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MAPPING LOCAL PRODUCTIVITY ADVANTAGES IN ITALY: INDUSTRIAL DISTRICTS, CITIES OR BOTH?

by Valter Di Giacinto*, Matteo Gomellini*, Giacinto Micucci* and Marcello Pagnini*

Abstract

We compare the magnitude of local productivity advantages associated with two different spatial concentration patterns in Italy – urban areas and industrial districts. The former have high population density and host a wide range of economic activities, while the latter are marked by a high concentration of small firms producing relatively homogenous goods. Using data from a large sample of Italian manufacturing firms observed over the 1995-2006 period, we detect local productivity advantages for both urban areas and industrial districts. However, firms located in urban areas reap a larger productivity premium than those operating within districts. The advantages of industrial districts have declined over time; those of urban areas have remained stable. Differences in the composition of firm employees between white- and blue-collars explain a small fraction of the urban productivity premium. The quantile regressions show how more productive firms gain larger benefits by locating in urban areas. Our analysis raises the question of whether Italian industrial districts are less fit than urban areas to prosper in a world characterized by advancing globalization and the growing use of ICT.

JEL Classification: C52, D24, R12.
Keywords: urban areas, industrial districts, agglomeration economies, productivity, white- and blue-collars, Italian economy.

Contents

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1. Introduction[1]

The forces driving spatial agglomeration manifest themselves in different ways even within the same country or sector of economic activity. Urban areas typically have high population density, a wide range of economic activities, including a highly diversified service sector, and extensive local amenities coupled with high congestion costs. Industrial clusters or districts, instead, are usually located outside of urban areas, show a high concentration of small firms producing relatively homogenous goods and, albeit in a different way, may also be affected by congestion (for surveys of the empirical literature on agglomeration economies, see Rosenthal and Strange, 2004, and Melo, Graham and Noland, 2009).

In this paper we address several questions concerning these two spatial concentration patterns with regard to the Italian economy: i) Are plants located in urban areas and industrial districts more productive than firms located elsewhere? ii) Are the local productive advantages in the two spatially concentrated areas comparable in magnitude? iii) How have these advantages changed in recent years?

Answering the first question may shed light on the mechanisms that generate agglomeration economies, a long-debated issue in the literature. The second question is relatively new and especially relevant in the context of the Italian economy. Finally, the third question aims at documenting how the comparative advantages of urban areas and industrial districts have evolved in the new environment shaped by increasing competition from newly industrialized countries and the advent of information and communication technologies (Glaeser and Ponzetto, 2010).

The empirical literature on agglomeration economies has usually addressed similar questions by regressing average productivity across areas on a series of explanatory variables including local market size, usually proxied by population or population density, the sectoral diversification of the local economy, its relative specialization in a specific sector and the share of small firms. In this context, positive partial correlation between productivity and market size or diversity is usually interpreted as evidence that urbanization is responsible for agglomeration economies, while a positive coefficient for the specialization indicator or the share of small

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firms is taken as a signal that spatial clustering in the industrial districts is the main driver of the local productivity advantages.

In this paper we take a slightly different route by mapping the Italian territory into three non-overlapping areas: a) urban areas, defined as locations with a population above a certain threshold; b) industrial districts, identified through a complex algorithm that will be defined later in the paper; and c) other locations. We then measure average local productivity differentials by regressing firm-level indicators of productive efficiency on UA and ID dummies plus a set of controls.[2]

Apart from permitting a straightforward comparison of the magnitudes of productivity gains associated with industrial districts and urban areas, the advantages of this empirical strategy are manifold. Good proxies for the positive externalities associated with urban areas are usually difficult to devise and are in any case related to the fact that the local population has to be above a certain threshold for these agglomeration forces to produce their effects (this consideration equally applies to negative externalities, namely congestion effects). The identification of industrial districts is also quite complex. In Italy, an official definition of industrial district is produced by the National Statistical Institute (Istat) as the outcome of a multi-step algorithm. Since mimicking that algorithm in a regression analysis using a set of continuous variables would be both demanding and inefficient, we chose to summarize the complex structural characteristics of Italian industrial districts by means of a dummy variable that singles out the local labor markets classified as districts in Istat's taxonomy.

For our inquiry we use a panel of 29,000 Italian manufacturing firms observed over the period 1995-2006. Our main findings are the following: The two different spatial concentration patterns associated with urban areas and industrial districts are both able to generate local productivity advantages; however, the advantages are greater in urban areas. Moreover, comparative advantages in cities remained stable over the period 1995-2006, while those in the industrial districts declined. In addition, productivity advantages persist in urban areas even controlling for differences in workforce composition. Blue-collar workers are more productive in industrial districts, while white-collar workers, whose role in upgrading production is increasingly important, show higher productivity in urban areas. Finally, a quantile regression is used to show that in industrial districts there is a stronger positive impact on the lower tail of the TFP distribution, while urban areas benefit more firms belonging to the upper tail. Several

[2] For a survey of recent empirical work on productivity differentials across firms, see Syverson (2010).

shocks – the introduction of the euro, the rapid diffusion of ICT and growing globalization – affected the Italian economy at the turn of the century. Our results suggest that urban areas responded more effectively than industrial districts to those developments.

The rest of the paper is organized as follows. Section 2 presents a brief review of literature investigating the importance of agglomeration effects for firms' productivity. Sections 3 and 4 discuss, respectively, the territorial level of analysis and the data. Section 5 reports the TFP estimation. Section 6 analyses the impact of spatial concentration on firms' TFP. In Section 7 several extensions to the baseline results are proposed including the effects of human capital heterogeneity on firms' productivity. Section 8 concludes.

2. Industrial districts and urban areas as sources of local productivity advantages

Spatial concentration may generate local productivity advantages through different mechanisms. Agglomeration economies in the form of technical or knowledge spillovers, labor market pooling and proximity to local buyers or sellers may increase the productivity of firms located in densely populated areas. In addition, recent studies point to a mechanism based on selection: large markets attract more entrants, thereby fostering competition and inducing less efficient firms to exit the local market.[3] Finally, other contributions stress the sorting of firms or workers.[4] Ex ante heterogeneous firms may differ in their ability to exploit local productivity advantages; for instance, less efficient firms may avoid the harshness of competition by locating in less dense areas, while large and more productive firms may be better able to exploit the benefits of different kinds of agglomeration economies.

Urban areas and industrial districts are examples of geographical concentration with different characteristics. The question we want to address is whether and to what extent these differences will be reflected in the strength of local productivity advantages generated by the two environments.

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[3] For this class of models see Melitz (2003) and Melitz and Ottaviano (2008). Syverson (2004a) analyses the effects of local market size on productivity and firm selection in the special case of the concrete industry, where transport costs are significant. Syverson (2004b) and Del Gatto, Ottaviano and Pagnini (2008) investigate how selection effects vary across different industries in response to a set of their characteristics (elasticity of demand, openness to trade). Their implicit assumption is that markets in many branches of manufacturing are integrated through domestic trade.

[4] The fast-growing literature on sorting focuses mainly on workers; see Combes, Duranton and Gobillon (2008) for France, and Matano and Naticchioni (2011) for Italy. For the theoretical literature on firm sorting, see also Baldwin and Okubo (2006) and Okubo, Picard and Thisse (2010). Nocke (2006) pursues a similar line of research, starting out, however, from the tenets of oligopoly theory.

In the view of some scholars, Italy's industrial boom after the Second World War was triggered by the growth of industrial districts, areas with a high concentration of small firms cooperating along the production chain of a unique final good.[5] Industrial districts usually have a strong specialization in manufacturing, and the district "community" may also include local institutions, political parties, associations and local banks.

Urban areas, with their high population density, attract a diversified set of activities, including transport, recreational and other services. This also stimulates the production of local amenities (cultural activities) and disamenities (pollution and so on).

Given these characteristics, it is likely that both urban areas and industrial districts will be able to generate some agglomeration economies. An important question is whether these will be produced by the interactions of firms and workers within the same industry (Marshall externalities) or, alternatively, belonging to different industries (Jacob externalities). Quite clearly, Marshall externalities are typical of industrial districts, while Jacob externalities are more likely to arise in urban areas.

To avoid the paradoxical outcome of an economy concentrated in just one type of region, these local productivity advantages have to be traded off against other factors whose nature depends on the kind of the production process and that may induce firms to locate outside industrial districts and urban areas. Congestion costs, for instance, can lead to resource mismanagement within a firm, thereby lowering production efficiency in cities.[6] Although industrial districts can save on congestion costs thanks to their specialization in a specific industry, they can still be exposed to the problems caused by the crowding of firms and workers in a relatively small area. Moreover, their productivity advantages can diminish when indivisibilities are important. In those circumstances, the network externalities generated within industrial districts are weak and production tasks can be more efficiently performed within large and hierarchical organizations. Finally, these sources of local comparative advantages may change over time because of the evolution of technology or changes in the domestic or international competitive environment (liberalizations and so on).

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[5] Becattini (1990) provides a conceptualization of the industrial district, defining it as a socio-territorial entity characterized by the active presence of both a community of people and a population of firms in one naturally and historically bounded area. Thus, an economic definition of the industrial district that aims to be comprehensive will have to include both the network of links between firms and the above mentioned social conditions. For a recent survey and empirical analysis on Italian districts, see Iuzzolino and Micucci (2011).

[6] Moreover, they can push up local land prices, so that firms whose production is land-intensive will be induced to locate outside urban areas.

As for the selection effects and sorting, it is difficult to say a priori whether they will be stronger in industrial districts and urban areas. We will discuss them in Section 7.

The empirical literature on the sources of local productivity advantages analyses the effects of urban areas mainly through the size of the local market. A positive correlation between market size and productivity is usually interpreted as evidence that cities promote production efficiency. Doubling city size would increase productivity by between 3 and 8 per cent, depending on the study and the country considered.[7] As far as we know, no paper has estimated that elasticity for Italy. The contribution that comes closest is that of Cingano and Schivardi (2005), who show that moving from the first to the third quartile of city-size distribution would increase the annual growth of total factor productivity (TFP) by 0.6 per cent for a sample of Italian manufacturing firms.

Whereas the contributions referring to other countries emphasize urban effects, the empirical literature in Italy has focused mainly on the productivity advantages associated with industrial districts.[8] In particular, Signorini (1994; see Table 1), using data for the provinces of Prato and Biella, finds that firms in districts have higher per capita value added. Fabiani et al. (2000) extend the analysis to all of Italy, showing that between 1982 and 1995 district firms outperformed non-district firms. In 1995, district firms' return on investment was higher by 2 percentage points and their return on equity by 4.1 points. Value added per worker was 1.3 per cent higher on average in district firms. Furthermore, district firms were less inefficient than non-district firms in 8 out of the 13 sectors considered.[9]

Cainelli and De Liso (2005) estimate the effects of clustering of the firms in districts on productivity. Disentangling process and product innovation, they trace most of the productivity advantages for district firms to the latter. They find that the district effect, measured as the differential in value added growth rates, ranges between 2.0 and 2.6 percentage points.

