textiles and textile products	0.052	0.011	1.027	1975	1941	0.928
	*(0.01)**	*(0.01)*	*(0.04)*			
Leather and leather products	0.013	0.012	1.137	1229	310	0.796
	(0.02)	*(0.02)*	*(0.14)*			
Wood and products of wood and cork (except furniture)	0.037	-0.004	1.002	626	346	0.830
	(0.04)	*(0.13)*	*(0.11)*			
Pulp, paper and paper products; recorded media; printing services	0.035	-0.001	1.021	738	747	0.745
	*(0.02)**	*(0.01)*	*(0.07)*			
Coke, refined petroleum products and nuclear fuel	-0.048	0.081	1.102	42	31	0.159
	(0.29)	*(0.47)*	*(0.37)*			
Chemicals, chemical products and man-made fibres	0.018	0.060	1.164	374	375	0.891
	(0.04)	*(0.04)*	*(0.14)*			
Rubber and plastic products	0.030	0.012	1.011	887	731	0.869
	(0.02)	*(0.02)*	*(0.09)*			
Other on metallic mineral products	0.055	-0.000	0.916	1170	567	0.899
	(0.05)	*(0.23)*	*(0.10)*			
Basic metals and fabricated metal products	0.044	0.002	0.939	3689	3116	0.988
	*(0.00)**	*(0.00)*	*(0.03)**			
Machinery and equipment n.e.c.	0.031	0.003	1.000	2165	1970	0.950
	*(0.01)**	*(0.00)*	*(0.03)*			
Electrical and optical equipment	0.034	-0.001	1.066	1274	1157	0.887
	(0.02)	*(0.04)*	*(0.07)*			
Transport equipment	0.017	0.006	0.982	549	441	0.882
	(0.06)	*(0.21)*	*(0.16)*			
Other manufactured goods n.e.c.	0.026	-0.023	1.053	1602	1022	0.828
	(0.03)	*(0.07)*	*(0.10)*			

Source: elaborations on Centrale dei Bilanci, Cerved.
Estimations of Average Total Factor Productivity per firm, by adopting the procedure of Levinsohn and Petrin. Period: 1995-2006. The t statistics are obtained from 50 bootstrapped replications. *: for A and S significantly different from 0 at 5%, for D significantly different from 1 at 5%.

Table 7

Estimates of Agglomeration (A), Selection (S) and Dilation (D).
Urban areas: population > 200,000, excluding LLMA with s'> 90th percentile

Sectors	A (s.e.)	S (s.e.)	D (s.e.)	Obs. for non UA	Obs. for UA	R2
Food products, beverages and tobacco	0.091 *(0.07)*	0.007 *(0.19)*	1.110 *(0.09)*	1658	847	0.948
Textiles and textile products	0.050 *(0.01)**	0.003 *(0.01)*	1.039 *(0.04)*	2566	2172	0.923
Leather and leather products	-0.004 *(0.02)*	0.009 *(0.01)*	1.041 *(0.08)*	1518	511	0.920
Wood and products of wood and cork (except furniture)	0.033 *(0.02)*	0.001 *(0.04)*	1.029 *(0.09)*	786	400	0.932
Pulp, paper and paper products; recorded media; printing services	0.025 *(0.02)*	-0.006 *(0.01)*	1.058 *(0.06)*	915	915	0.942
Coke, refined petroleum products and nuclear fuel	0.009 *(0.25)*	-0.021 *(0.63)*	0.938 *(0.31)*	52	43	0.786
Chemicals, chemical products and man-made fibres	-0.001 *(0.04)*	0.053 *(0.03)*	1.203 *(0.13)*	438	439	0.852
Rubber and plastic products	0.022 *(0.02)*	0.009 *(0.01)*	1.056 *(0.06)*	1184	829	0.894
Other on metallic mineral products	0.048 *(0.02)**	0.004 *(0.01)*	0.982 *(0.06)*	1545	672	0.957
Basic metals and fabricated metal products	0.033 *(0.00)**	0.001 *(0.00)*	0.949 *(0.02)**	4602	3660	0.988
Machinery and equipment n.e.c.	0.032 *(0.01)**	0.002 *(0.00)*	1.013 *(0.03)*	2642	2303	0.981
Electrical and optical equipment	0.041 *(0.01)**	-0.001 *(0.01)*	1.066 *(0.05)*	1597	1394	0.978
Transport equipment	0.030 *(0.03)*	0.008 *(0.04)*	1.014 *(0.08)*	651	588	0.927
Other manufactured goods n.e.c.	0.027 *(0.02)*	-0.000 *(0.03)*	1.078 *(0.05)*	1960	1243	0.954

