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Trust your neighbour. Spatial agglomeration, social capital and outsourcing

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Abstract

Relying on a unique dataset on small machine-tool firms located in Emilia Romagna, we empirically isolate the effect of proximity (through reduced transport costs) from the effect of social capital (through reduced opportunism and transaction costs) on the propensity to fully or partially outsource production activities. We focus on a series of 29 production phases, from design to assembling and repairing, for which we know if they have been operated in-house or externally though a full outsourcing or a concurrent sourcing strategy. After controlling for endogeneity, we find that, all the rest being equal, the effect of spatial proximity and social capital on outsourcing are nonlinear. In particular, while density is subject to threshold effects, social capital positively affects the propensity to fully outsource only if it interacts with spatial proximity. Differently, the propensity to concurrently source is affected neither by proximity nor by social capital. We interpret this evidence as the result of the monitoring activity of the firm that better controls over the outsourcing process and is less sensitive to the risk of opportunistic behaviour. Finally, when we estimate our model by each production phase, we observe that: (i) the full outsourcing of core phases is only affected by local social capital; (ii) the impact of density is often subject to threshold effects; (iii) the full outsourcing of post-production phases is jointly affected by proximity and social capital; (iv) apart from design, social capital never affects concurrent sourcing, while

proximity, where significant, is always subject to threshold effects.

Jelcodes:C21,L23

Trust your neighbour.
Proximity, social capital and outsourcing

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Abstract

Recent urban economics studies identify spatial agglomeration as a key element for determining the degree of vertical disintegration of firms, because it reduces transport, search and managerial costs, but also the scope for opportunistic behaviour. Relying on a unique dataset on small machine-tool firms located in Emilia Romagna, Italy, we empirically isolate the effect of spatial and technological proximity from the effect of social capital on the propensity to fully or partially outsource production activities. We focus on a series of 29 production phases, from design to repairing, for which we know if they have been operated in-house or outside the firm. After controlling for endogeneity, we find that: (i) full outsourcing is positively related to social capital, but such an effect vanishes as the technological proximity among firms increases; (ii) firms engage in concurrent sourcing only when technological proximity is high; (iii) geo-technological proximity and social capital act like substitute in driving concurrent sourcing. The phase-estimates confirm this picture, and show that, while proximity matters for the full outsourcing of the earliest stages of production, social capital does matter for the core assembling and post-production stages.

JEL classification: A13, D23, L23, L24, L64, R12

Keywords: concurrent sourcing, full outsourcing, proximity, social capital, machine-tool industry

1. Introduction

Recent urban economics studies identify spatial agglomeration as a key element for determining the degree of vertical disintegration of firms. This relationship dates back to Stigler's (1951) work, and rests on the idea that spatial proximity to suppliers reduces transport, search and managerial costs and reduces the scope for opportunistic behaviour by increasing mutual visibility and reciprocal trust.

Holmes (1999) provides a seminal empirical study on this topic. Using 1987 census data on US manufacturing plants, he finds that the intensity of a plant's input purchases is positively correlated with the level of employment in neighbouring plants in the same industry. Similar results are obtained by Ono (2007) for the US, Li and Lu (2009) for Chinese manufacturing, Taymaz and Kiliçaslan (2005) for the Turkish textile industry, Rama and Calatrava (2002) and Rama *et al.* (2003) for the Spanish electronic industry, Antonietti and Cainelli (2008, 2012) and Cainelli and Iacobucci (2009, 2012) for Italian manufacturing, and Antonietti et al. (2012) for the machine tools sector in the Emilia Romagna region of Italy.

All these studies find that, as the local concentration of employment increases, so does the propensity of firms to increase their purchase of material and business service inputs from external suppliers. The ways through which spatial agglomeration favours the outsourcing of production and service activities are basically two: reduced transport costs and reduced transaction costs, because of lower opportunism. According to Love and Roper (2001, p. 319): «*Proximity between purchaser and provider of the outsourced activity may influence the outsourcing decision due to agglomeration or clustering effects.* […] *These may affect the outsourcing decision by impacting on the costs of the outsourced activity, influencing the governance or management costs associated with outsourcing,* […] *or by changing the risks associated with information asymmetries, bounded rationality and opportunism*».

Spatial agglomeration allows firms to save in the transportation necessary for outsourcing, to gain from specialized services provided by local suppliers, or to benefit from increased scope of outsourcing, due to the presence of locally developed interpersonal networks and supply-chains. On the behavioural side, spatial clustering facilitates personal contacts and social interactions that reduce governance and management costs through the development of reciprocal trust among partners (Goldstein and Gronberg, 1984). In this way, «*the potential for such proximity effects – or outsourcing economies – is likely to be greater in urbanised or metropolitan areas*» (Love and Roper, 2001, p. 319), because «*agglomeration reduces opportunism, and so serves as a substitute for integration*» (Helsley and Strange, 2007, p. 57).