Cingano and Schivardi (2005) offer indirect evidence of a positive district effect by showing that increasing local sectoral specialization (a characteristic associated with industrial

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[7] Rosenthal and Strange (2004). See also Melo, Graham and Noland (2009) for a survey of this literature and for a meta-analysis of the relation between productivity and city size.

[8] For a short review of the papers assessing industrial district advantages, see the list in Table 1.

[9] The authors use a stochastic frontier approach to measure inefficiency. They define technical inefficiency as "the failure to produce the maximum possible output for any chosen combinations of inputs", including "the inefficiency arising from the managerial and organisational structure and the socio-economic environment in which firms operate". Fabiani et al., (2000), p. 58.

districts) would raise local TFP growth by between 0.2 and 0.5 per cent, depending on the specification adopted (according with their results TFP growth is enhanced by specialization and city size but not by urban diversity). Despite this nearly unanimous agreement, the most recent studies have shown that districts' localization advantages are diminishing (as globalization reduces district externalities). Examining the internal features of industrial districts, major recent structural changes can affect their evolution in the future.[10] Foresti, Guelpa and Trenti (2009) use balance sheet indicators for a wide sample of manufacturing firms (unbalanced panel) over the period 1991-2006. Controlling for different characteristics (e.g. sectoral specialization, size) they find signs of a fading of the district effect from the late 1990s onwards.

3. Industrial districts and urban areas in Italy: definitions and structural differences

To assess the existence of local productivity advantages, it is necessary first to map industrial districts and urban areas. In Italy, industrial districts are officially defined by Istat using a multistep algorithm. Although this method is not without flaws, it rapidly became a sort of benchmark for assessing the so-called industrial district premium, i.e. the productivity gain associated with being located in an industrial district. Here we will then describe the methodology used to define these areas.

The starting point is the data on daily commuting flows from place of residence to place of work available for Italy's 8,100 municipalities. Contiguous municipalities are then aggregated into larger areas called Local Labor Market Areas (LLMAs) using a procedure that maximizes labor mobility within these areas and minimizes it between them. This procedure was used to map the Italian territory into 784 LLMAs in 1991 (686 in 2001).[11] Notice that LLMA's represent an ideal partition to analyze many agglomeration effects since 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 (more on this below).

Industrial districts are defined as LLMAs that satisfy the following conditions:

[10] On the districts' structural evolution, see also Carabelli, Rabellotti and Hirsch (2009).

[11] We conduct our empirical analysis on the basis of the 1991 map, which allows us to use a classification that is predetermined with respect to the sample period. This reduces simultaneity problems, due to possible feedback effects from local productivity dynamics on the likelihood that a LLMA is classified as an industrial district. However, using the 2001 map does not basically affect our main results.

a) specialization in the manufacturing sector, i.e. $l_a = \frac{(x_{am}/x_a)}{(x_{\bullet m}/x_{\bullet\bullet})} > 1$ where x_{am} denotes the number of employees in area *a* and in all the local manufacturing industries, x_a denotes total employment (including in services and construction) in the area, and $x_{\bullet m}, x_{\bullet\bullet}$ are the corresponding figures at national level.

b) $s_a = \frac{(x_{am}^{small}/x_{am})}{(x_{\bullet m}^{small}/x_{\bullet m})} > 1$ where the upper index "small" indicates the number of employees in small and medium-sized enterprises.

c) Let $l_{as} = \frac{(x_{as}/x_{am})}{(x_{\bullet s}/x_{\bullet m})}$ denote the location quotient for each specific manufacturing industry *s* and define the "dominant manufacturing industry" *d* as the one for which $l_{ad} > 1$ and the level of employment is maximum among the local specialized industries. For *d*, the following condition must hold: $s_{ad} = (x_{ad}^{small}/x_{ad}) > .5$.

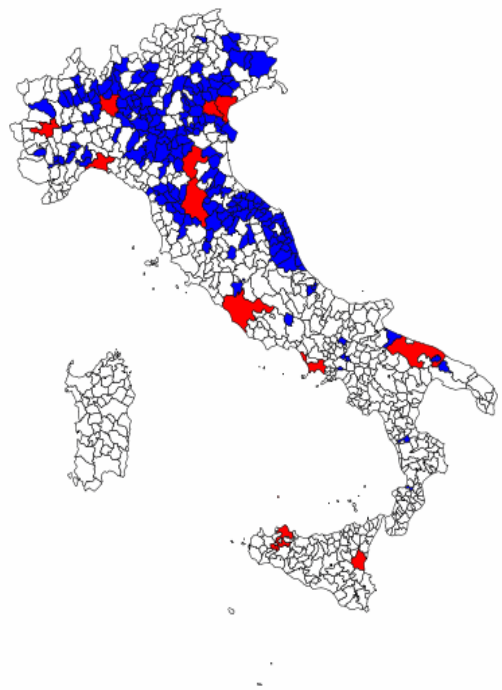
d) Finally, where there is only one medium-sized enterprise, small enterprises' employment share must exceed half that of the medium-sized firm.

Put simply, according to this definition industrial districts are LLMAs where small and medium-sized enterprises account for a significant share of employment both in manufacturing as a whole and in the sector of specialization. Notice that condition a) nearly automatically rules out the possibility that an urban area can be defined as an industrial district, since the former are usually characterized by an extensive presence of services.

As for the mapping of urbanization in Italy, we use a very simple definition: urban areas are LLMAs with a resident population of more than 500,000. Although Italy was historically known as the "land of a hundred cities", it has not seen the growth of mega-cities like those found in several industrial and emerging countries. Setting a relatively low threshold level to define urban areas is therefore consistent with Italy's relatively low degree of urbanization. Using these categories we obtain three non-overlapping sets of localities (the third set is defined as a complement with respect to the groups of LLMAs included in industrial districts and urban areas; Figure 1). Only Padua had characteristics matching both the definition of industrial district and urban area; we opted to include it in the set of industrial districts.

In 1991 the algorithm singled out 199 industrial districts (out of 784 LLMAs); in 2001 the number fell to 156 (out of 686). As the map clearly shows, a prominent spatial feature of clusters in Italy is their location almost exclusively in the North and Centre. As for the spatial distribution of urban areas, they are distributed more evenly throughout the country.

Figure 1 - Map of industrial districts (blue) and urban areas (red) in 1991



4. Data

The empirical analysis presented in this paper was conducted on a large panel of approximately 29,000 Italian manufacturing firms (not plants), observed over the period 1995-2006, and constructed as follows.

Annual balance sheet figures on value added, consumption of intermediate goods, fixed investment 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 (up to the 4-digit SIC sector classification), firm location (municipality where the firm is established) and number of employees were also included as auxiliary information in the database.

The information on the municipalities where firms are located allows us to map them into the 784 LLMAs and hence into the three area types described above. 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 costs as the main auxiliary information (see Appendix 1 for methodological details). Unlike the number of employees, data on total labor costs are available for all the sample firms.

The capital stock at firm level was estimated from the book value of investment using the permanent inventory method and deriving the sector-specific depreciation rates from Italian national accounts data. The capital stock in the initial year was estimated using the deflated book value, adjusted for the average age of capital calculated from cumulated depreciation (see Bond et al., 1997). Nominal value added and consumption of intermediate goods figures were deflated using industry-specific price indexes.

Firms with fewer than 5 employees were removed from the sample, since the data were very noisy for that size class. Our final dataset comprises 392,874 observations, nearly equally distributed over the two sub-periods (1995-2000 and 2001-2006; see Table 2). Due to the exclusion of some outliers (see more on this below), we actually use 344,353 observations in our econometric analysis: this means that we have on average about 28,700 firms per year, a very large sample compared with those used in all previous contributions on this topic.

Slightly more than a half of the observations refer to firms in industrial districts and nearly a quarter to urban areas. Consistently with the characteristics of the entire population (see Istat, 2006) the share of firms located in the South is quite small in both the urban area and the industrial district samples.

On average, firms in urban areas have 77.5 employees, as against 43.9 for the district firms and 54.4 for non-urban, non-district firms. Clearly, our sample is partially biased toward large firms, especially if one recalls the prevalence of small enterprises in Italian manufacturing. This characteristic mainly reflects our decision to drop firms with fewer than 5 employees from the sample; to a lesser extent it is also related to the fact that the Centrale dei Bilanci / Cerved database does not include certain categories of firms, e.g. sole proprietorships. Although we are aware that this requires some caution in the interpretation of our results, we strongly prefer dropping firms below the 5-employee threshold in order to preserve data quality. Average firm size for the entire sample fell from 88 to 67 employees between the two sub-periods while it remained constant in the industrial districts (Table 3).

As for ranking areas by labor productivity, the descriptive statistics show that in the North of Italy firms in industrial districts have higher per capita value added than firms in non-agglomerated areas, but lower than those in urban areas. In the Centre and South, district firms trail both urban-area firms and non-district, non-urban firms (Table 4).

The North-South gap in labor productivity (25-30 percent, in line with other studies[12]) emerges in all three groups of areas (districts, urban areas, other LLMA's) and is largest for industrial districts. The sectoral distribution shows that about 45 per cent of the observations are related to the metal and metal products, mechanical and machinery, textiles and apparel industries.

5. TFP estimation

Our estimation strategy proceeds in several steps. First, production function estimates at firm-level are obtained using different methodologies and total factor productivity (TFP) for each firm is computed as the residual of the estimated production function. Second, firm-level TFP estimates are regressed on a set of independent variables to uncover productivity differentials across the three groups of areas defined in the previous section.

In order to derive individual TFP measures, the following standard Cobb-Douglas production function was considered:

$$Q_{i\in(r,s)t} = \Phi_{it} L_{it}^{\alpha_s} K_{it}^{\beta_s} \quad (1)$$

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 [13]; α_s and β_s are the production function coefficients, which are allowed to vary across sectors.

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[12] The North-South divide is an issue of paramount importance for the Italian economy (see for example: Cannari, Magnani and Pellegrini, 2009). Investigating it in relation to the geographical distribution of agglomeration economies could be rewarding but is beyond the scope of the present paper.

[13] 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.