Source: elaborations on Centrale dei Bilanci, Cerved.
Estimations of Average Total Factor Productivity per firm, by adopting the procedure of Levinsohn and Petrin. Period: 1995-2006. The t statistics are obtained from 50 bootstrapped replications. *: for A and S significantly different from 0 at 5%, for D significantly different from 1 at 5%.

Table 8

Estimates of Agglomeration (A), Selection (S) and Dilation (D).
LLMA with better access to foreign markets: LMMA with a ratio between local employees in exporting plants and total employees > 0.2705 (the 75^ percentile of this variable across LMMA)

Sectors	A (s.e.)	S (s.e.)	D (s.e.)	Obs. for non UA	Obs. for UA	R2
Food products, beverages and tobacco	0.194	0.031	1.067	1,397	1,613	0.984

	*(0.02)**	*(0.02)**	*(0.06)*			
Textiles and textile products	0.062	0.008	0.922	1,986	3,477	0.937
	*(0.02)**	*(0.01)*	*(0.04)**			
Leather and leather products	0.121	0.012	1.020	678	1,674	0.952
	(0.07)	*(0.08)*	*(0.13)*			
Wood and products of wood and cork (except furniture)	0.087	0.020	0.892	454	917	0.967
	*(0.02)**	*(0.02)*	*(0.06)*			
Pulp, paper and paper products; recorded media; printing services	0.115	0.021	0.866	763	1,961	0.955
	*(0.02)**	*(0.02)*	*(0.04)**			
Coke, refined petroleum products and nuclear fuel	0.129	0.019	1.203	79	67	0.854
	(0.23)	*(0.25)*	*(0.38)*			
Chemicals, chemical products and man-made fibres	0.169	0.019	0.873	344	1,142	0.994
	*(0.03)**	*(0.01)*	*(0.06)**			
Rubber and plastic products	0.142	0.015	0.867	590	1,897	0.988
	*(0.02)**	*(0.01)*	*(0.05)**			
Other on metallic mineral products	0.149	0.015	0.784	1,097	1,529	0.975
	*(0.02)**	*(0.02)*	*(0.05)**			
Basic metals and fabricated metal products	0.102	0.026	0.930	2,494	7,355	0.986
	*(0.01)**	*(0.01)**	*(0.03)**			
Machinery and equipment n.e.c.	0.092	0.016	0.974	1,119	5,048	0.988
	*(0.01)**	*(0.01)**	*(0.03)*			
Electrical and optical equipment	0.106	0.003	0.884	1,077	3,093	0.964
	*(0.02)**	*(0.02)*	*(0.05)**			
Transport equipment	0.072	0.020	0.881	570	892	0.974
	*(0.02)**	*(0.01)*	*(0.05)**			
Other manufactured goods n.e.c.	0.102	0.004	0.874	1,017	2,733	0.920
	*(0.02)**	*(0.01)*	*(0.06)**			

Source: elaborations on Centrale dei Bilanci, Cerved.
Estimations of Average Total Factor Productivity per firm, by adopting the procedure of Levinsohn and Petrin. Period: 1995-2006. The t statistics are obtained from 50 bootstrapped replications. *: for A and S significantly different from 0 at 5%, for D significantly different from 1 at 5%. LMMA are defined in 2001.