In this paper we argue that, from an empirical point of view, the literature investigating the link between agglomeration and outsourcing suffers from three major limits. First, the use of a single measure of geographical concentration of economic activities as an explanatory variable does not help to clearly distinguish among the effects of the two basic elements, i.e. on transport or on transaction costs (opportunism)[1]. Is outsourcing more profitable when transport costs are lower? Or is it only a matter of lower opportunism? Or both? In addition, the use of different levels of geographical aggregation does not help clearly understand how important can be the role of cognitive and technological proximity, or relatedness (Boschma, 2005, 2009), among neighbouring firms. The decision to subcontract may depend not only on transport and static transaction costs, but also on how aligned are the competencies and knowledge bases between providers and suppliers. A higher cognitive distance among the parties implies higher dynamic transaction costs (Langlois, 1992), in terms of costs of persuading, negotiating and coordinating with, and teaching others. This

[1] Burker and Minerva (2010) directly investigate the relationship between local civic capital, as a form of social capital that decreases opportunism in transactions, and outsourcing of service inputs in Italian manufacturing. In their case, while the link between opportunism and outsourcing is clearly modelled, the role of spatial agglomeration and proximity is missing.

is particularly true for small-sized firms, where typically financial resources and bargaining power are lower or not enough for bearing such costs.

A second issue concerns the nature of outsourcing. Drawing on transaction cost theory (Coase, 1937; Williamson, 1985), both theoretical and empirical studies on agglomeration and outsourcing typically focus on the dichotomous make-or-buy choice. As stressed by some recent business and organization studies (Parmigiani, 2007; Parmigiani and Mitchell, 2009; Puranam et al., 2013), firms, in practice, operate joint sourcing decisions, and do simultaneously make *and* buy the same good, a phenomenon often labelled as *concurrent sourcing*, or *partial outsourcing*, or *tapered integration* (Harrigan, 1984; see Parmigiani (2007) for a finer distinction between these forms of integration). When concurrently sourcing, the firm incurs both the costs of coordinating the accompany internal production and the costs of searching, finding, monitoring and maintaining external suppliers. Since monitoring and coordination activities differ between full and partial outsourcing, spatial agglomeration can exhibit different effects on the vertical boundaries of the firm. However, a direct investigation of these effects is still lacking in the literature.

Finally, the third issue concerns the nature of the outsourced activity. With few exceptions - e.g. Love and Roper (2001), who focus on the outsourcing within the innovation process, and Cusmano et al. (2009) who broadly distinguish among production, R&D, design and service activities) - the empirical literature on the local determinants of outsourcing uses dummy variables for measuring the probability to outsource (Love and Roper, 2001; Ono, 2007; Antonietti and Cainelli, 2008; Cusmano et al., 2009; Antonietti et al., 2012), or a synthetic indicator of the intensity of outsourcing, given by the costs for purchased services over total production costs (Antonietti and Cainelli, 2012) or by the share of subcontracted inputs in all inputs (Taymaz and Kiliçaslan, 2005), or by the standard Adelman index of vertical (dis)integration (Holmes, 1999; Li and Lu, 2009; Burker and Minerva, 2010).

Apart roughly distinguishing between material and service activities, all these indicators do not clearly identify which phase of the production process, or which task, is contracted out by the firm. We believe that neglecting this aspect may be problematic when studying the effects of agglomeration on outsourcing. In practice, production processes are heterogeneous, as they involve simple and complex tasks, more or less standardized activities, core and peripheral phases, innovative and mature processes. If this is the case, the importance of transport and transaction costs may vary across production phases, the former being particularly important for peripheral or more standardized activities, the latter for core, innovative and high-value added ones.

In this paper we try to fill this threefold gap as follows. First, we clearly distinguish between geographical/technological proximity and social capital forces, and we isolate their impact on firm propensity to outsource production activities. While the former influences outsourcing through transport and knowledge sharing costs, the latter acts though reducing the level of opportunism in transactions. Second, we clearly distinguish between full and partial outsourcing, and we empirically investigate how different is the impact of proximity and social capital on these two different production organization strategies. Third, we take account of the specific production phase being outsourced. For each of them, we assess the impact of proximity and social capital, so to address the phase, or task-heterogeneity underlying the agglomeration-outsourcing relationship.