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

$$q_{it} = \alpha_s l_{it} + \beta_s k_{it} + \phi_{it} \quad (2)$$

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

$$\hat{\phi}_{it} = q_{it} - \hat{\alpha}_s l_{it} - \hat{\beta}_s k_{it} \quad (3)$$

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

Equation (2) 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). The latter methodology is based on the idea that the error term in (2) can be decomposed into two components: $\phi_{it}=\omega_{it}+\varepsilon_{it}$ where the first is observed by the firm but not by the econometrician while the second one is assumed to be an i.i.d noise uncorrelated with the inputs. To eliminate the correlation between ω_{it} and input choice, LP propose using the following control function: $m_{it}=f_t(\omega_{it}, k_{it})$ where the demand of the intermediated inputs such as electricity, fuel and materials is considered a function of the productivity shock observed by the firm and the (predetermined) capital stock at time t. Under the assumption that the latter function is monotonic in m_{it} it is possible to invert $\omega_{it} = f_t^{-1}(m_{it}, k_{it})$ and substitute this expression into (2). The unobserved component of firm productivity causing the simultaneity bias is thereby eliminated and equation (2) can be estimated through non parametric methods after some additional moment restrictions. Unlike FE, this methodology does not assume that the unobserved productivity component is time invariant; in addition, it proposes a control function solidly based on profit maximization; finally, it is relatively easy to implement and less demanding in terms of data requirements than, for instance, the procedure in Olley and Pakes (1996).[14]

Given that the elasticity of output to capital and labor inputs may vary considerably across industries owing to intrinsic differences in production technologies, we run distinct regressions for each industry according to the two-digit SIC classification. In this way we can also control

[14] Olley and Pakes (1996) propose the control function based on investment rather than on intermediate goods. The trouble is that this function cannot be inverted when investment is zero, a frequent occurrence in the data including our sample of manufacturing firms. For this reason we resort to the LP methodology.

for sector-specific time trends by introducing temporal fixed effects in the panel estimation procedure. To allow for some degree of firm heterogeneity within each two-digit SIC industry, fixed effects at the level of three-digit SIC codes were also included.

Firms with fewer than 5 employees were dropped from the sample prior to estimation for reasons of data reliability. Following the same line of reasoning, firms with outlier K/L ratios were also excluded, reducing the final sample to about 28,700 firms per year. Despite the trimming and quality controls, our sample is at least twice as large as those used in similar papers on Italian manufacturing firms.

Estimated labor and capital elasticities are shown in Table 5. Overall, the results obtained with the three estimation methods do not differ greatly, although the LS estimates exhibit slightly higher values compared with those derived with FE and LP, thus confirming the likely presence of the expected positive simultaneity bias. LP estimates show generally higher elasticities for the capital input and correspondingly lower estimates for the labor input compared with 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. There is a high correlation of estimated TFP levels across the three estimation methods, the Pearson correlation coefficient attaining values of 0.95 or higher.

6. Estimation of TFP differentials

Based on firm-level TFP estimates obtained with the procedure described above, we run the following regression:

$$\hat{\phi}_{it} = \delta UA + \eta ID + \rho \, flagimp_{it} + \Sigma_h \mu_h \, firmsize_{it}^h + \gamma_g + \lambda_s + \varpi_t + \varepsilon_{it} \quad (4)$$

where

- UA and ID are binary dummies indicating firms located in urban areas or industrial districts and δ and η are unknown coefficients measuring average TFP differentials between these two types of LLMAs and the remaining ones, which act as the reference group;

- *flagimp* is a control dummy signaling if L_{it} has been either imputed or, alternatively, reported by the firm;
- *firmsize*^{h} is dummy variable taking the value of 1 if the size of the firm, measured by the number of employees, belongs to the h-th of H classes resulting from a discretization of the range of possible employment levels (size categories are: small firms ≤ 49 employees; medium-sized firms: 50-249; large firms: ≥ 250);
- γ_g , λ_s and ω_t are geographical area[15](macro areas are: North-West, North-East, Centre; South), industry and year fixed effects;
- ε_{it} is an error term defined as the sum of two independent random components, an LLMA component and a purely idiosyncratic residual:

$$\varepsilon_{it} = \iota_r + \eta_{it} \quad (5).$$

By including a firm size indicator in the specification we get rid of the differences in productivity levels that may depend on the fact that industrial districts can be more favorable areas for small business location (see Appendix 2 for a discussion on the relation between TFP and firm size). The geographical fixed effects γ_g allow for unobserved, time invariant factors affecting firm productivity across different areas. Industry fixed effects control for the influence that differences of sectoral composition between urban areas and industrial districts might have on the estimation results as well as for the well known problem of comparing productivity levels across different sectors.

Finally, the rationale for introducing a control for the data imputation process is to prevent any systematic bias possibly affecting our TFP estimates for firms with imputed employment levels from being transmitted to the estimates of spatial productivity differentials (which, in any event, would only occur if the share of imputed observations is not the same across urban areas, industrial districts and other LLMAs).

Given the assumptions about the error term in (5), we estimate equation (4) by clustering error terms at the individual LLMA level. Estimation results for this specification and for LP estimation method are reported in Table 6.[16]

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[15] Two broad partitions of the Italian territory are considered in this respect, corresponding, with some minor exceptions, to the NUTS1 and NUTS2 levels of the European regional classification.

The estimated TFP differential is positive and highly statistically significant for both urban areas and industrial districts. With respect to the reference group, a larger advantage is estimated for firms located in urban areas (10 per cent) than the gain observed for those based in industrial districts (3 per cent). In unreported evidence we show that these results do not change when TFP obtained through OLS or FE estimation methods is used. Moreover, we tested that the coefficients for urban areas and industrial districts are systematically different. For instance, for Model I in Table 6, we run a Wald test and obtain an F(1,688) with value 66.31 showing that we can strongly reject the null hypothesis that the two coefficients are not significantly different. This test is performed throughout all the other specifications and the results always reject this hypothesis. To save space we do not report the results of these tests.

In line with previous evidence, firms located in the Centre and, above all, in the South have much lower productivity levels than those in the North; the estimated gap is about 24 per cent for southern firms and 3 per cent for those located in the Centre.

Estimated coefficients display a significant non-linear relationship between firm size and log-TFP, suggesting that the productivity levels of medium-sized firms are only slightly higher than those of small firms, while large firms attain a greater advantage. However, the link between firm size and productivity may depend on the characteristics of the local environment. More precisely, we expect that small firms will achieve comparative advantages by locating in industrial districts. To explore this issue, we introduce into the regression the interaction between firm size and LLMA type (industrial district and urban area). This exercise shows that the productivity disadvantage of smaller firms is less marked within industrial districts. Overall, the estimates of the extra productivity in urban areas and industrial districts obtained with the baseline specification are confirmed.

The TFP advantages of urban areas and industrial districts diminish slightly when the three area dummies are replaced by a full set of fixed effects for Italy's 20 administrative regions (Table 6, Model III).

Our production function estimates do not take into account the so-called output price dispersion problem.[17] Specifically, valued added has been deflated by a common industry-wide

[16] For the sake of brevity, estimation results for the *flagimp* variable are not reported. In all cases, the estimated coefficients turned out to be negative and significant. This suggests that firms that do not report employment data are less productive than the average firm. In any event, including or excluding this control variable did not significantly alter our main estimation results.

[17] See Del Gatto, Ottaviano and Pagnini (2008) for a discussion and a possible empirical solution.

price index. If firms in urban areas set higher prices, these would end up in the residual (see equation 3) and would bias the estimated urban productivity premium upwards. Prices in urban areas could be higher if firms located in them have more market power or produce higher quality goods, or because congestion or living costs are greater in cities than elsewhere. This potential criticism can be easily dismissed on the grounds that local conditions can hardly have a significant effect on the prices of manufacturing goods, whose relevant market is nation-wide if not global. Moreover, if local conditions have any effect, they would likely induce firms in cities to set lower prices, because competition is stiffer in cities or because the distributive sector is larger and more efficient than in other areas. Hence, our estimated urban productivity premium may be excessively conservative.

To check our results, we modify the definition of urban areas by using two different population thresholds (200,000 and 900,000) and rerun equation 4 accordingly. Notice that using the lower threshold would make interpreting the results more complex as now some industrial districts can also be included in the group of urban areas. In unreported evidence, we show that local productivity advantages in urban areas defined according to the two thresholds are a bit lower that those estimated in the baseline specification. For industrial districts, we obtain similar results with the 200,000 population threshold, but the productivity premium vanishes with the higher one (900,000 inhabitants). The latter result is due to the fact that the non-district, non-urban areas now encompass highly productive locations that are not at a disadvantage compared with industrial districts. Although we modify our definition of urban area as a robustness check, we want to emphasize that our previous choice of 500,000 inhabitants has the twofold advantage of generating a non-overlapping classification of the area types and at the same time setting a threshold above which it is likely that urbanization effects fully unfold.

We also run distinct regressions for each industry and unreported results indicate that comparative advantages associated with industrial districts and urban areas do not differ greatly across sectors. In Appendix 3 we report additional robustness checks, based on running similar regressions to equation (4) at aggregate rather than at individual firm level, using instrumental variables and for the subsample of small firms. These additional checks confirm our results.

7. Discussion of the main results and further extensions

One of the main results of our analysis is that firms located in urban areas outperformed those located in industrial districts in terms of productivity advantages. As a first step towards identifying the factors that may explain this finding, in this section we provide additional evidence on the evolution of the local productivity advantages, the role of the skill composition of the labor force and, finally, a quantile regression analysis of the data.

7.1 The evolution of local productivity advantages in urban areas and industrial districts

During the twelve years covered by our analysis, the Italian economy underwent some major transformations. The rapid and increasing diffusion of information and communication technologies, the upsurge of China, India and Brazil in world trade and finally the introduction of euro prompted a deep restructuring of Italian manufacturing firms. Moreover, all these factors probably gained momentum in the second part of the period: the euro was introduced in 2001, the effects of new technologies on workplace organization fed through in full in the same period and China's rise in world trade gained pace after the 2000. The question we want to investigate is whether these factors worked more in favor of firms located in urban areas or those established in industrial districts.

To this end, the three specifications considered in Table 6 were subsequently estimated by splitting the panel into two sub-periods, 1995 to 2000 and 2001 to 2006. The main findings point to a relative stability of the TFP advantage in urban areas over the two sub-periods, while the productivity premium estimated for industrial districts declined from about 4 per cent to 2 per cent, losing statistical significance when regional fixed effects are introduced (Table 7, Model III). These results suggest that firms located in urban areas coped with the shocks that hit the world economy better than district firms.

