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Urban size and KIBS vertical disintegration: Evidence from Lombardy

Roberto Antonietti[♦] Giulio Cainelli[▲]

Abstract

A recent strand of the economic literature has emphasised the role of services, and in particular knowledge-intensive business services (KIBS), as a primary source of knowledge creation and diffusion. Since this transferring process often occurs through strong face-to-face interactions, the role of spatial proximity becomes crucial. Theoretical and empirical literature show that the geographic concentration of industry induces firms to vertically disintegrate their production, due to the lowering of transport and governance costs as well as to the reduction of opportunism in managing transactions. However, the evidence is primarily based on manufacturing firms, whereas little or no attention is given to service firms.

In this paper we try to fill this gap by estimating the effects of urban agglomeration on knowledge intensive business service firms' vertical disintegration in a longitudinal context, with reference to the Lombardy region in Italy. Data used in this work are drawn from AIDA, a commercial database collected by Bureau Van Dijk gathering information on balance sheets data as well as the geographical position of Italian joint stock companies. Relying on this rich firm-level dataset, we build a sample of almost 17.000 KIBS firms located in Lombardy over the period 2004-2009, and we estimate both a first difference and an instrumental variable GMM model in which, as dependent variable, we use both the share of purchased business services and the share of material inputs, while, as explanatory variables, we include firm size, age and population size at the municipality and local labour system level. In so doing, we estimate the impact that the short-run variations in urban size have on the short-run variations in the degree of vertical disintegration of KIBS, while controlling for potential endogeneity issues due to unobserved heterogeneity and simultaneity, and for the robustness of our measure of urban size to alternative specifications.

Our results complement previous cross-sectional evidence and point to a positive and statistically significant effect of urban size on the degree of vertical disintegration. In addition, we find that this effect is particularly strong for professional KIBS and for the purchase of business services rather than for technological KIBS and for the purchase of material inputs.

Keywords: agglomeration, KIBS, urban size, vertical disintegration

JEL: C33; D22; R12; L24

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1. Introduction

Recently, next to the outsourcing of material inputs and the low skill-intensive stages of production, firms have begun to outsource business services and high skill-intensive tasks: improvements in communication technology as well as the increasing globalization of information software have enabled business services to be broken down into modules, that do not need to be developed internally, and can be produced almost anywhere in the world. Thus firms are able to contract out services, ranging from routine call centre work to higher value software programming and research and development (R&D) activities.

Although outsourcing of intermediate material inputs has undoubtedly a higher incidence in trade statistics, there is much current debate about the relocation of white-collar jobs, in particular high-skill intensive business-related services. Despite the attention this is receiving in the media and among policy makers, little empirical research has been conducted on outsourcing of services, generally and, particularly, on the outsourcing of knowledge intensive business services (KIBS).

The literature has identified two types of KIBS: (i) *advisory services*, primarily involving legal activities, bookkeeping, auditing, business and management consulting, marketing, advertising and other administrative tasks; and (ii) *technical services*, such as computer services, engineering and design, technical testing and analysis (Koschatzky and Zenker, 1999).

Miles *et al.* (1995) make a further distinction between (i) *traditional professional services* which are likely to be intensive users of new technology (marketing, advertising, training, design, financial services, office services, building services, management consultancy, accounting, legal services, environmental services), and (ii) *new technology-based services* (telematics and computer networks, training in new technologies, design involving new technologies, technical engineering, research and development, IT-based building and environmental services, and so on).

In addition, KIBS are characterized by their heavy reliance on professional knowledge, both codified-explicit and tacit-implicit. They can be considered a primary source of information and external knowledge; they can use their knowledge to produce intermediary services for their clients' production processes; and, they are typically supplied to business through strong supplier-user interactions (Miles *et al.*, 1995; Muller and Zenker, 2001).

This last feature is of particular importance for two reasons. First, the client-related nature of the service helps to shape the process of knowledge creation and diffusion by KIBS.