For the empirical analysis, we rely on a new and original dataset of small firms located in Emilia Romagna region, in Italy, and belonging to the manufacturing of machinery and equipment industry (ATECO 2001 code D29, NACE rev. 2 code C28). This region represents an interesting case study because of its rapid post-war recovery, based on the industrial district model (Brusco, 1982), in which a strong division of labour and a high recourse to subcontracting with local specialized suppliers is mixed with high cooperation and competition among firms and highly localized social learning patterns (Asheim et al., 2009). Emilia Romagna represents also an interesting example of regional branching based on knowledge transfer across related sectors: «*Many successful sectors like ceramic tiles, the packaging industry and robotics emerged out of a* *pervasive regional knowledge base in engineering. These sectors not only built and expanded on this extensive knowledge base, they also renewed and broadened the regional economy of Emilia Romagna*» (Boschma, 2009, p. 9). Moreover, the industrial-district based Emilian model described by Brusco (1992), as well as recent empirical evidence (Cusmano et al., 2009) show that outsourcing in this region occurs predominantly at the local level, particularly in the machine-tool related industries. For all these reasons, we believe Emilia Romagna represents an appropriate example for testing the effects of proximity and social capital on the local division of labour.

The rest of the paper develops as follows. Section 2 presents the theoretical background and the main research hypotheses: first, we discuss a descriptive model for the general probability to full and partial outsource (2.1), and then we go through a full versus partial outsourcing model for each single production phase (2.2). Section 3 describes the data (3.1), the empirical strategy and the variables utilized in the estimates (3.2). In Section 4 we present and discuss the estimation results. Finally, Section 5 concludes.

2. Theoretical background and research hypotheses

2.1. A descriptive model for full and partial outsourcing

The wide literature on transaction costs has deeply investigated the factors that push firms to subcontract material or service activities to external suppliers. Generally, the recourse to the market depends on the level of transaction costs, which, in turn, depend on the degree of contractual incompleteness affecting economic transactions (Williamson, 1985). Asset specificity, market and technological uncertainty, information asymmetries and the risk of opportunistic behaviour all contribute to increase hold-up problems and discourage firms to outsource goods and services.

According to Williamson (2005), the vertical boundaries of the firm are not only determined by transaction attributes, but also by the characteristics of the surrounding environment. In this paper we focus on two factors that are supposed to drive the make-or-buy choice, and characterize the local environment in which the firm is located: proximity and social capital.

Although both of them contribute to determine the level of transaction costs, we here assume that they influence the outsourcing decision of firms in two different ways. The geographic concentration of activities, that we measure in terms of firm density, increases the spatial proximity between clients and suppliers, and reduces transport costs. First of all, a higher density of firms and employment reduces search costs for finding suitable partners and favours the efficient matching between providers and suppliers (Duranton and Puga, 2004). Secondly, a thicker market decreases the average price of outsourcing services, due to a higher local competition between suppliers (Ono, 2007). Thirdly, a densely populated area decreases the scope for opportunistic behaviour because it increases mutual visibility and facilitates monitoring (Goldstein and Gronberg, 1984; Helsley and Strange, 2007).

This latter aspect is not only due to the spatial proximity between agents, but also to their cognitive and technological proximity (Nooteboom, 1999; Boschma, 2005). The higher is the technological relatedness among firms and suppliers, the easier should be the monitoring over the service provided, as firms may easily exchange technical advice and information, and can better receive, absorb, decode and master external knowledge, often tacit, procedural and of a know-how type (Zander and Kogut, 1995), from business partners. In this way, cheating behaviour is discouraged by the fact that both providers and suppliers share the same knowledge base. Therefore, spatial and technological proximity can act as a substitute for social capital, as they reduce the need of building trust when managing market transactions.

Social capital is a difficult concept to define, since it encompasses different aspects of human being. Here social capital is conceived from a macroeconomic perspective as a system of shared values and beliefs that should prevent opportunistic behaviour by favouring trust building and mutual cooperation among people. This definition is in line with the one provided by Putnam et al. (1993), according to whom social capital refers to features of social organisation, such as trust, norms, and networks, that can improve the efficiency of society by facilitating coordinated actions. Our concept of social capital is also coherent with the one provided by Bowles and Gintis (2002, p.

F419), where it: «*generally refers to trust, concern for one's associates, a willingness to live by the norms of one's community and to punish those who do not*» (see Durlauf and Fafchamps (2005) for an extensive review of the definition and measurement of social capital).

In the last decades, the notion of social capital has been extensively utilized in many fields, including economics, management, organization, sociology, psychology, political science, and planning. Social capital is generally related to many aspects of socio-economic life, like, among the others, higher economic growth (Zak and Knack, 2001), higher financial development (Guiso et al., 2004), higher innovation (Akçomak and ter Weel, 2009), higher education (Coleman, 1988; OECD 2001), and higher local development (De Blasio and Nuzzo, 2009).