There are different possible explanations for this finding. Here we shall briefly indicate some. On one hand, it is possible that the larger endowment of skilled workers in urban areas permitted firms to make more efficient use of the new technologies and made it easier for them to improve product quality and introduce product innovation in response to increased competition (see the following sub-section). On the other, firms may have benefitted from the diversity of urban-area environment. In a period when the ability to update products and to innovate were crucial for firms' success, interactions with enterprises in other industries and with service firms amplified the possibility for firms under restructuring to undertake new production methods and test new strategies.[18] The same advantages could not be reproduced by interactions within industrial districts, which involve small manufacturing firms belonging to relatively similar industries.

7.2 The role of human capital

A source of comparative advantage for cities may consist in higher human capital endowments. Urban areas may be especially successful in attracting more educated people because they allow skilled workers a better chance to find a good match with a firm on the large, diversified local job market. At the same time, cities may attract highly educated people through the local supply of urban-specific amenities. The empirical evidence detailing higher levels of labor force educational attainment in larger cities is clear and abundant. For the Italian case, recently Di Addario and Patacchini (2008) confirmed that skilled workers concentrate in the most populous cities and benefit from an urban wage premium.

If, ceteris paribus, firms located in urban workers hire more skilled workers than those in other local labor systems, omitting to control for the skill differential in the labor force will result in larger residuals in the estimated production function, which can be wrongly attributed to higher TFP levels.

In order to provide some new evidence on the impact of human capital on productivity in local labor markets, we relied on a measure of labor-force composition at firm level obtained from the Italian social security administration (Istituto Nazionale Previdenza Sociale, INPS) archives. The INPS database covers the entire universe of Italian firms with at least one employee and provides information on the total number of employees broken down into production and non-production workers, respectively defined as white-collar and blue-collar workers in what follows.

Using Italian data, Castellani and Giovannetti (2010) show that the share of blue-collar workers is strongly associated with firms' TFP, thus highlighting a possible misspecification in the production function. They suggest that the labor input should be split into different components capturing the different skill intensities, allowing for a more flexible specification of the production function.

[18] The mechanism we are describing is similar to the "nursery effect" of Duranton and Puga (2001) with the difference that we do not think it can be restricted to young and small firms.

Building on this argument, we resort to a new set of production function estimates that include explicit controls for the labor force composition at the firm level. To do so, we pooled data on the number of blue- and white-collar workers from the INPS archives with our original Centrale dei Bilanci/Cerved (CEBI) database. The resulting panel includes fewer firms, owing to imperfect matching of firm codes in the two data sets and to a shorter time span covered by the INPS archive (it is limited to 1995-2002).

Using this database, we replicated our multi-step estimation strategy. In the first step the Levinsohn and Petrin method was employed to estimate the following augmented production function:

$$q_{it} = \alpha_s^b l_{it}^b + \alpha_s^w l_{it}^w + \beta_s k_{it} + \tilde{\phi}_{it} \quad (2b)$$

where l^b and l^w and respectively denote (the log of) the number of blue- and white-collar employees. Subsequently, the revised TFP estimates obtained from the residuals of equation (2*b*) were used to run a TFP regression analysis akin to the one detailed in equations (4) and (5). Regression results based on TFP estimates derived from model (2*b*) are reported in Table 8. Considering that the augmented production function was estimated on a different sample, in order to provide a proper benchmark we also re-estimated TFP levels fitting the baseline Cobb-Douglas production function specification (equation 3) to the pooled INPS/CEBI data set. All in all, relying on a different panel of firms, featuring partially dissimilar employment data, does not appear to affect the estimation results substantially, as can be directly checked by comparing the results in Table 9 and Table 6.

Controlling for labor force composition, the estimated TFP advantage of firms located in urban areas remains large, with only a slight declining compared with the baseline results (from roughly 9 to 8 percentage points; see Tables 8 and 9). In other words, the productivity differential in favor of urban-area firms does not depend (or depends only marginally) on the fact that the labor force in urban areas has a larger share of skilled workers.

As a further refinement, we have obtained new estimates of the augmented production function specification, allowing the elasticity of output for the two labor inputs to take different values for firms located in industrial districts and urban areas. This less restrictive specification is introduced because white-collar workers may be more productive in urban areas, while blue-collar workers may be more efficiently employed in industrial districts.

On the one hand, the growing literature on urban agglomeration has underlined the role of cities in the generation and transmission of new ideas that can spur innovation and productivity. Highly educated workers may be better equipped than less skilled ones to benefit from the flow of information that is diffused within urban areas by recurrent face-to-face interactions (Glaeser, Rosenthal and Strange, 2009; Glaeser and Ponzetto, 2010). On the other hand, the literature on industrial districts has emphasized the impact of agglomeration on skill accumulation by production workers, whose ability to "make things well" benefits from the local "industrial atmosphere" (according to Marshall's well-known definition), facilitating learning by doing.

Extended production function estimates (reported in Table 10) support the hypothesis that white-collar workers are more productive in urban areas: the estimated elasticity is higher for firms located in urban areas than for those located in districts or other areas, while blue-collar workers are more productive in non-urban areas. These results make sense in light of the theoretical a priori. However, the evidence that blue-collar workers are relatively more productive in industrial districts than in urban areas is not necessarily good news for districts' economic prospects: in the current competitive environment, marked by mounting competition from newly industrialized countries, the role of white-collar workers may prove crucial in fostering innovation and upgrading of firms' products.[19]

When different output elasticities to labor inputs are allowed for, estimated TFP differentials show a slight erosion of urban areas' productive advantage. Nonetheless, that advantage remains significant and substantial, ranging between 4.4 and 6.9 percentage points according to the different specifications (Table 11). The coefficient of the industrial district dummy now becomes not statistically significant, suggesting that the TFP differential in favor of industrial districts found by our baseline estimates may be basically due to the higher productivity of blue-collar workers in that environment rather than to a global shift in the efficiency of production. The large advantage of urban areas, instead, is due only in small part to the professional qualification of urban workers: in this sense, it remains unexplained.

7.3 Quantile analysis

The three sources of local productivity advantages discussed so far – agglomeration economies, selection and sorting – may have different effects when the TFP distributions of

[19] See results in Section 7.1, the report on the recent evolution of Italian manufacturing sector by Brandolini and Bugamelli (2009) and also the discussion in Glaeser and Ponzetto (2010).

regions with a high and low concentration of economic activity are compared.[20] Agglomeration economies are assumed to raise the productivity of all the firms in a spatially concentrated region, so we should expect a rightward shift of the entire TFP distribution. Selection models show that the positive effect of geographical concentration mainly concerns the lower tail of the TFP distribution, since in dense areas less efficient firms are forced to exit the local market. Finally, if highly skilled workers or more efficient firms benefit to a greater extent from agglomeration economies we could have a positive effect on the upper tail of the TFP distribution (dilation effects).

To understand how these three forces shape the TFP distribution in urban areas and industrial districts we extend our econometric analysis to a quantile regression.[21] This allows us to enrich the picture of the relationship between the response variable and the regressors at different points in the conditional distribution of the dependent variable., whereas the linear in mean regression analysis adopted so far simply assumes that the effect of the regressors on the conditional mean is representative of the shift in the entire distribution. Apart from this advantage, the quantile regression is also less exposed than the mean regression to the problems of outliers. Finally, being semiparametric in the sense that it avoids assumptions about the distributions of the error terms, this tool is particularly suitable for heteroskedastic data.

Results based on the quantile regression are reported in Table 12. To improve the efficiency of the estimation further, we bootstrapped the standard errors. In Figure 2 we also report a graphical analysis including OLS and the quantile regression coefficients for industrial districts and urban areas.

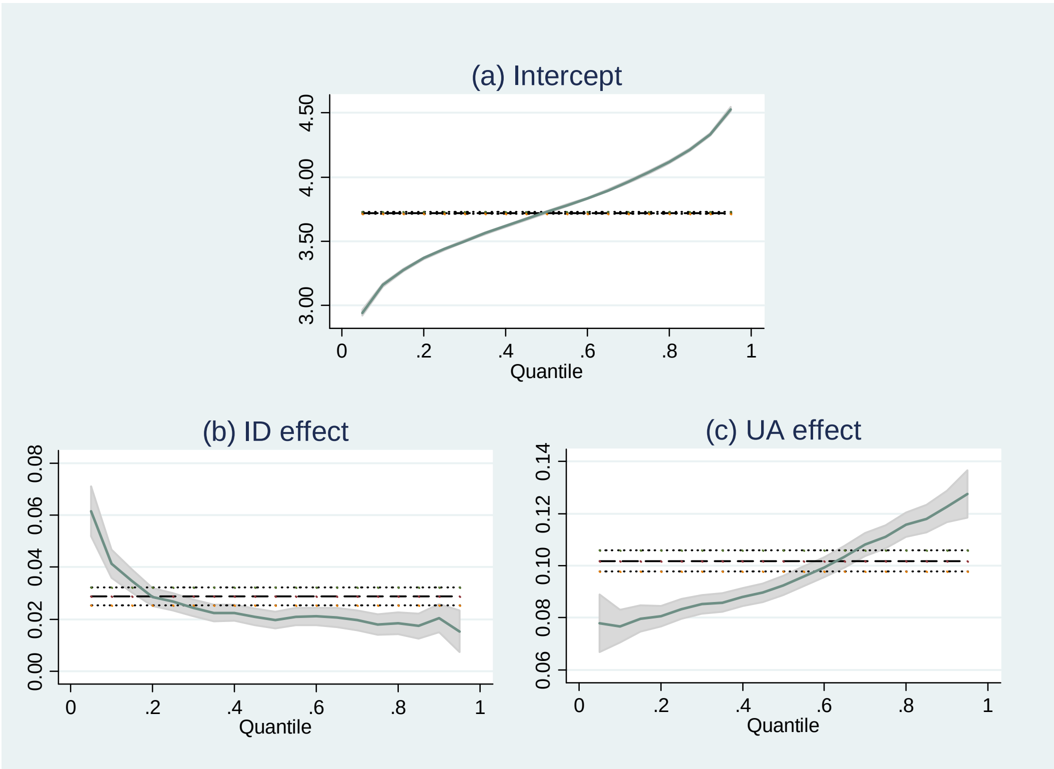
Several interesting patterns can be gleaned from this additional evidence. First, the productivity advantages associated with urban areas and industrial districts are confirmed across the different percentiles of the TFP distribution, thereby showing that the previous findings were not restricted to the impact of the covariates on the conditional mean. Moreover, apart from the first percentile of the TFP distribution, the productivity premium in urban areas is always greater than that observed in industrial districts, consistently with our previous results. Finally, the productivity advantages associated with industrial districts distinctly

[20] See Combes et al. (2009) for a thorough discussion of this topic.