In this context, Muller and Zenker (2001) and Strambach (2001) distinguish among three types of interaction: (i) knowledge acquisition, which takes place through interaction with client firms; (ii) knowledge recombination which occurs within KIBS and involves interaction between newly acquired and existing knowledge; (iii) knowledge transfer from KIBS to clients which occurs when knowledge has been acquired and recombined and takes the form of new or enhanced services.

. This evidence is in line with input-output data (Figure 1) provided by the Italian Institute of Statistics (Istat), in which the average share of purchased services by knowledge-intensive service industries in 2005 is around 75%, with respect to an average 33% by the manufacturing industry.

Moreover, the face-to-face contacts needed for the exchange of knowledge and information make spatial proximity crucial, even in the presence of globalized knowledge flows. In this respect, the aim of this work is to assess the impact of spatial agglomeration on the degree of vertical disintegration of KIBS firms. Relying on a rich panel of firm-level data, we estimate the impact of urban (population) size on the share of purchased business services and material inputs by KIBS headquarter firms located in the Lombardy region, Italy. Since we examine a relatively short period of time, i.e. six years from 2004 to 2009, we interpret our results in terms of the impact of short-term variations in employment density on short-term variations in vertical disintegration (Martin, Mayer and Mayneris, 2011). In addition, the use of first difference and IV-GMM panel data models allows to control for endogeneity biases that typically arise when estimating agglomeration economies, due to the presence of unobservable characteristics and to simultaneity.

Our main points are three: first, we do expect that the scale of urban population does have a positive effect on the degree of vertical disintegration of KIBS firms. Second, we also expect that such a positive effects is higher when firms purchase business services, as these are characterized by more complex transactions, due to the intangible nature of the service exchanged and to the strategic value of these activities. Third, we do expect that this effect holds for professional KIBS, since they are typically located within denser urban areas and that rely more on social interactions than technological KIBS.

The rest of the paper develops as follows. Section 2 briefly presents the related literature on the effect of spatial agglomeration on the vertical disintegration of firms. Section 3 shows the dataset we use in the econometric analysis and describes the variables involved. In Section 4 we discuss the estimation results. Finally, Section 5 concludes.

2. Related literature

Recent developments in regional and urban economics has identified in the spatial clustering of firms a crucial factor for determining the degree of vertical disintegration of firms. This relationship dates back to Stigler's (1951), and rests on the ideas that, on the one hand, spatial proximity to suppliers *per sé* reduces particular transport, search and managerial costs, leading to higher vertical disintegration (Goldstein and Gronberg, 1984), while, on the other, it reduces the scope for opportunistic behaviour by increasing mutual visibility and reciprocal trust (Helsley and Strange, 2007), particularly when dealing with innovation processes and complex transactions (Love and Roper, 2001).

On this purpose, Holmes (1999), using census data on US manufacturing plants in 1987, finds that the intensity of input purchase by a plant is positively correlated with the level of employment of neighbouring plants in the same industry. In this case, a positive relationship arises between outsourcing and industrial specialisation, whereas a null or even negative correlation seems to emerge with respect to the employment level in neighbours operating in related industries. Finally, a mixed evidence characterises the relationship between vertical disintegration and urbanisation: positive up to a certain level of population density, and negative afterwards.

Similar results are also obtained by Ono (2001, 2006) for the USA and Li and Lu (2009) for China. Using data from the 1992 Annual Survey on Manufacturers, the former finds that, once controlled for firm characteristics, a final producer is more likely to outsource when it is located in thick markets, as measured by the level of employment in metropolitan areas. This effect derives from an increase in the local demand for outsourcing, which, in turn, increases the localisation of specialised suppliers, thus decreasing the price of the service. A lower price, then, will increase the potential benefits for the manufacturing firm, thus increasing the likelihood to outsource. In particular, she finds that a doubling of U.S. local demand for white collar services increases the probability to outsource by an amount between 7% and 25%.

Looking at Chinese manufacturing in 2002 and 2003, the latter also find a positive effect of the geographic concentration and the degree of vertical disintegration, even once controlling for endogeneity. In particular, a 1000 increase in own neighbouring employment increases the firm purchased-input intensity by 0.017 percentage points when endogeneity is not controlled and simple OLS are used, while up to a 0.098 percentage points when instrumental variables are used.