Some other studies from organization science, labour economics and game theory have focused on social capital as a determinant of governance structure and establishment size, through the role that increased trust, or reduced opportunism, play on the decentralization of decision in larger firms, in the avoiding of shirking behaviour when working in team, or in building reputation in one-shot transactions (for a short review see Burker and Minerva, 2012). According to Williamson (1985), trust is a social norm which reduces the need to use hierarchy and vertically integrated structures to attenuate opportunism[2]. Areas where social capital is higher are also expected to have higher levels of trust and pro-social attitudes like altruism, preferences for reciprocal fairness and moral obligations not to defect or behave with guile. In such a kind of local environment, market transactions are favoured, and outsourcing should be easier to manage.

We begin assuming that the probability for firm i to fully outsource (*FO*) production activities depends, other than from a set of firm-level characteristics, on the spatial and technological proximity with potential suppliers. On the one hand, spatial proximity reduced transport costs that make search, matching and monitoring easier. On the other, technological proximity facilitates knowledge absorption and transfer, and reduces uncertainty in subcontracting

[2] Bloom et al. (2012) provide cross-country evidence that trust favours decentralization of decisions and reduces the average size of plants. Similar results are also found for Italy by Burker and Minerva (2012).

relations. In the following, we capture spatial and technological proximity with a single density indicator, where the numerator measures the number of firms (i.e local units) belonging, respectively, to the same 1 digit industry (i.e manufacturing), 2 digit industry (i.e. machine tool manufacturing), or 3 digit industry (i.e. manufacturing of general purpose machinery, manufacturing of agricultural machinery, manufacturing of hand tool machinery, manufacturing of machinery for domestic use) of the subcontracting firm. In this way, the numerator is given by the interaction between spatial and technological (i.e. sectoral) proximity.

Other things being equal, we do expect that:

H1: *a higher local density of manufacturing activities is related to a higher propensity to full outsource production activities*;

H2*: the higher the level of social capital within the area of firm location, the higher the probability to fully outsource production activities*.

However, the higher is the degree of technological proximity across firms, the lower should be the role of social capital in predicting the propensity to outsource activities. Then:

H3: *the higher the technological proximity of firms (i.e. the higher the co-localization of neighbouring firms belonging to the same three-digit industry), the lower the importance of social capital in predicting full outsourcing.*

Differently, when undertaking concurrent sourcing (*CS*) strategies, firms balance higher production costs, because the operation of the outsourced task is partly kept in house, and lower transaction management costs because they can better monitor the quality of the service provided.

This latter aspect is of crucial importance for modelling the role of social capital and technological proximity. While it is reasonable to assume concurrent sourcing to be favoured by spatial agglomeration forces (still through reduced transport costs and increased knowledge codification), less evident is the effect of social capital. Since the firm can operate a direct control on the outsourcing process, the need to locate in a high trust-building environment is lower. In addition, such a kind of control should be facilitated by higher technological proximity, since the firm can share the same knowledge base, the same competencies or it can receive and reciprocate pieces of tacit knowledge with specialised suppliers. Therefore, we do expect that, other things being equal:

> H4*: the propensity of firms to concurrently source production activities is positively related to higher local density of technologically related neighbouring firms, but not necessarily to the level of local social capital*.

2.2. Phase-heterogeneity in full and partial outsourcing

All the hypotheses previously formulated refer to a general model of full and partial outsourcing, where no information is provided on the single activity being subcontracted. Our data, described later in Section 3, allow to separate a typical machinery production process into a set of 29 phases, listed in Table 1. To our knowledge, this is the first time that the outsourcing decision of the firm is analysed at this level of disaggregation. This piece of information is particularly important since it allows understand the microeconomic motivations underlying the general propensity to outsource production.

TABLE 1 AROUND HERE

These phases include:

- preliminary (knowledge-intensive) activities like design and machinery projecting;

- early working activities like hot and cold-working, gear working;
- treatments;
- assembling;
- ancillary activities like rubber, glass and wood working or software development;
- final stages like testing, painting and refining;
- post-production activities like repairing and component replacement or re-working.

Table 1 shows the number of firms operating each single phase, and the percentage of firms developing them in-house or outside through full (FO) or partial outsourcing (CS).

Interestingly, the organization of production across phases is quite heterogeneous. For instance, we note that the five phases which are fully outsourced most frequently are sintering, thermal and surface treatments, glass working and sand blasting, whereas the five ones which are concurrently sourced most frequently are cold-working, working by shaving removal, assembling by welding, electrical assembling and installing. On average, assembling and post-production phases are the mostly internalized ones (i.e the ones for which, on average, the %INT is higher than the sum of %FO and %CS), followed by final stages. Early and ancillary stages, instead, are less frequently internalized and more outsourced. We then consider the former as the core phases of firm specialization, and the latter as being the peripheral or ancillary ones, where the firm is less specialized and competent. We also note that concurrent sourcing is generally less frequent than full outsourcing, except for the case of post-production stages.