Table 9

Estimates of Agglomeration (A), Selection (S) and Dilation (D).
Urban Areas: Italian provinces with population above the mean level (554,467 people)

Sectors	A *(s.e.)*	S *(s.e.)*	D *(s.e.)*	Obs. for non UA	Obs. for UA	R2
Food products, beverages and tobacco	0.065	-0.001	1.063	1377	1674	0.943
	(0.037)	(0.048)	(0.076)			
Textiles and textile products	-0.029	-0.001	1.035	2440	3035	0.923
	(0.009)	(0.004)	(0.031)			
Leather and leather products	0.008	0.032	1.134	1128	1197	0.881
	(0.015)	(0.018)	(0.071)			

Wood and products of wood and cork (except furniture)	0.061	0.010	0.937	645	730	0.970
	(0.018)*	(0.012)	(0.056)			
Pulp, paper and paper products; recorded media; printing services	0.066	-0.004	0.971	774	1958	0.900
	(0.016)*	(0.006)	(0.047)			
Coke, refined petroleum products and nuclear fuel	0.104	-0.009	1.269	51	96	0.894
	(0.247)	(0.361)	(0.422)			
Chemicals, chemical products and man-made fibres	0.056	0.056	1.221	365	1106	0.841
	(0.047)	(0.04)	(0.113)			
Rubber and plastic products	0.070	0.021	1.039	847	1635	0.962
	(0.018)*	(0.019)	(0.075)			
Other on metallic mineral products	0.024	0.014	1.056	1144	1482	0.915
	(0.014)	(0.008)	(0.044)			
Basic metals and fabricated metal products	0.044	0.008	1.020	3477	6412	0.934
	(0.005)*	(0.004)	(0.02)			
Machinery and equipment n.e.c.	0.042	0.001	1.007	2160	4020	0.962
	(0.006)*	(0.004)	(0.029)			
Electrical and optical equipment	0.081	0.002	1.072	1224	2945	0.968
	(0.011)*	(0.005)	(0.041)			
Transport equipment	0.047	0.010	1.024	518	950	0.908
	(0.026)	(0.034)	(0.084)			
Other manufactured goods n.e.c.	0.018	0.010	1.030	1742	1995	0.951
	(0.009)	(0.006)	(0.037)			

Source: elaborations on Centrale dei Bilanci, Cerved.
Estimations of Average Total Factor Productivity per firm, by adopting the procedure of Levinsohn and Petrin. Period: 1995-2006. The t statistics are obtained from 50 bootstrapped replications. *: for A and S significantly different from 0 at 5%, for D significantly different from 1 at 5%. LMMA are defined in 2001.

Table 10

Estimates of Agglomeration (A), Selection (S) and Dilation (D).
Urban Areas: Italian provinces with population density above the mean level (242.12)

Sectors	A *(s.e.)*	S *(s.e.)*	D *(s.e.)*	Obs. for non UA	Obs. for UA	R2
Food products, beverages and tobacco	0.126	0.001	1.042	1722	1329	0.985
	(0.018)*	(0.006)	(0.038)			
Textiles and textile products	0.050	0.014	1.036	1878	3573	0.936
	(0.009)*	(0.007)*	(0.032)			
Leather and leather products	0.032	0.017	1.056	1149	1192	0.910
	(0.015)*	(0.015)	(0.058)			
Wood and products of wood and cork (except furniture)	0.066	0.003	0.944	707	672	0.929
	(0.019)*	(0.03)	(0.071)			
Pulp, paper and paper products; recorded media; printing services	0.093	-0.004	1.009	833	1899	0.912
	(0.015)*	(0.006)	(0.043)			
Coke, refined petroleum products and nuclear fuel	0.049	-0.017	1.210	63	83	0.781

	(0.258)	(0.506)	(0.428)			
Chemicals, chemical products and man-made fibres	0.105	0.011	1.091	398	1088	0.883
	(0.056)	(0.051)	(0.126)			
Rubber and plastic products	0.076	0.020	0.991	942	1537	0.943
	(0.015)*	(0.014)	(0.055)			
Other on metallic mineral products	0.060	0.019	0.991	1525	1088	0.971
	(0.015)*	(0.011)	(0.049)			
Basic metals and fabricated metal products	0.053	0.013	0.997	4202	5660	0.971
	(0.005)*	(0.004)*	(0.023)			
Machinery and equipment n.e.c.	0.046	-0.002	1.005	2526	3652	0.960
	(0.008)*	(0.004)	(0.025)			
Electrical and optical equipment	0.093	0.007	1.144	1341	2825	0.968
	(0.011)*	(0.006)	(0.034)*			
Transport equipment	0.061	0.011	1.046	594	873	0.971
	(0.018)*	(0.01)	(0.062)			
Other manufactured goods n.e.c.	0.043	0.007	1.005	1722	2019	0.909
	(0.01)*	(0.006)	(0.04)			