[21] For similar analyses, see Arimoto, Nakajima and Okazaki (2009) and Briant (2010). Quantile regression was proposed for the first time by Koenker and Bassett (1978).

diminish as we move from the lower to the upper tail of the distribution while the opposite holds true for urban areas.

Figure 2 – Quantile regression: ID and UA effects (1)



(1) The horizontal line corresponds to OLS coefficients, grey areas and horizontal dotted lines denote 95% confidence intervals for the estimated parameters. Quantiles vary by 0.05, from 0.05 to 0.95.

The fact that industrial district and especially urban area coefficients are positive and significant at all quantiles suggests that agglomeration economies actually shift the entire TFP distribution rightward or that at least part of them positively affect TFP of all the firms located in dense regions. At the same time, the magnitude of these coefficients vary across quantiles and according to different patterns in industrial districts and urban areas, indicating that selection and sorting may also help shape the TFP distribution.

We also detected some evidence consistent with selection in industrial districts, as their productivity advantages are stronger in the lower tail of the TFP distribution, while we do not find a similar effect in urban areas (Figure 2, panels b and c). The alternative interpretation based on sorting would argue that more efficient firms reap greater benefits from the kind of agglomeration economies created in urban areas, while, conversely, less efficient firms are better equipped to gain from the externalities generated in industrial districts.

Although disentangling these alternative explanations is beyond the scope of the paper, we doubt that selection models can actually help explain the different patterns in the relationship between geographical concentration and TFP found in industrial districts and urban areas: the geographical scale of LLMAs adopted in our approach is too small and therefore not suited to represent the relevant market in the case of manufacturing products: Accetturo et al. (2011) show that a selection effect may emerge when a broader spatial scale is considered.

Hence, we conjecture that the differences between the two curves in Figures 2b and 2c, may be driven by some kind of sorting process. Industrial districts are able to generate local productivity advantages that can be more effectively appropriated by less efficient firms, while the externalities produced in urban areas can be better exploited by the more efficient firms. The dense network of productive relationships generated by the industrial districts seems to bring the greatest benefits to firms that would be very inefficient if they operated on their own outside that network. As for urban areas, more efficient firms that are able to survive in that tougher competitive environment are also likely to be the ones to benefit more from interaction with firms in other sectors (diversity) or from improved matching with a skilled local labor force.[22] This result partially contradicts the finding of Duranton and Puga (2001) that cities benefit younger and relatively less efficient firms. Nor does it square fully with the evidence presented by Holmes and Stevens (2010) showing that US cities attract small, less efficient firms producing high-quality goods while non-urban specialized regions host large, more efficient firms producing standardized goods.

Plainly, further investigation of these results is needed in order to check their robustness and for possible policy prescriptions.

8. Conclusion

This paper has investigated the issue of local productivity advantages, using data on 29,000 Italian manufacturing firms over an observation period of 12 years (1995-2006). We

[22] For a model where agglomeration benefits are higher for more productive firms, see Combes et al (2009). For a model taking into account the effects of an intense competition, see Venables (2011).

mapped firms into three non-overlapping categories according to their respective location (urban areas, industrial districts, and other areas) and performed firm-level TFP estimates using a broad set of techniques.

On the whole, our analysis suggests that spatial concentration exerts favorable effects on local productivity. The estimated coefficients for the urban areas and industrial districts dummies are both positive and significant. However, locating in an urban areas is generally more beneficial than in an industrial district (with an estimated coefficient 3 to 5 times greater depending on the specification used).

While manufacturing firms located in urban areas on average employ a more skilled labor force, TFP estimates that explicitly control for this skill differential show that the productivity advantage of large cities depends to only a minor extent on differences in the human capital endowment of employees. Using quantile regression techniques, we also show that industrial districts generate local productivity advantages that can be more effectively appropriated by less efficient firms, while the externalities arising within cities can be better exploited by more efficient enterprises.

With the purpose of evaluating the dynamic pattern of productivity over the period (1995-2006), we run a new regression analysis splitting the sample in two sub-periods. It turns out that comparative advantages of urban areas remain stable while those of industrial districts show a tendency to decline over time. Within cities agglomeration economies have remained vital, even in a period characterized by the growing globalization. Thus, our results suggest that firms operating within urban areas, better than those located in industrial districts, have shown a high degree of resilience to the shocks that hit the world economy over the last decade.

Finally, let us consider the policy implications of our findings. The purpose of our work is not to suggest a path of development for the local productive systems, nor do we intend to propose active policy measures to support industrial districts or urban areas, since defining optimal policies for clusters is very difficult. In fact, the question is: what should these policies do? If the answer is "solve major inefficiencies", then policy makers should know exactly where these inefficiencies come from (see Duranton, 2011, for a more detailed analysis). Appropriate policies are thus not easy to formulate and must be supported by a thorough knowledge of the inefficiencies to be addressed (linked, for example, to congestion or to the fading away of positive externalities). Such knowledge is a prerequisite for effective policy measures. The present paper can be considered as a first step in this line of research.

TABLES

Table 1

The importance of being agglomerated: the district effect in Italy

Authors	Strategy		Model	Variable of interest	Agglomeration advantage (1)
Signorini (1994)	Firms' performance	Case study on Prato industrial district (1982-1989)	OLS	Total factor productivity	+ 41 %
Fabiani et al. (2000) (2)	Firms' performance	Cross section in 1995 (firm level)	Descriptive stats.	ROI	+ 2.0 p.p.
			&	ROE	+ 4.1 p.p.
			Stochastic Frontiers – ML estimates	Value added per worker	+ 1.3 %
Gola and Mori (2000)	Export structure	Panel data (firm level) 1,092 obs period 1983-1995	Fixed effect estimates	Normalized trade balance	+ 3.4 %
Bronzini (2000)	Export performance	Data at provincial level; pooled data (1995-1997)	OLS, SURE estimates	Export propensity (log of export per worker as a share of national average)	+ 7.0 %
Becchetti and Rossi (2000)	Export intensity	Mediocredito survey. Firm level data; 1989-1991 (avg) 3,695 obs.	Tobit estimates	Share of export on total sales	+ 3.6
			Probit estimates	Exporter status (marginal effect)	+ 20 %
Cainelli and De Liso (2005)	Firms performance	Period 1992-1995 (2,821 obs.)	OLS, IV estimates	Rate of change of real value added	+ 2.0 / 2.6 %
Becchetti and Castelli (2005)	Firms' performance	Mediocredito Survey (two waves: 1995-1997 and 1998-2000)	Stochastic Frontier	Value added per worker	+ 1.8 %
Bugamelli and Infante (2005)	Exporter status	Firm level (1982-1999).	Probit estimates	Exporter status	+ 0.02
Cingano and Schivardi (2005) (3)	Firms' performance	Firm level (1,602 obs.)	OLS estimates	Average TFP growth rate 1986-1998	+ 0.2 / 0.5 %
Foresti, Guelpa and Trenti (2009)	Firms' performance	Different indicators 2006	Descriptive statistics	ROI	- 0.25 p.p.

(1) Firms in districts with respect to firms not in districts. - (2) The authors also perform a sectoral analysis of firms' efficiency using the stochastic frontier approach, finding evidence of lower for firms located in districts for 8 out of 13 sectors. - (3) They produce indirect (though robust) evidence in favor of a district effect, testing whether the increase of the industry degree of specialization in LLMAs (an index of externality typical of districts) determines a change in TFP growth.

Table 2

The sample: number of observations

Sectors	Industrial districts	Urban areas	Other	Total
Food products, beverages and tobacco	9,985	4,837	10,549	25,371
Textiles and textile products	28,656	6,418	7,528	42,602
Leather and leather products	11,847	3,456	2,078	17,381
Wood and products of wood and cork (except furniture)	5,588	1,575	3,898	11,061
Pulp, paper and paper products; recorded media; printing services	9,046	10,048	4,934	24,028
Coke, refined petroleum products and nuclear fuel	290	496	562	1,348
Chemicals, chemical products and man-made fibres	4,938	5,810	2,796	13,544
Rubber and plastic products	11,512	5,152	5,275	21,939
Other on metallic mineral products	10,266	3,205	8,435	21,906
Basic metals and fabricated metal products	40,834	18,479	20,952	80,265
Machinery and equipment n.e.c.	29,635	14,547	12,286	56,468
Electrical and optical equipment	14,387	12,741	7,540	34,668
Transport equipment	3,658	3,725	3,759	11,142
Other manufactured goods n.e.c.	18,371	5,690	7,090	31,151
North-West	80,260	52,260	27,198	159,718
North-East	74,113	18,268	28,630	121,011
Centre	40,088	14,566	16,580	71,234
South and islands	4,552	11,085	25,274	40,911
1995-2000	93,251	46,803	43,783	183,837
2001-2006	105,762	49,376	53,899	209,037
Total	**199,013**	**96,179**	**97,682**	**392,874**

Sources: Based on Centrale dei Bilanci and Cerved data.

Table 3

Descriptive statistics: Firms' size (number of employees)

Sectors	Size (average)			Size (median)		
	Industrial districts	Urban areas	Other	Industrial districts	Urban areas	Other
Food products, beverages and tobacco	53.1	95.4	46.0	19.1	21.5	17.2
Textiles and textile products	44.9	43.8	68.2	20.0	15.9	20.0
Leather and leather products	35.1	32.7	48.2	18.0	17.8	18.6
Wood and products of wood and cork (except furniture)	27.8	25.7	28.9	17.6	13.5	14.3
Pulp, paper and paper products; recorded media; printing services	37.4	57.0	44.0	16.0	14.5	16.1
Coke, refined petroleum products and nuclear fuel	93.7	276.6	39.4	19.0	34.0	14.0
Chemicals, chemical products and man-made fibres	62.8	154.9	87.2	21.0	40.0	19.0
Rubber and plastic products	42.2	77.9	51.0	21.3	21.0	21.1
Other on metallic mineral products	59.3	52.3	36.3	20.0	19.0	16.0
Basic metals and fabricated metal products	36.2	45.5	36.3	16.8	14.8	16.7
Machinery and equipment n.e.c.	47.8	67.2	80.6	19.8	18.5	19.5
Electrical and optical equipment	47.7	92.0	65.1	17.5	17.0	16.3
Transport equipment	104.4	329.6	149.2	23.2	26.0	23.1
Other manufactured goods n.e.c.	34.1	29.1	33.6	17.0	14.4	16.9
North-West	49.0	93.0	60.7	19.1	18.7	18.6
North-East	45.3	51.0	61.9	19.0	18.2	19.2
Centre	32.0	75.7	52.5	16.3	14.7	16.3
South and islands	38.9	50.8	40.2	19.8	15.4	15.7
1995-2000	46.0	88.0	60.6	20.0	18.8	19.6
2001-2006	42.2	67.6	49.3	17.1	16.2	16.0
Total	**43.9**	**77.5**	**54.4**	**18.4**	**17.3**	**17.5**

Sources: Based on Centrale dei Bilanci and Cerved data.