At this stage it is difficult to predict how proximity and social capital can influence each single production phase. In general, we can expect that the full outsourcing of core activities is particularly sensitive to opportunism and dynamic transaction costs (i.e. cognitive/technological relatedness), whereas the peripheral, or ancillary, stages should be more affected by transport costs. For the concurrent sourcing case, we still do expect social capital to be unsignificant, unless the subcontracted activity is highly skill intensive or highly strategic for the firm, like design.

Since we cannot formulate any clear hypothesis *a priori*, we somehow infer assumptions from our data. Therefore, we do expect (H5) social capital to positively affect the firm propensity to full outsource assembling, final and post-production stages, whereas proximity should play a major role in affecting the full outsourcing of early working and ancillary phases.

With respect to concurrent sourcing, we rest on the general hypothesis that social capital should not be relevant in affecting this choice. Since CS is the less frequent subcontracting strategy, we do expect (H6) that higher proximity and social capital favours the partial release of post-production stages. In other words, CS is less preferred with respect to FO, but when it is more frequent (i.e. post-production phases), it occurs because of the low transport and transaction costs of the area.

The picture emerging from the estimates will induce us to formulate general conclusions on the outsourcing behaviour of machine-tool firms in Emilia Romagna. The main drawback is that we can consider this evidence as strictly pertaining our sample of firms, without any sake of generalization.

3 Dataset and variables

3.1 The dataset

The data are extracted from the so called Sector Studies (*Studi di Settore*), developed by the Italian Fiscal Authority (*Agenzia delle Entrate*) with the aim of establishing a benchmark of relevant fiscal data and provide the most detailed and objective picture on firms' fiscal position[3].

We obtained a dataset of about 4,500 firms belonging to the machine-tool industry (NACE code C28, ATECO 2001 code D29), located in Emilia Romagna region in 2005, and employing less than 100 employees (i.e. and with annual turnover of less than 5,164,169 euros). After cleaning data from missing values in the variables of interest, we come up with a final sample of 3,280 firms.

[3] These data have been obtained thanks to a formal agreement between the University of Bologna (Department of Statistical Sciences), Emilia-Romagna Region and the Italian Statistical Institute (ISTAT).

Table 2 shows the sample distribution of firms by industry, employment class and (NUTS 3) region of firm location. Table 3, instead, shows some statistics on the representativeness of our data, once compared with 2001 Census data.

TABLE 2 AROUND HERE

TABLE 3 AROUND HERE

3.2 Empirical strategy and variable description

Our empirical strategy consists of two steps. In the first, we estimate the general probability for firms to fully or partially outsource their production process. In the second one, we separately estimate the probability to fully or partially outsource each single phase (see Table 1) of the production process.

We consider two dependent variables. The first is a dummy equal to 1 when the firm fully outsources its production phases (*FO*) and 0 otherwise; the second is a dummy equal to 1 when the firm concurrently source its production phases (*CS*), and 0 otherwise. When we refer to the whole production process (first step of the empirical analysis), *FO* (*CS)* is equal to 1 when the firm fully (partially) outsources at least one of its production activities, whereas when we refer to the single phase (second step) a value of 1 for *FO* (*CS*) refers to the decision to fully (partially) outsource the specific phase.

In the following we report the specifications of the probit models for the two described dependent variables:

$$(1)\ \Pr(FO_{ir}=1\,|\,\mathbf{X}_{ir}, Density_r, SocialCapital_r)=\Phi(\mathbf{X}_{ir}^{'}\boldsymbol{\beta}_{FO}+Density_r\gamma_{FO}+SocialCapital_r\gamma_{FO})$$

$$(2)\ \Pr(CS_{ir}=1\,|\,\mathbf{X}_{ir}, Density_r, SocialCapital_r)=\Phi(\mathbf{X}_{ir}^{'}\boldsymbol{\beta}_{CS}+Density_r\gamma_{CS}+SocialCapital_r\gamma_{CS})$$

where *i* represents the firm and *r* represents the NUTS 3 region (province) of firm location.
Both models are first estimated over the entire sample of 3280 firms, and then phase by phase.