Source: elaborations on Centrale dei Bilanci, Cerved.
Estimations of Average Total Factor Productivity per firm, by adopting the procedure of Levinsohn and Petrin. Period: 1995-2006. The t statistics are obtained from 50 bootstrapped replications. *: for A and S significantly different from 0 at 5%, for D significantly different from 1 at 5%. LMMA are defined in 2001.

Appendix

Appendix a1

The proof of point 1 directly follows from the definition of A_i, A_j, D_i and D_j, when $\delta < 1$.

The proof of point 2 is more involved. First suppose that $G(h) = \left(\frac{h}{h_M}\right)^k$, where h_M is the upper bound of the support of the realization of h. Equation (6) can now be rewritten as:

$$\upsilon(\bar{h}_1(N_1), \tau) = \frac{s(N_1) + K}{N_1} \quad where \quad K = N_2 \upsilon(\bar{h}_2, \tau) - s(N_2)$$

Differentiating with respect to N_1 we obtain:

$$\frac{\upsilon(\bar{h}_1(N_1), \tau)}{\partial \bar{h}_1} \frac{d\bar{h}_1}{dN_1} = \frac{s'(N_1)N_1 - s(N_1)}{(N_1)^2} - \frac{K}{(N_1)^2}$$

And hence given that $\frac{\upsilon(\bar{h}_1(N_1), \tau)}{\partial \bar{h}_1} > 0$ and the quantity $\frac{K}{(N_1)^2}$ tends to zero for N_1 sufficiently large, it follows that:

$$\frac{d\bar{h}_1}{dN_1} \geq 0 \quad iff \quad \frac{s'(N_1)N_1 - s(N_1)}{(N_1)^2} \geq 0 \quad or \quad s'(N) \geq \frac{s(N)}{N}$$

Furthermore, we show that the condition for selection we found in Proposition 1 for a Pareto distribution also holds for a generic cumulative distribution $G(h)$ and for an R-region economy.

Assume that the economy is divided into R regions (*R*>*2*), that the entry cost function is continuous, increasing and twice differentiable w.r.t. *N* and with s'>0 and S">0. We prove the following proposition.

Proposition A1

In a R-region economy with asymmetric entry costs and positive trade costs, the equilibrium cutoff levels will change in response to a change in the market size in market 1 (the largest market) as follows:

a) for market 1:

$$\frac{d\bar{h}_1}{dN_1} > 0 \quad iff \quad s'(N_1) > \Phi_1$$

where it will be shown later that Φ_1 is positive whatever the equilibrium solutions in terms of the cut-offs are.

b) for market j (j ≠1) :

$$\frac{d\bar{h}_j}{dN_1} < 0 \quad iff \quad s'(N_1) > \Phi_0 \quad (j = 2,...,R)$$

c) Moreover, it can be shown that:

$$\Phi_1 > \Phi_0$$

d) Finally, under the assumption of symmetric and constant trade costs, we obtain:

$$\frac{d\bar{h}_1}{dN_1} = \Phi_{1s}$$

where Φ_{1s} will be negative for all the equilibrium solutions.