Table 4

Descriptive statistics: Added value per worker (thousands of euros)

Sectors	Added value per worker (average)			Added value per worker (median)		
	Industrial districts	Urban areas	Other	Industrial districts	Urban areas	Other
Food products, beverages and tobacco	64.5	66.7	57.0	159.2	157.2	172.4
Textiles and textile products	43.1	43.5	35.5	73.1	61.1	62.4
Leather and leather products	41.9	41.4	36.6	46.7	33.9	39.5
Wood and products of wood and cork (except furniture)	41.9	44.7	38.9	74.3	69.4	74.8
Pulp, paper and paper products; recorded media; printing services	52.0	55.1	48.9	99.3	81.9	101.9
Coke, refined petroleum products and nuclear fuel	118.5	111.9	92.7	253.4	425.5	224.4
Chemicals, chemical products and man-made fibres	69.6	74.8	66.1	137.2	134.0	141.4
Rubber and plastic products	48.4	49.8	44.6	95.6	96.6	104.2
Other on metallic mineral products	55.2	54.4	50.8	118.1	127.5	139.2
Basic metals and fabricated metal products	51.2	51.7	45.5	80.3	74.6	68.9
Machinery and equipment n.e.c.	53.1	54.8	50.1	60.6	57.1	60.5
Electrical and optical equipment	50.4	54.8	47.0	52.9	51.4	51.9
Transport equipment	46.0	48.3	42.8	70.2	72.0	68.3
Other manufactured goods n.e.c.	39.6	45.0	39.8	57.3	61.5	62.9
North-West	52.2	56.6	51.3	88.2	78.9	88.7
North-East	50.2	52.6	49.7	77.8	72.2	80.9
Centre	44.6	52.9	46.0	63.9	77.1	80.6
South and islands	38.3	43.8	40.5	78.3	91.5	103.9
1995-2000	44.9	48.4	42.2	77.1	76.8	88.0
2001-2006	53.7	58.9	51.1	81.1	80.8	89.7
Total	**49.6**	**53.8**	**47.1**	**79.2**	**78.8**	**89.0**

Sources: Based on Centrale dei Bilanci and Cerved data.

Table 5

Returns to scale by industry

(standard errors in brackets)

	Levinsohn-Petrin			Fixed effects			Ordinary least squares		
Sectors	Labor coeff.	Capital coeff.	RTS	Labor coeff.	Capital coeff.	RTS	Labor coeff.	Capital coeff.	RTS
Food products, beverages and tobacco	0.572	0.218	0.790	0.673	0.200	0.873	0.837	0.195	1.032
	(0.013)	(0.030)		(0.010)	(0.009)		(0.005)	(0.004)	
Textiles and textile products	0.708	0.272	0.980	0.866	0.131	0.997	0.871	0.123	0.993
	(0.008)	(0.015)		(0.008)	(0.007)		(0.004)	(0.003)	
Leather and leather products	0.716	0.261	0.977	0.842	0.136	0.978	0.884	0.137	1.021
	(0.009)	(0.020)		(0.011)	(0.009)		(0.005)	(0.004)	
Wood and products of wood and cork (except furniture)	0.724	0.235	0.959	0.830	0.110	0.940	0.898	0.125	1.023
	(0.018)	(0.027)		(0.012)	(0.009)		(0.006)	(0.004)	
Pulp, paper and paper products; recorded media; printing services	0.710	0.195	0.905	0.744	0.148	0.893	0.907	0.133	1.040
	(0.016)	(0.015)		(0.010)	(0.008)		(0.005)	(0.003)	
Coke, refined petroleum products and nuclear fuel	0.519	0.557	1.076	0.569	0.242	0.811	0.851	0.219	1.069
	(0.087)	(0.102)		(0.041)	(0.042)		(0.023)	(0.016)	
Chemicals, chemical products and man-made fibres	0.660	0.292	0.952	0.750	0.171	0.921	0.925	0.114	1.039
	(0.018)	(0.029)		(0.013)	(0.012)		(0.007)	(0.005)	
Rubber and plastic products	0.696	0.284	0.981	0.791	0.166	0.957	0.855	0.171	1.026
	(0.012)	(0.019)		(0.008)	(0.008)		(0.005)	(0.003)	
Other non metallic mineral products	0.665	0.312	0.977	0.816	0.131	0.946	0.880	0.171	1.051
	(0.012)	(0.031)		(0.009)	(0.009)		(0.005)	(0.003)	
Basic metals and fabricated metal products	0.727	0.207	0.934	0.821	0.127	0.948	0.871	0.139	1.011
	(0.004)	(0.007)		(0.004)	(0.003)		(0.002)	(0.001)	
Machinery and equipment n.e.c.	0.737	0.212	0.949	0.831	0.135	0.966	0.912	0.102	1.015
	(0.007)	(0.011)		(0.005)	(0.004)		(0.003)	(0.002)	
Electrical and optical equipment	0.730	0.193	0.923	0.825	0.119	0.945	0.904	0.110	1.014
	(0.008)	(0.012)		(0.007)	(0.006)		(0.004)	(0.003)	
Transport equipment	0.758	0.196	0.954	0.873	0.110	0.983	0.911	0.096	1.007
	(0.015)	(0.019)		(0.013)	(0.010)		(0.006)	(0.004)	
Other manufactured goods n.e.c.	0.746	0.210	0.956	0.856	0.139	0.995	0.935	0.107	1.043
	(0.009)	(0.015)		(0.008)	(0.007)		(0.004)	(0.003)	

Sources: Based on Centrale dei Bilanci and Cerved data.

Table 6

Estimation results on firm-level data.
Dependent variable: log of TFP measured through LP method (1)
(standard errors in brackets) (2)

	Model I	Model II	Model III (3)
UA	0.102***	0.108***	0.092***
	(0.01)	(0.01)	(0.01)
ID	0.029***	0.036***	0.016*
	(0.01)	(0.01)	(0.01)
Medium-sized	0.033***		0.037***
	(0.01)		(0.01)
Large	0.160***		0.164***
	(0.01)		(0.01)
North-East	-0.001	-0.001	
	(0.01)	(0.01)	
Centre	-0.035**	-0.036**	
	(0.01)	(0.01)	
South	-0.242***	-0.242***	
	(0.01)	(0.01)	
UA*medium-sized		-0.039*	
		(0.02)	
UA*large		0.030	
		(0.03)	
ID*medium-sized		-0.037**	
		(0.01)	
ID*large		-0.001	
		(0.03)	
Number of observations	344,353	344,353	344,353
Adjusted R^2	0.677	0.678	0.679

Sources: Based on Centrale dei Bilanci and Cerved data.
(1) All specifications include year and industry fixed effects plus a control for imputed employees data. - (2) Standard errors are corrected for clustering at the level of individual LLMAs. - (3) Includes 20 region fixed effects.

Table 7

Estimation results on firm-level data, by period.
Dependent variable: log of TFP measured through LP method (1)
(standard errors in brackets) (2)

	Model I		Model II		Model III	
	1995-2000	2001-2006	1995-2000	2001-2006	1995-2000	2001-2006
UA	0.103***	0.102***	0.112***	0.105***	0.094***	0.090***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
ID	0.038***	0.021*	0.048***	0.025**	0.023**	0.010
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Medium-sized	0.011	0.053***			0.016*	0.056***
	(0.01)	(0.01)			(0.01)	(0.01)
Large	0.133***	0.187***			0.140***	0.190***
	(0.01)	(0.02)			(0.01)	(0.02)
North-East	-0.002	0.000	-0.002	-0.000		
	(0.01)	(0.01)	(0.01)	(0.01)		
Centre	-0.032	-0.039***	-0.032	-0.039***		
	(0.02)	(0.01)	(0.02)	(0.01)		
South	-0.267***	-0.220***	-0.267***	-0.220***		
	(0.01)	(0.01)	(0.01)	(0.01)		
UA*medium-sized			-0.051**	-0.029		
			(0.02)	(0.02)		
UA*large			0.010	0.052		
			(0.03)	(0.04)		
ID*medium-sized			-0.047***	-0.031*		
			(0.01)	(0.01)		
ID*large			-0.022	0.017		
			(0.03)	(0.04)		
Number of obs.	166,168	178,185	166,168	178,185	166,168	178,185
Adjusted R^2	0.690	0.666	0.690	0.667	0.692	0.668

Sources: Based on Centrale dei Bilanci and Cerved data.
(1) All specifications include year and industry fixed effects plus a control for imputed employees data. - (2) Standard errors are corrected for clustering at the level of individual LLMAs. - (3) Includes 20 region fixed effects.

Table 8

Estimation results on firm-level data,
using two labor inputs (white-collar and blue-collar workers).
Dependent variable: log of TFP measured through LP method (1)
(standard errors in brackets) (2)

	Model I	Model II	Model III (3)
UA	0.078***	0.078***	0.069***
	(0.01)	(0.01)	(0.01)
ID	0.026**	0.040***	0.014
	(0.01)	(0.01)	(0.01)
Medium-sized	0.133***		0.137***
	(0.01)		(0.01)
Large	0.336***		0.344***
	(0.02)		(0.02)
North-East	0.018	0.019	
	(0.01)	(0.01)	
Centre	-0.012	-0.013	
	(0.02)	(0.02)	
South	-0.237***	-0.236***	
	(0.02)	(0.02)	
UA*medium-sized		-0.013	
		(0.02)	
UA*large		0.062	
		(0.04)	
ID*medium-sized		-0.057***	
		(0.01)	
ID*large		-0.060	
		(0.04)	
Number of observations	188,275	188,275	188,275
Adjusted R^2	0.796	0.796	0.797

Sources: Based on Centrale dei Bilanci, Cerved aand INPS data.
(1) All specifications include year and industry fixed effects plus a control for imputed employees. Data on labor inputs are drawn by INPS dataset. Estimation period: 1995-2002. - (2) Standard errors are corrected for clustering at the level of individual LLMAs. - (3) Includes 20 regional fixed effects.