Among regressors, we distinguish firm-level controls **X**, density (*Density*) and social capital (*Social Capital*). Controls include variables capturing the internal organization of the firm and standard determinants of the make-or-buy decision: (log) age, computed as 2005 minus the start-up year of the firm (*Age*); employment size (*Size*), given by two dummy variables equal to 1 for firms employing 1 to 10 employees and 11 to 50 employees respectively (this latter used as the reference); the level of human capital (*Human Capital*), or skill intensity, of the workforce, given by the (log) share of white collars (managers, executives and clerks); (log) labour cost per employee (*Labour Cost*); the number of products offered by each firm, as a proxy for scope economies or product complexity (*Nprod*); an ordinal variable (*Area*) describing the geographical scope of the market area in which the firm operates, being 1=municipality, 2=province (NUTS 3), 3=up to 3 regions (NUTS 2), 4=more than 3 regions (NUTS 2); a dummy capturing the propensity of firms to serve global markets through exports (*Export*); two variables measuring the type of production, i.e. catalogue production (*Catalogue*) or production based on client's design (*Client Design*), both computed as the share over total orders[4]; two variables measuring own production (*Prod_own*) (in Italian *Conto-proprio*) and production on behalf of a third party (*Third party*) (in Italian *Conto-terzi*), both in terms of share over total turnover. In addition, we include five three-digit industry dummies in order to control for sector-specific effects, and 29 phase dummies in order to account for the nature, and the structure, of the production process of each firm.

Finally, we include two covariates referring to the characteristics of the environment in which our machine-tool firms operate. *Density* refers to the NUTS 3 region (i.e the province) in which firm *i* is located and it is calculated in three ways: (i) as (log) manufacturing (1 digit,

[4] These two variables should capture the degree of asset specificity surrounding firm activity. Producing from catalogue implies a standardized, and thus more general, type of production, whereas producing using customers' design should imply a more client-specific type of production.

ATECO2002 code D) employment (from 2001 Census data provided by ISTAT) per square kilometre of the province (*Density_1digit*); (ii) as (log) machine-tool manufacturing (2 digit, ATECO2002 code 29) employment per square kilometre of the province (*Density_2digit*); (iii) as (log) manufacturing (3 digit, ATECO2002 codes 29.1, 29.2, 29.3, 29.4, 29.5 and 29.7) employment per square kilometre of the province (*Density_3digit*).

As described in Section 2, a higher firm density is related to higher availability of suppliers (and then higher efficiency and quality of matching and lower search costs), lower transport costs and higher reciprocal visibility among partners and competitors, but also to higher technological proximity as far as the numerator passes from one to three-digit employment. Since the absolute number of firms decreases when the number of digits increases, we have that *Density_1digit* captures a higher geographical proximity and a lower technological proximity between firms, *Density_3digit* captures a lower geographical proximity but the highest technological proximity, and *Density_2digit* represents an intermediate situation.

Social Capital is measured by synthetic index provided by Cartocci (2007), which borrows the key elements from the one originally developed by Putnam et al. (1993). This index is obtained by synthesizing, through the principal component analysis, the following four indicators: (i) the number of newspapers circulating among 1,000 inhabitants (average between 2001 and 2002); (ii) the amount of population participating to the electoral turnouts over 100 voters (in years 1999-2001); (iii) the average between the standardized number of blood donations and number of donors per 1,000 (in 2002); (iv) the average between the number of sport associations (in 1999) and the number of sports memberships by 1,000 inhabitants (in 2001). For all the methodological details see Cartocci (2007).

A final issue concerns endogeneity. Since our data are cross-sectional and refer to one year only, a potential simultaneity bias may affect our probit estimates. In order to mitigate reverse causality effects, we adopt an instrumental variable approach (IV probit model) in which we use historical values of the potentially endogenous variables as instruments (as in Acemoglu et al., 2009 and De Blasio and Nuzzo, 2009). To instrument our three density variables we use the same values in 1991, while for *Social Capital* we use an index computed from 1958-60 data and provided by Arrighetti et al. (2003)[5]. The identification assumption implied by our approach is that, conditional on the other controls included in Equations 3 and 4, density in 1991 and social capital in 1960 have no effect on full and partial outsourcing decisions in 2005 other than through the persistence of density and social capital.

4. Results

Tables 4 and 5 provides the probit estimation results for the whole sample, while Tables 6 and 7 show probit results for the probability to fully and partially outsource each single phase separately.

From Table 4, we observe that the propensity to fully outsource production activities is negatively related to both employment size and final market size (*Local*), whereas it is positively and significantly related to labour cost and own production.