The positive correlation between spatial clustering of firms also arises in the Turkish textile and engineering industries (1993-2000), as well as in the Spanish electronic industry (1995-1997). In the former case, Taymaz and Kiliçaslan (2005) find that the increase in the number of firms operating in the same sector and province has a positive relation with the firm propensity to both subcontracting offering and receiving. In the latter case, Rama and Calatrava (2002) and Rama, Ferguson and Melero (2003) find that the probability to establish stable outsourcing relationships among entrepreneurs increases, among other factors, with the geographical and professional proximity of firms, being particularly relevant within industrial districts.

Looking at Italian manufacturing firms over the period 1998-2003, Antonietti and Cainelli (2008) find that the outsourcing of knowledge-intensive business services as well is driven by the interplay between R&D and firms localization within dense local production systems. This finding reinforces Love and Roper (2001) results in stressing the role of geographic proximity, knowledge spillovers and closer interaction among agents in simplifying the management of complex transactions and in increasing firms competitiveness even in the face of increasing globalisation of production.

On the same line, Antonietti, Ferrante and Leoncini (2012), using data collected by the national Fiscal Authority, find that the propensity by small firms operating in the machine tools industry of Emilia Romagna region to fully outsource production activities to external suppliers increases with the density of neighbouring employment in related three-digit sectors, whereas spatial agglomeration forces do not play any role in affecting partial outsourcing.

Finally, Cainelli and Iacobucci (2012), looking at business groups, find that the degree of vertical disintegration increase with the level of variety of a local system, whereas it decreases in presence of a higher technological relatedness with firm activities.

All these studies, then, find a that as the local concentration of employment increases, firms tend to increase the purchase of material inputs or business services from external suppliers. This relationship, however, is generally estimated with respect to manufacturing firms, whereas little or no attention is given to the service outsourcing activities of service firms.

3. Data and variables

Data are drawn from AIDA, a commercial database collected by Bureau Van Dijck. This large data set of Italian joint stock companies gathers information on balance sheet data like sales, number of employees, labour costs, output value, as well as the sector of activity. In this

paper we rely on an unbalanced panel of almost 18.000 service firms (headquarter) - and almost 60.000 observations - located in the Italian Lombardy region and active over at least three consecutive years over the time span 2004-2009.

In the following, we consider as KIBS those firms belonging to the “professional, scientific, and technical activities” industry (according to the standard ATECO 2007 classification), and, in particular, to the following two-digit sectors: 62 - computer programming, consultancy and related activities; 63 - data processing, hosting, and related activities; 69 - legal and accountability activities; 70 – head offices and management consultancy activities; 71 - architectural and engineering activities, technical testing and analysis; 72 – scientific research and development; 73 – advertising; 74 - other professional, scientific and technical activities.

Miles *et al.* (1995) make a further distinction between (i) *traditional professional services* which are likely to be intensive users of new technology (marketing, advertising, training, design, financial services, office services, building services, management consultancy, accounting, legal services, environmental services), and (ii) *new technology-based services* (telematics and computer networks, training in new technologies, design involving new technologies, technical engineering, research and development, IT-based building and environmental services, and so on).

Therefore, we also split our sample between professional KIBS (P-KIBS) and technological KIBS (T-KIBS), where the former category includes sectors 69, 70, 73 and 74, and the latter the remaining sectors 62, 63, 71 and 72.

As dependent variable, we consider the degree of vertical disintegration of the firm that we measure, respectively, as the share of purchased services over total production costs and as the share of purchased material inputs over total production costs:

$$DIS_{it}^j = \left(\frac{C_j}{TC} \right)_{it} \text{ with } j=\text{services, material}$$

where C_j is the value of purchased services or material inputs by firm i in period t , TC_{it} is total production costs defined as the sum of C_j , labor costs, depreciation, and other costs including energy and material costs, transport, reimbursements, training, advertising, and so on. Since the variable is a fraction bounded between 0 and 1, we apply a logistic transformation and we obtain the following variable that we include in the estimates: $VDIS_{it}^j = \ln[DIS_{it}^j / (1 - DIS_{it}^j)]$.