Table 9

Estimation results on firm-level data,
using only one labor input (white + blue-collar workers).
Dependent variable: log of TFP measured through LP method (1)
(standard errors in brackets) (2)

	Model I	Model II	Model III (3)
UA	0.089***	0.089***	0.079***
	(0.01)	(0.01)	(0.01)
ID	0.033**	0.046***	0.020
	(0.01)	(0.01)	(0.01)
Medium-sized	0.130***		0.135***
	(0.01)		(0.01)
Large	0.322***		0.330***
	(0.02)		(0.02)
North-East	0.015	0.015	
	(0.01)	(0.01)	
Centre	-0.026	-0.027	
	(0.02)	(0.02)	
South	-0.260***	-0.259***	
	(0.01)	(0.01)	
UA*medium-sized		-0.014	
		(0.02)	
UA*large		0.051	
		(0.03)	
ID*medium-sized		-0.053***	
		(0.01)	
ID*large		-0.047	
		(0.04)	
Number of observations	188,275	188,275	188,275
Adjusted R^2	0.801	0.801	0.803

Sources: Based on Centrale dei Bilanci, Cerved aand INPS data.
(1) All specifications include year and industry fixed effects plus a control for imputed employees. We use only one labor input drawn by INPS dataset (White + Blue collars). Estimation period: 1995-2002. - (2) Standard errors are corrected for clustering at the level of individual LLMAs. - (3) Includes 20 regional fixed effects.

Table 10

Production function coefficients by area type, industry and labor force characteristics
(standard errors in brackets)

	Labor						Capital
	White-collar workers			Blue-collar workers			
Area Type	*Non-ID/UA*	*Urban areas (1)*	*Industrial districts (1)*	*Non-ID/UA*	*Urban areas (1)*	*Industrial districts (1)*	
Sectors							
Food products, beverages and tobacco	0,200***	0,043	-0,030	0,256***	-0,023	0,045***	0,264***
	(0,020)	*(0,029)*	*(0,024)*	*(0,018)*	*(0,021)*	*(0,016)*	*(0,064)*
Textiles and textile products	0,182***	0,094***	-0,005	0,355***	-0,057***	0,012	0,407***
	(0,019)	*(0,024)*	*(0,016)*	*(0,013)*	*(0,017)*	*(0,010)*	*(0,027)*
Leather and leather products	0,139***	0,038	0,013	0,398***	0,014	0,008	0,376***
	(0,034)	*(0,038)*	*(0,033)*	*(0,021)*	*(0,017)*	*(0,016)*	*(0,030)*
Wood and products of wood and cork (except furniture)	0,208***	0,020	-0,026	0,408***	0,010	0,017	0,349***
	(0,024)	*(0,039)*	*(0,027)*	*(0,020)*	*(0,018)*	*(0,014)*	*(0,029)*
Pulp. paper and paper products; recorded media; print. services	0,193***	0,055**	-0,052**	0,263***	-0,017	0,049***	0,269***
	(0,021)	*(0,026)*	*(0,024)*	*(0,021)*	*(0,016)*	*(0,014)*	*(0,024)*
Coke. refined petroleum products and nuclear fuel	0,025	-0,009	0,143	0,124***	0,025	-0,084	0,886***
	(0,087)	*(0,143)*	*(0,152)*	*(0,077)*	*(0,107)*	*(0,139)*	*(0,195)*
Chemicals. chemical products and man-made fibers	0,278***	0,105***	0,014	0,167***	-0,091***	-0,006	0,495***
	(0,030)	*(0,028)*	*(0,033)*	*(0,024)*	*(0,028)*	*(0,029)*	*(0,039)*
Rubber and plastic products	0,169***	0,067***	0,021	0,362***	-0,024	0,008	0,439***
	(0,020)	*(0,027)*	*(0,023)*	*(0,021)*	*(0,017)*	*(0,014)*	*(0,028)*
Other non metallic mineral products	0,125	0,063	-0,004	0,312***	-0,020	0,019	0,505***
	(0,018)	*(0,034)*	*(0,021)*	*(0,022)*	*(0,021)*	*(0,013)*	*(0,026)*
Basic metals and fabricated metal products	0,167***	0,042***	0,018	0,413***	-0,017	-0,002	0,301***
	(0,008)	*(0,016)*	*(0,010)*	*(0,008)*	*(0,009)*	*(0,006)*	*(0,015)*
Machinery and equipment n.e.c.	0,251***	0,086***	0,008	0,324***	-0,059***	0,000	0,319***
	(0,013)	*(0,016)*	*(0,013)*	*(0,011)*	*(0,012)*	*(0,010)*	*(0,014)*
Electrical and optical equipment	0,275***	0,082***	0,007	0,266***	-0,062***	0,001	0,358***
	(0,017)	*(0,017)*	*(0,019)*	*(0,015)*	*(0,013)*	*(0,014)*	*(0,027)*
Transport equipment	0,221***	0,050	-0,066	0,313***	-0,042	0,037	0,335***
	(0,031)	*(0,062)*	*(0,035)*	*(0,033)*	*(0,042)*	*(0,023)*	*(0,061)*
Other manufactured goods n.e.c.	0,160***	0,061	0,025	0,404***	-0,026	-0,023	0,291***
	(0,025)	*(0,035)*		*(0.020)*	*(0,023)*	*(0,020)*	*(0,028)*

Sources: Based on Centrale dei Bilanci, Cerved and INPS data.
(1) Deviations from Non-ID/UA coefficients.

Table 11

Estimation results on firm-level data,
using two labor inputs (white- and blue-collar workers) and two distinct coefficients for UA and ID. Dependent variable: log of TFP measured through LP method (1)
(standard errors in brackets) (2)

	Model I	Model II	Model III (3)
UA	0.053***	0.068***	0.044***
	(0.01)	(0.01)	(0.01)
ID	0.002	0.020	-0.010
	(0.01)	(0.01)	(0.01)
Medium-sized	0.126***		0.131***
	(0.01)		(0.01)
Large	0.317***		0.324***
	(0.01)		(0.01)
North-East	0.019	0.019	
	(0.01)	(0.01)	
Centre	-0.012	-0.013	
	(0.02)	(0.02)	
South	-0.233***	-0.232***	
	(0.01)	(0.01)	
UA*medium-sized		-0.065***	
		(0.02)	
UA*large		-0.039	
		(0.04)	
ID*medium-sized		-0.073***	
		(0.01)	
ID*large		-0.083*	
		(0.04)	
Number of observations	188,275	188,275	188,275
Adjusted R^2	0.800	0.800	0.801

Sources: Based on Centrale dei Bilanci, Cerved aand INPS data.
(1) We use two labor inputs drawn from the INPS dataset (white- and blue-collar workers) and two distinct coefficients for industrial districts and urban areas. All specifications include year and industry fixed effects plus a control for imputed employees. Estimation period: 1995-2002. - (2) Standard errors are corrected for clustering at the level of individual LLMAs. - (3) Includes 20 regional fixed effects.

Table 12

Quantile regression. Estimation results on firm-level data.
Dependent variable: log of TFP measured through LP method (1) (2**)**
(standard errors in brackets) (3)

	Q01	*Q05*	*Q10*	*Q25*	*Q50*	*Q75*	*Q90*	*Q95*	*Q99*
UA	0.069**	0.078***	0.077***	0.083***	0.092***	0.111***	0.123***	0.128***	0.160***
	(0.02)	*(0.01)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.01)*
ID	0.114***	0.061***	0.041***	0.027***	0.020***	0.018***	0.020***	0.015***	0.023**
	(0.02)	*(0.01)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.01)*
Medium-sized	0.117***	0.068***	0.064***	0.052***	0.037***	0.019***	0.001	-0.011**	-0.043***
	(0.02)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.01)*
Large	0.185***	0.135***	0.141***	0.153***	0.155***	0.162***	0.184***	0.186***	0.192***
	(0.05)	*(0.01)*	*(0.01)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.01)*	*(0.01)*	*(0.02)*
North-East	0.062***	0.010*	0.002	-0.001	-0.003*	-0.007***	-0.014***	-0.012***	-0.028***
	(0.02)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.01)*
Centre	-0.140***	-0.070***	-0.056***	-0.046***	-0.039***	-0.034***	-0.024***	-0.021***	-0.035***
	(0.03)	*(0.01)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.01)*	*(0.01)*
South	-0.640***	-0.404***	-0.317***	-0.249***	-0.219***	-0.202***	-0.196***	-0.190***	-0.156***
	(0.04)	*(0.01)*	*(0.01)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.01)*	*(0.01)*
N. obs.	344353	344353	344353	344353	344353	344353	344353	344353	344353
Pseudo R^2	0.2728	0.4712	0.5137	0.5107	0.4722	0.4212	0.3989	0.3933	0.3856

(1) All specifications include year and industry fixed effects plus a control for imputed employees data. - (2) Q01, ..,Q99 indicate estimation carried out at the different percentiles of the TFP distribution (Q01 denotes the first percentile ,and so on). - (3) Bootstrapped standard errors, 20 replications.

Appendix 1 - Imputing employee data

Average unit labor costs measured on the sub-sample of firms for which employment counts information is available provide 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 have 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 costs for a given number of employees.

In each stratum the median of observed firm-level average labor costs was computed, and these estimates were subsequently used to impute missing employment data by taking the ratio of total firm labor costs to the median wage of the stratum in which the firm is classified.

Appendix 2 - The relation between TFP and firm size

Estimates of agglomeration effects on TFP levels discussed so far were based on regression analyses at the firm level. As such, they tend to be prone to measurement problems and the presence of outliers, possibly affecting estimation results in unexpected ways.

Considering that no constraints on returns to scale were introduced when estimating the production function at the firm level, the introduction of a relationship between estimated TFP levels and firm size can be motivated by the existence of a possibly non (log)linear function linking TFP to firm size. To illustrate the argument, let us assume that the log TFP level can be expressed as a generic function of firm size, measured by the employment level,

$$\phi_{it} = h(l_{it}) \quad (1a).$$

Under the hypothesis that the function *h*(.) can be well approximated by means of a polynomial of order *p*, equation (2) in the main text can be restated as:

$$q_{it} = \alpha\, l_{it} + \beta\, k_{it} + \rho_0 + \rho_1 l_{it} + \rho_2 l_{it}^2 + \ldots + \rho_1 l_{it}^p$$
$$= \tilde{\alpha}\, l_{it} + \beta\, k_{it} + \tilde{\phi}_{it} \qquad (2a)$$

where $\tilde{\alpha} = \alpha + \rho_1$ and $\tilde{\phi}_{it} = \rho_0 + \rho_2 l_{it}^2 + \ldots + \rho_1 l_{it}^p$.