As regard proximity and social capital, we find that higher local density of manufacturing activities is related to higher likelihood to fully outsource production activities. This effect becomes more and more significant as the sectoral proximity between neighbouring firms increases, i.e. passing from *Density_1digit* to *Density_3digit*. Then, we can consider H1 as being satisfied by our estimates. Results in Column 2 seem to corroborate H2: a unit increase in log social capital is related to a 11% increase in the probability to fully outsource production activities. Columns 3 and 4, instead, show that the positive effect of social capital vanishes as the technological proximity between neighbouring firms increases, as predicted in H3. In this case, while the coefficient of our density variables remains highly significant, the one pertaining social capital becomes not statistically significant.

[5] The social capital index developed by Arrighetti et al. (2003) is slightly different than the one provided by Cartocci (2007), since it considers the literacy rate of the local population, the participation to electoral turnouts and to two important referenda. For all details see Arrighetti et al. (2003).

We then estimate IV probit models, in which we separately test for the exogeneity of our density and social capital variables[6]. With respect to the former, we find that the instruments for the three density variables are highly significant and robust, as given also by the extremely high value of the F statistic (higher than the rule-of-thumb value of 10). Among the three, we register a weak endogeneity only for the *Density_1digit* variable (at 10% level), but its IV coefficient remains statistically significant at 5% level. With respect to *Social Capital*, we find that the selected instrument (i.e. social capital in 1960), is highly significant and robust, while the Wald test does never reject the null hypothesis of exogeneity.

Passing now at concurrent sourcing, Table 5 shows a quite different picture with respect to Table 4. The decision to concurrently source is negatively related to the small size of the market area and to the propensity to produce on its own, and positively related to higher labour cost, firm age and size. Column 1 shows that neither spatial proximity nor social capital are significant predictors of the likelihood to partially outsource production. However, Column 2 and 3 show that, as the technological proximity increases, the effect of social capital turns negative and statistically significant. In this case, proximity and social capital seem to act like substitute variables. Therefore, our estimates seem to confirm H4. This results still hold after controlling for the endogeneity of *Density_3digit* and *Social Capital*. While the Wald test leads not to reject the null hypothesis of exogeneity for *Social Capital*, technological proximity is found to be endogenous (at 1% level). However, the marginal effect after IV probit is still positive and significant.

We now look at the estimation results for each single phase. Due to the limited amount of observations pertaining certain production phases, Tables 6 and 7 show the results for the phases for which we could actually run the probit estimates[7].

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[6] We first tried to simultaneously instrument density and social capital, but the log-likelihood function was never able to become concave and reach a maximum value. We then proceeded by instrumenting each of them separately.

[7] For reasons of space, we only report the level of statistical significance of the estimated coefficients of our density and social capital variables. In addition, Table 7 only reports the phases for which we registered a significant effect in the variables of interest, namely proximity and social capital.

Results from Table 6 partially confirm our general expectations, that is H5. Higher social capital alone is particularly relevant for the full outsourcing of core assembling and post-production phases. Fully externalizing these kind of activities requires a highly trusty environment, independently on the geographical or technological proximity with suppliers. Early working and final stages are characterized by a mixed picture. In the former case both proximity and social capital do matter, although it is not possible to draw a clear picture. In the latter case, a substitution effect between density and social capital seems to be at work. When the technological proximity increases, the importance of trust vanishes. Finally, we observe that proximity dominates social capital in affecting the full outsourcing of ancillary phases, like treatments and control software development, whereas for design we do not find any relevant effect.

When looking at Table 7, we find a partial validation for our H6: density and social capital predict the concurrent sourcing choice of few phases only, predominantly the post-production ones. However, for these latter, we find that the increase from spatial to technological proximity make social capital to turn negative, as in a sort of substitution effect. The econometric evidence arising from Table 5 finds here a further confirmation: when the firm can control over the outsourcing process, then the need for a high level of local trust disappears.

5. Conclusions

Relying on a new firm-level dataset on machine-tool firms located in Emilia Romagna region, Italy, the paper empirically investigates the relationship between proximity, social capital and full versus partial outsourcing. Once controlled for firm-specific attributes, and endogeneity, we find that geo-technological proximity and low opportunism (or high trust and commitment) are important predictors of the choice to fully outsource production activities. Differently, since the firm can better monitor external suppliers, the decision to partially outsource is not affected by social capital, but only by agglomeration forces which reduce transport, search and service costs.

When looking at the single activity being fully or partially outsourced, we find quite heterogeneous results. While concurrent sourcing is little or no related with local social capital, the full outsourcing of assembling and post-production phases seems to be particularly sensitive to it. For the full outsourcing of the final stages, instead, we observe that higher technological proximity substitutes for social capital.

With these results we provide additional empirical evidence on the relationship between proximity and firm vertical boundaries. Differently from previous studies, we clearly distinguish the effect played by both spatial and technological proximity from the effect of social capital, which contributes to reduce opportunism and increase trust and cooperation. For the first time, we are also able to estimate such a relationship for each single phase of the machine-tool production process.