As explanatory variables we consider: firm age (*AGE*), computed as 2009 minus the birth date of the firm (in natural logarithm); firm size (*SIZE*), as given by the yearly real value of output produced (in natural logarithm); urban size (*URBAN*). This last variable is computed as the stock of population of the municipality in which the firm is located, and can be considered as a proxy for the scale of the city.

Moreover, as robustness checks, we also consider an alternative measure of urban size based on the amount of population of the local labour system of reference. Table 1 provides the summary statistics of all these variables.

Finally, as additional controls, we also include year and industry dummies and a dummy equal to 1 for firms located within the local labour system of Milan, which represent the most important urban area of Lombardy and usually attracts a high number of KIBS firms.

4. Econometric specification and estimation issues

Specifically, the relation we want to estimate is the following:

$$(1) \quad \text{VDIS}_{it}^j = \beta_0 + \beta_1 \text{AGE}_i + \beta_2 \text{SIZE}_{it} + \beta_3 \text{SIZE}_{it}^2 + \beta_4 \text{URBAN}_{kt} + \varepsilon_{it}$$

where the subscript *k* refers to the municipality where firm *i* is located.

However, when estimating this equation with OLS, two potential issues arise. The first concerns unobserved heterogeneity, which makes the error term ε to be correlated with the other independent variables because of the presence of unobservable factors that can affect vertical disintegration without being strictly related to urban size. Some examples, for instance, may refer to transportation facilities, public services, or the presence of hot spots (like bars, restaurants and meeting points) where people and workers are likely to meet and exchange information.

In order to couple with this issue, we decide to estimate equation (1) in first difference, so to eliminate every firm specific, time invariant, characteristic (either observable or not). Therefore, our specification becomes:

$$(2) \quad \Delta \text{VDIS}_{it}^j = \beta_1 \Delta \text{AGE}_i + \beta_2 \Delta \text{SIZE}_{it} + \beta_3 \Delta \text{SIZE}_{it}^2 + \beta_4 \Delta \text{URBAN}_{kt} + \Delta \varepsilon_{it}$$

The second issue, instead, concerns simultaneity, namely reverse causality. Following Martin et al. (2011), we adopt an IV-GMM strategy by first-differencing each variable and then instrumenting first-differenced independent variables by their level at time $t-2$, following a GMM procedure. By using longitudinal data and panel techniques, we should capture short-run, i.e. yearly, effects of spatial agglomeration on firm boundaries, rather than long-run effects that can be assessed from cross-sectional estimation strategies. Due to this, the kind of agglomeration externalities that we capture are more closed to labour and input market spillovers than to knowledge spillovers.

5. Estimation results

Table 2 shows the first set of estimates concerning variables in first-difference, while Table 3 provides the estimates when using an IV-GMM approach. Finally, in Tables 4 we provide the IV-GMM estimates when using the alternative measure of urban size based on local labour systems as the geographical unit of reference.

TABLE 2 HERE

TABLE 3 HERE

TABLE 4 HERE

From Table 2 we can take note two interesting results. First, after controlling for firm age, size, and fixed effects, the coefficient of the URBAN variable is high and statistically significant. In particular, a 1% increase in urban population is associated to a 1.2% increase in the degree of vertical disintegration of KIBS firms, regardless of their specialization. This value of the estimated coefficient is considerably higher than the ones emerging from the empirical literature on manufacturing firms.

Second, this picture seems to hold particularly for P-KIBS, where the average impact of a unit increase in urban size is 1.6%. Differently, a weaker effect is registered with respect to T-KIBS, where a 1% increase in urban size is correlated to a 0.7% increase in vertical disintegration. Finally, no effect is registered between urban size and the purchase of material inputs, both for P-KIBS and for T-KIBS.

Therefore, when controlling for firm-specific attributes, we find that proximity to employment and customers is particularly important for making KIBS firms to release their activities, thus reducing their boundaries.