<u>Proof A1a</u>

Rewrite the free entry conditions for our case:

$$\frac{N_1}{4\gamma}\int_0^{\bar{h}_1}(\bar{h}_1 - h)^2 g(h)dh + \frac{N_2}{4\gamma}\int_0^{\bar{h}_2/\tau}(\bar{h}_2 - \tau h)^2 g(h)dh + ... + \frac{N_R}{4\gamma}\int_0^{\bar{h}_R/\tau}(\bar{h}_R - \tau h)^2 g(h)dh = s(N_1)$$

....

$$\frac{N_j}{4\gamma}\int_0^{\bar{h}_j}(\bar{h}_j - h)^2 g(h)dh + \frac{N_1}{4\gamma}\int_0^{\bar{h}_1/\tau}(\bar{h}_1 - \tau h)^2 g(h)dh + ... + \frac{N_R}{4\gamma}\int_0^{\bar{h}_R/\tau}(\bar{h}_R - \tau h)^2 g(h)dh = s(N_2)$$

....

$$\frac{N_R}{4\gamma}\int_0^{\bar{h}_R}(\bar{h}_R - h)^2 g(h)dh + \frac{N_1}{4\gamma}\int_0^{\bar{h}_1/\tau}(\bar{h}_1 - \tau h)^2 g(h)dh + ... + \frac{N_{R-1}}{4\gamma}\int_0^{\bar{h}_{R-1}/\tau}(\bar{h}_{R-1} - \tau h)^2 g(h)dh = s(N_R)$$

Assume that an equilibrium for this economy does exist and totally differentiate equations above w.r.t. N_1:

$$\left[2N_1\int_0^{\bar{h}_1}(\bar{h}_1-h)g(h)dh\right]d\bar{h}_1+\left[\frac{2N_2}{\tau}\int_0^{\frac{\bar{h}_2}{\tau}}(\bar{h}_2-\tau h)g(h)dh\right]d\bar{h}_2+\ldots+\left[\frac{2N_R}{\tau}\int_0^{\frac{\bar{h}_R}{\tau}}(\bar{h}_R-\tau h)g(h)dh\right]d\bar{h}_R=s'(N_1)4\gamma dN_1-\left[\int_0^{\bar{h}_1}(\bar{h}_1-h)^2g(h)dh\right]dN_1$$

$$\left[\frac{2N_1}{\tau}\int_0^{\frac{\bar{h}_1}{\tau}}(\bar{h}_1-\tau h)g(h)dh\right]d\bar{h}_1+\left[2N_2\int_0^{\bar{h}_2}(\bar{h}_2-h)g(h)dh\right]d\bar{h}_2+\ldots+\left[\frac{2N_R}{\tau}\int_0^{\frac{\bar{h}_R}{\tau}}(\bar{h}_R-\tau h)g(h)dh\right]d\bar{h}_R=-\left[\int_0^{\frac{\bar{h}_1}{\tau}}(\bar{h}_1-\tau h)^2g(h)dh\right]dN_1$$

$$\ldots$$

$$\left[\frac{2N_1}{\tau}\int_0^{\frac{\bar{h}_1}{\tau}}(\bar{h}_1-\tau h)g(h)dh\right]d\bar{h}_1+\left[\frac{2N_2}{\tau}\int_0^{\frac{\bar{h}_2}{\tau}}(\bar{h}_2-\tau h)g(h)dh\right]d\bar{h}_2+\ldots+\left[2N_R\int_0^{\bar{h}_R}(\bar{h}_R-h)g(h)dh\right]d\bar{h}_R=-\left[\int_0^{\frac{\bar{h}_1}{\tau}}(\bar{h}_1-\tau h)^2g(h)dh\right]dN_1$$

Now rewrite the system in matrix notation as follows:

$$\begin{pmatrix} a_1+d_1 & a_j & a_R \\ a_1 & & \\ & a_j+d_j & \\ & & \\ a_1 & a_j & a_R+d_R \end{pmatrix}\begin{pmatrix} d\bar{h}_1 \\ \\ d\bar{h}_j \\ \\ d\bar{h}_R \end{pmatrix}=\begin{matrix} [s'(N_1)4\gamma-z]dN_1 \\ -ldN_1 \\ -ldN_1 \\ \\ -ldN_1 \end{matrix}$$

or in a more compact way:

$$(D+ia')x=y$$

where:

$$d_j=\int_0^{\bar{h}_j}(\bar{h}_j-h)g(h)dh-\int_0^{\bar{h}_j/\tau}(\bar{h}_j-\tau h)^2g(h)dh \quad and\ a_j=\int_0^{\bar{h}_j/\tau}(\bar{h}_j-\tau h)^2g(h)dh$$

$$D=diag(d_1,d_2,\ldots,d_R)\quad and\ d_j>0\quad a'=(a_1,\ldots,a_R)\quad and\ a_j>0\quad i'=(1,\ldots 1)$$

and

$$x'=(d\bar{h}_1,\ldots,d\bar{h}_R)\quad and\quad y'=([s'(N_1)4\gamma-z]dN_1,-ldN_1\ldots,-ldN_1)$$

$$z=\left[\int_0^{\bar{h}_1}(\bar{h}_1-h)^2g(h)dh\right]\quad and\quad l=\left[\int_0^{\frac{\bar{h}_1}{\tau}}(\bar{h}_1-\tau h)^2g(h)dh\right]$$

Notice that d_j and a_j are the j^{th} elements of the vectors *d* and *a* respectively while *z* and *l* are two scalars. It can be easily proofed that the *d*'s are always positive.

After some algebra, it can be shown that the solutions are:

$$x = (D + ia')^{-1} y = \left(\left[-l - \frac{a_1}{d_1}(s'(N_1)4\gamma - z + l) \right] t + \frac{(1 + a't)}{d_1}(s'(N_1)4\gamma - z + l)e_1 \right) \frac{dN_1}{1 + a't}$$

where $t' = (1/d_1, ..., 1/d_R)$ *and* $e_1 = (1,0,...,0)$.

Although this expression is quite involved, it can be used to obtain the sign of the first element of vector *x* and for a generic *j* element (the latter are all the same).

Consider the first element of vector of solutions *x* and observe that the term outside the big parentheses is always positive, then the sign of x_1 will depend on the term within the parentheses. After some tedious but straightforward computations we can obtain the following condition:

$$\frac{d\bar{h}_1}{dN_1} > 0 \quad iff \quad s'(N_1) > \frac{[d_1(1 + a't) - a_1]z - [d_1(a't) - a_1]l}{4\gamma[d_1(1 + a't) - a_1]} = \Phi_1 > 0$$

where both the numerator and the denominator of Φ_1 can be proved to be always positive whatever the equilibrium solutions are.

Proof A1b

Consider an element *j* of the vector *x* with *j* different from 1, it is easy to show that :

$$\frac{d\bar{h}_j}{dN_1} < 0 \quad for \quad s'(N_1) > \frac{a_1 z - l(1 + d_1)}{4\gamma a_1} = \Phi_0 \quad \forall j \neq 1$$

Notice that this condition is the same across the different markets and does not depend on the number of regions considered.

Proof A1c

To show that $\Phi_1 > \Phi_0$, compare directly the two:

$$\frac{[d_1(1+a't)-a_1]z-[d_1(a't)-a_1]l}{4\gamma[d_1(1+a't)-a_1]} > \frac{a_1 z-(1+d_1)l}{4\gamma a_1}$$

$$z-\frac{[d_1(a't)-a_1]l}{[d_1(1+a't)-a_1]} > z-\frac{(1+d_1)l}{a_1}$$

$$-\frac{-a[d_1(a't)_1]}{[d_1(1+a't)-a_1]} > -\frac{(1+d_1)}{a_1}$$

$$a_1[a_1-d_1(a't)] < (1+d_1)[d_1(1+a't)-a_1]$$

The last inequality is always satisfied given that the second expression on the left hand side is always negative and all the other terms on both sides of the inequality are positive.

<u>Proof A1d</u>

It immediately follows from the solutions to the free entry condition system of equations in the case of symmetric entry costs.