Expression (2*a*) above shows how estimating a Cobb-Douglas production function with unrestricted elasticities purges the residual TFP estimates of scale effects only under the restrictive assumption of an exact log-linear relation between individual TFP and firm size. In the presence of a more general non linear relation, production function residuals will be correlated with higher powers of the labor input.[23]

As a consequence, omitting to control for firm size in equation (4) in the main text may result in biased estimates of agglomeration productivity advantages if size is uneven across different LLMA classes, (i.e., if the UA and ID regressors are correlated with firm size).

Appendix 3 - Additional robustness checks

In this section we discuss robustness checks based on running similar regressions to equation (4) in the main text at aggregate rather than at individual firm level, using instrumental variables and for the subsample of small firms.

Considering that the research focuses on productivity differentials at the level of local labor markets, a more robust estimation approach can be implemented if individual TFP levels are aggregated prior to running the regression analysis. For this purpose, data were first aggregated at the level of the industry/LLMA/year by taking employment-weighted averages of individual TFP levels, the choice of the weighting variable being motivated by the expectation that data quality deteriorates as firm size decreases:

$$\phi_{srt} = \frac{1}{L_{srt}} \sum_{i \in (r,s,t)} L_{it} \phi_{it} \qquad (3a)$$

[23] The correlation between inputs and the residual term stemming from equation (2*a*) when p>1 provides an additional argument in favor of estimation methods that can cope with this issue, like the Olley-Pakes (1996) and Levinshon-Petrin (2003) procedures.

Using data at this level of aggregation, equation (4) in the main text was re-estimated by weighted least squares, using the number of firms in each stratum as weight. Estimation results, displayed in Table a1, while confirming the previous evidence of a productivity surplus in urban areas and industrial districts, also show a larger differential, especially in favor of urban areas, where it rises to about 17 per cent. Introducing unobserved regional effects lowers the estimated comparative advantages for urban areas and industrial districts, as in the previous section (see Table a1, column 2).

At this stage, a first attempt was made to deal with the endogeneity issue that is likely to affect the variables identifying urban areas and industrial districts with respect to local productivity levels. In fact, since firm location is not set exogenously but results from individual optimizing choices, plant location can be correlated with unobserved firm characteristics and, in particular, with firm productivity, thus undermining the causal interpretation of the productivity differential estimated above.

Following a standard approach, instrumental variable estimators were used to cope with this endogeneity issue. In line with the previous literature (Ciccone and Hall, 1996; Combes et al., 2008), the basic intuition is that history and geography may provide a source of exogenous spatial variation that affects the likelihood of having a city or an industrial district in a specific location. At the same time we expect these factors will be uncorrelated with current firm productivity in the manufacturing sector. Taking into account the discrete nature of the endogenous regressors, instruments for the UA and ID dummies were obtained taking the predicted value from a multinomial logit regression of LLMA type on a set of strictly exogenous or predetermined variables. Angrist and Pischke (2008, Sec. 4.6.1) show how this procedure can improve the fit of the instruments in the first stage, thus enhancing the precision of IV estimators.

The set of instrumental variables used in the first stage multinomial logit step includes the log of population density in 1921 and the share of population with an university or secondary school degree in 1971 (history), plus the share of LLMA's land near the coastline and the log of the LLMA average altitude (geography).

IV estimates, displayed in the third column of Table a1, not only confirm previous results but point to larger agglomeration effects on manufacturing productivity levels for both industrial districts and urban areas.

To evaluate the dynamic pattern of productivity over the time span considered (1995-2006), the sample was split into two sub-periods. In line with evidence from the baseline model specification, it turns out that comparative advantages for urban areas remain stable while those of industrial districts show a tendency to decline over time (see Table a2 for detailed estimation results).

To single out aggregate TFP variation across differing LLMA types, in a final stage the other panel data dimensions were collapsed, yielding a single spatial cross-section featuring average TFP figures at the LLMA level. The aggregate TFP levels as defined in (3*a*) were first netted out of sectoral, size and statistical imputation effects by running the following regression:

$$\phi_{rst} = \alpha shflagimp_{rst} + \beta avfirmsize_{rst} + \lambda_s + \varepsilon_{rst} \quad (4a)$$

where *shflagimpg* and *avfirmsize* denote respectively the share of firms with imputed employment data and the average firm size in each stratum. Weighted least squares estimators were used to take account of the differences in the size of the strata.

Estimated residuals $\hat{\varepsilon}_{rst}$, obtained by fitting equation (4*a*) to the sample data, were subsequently averaged over industries using relative frequencies as weights, and these figures were finally averaged across years, yielding the desired aggregate TFP indicator at LLMA level, $\bar{\varepsilon}_r$. The latter was subsequently regressed on the ID and UA dummies plus geographical controls.

OLS and IV estimation results are displayed in Table a3. The TFP advantage of urban areas and industrial districts stand out even more sharply, especially in the case of IV estimates, which show the highest values across the different model specification considered here (a TFP gain of about 10 and 30 per cent for industrial districts and urban areas respectively).

The specifications outlined above were also estimated considering the sub-sample of small firms (those with below sector-year median employment level.). A twofold purpose motivates the exercise. First, we are interested in evaluating the case of small firms, as the theoretical literature has emphasized that in agglomerated areas they may benefit from external scale economies while remaining small. Second, our results on cities could be distorted by the presence of multi-plant firms. Usually these firms locate their corporate headquarters in big cities and their factories outside of urban areas. In our data set the local productivity advantages of these factories accrue to the urban area where the corporate headquarters are based, thereby distorting the assessment of a productivity premium in urban areas. To address this problem, we replicate the analysis by restricting the sample to firms with below sector-year median employment level, on the grounds that small firms usually are more likely to own a single plant.

Estimation results are reported in Tables a4 and a5 for the various specifications considered. Overall, the productivity advantage of urban areas and industrial districts is confirmed for the sub-sample of small firms, as is the ranking of urban areas and industrial districts.

On the whole, the robustness analysis carried out in this section confirms the ranking of the productivity advantages across areas as well as its evolution over time.

Table a1

Weighted Least Squares estimation of TFP at LLMA and sector level
(standard errors in brackets) (1)

	WLS with area dummies	WLS with regional dummies	Instrumental variables
ID	0.044***	0.023***	0.063***
	(0.004)	(0.004)	(0.007)
UA	0.180***	0.163***	0.250***
	(0.008)	(0.007)	(0.014)
Lsize	0.019***	0.027***	0.048***
	(0.004)	(0.004)	(0.003)
North-East	-0.004		-0.004
	(0.005)		(0.004)
Centre	-0.044***		-0.060***
	(0.007)		(0.005)
South	-0.274***		-0.275***
	(0.007)		(0.006)
Number of observations	46,094	46,094	46,094
Adjusted R^2	0.884	0.886	0.792

Sources: Based on Centrale dei Bilanci and Cerved data.
(1) Standard errors are corrected for clustering at the level of individual LLMAs.

Table a2

Weighted Least Squares estimation of TFP at LLMA and sector level, by period
(standard errors in brackets) (1)

	1995-2000 (with area dummies)	2001-2006 (with area dummies)	1995-2000 (with regional dummies)	2001-2006 (with regional dummies)
ID	0.047***	0.040***	0.024***	0.023***
	(0.005)	(0.005)	(0.006)	(0.006)
UA	0.175***	0.184***	0.159***	0.168***
	(0.010)	(0.001)	(0.010)	(0.011)
Lsize	0.010	0.027***	0.020***	0.032***
	(0.006)	(0.005)	(0.005)	(0.005)
North-East	-0.005	-0.002		
	(0.006)	(0.007)		
Centre	-0.041***	-0.047***		
	(0.010)	(0.010)		
South	-0.293***	-0.259***		
	(0.010)	(0.009)		
Number of observations	22,275	23,819	22,275	23,819
Adjusted R^2	0.892	0.877	0.895	0.879

Sources: Based on Centrale dei Bilanci and Cerved data.
(1) Standard errors are corrected for clustering at the level of individual LLMAs.

Table a3

Estimation of TFP at LLMA level
(standard errors in brackets) (1)

	Weighted Least Squares	Instrumental variables
ID	0.058 **	0.114 **
	(0.021)	(0.042)
UA	0.184 **	0.332 **
	(0.067)	(0.111)
North-East	-0.019	-0.020
	(0.027)	(0.027)
Centre	-0.050	-0.050
	(0.028)	(0.028)
South	-0.281 ***	-0.259 ***
	(0.025)	(0.029)
Number of observations	689	689
Adjusted R^2	0.278	0.266

Sources: Based on Centrale dei Bilanci and Cerved data.
(1) Standard errors are corrected for clustering at the level of individual LLMAs.

Table a4

Weighted Least Squares estimation of TFP at LLMA and sector level; small firm sample (1)
(standard errors in brackets) (2)

	With area dummies	With regional dummies	Instrumental variables
ID	0.028 ***	0.018 ***	0.055 ***
	(0.003)	(0.003)	(0.008)
UA	0.109 ***	0.099 ***	0.173 ***
	(0.004)	(0.004)	(0.014)
Lsize	0.040 ***	0.037 ***	0.048 ***
	(0.006)	(0.006)	(0.006)
North-East	-0.017 ***		
	(0.003)		
Centre	-0.051 ***		
	(0.004)		
South	-0.258 ***		
	(0.005)		
Number of observations	35,755	35,755	35,755
Adjusted R^2	0.885	0.866	0.773

Sources: Based on Centrale dei Bilanci and Cerved data.
(1) Small firms are those with below sector-year median employment level. - (2) Standard errors are corrected for clustering at the level of individual LLMAs.

Table a5

Weighted Least Squares estimation of TFP at LLMA and sector level; small firm sample, by period (1)
(standard errors in brackets) (2)

	1995-2000 (with area dummies)	2001-2006 (with area dummies)	1995-2000 (with regional dummies)	2001-2006 (with regional dummies)
ID	0.037***	0.020***	0.024***	0.013***
	(0.004)	(0.004)	(0.005)	(0.005)
UA	0.108***	0.110***	0.099***	0.101***
	(0.005)	(0.005)	(0.005)	(0.005)
Lsize	0.035***	0.043***	0.032***	0.042***
	(0.009)	(0.009)	(0.009)	(0.009)
North-East	-0.013***	-0.020***		
	(0.004)	(0.004)		
Centre	-0.045***	-0.056***		
	(0.006)	(0.005)		
South	-0.283***	-0.236***		
	(0.007)	(0.007)		
Number of observations	17,295	18,460	17,295	18,460
Adjusted R^2	0.889	0.882	0.891	0.883

Sources: Based on Centrale dei Bilanci and Cerved data.
(1) Small firms are those with below sector-year median employment level. - (2) Standard errors are corrected for clustering at the level of individual LLMAs.

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