From Table 3, instead, we report for simplicity the estimated coefficient of the URBAN variable, when controlling for simultaneity bias. Interestingly, we find that the previous picture is not only confirmed, but estimated coefficients become even larger, although slightly less significant. In particular, we now note that a 1% increase in urban size determines an almost 2% increase in vertical disintegration, and this effect increases to 2.7% when referring to professional KIBS.

Finally, from Table 4 we try to account for the potential Modifiable Area Unit Problem (MAUP), which could make previous results strictly dependent on the spatial scale of the agglomeration variable selected. On this purpose, we recalculate our URBAN variable at the local labour system level, whose area is generally larger than the one of a municipality. As can be seen, the sign and the significance of urban size remain unaltered, whereas the magnitude of the coefficient increases. Interestingly, we also find a significant effect of urban size on the purchase of material inputs, but smaller, and less significant, than the effect for the purchase of business services. In addition, when looking at the purchase of material inputs by T-KIBS, we register now a very strong effect of urban size (+12.7%). This means that, when enlarging the geographical scale of our agglomeration variable, including the surrounding areas which better capture labour commuting flows, even technological business activities heavily rely on spatial proximity for acquiring their tangible inputs.

6. Conclusions

In this paper we try to assess if urban size, as a measure for spatial proximity, does affect the degree of vertical disintegration of KIBS firms in Lombardy region, Italy. Relying on a very rich dataset, we estimate first-difference and IV-GMM panel data models through which we can control for the two main sources of endogeneity, namely unobserved heterogeneity and simultaneity. Moreover, we also control for the MAUP using, first, a smaller geographical scale for urban size, i.e. the municipality, and, then, a larger one, namely the local labour system.

Our estimates clearly show that urban scale has a positive and highly significant effect on KIBS disintegration. In particular, when looking at the municipality level, P-KIBS seem to heavily benefit from spatial agglomeration when searching for business-related services.

Differently, when we include also peripheral areas in the computation of our agglomeration variable, i.e. local labour systems, we also register a strong positive effect of urban size on the purchase of material inputs by technological KIBS.

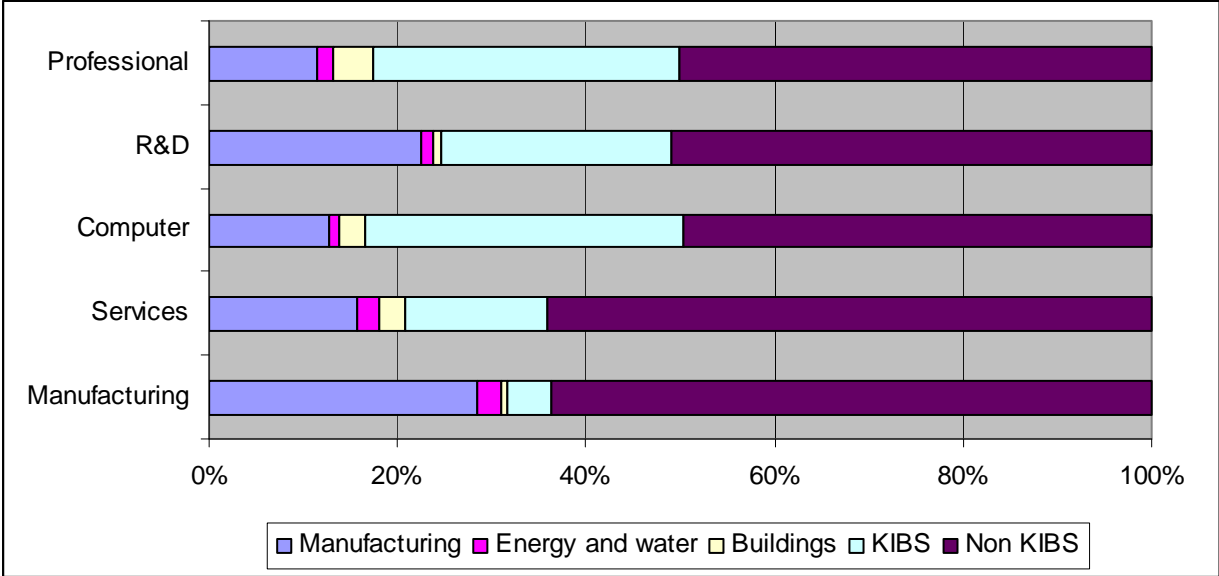
We conclude that, even more than manufacturing firms, KIBS firms tend to disintegrate more when located in more densely populated areas, where transport, managerial and search costs, as well as the level of opportunism, are lower. However, we also find that proximity does have a heterogeneous effect on KIBS' boundaries: in particular, the availability of a larger labour market helps professional KIBS in purchasing business-related activities and T-KIBS in purchasing material inputs.