<u>Corollary Proposition A1</u>

Now let us start from an equilibrium where even in the case of asymmetric entry costs solutions are such to obey to the ordering of markets in terms of the intensity of selection effects as represented by Combes et al (2010) in the case of symmetric entry costs ie :

$$N^*{}_1 > N^*{}_2 > \ldots > N^*_{R-1} > N^*_R \text{ implies } \bar{h}_1 < \bar{h}_2 < \ldots < \bar{h}_{R-1} < \bar{h}_R$$

Let us perturb these equilibrium conditions by increasing N_I. From propositions A1 a and b, we know that $\bar{h}_1$ will increase and $\bar{h}_j$ will decrease as a reaction to the shock, provided $s'(N_1) > \Phi_1$. How can we guarantee that by continuously increasing market size in region 1 we can end up with an equilibrium where the ranking in terms of the intensity of the selection effect is perverted, ie where $\bar{h}_1 > \bar{h}_2$? Consider the previous assumptions about *s(N)* and add the following condition:

$$s''(N_1) > \frac{d\Phi_1}{dN_1} > \frac{d\Phi_0}{dN_1} \quad for \quad N_1 \geq N_1^*$$

Under these additional assumptions, $\bar{h}_1$ will augment while $\bar{h}_j$ will keep on decreasing, thereby leading to an equilibrium solution where $\bar{h}_1 > \bar{h}_2$.

A clear cut implication deriving from proposition A1 is that whatever the equilibrium solutions for the cutoffs, there will always exist a threshold level such that when the slope of the entry cost function is below it, an increase in market size will have a pro-competitive effect (i.e. it will increase the toughness of competition and lower the cutoffs). On the contrary, when $s'(N_1)$ will be above that threshold, an augmented market size will allow more inefficient firms to survive to market competition (i.e. it will induce less selection and hence higher cutoffs).

Moreover the cut-offs in the large and in the small market will be affected in opposite directions by an increase in market size. Specifically, the one in the large market will augment implying a less intense competition while the one in the small market will decrease leading to tougher competition. Finally under the additional conditions described above, an implication of this result is that if we start from an equilibrium in which $\bar{h}_1 < \bar{h}_2$ and there is an increase in market size for the large market, then the new resulting equilibrium may end with $\bar{h}_1 > \bar{h}_2$ provided the slope of the entry cost function is sufficiently large.

Appendix a2

As before, the proof of point 1 directly follows from the definition of A_i, A_j, D_i and D_j, when $\delta < 1$. The selection effect will take place instead at macroregion level. This implies that for the two regions eq. (3) can be written as follows:

$$\frac{P_1}{4\gamma}\int_0^{\bar{h}_1}(\bar{h}_1 - h)^2 g(h)dh + \frac{P_2}{4\gamma}\int_0^{\bar{h}_2/\tau}(\bar{h}_2 - \tau h)^2 g(h)dh = s$$
$$\frac{P_2}{4\gamma}\int_0^{\bar{h}_2}(\bar{h}_2 - h)^2 g(h)dh + \frac{P_1}{4\gamma}\int_0^{\bar{h}_1/\tau}(\bar{h}_1 - \tau h)^2 g(h)dh = s$$

Subtracting these two equation we obtain:

$$P_1\upsilon(\bar{h}_1,\tau) = P_2\upsilon(\bar{h}_2,\tau).$$

Since $P_1 > P_2$, it must hold that $\upsilon(\bar{h}_1,\tau) < \upsilon(\bar{h}_2,\tau)$. Note, however that $\frac{\partial\upsilon(z,\tau)}{\partial z} = 2\left[(\tau-1)\int_0^{z/\tau} hg(h)dh + \int_{z/\tau}^{z}(z-h)g(h)dh\right] > 0$, this implies that $\bar{h}_1 < \bar{h}_2$.

Appendix a3

This Appendix describes the method we adopted to produce an estimate for the $s(N)$ function. Data on land prices are obtained from the Italian Land Registry Office ("Agenzia del Territorio" - AdT). The AdT reports information on house prices by type of house (villas and cottages, mansions, economic houses, typical houses, establishments), and the state of the building (poor, normal, excellent) and for industrial establishments in each Italian municipalities. We focus on the value for squared meters of establishments in a normal state. All data are aggregated at Local Labor Market (LLM) level by using population weights for each municipality within LLM. Each data-point represents the 2003-2005 average of the LLM value. This leaves us with 784 observations.

We estimate the following equation:

$$\ln(P_{LLM}) = f[\ln(POP_{LLM})] + \varepsilon \qquad \text{(A3.1)}$$

Where P_{LLM} is the average price level (in Euro) for buying an industrial establishments in the LLM for the period 2003-2005, POP_{LLM} is its population, and $f[\cdot]$ is an unknown function.

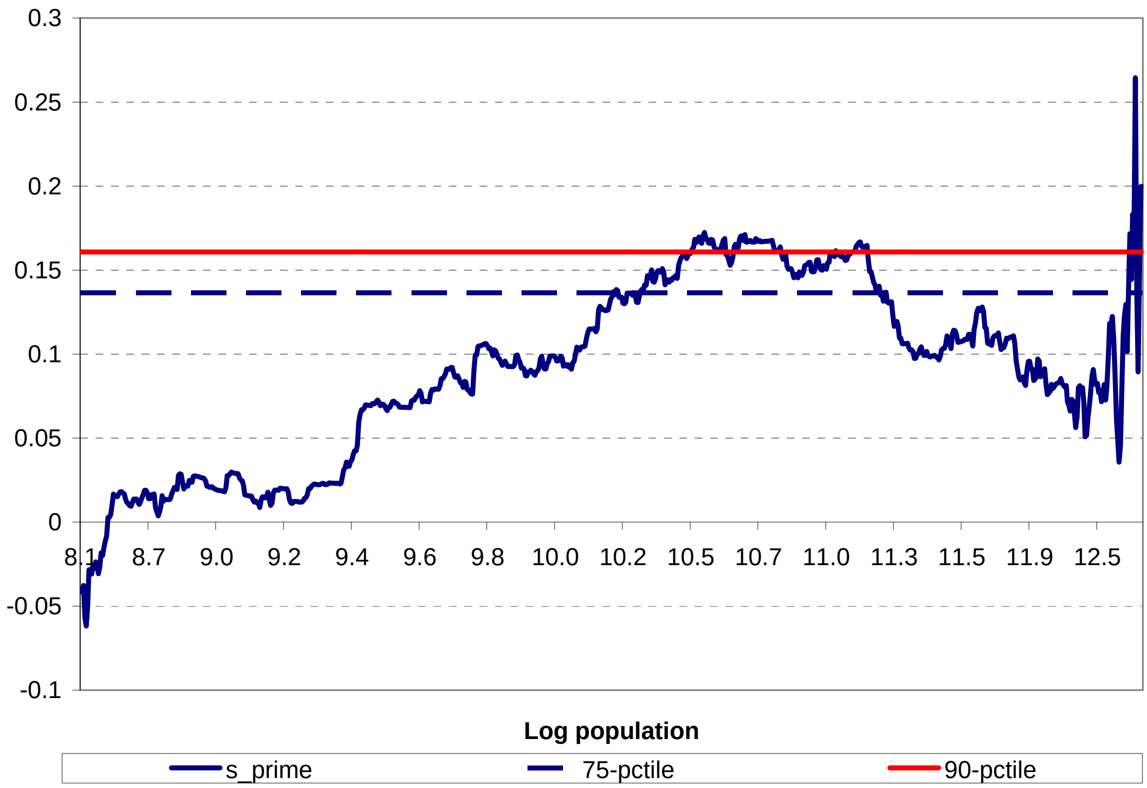
$f[\cdot]$ is estimated by using a kernel local polynomial smoothing (Epanechnikov kernel).

The fitted value of equation (A3.1) are used to calculate the values for $s(N)$ and s' employed in the empirical part. In particular, $s(N)$ is the value of the fitted prices, while s' is calculated as the Newton's difference quotient: $s'(N_{LLM}) = \frac{s(N_{LLM+1}) - s(N_{LLM})}{N_{LLM+1} - N_{LLM}}$.

Results of the estimates for $s'(N)$ are in figure A3.1, where the solid line represents our estimate for the $s'(N)$ function and the two horizontal lines represent the 75th and 90th percentile of the $s'(N)$ distribution.

Fig. A3.1

***S'(N)* FUNCTION**



Source: Authors' calculations on AdT data.

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