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Figure 1. The purchase of intermediate inputs by manufacturing and service industries



Source: Istat, national input-output tables, 2005.

Table 1. Summary statistics: mean values

	All sample	P-KIBS	T-KIBS
DIS ^{SERV}	0.534	0.550	0.503
DIS ^{MAT}	0.138	0.137	0.140
AGE	12	12	12
SIZE	3705460	4206893	2719175
URBAN	716681.8	4206893	562394.3
URBAN (LLS)	2135213	2253233	1881917

Table 2. First-difference approach

	VDIS ^{SERV}	VDIS ^{MAT}	VDIS ^{SERV} _{P-KIBS}	VDIS ^{SERV} _{T-KIBS}	VDIS ^{MAT} _{P-KIBS}	VDIS ^{MAT} _{T-KIBS}
AGE	0.039*** (0.003)	0.023*** (0.003)	0.039*** (0.005)	0.039*** (0.008)	0.025*** (0.008)	0.019** (0.009)
SIZE	0.074 (0.046)	-0.407*** (0.063)	0.061 (0.047)	0.132** (0.066)	-0.337*** (0.047)	-0.606*** (0.194)
SIZE ²	-0.004 (0.003)	0.030*** (0.003)	-0.003 (0.003)	-0.006** (0.002)	-0.026*** (0.003)	0.041*** (0.007)
URBAN	1.191*** (0.328)	-0.124 (0.492)	1.603*** (0.488)	0.697** (0.332)	-0.571 (0.778)	0.380 (0.600)
MILAN	-0.015** (0.006)	-0.013 (0.008)	-0.017** (0.008)	-0.010 (0.008)	0.001 (0.011)	-0.034** (0.015)
Year d.	Yes	Yes	Yes	Yes	Yes	Yes
Industry d.	Yes	Yes	Yes	Yes	Yes	Yes
Num. obs.	58529	40101	38499	20030	24909	15192
R ²	0.003	0.029	0.003	0.003	0.026	0.037

Table 3. Instrumental variable approach

	VDIS ^{SERV}	VDIS ^{MAT}	VDIS ^{SERV} _{P-KIBS}	VDIS ^{SERV} _{T-KIBS}	VDIS ^{MAT} _{P-KIBS}	VDIS ^{MAT} _{T-KIBS}
URBAN	1.939** (0.882)	6.785 (4.576)	2.714** (1.141)	0.770 (1.073)	-0.593 (1.833)	2.604 (1.996)
Num- obs.	48928	33235	32207	16721	20610	12625
Centered R ²	0.003	0.029	0.003	0.003	0.023	0.037
KP Wald F	65.86	10.11	62.10	61.34	56.76	16.38

Table 4. Instrumental variable approach: robustness check using local labour systems

	VDIS ^{SERV}	VDIS ^{MAT}	VDIS ^{SERV} _{P-KIBS}	VDIS ^{SERV} _{T-KIBS}	VDIS ^{MAT} _{P-KIBS}	VDIS ^{MAT} _{T-KIBS}
URBAN	4.677*** (1.405)	3.821* (2.107)	6.363*** (1.666)	1.950 (2.116)	-2.497 (2.654)	12.730*** (1.996)
Num- obs.	48928	33235	32207	16721	20610	12625
Centered R ²	0.002	0.027	0.002	0.003	0.023	0.035
KP Wald F	43.95	39.75	47.57	33.58	44.19	29.02