From a policy perspective, our results, although limited to the regional case study of Emilia Romagna, can be useful for designing the 'optimum' environment which allows the most efficient division of labour across firms and production phases. To build such an environment, policy makers should not only look at stimulating the clustering of economic activities, but they should also look at the type of specialization, at the degree of technological relatedness, and at macroeconomic factors favouring the building of trust and coordinated activities. As we have shown, the interplay between these two forces makes outsourcing more convenient and less risky.

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TABLES

Table 1. Phase description and distribution

Stage	Phase	N	%INT	% FO	%CS
Design	1 Design	1,276	69.83	11.76	18.42
Early working	2 Sintering	92	13.04	83.70	3.26
	3 Hot-working	403	23.33	66.25	10.42
	4 Cold-working	1,221	29,57	49,30	21,13
	5 Working by shaving removal	1,253	34.48	31.92	33.60
	6 Gear working	690	22.61	64.35	13.04
	7 Refining	1,126	53.37	29.57	17.05
	Average		*24.46*	*61.88*	*13.66*
Treatments	8 Thermal treatments	769	4.68	92.59	2.73
	9 Surface treatments	905	14.59	77.35	8.07
	Average		*9.635*	*84.97*	*5.400*
Assembling	10 Assembling by welding	1,712	50.53	26.29	23.19
	11 Assembling by sticking	331	69.49	23.26	7.25
	12 Assembling by riveting	586	77.30	14.16	8.53
	13 Mechanical assembling	2,121	76.47	7.73	15.79
	14 Electrical assembling	1,377	40.60	37.62	21.79
	Average		*62.88*	*21.81*	*15.31*
Ancillary	15 Control software development	693	28.28	56.71	15.01
	16 Rubber and plastics working	375	28.00	59.47	12.53
	17 Glass working	39	5.13	92.31	2.56
	18 Wood working	72	31.94	62.50	12.42
	Average		*23.34*	*67.75*	*8.92*
Final	19 Testing	1,846	84.56	6.66	8.78
	20 Packing	1,215	81.89	11.19	6.91
	21 Washing	489	75.46	18.61	5.93
	22 Sand-blasting	688	15.84	79.51	4.65
	23 Painting	1,264	24.84	62.74	12.42
	24 Installing	1,632	70.40	11.09	18.50
	Average		*56.52*	*35.74*	*7.74*
Post-production	25 Repairing and ordinary maintenance	2,182	79.97	7.01	13.02
	26 Repairing and scheduled maintenance	1,068	78.46	11.05	10.49
	27 General overhaul	1,223	83.73	7.85	8.42
	28 Component replacement	1,779	83.02	6.69	10.29
	29 Component re-working	619	70.60	18.26	11.15
	Average		*77.70*	*10.33*	*11.98*

Table 2. Sample statistics

Industry (3 digit)	Num. obs.	%
29.1 Manufacturing of general-purpose machinery	192	5.85
29.2 Manufacturing of other general-purpose machinery	1820	55.49
29.3 Manufacturing of agricultural and forestry machinery	286	8,72
29.4 Manufacturing of metal forming machinery and machine tools	260	7.93
29.5 Manufacturing of special-purpose machinery	689	21.01
29.7 Manufacturing of other-purpose machinery (domestic use)	33	1.01
Total	3280	100.0
Employment size		
1-10	2319	70.70
11-50	961	29.30
Provincial (NUTS 3 region) distribution		
Piacenza	190	5.79
Parma	529	16.13
Reggio Emilia	508	15.49
Modena	595	18.14
Bologna	747	22.77
Ferrara	155	4.73
Ravenna	211	6.43
Forlì-Cesena	143	6.16
Rimini	143	4.36
Total	3280	100.0

Table 3. Sample representativeness

Employment class	Census 2001	%	Sector Studies	%
≤ 5	3795	59.3	2932	63.8
6-9	765	11.9	557	12.1
10-15	638	10.0	466	10.1
16-19	252	3.9	231	5.0
20-49	599	9.4	393	8.6
50-99	177	2.8	14	0.3
≥ 100	176	2.7	-	-

Table 4. Full outsourcing: probit estimates, all sample

	(1)	(2)	(3)
Age	-0.017	-0.017	-0.016
	(0.017)	(0.017)	(0.017)
Size	-0.091**	-0.090**	-0.092**
	(0.035)	(0.035)	(0.035)
HC	0.100	0.097	0.095
	(0.131)	(0.131)	(0.131)
LC	0.029***	0.029***	0.028***
	(0.010)	(0.010)	(0.010)
Nprod	-0.007	-0.007	-0.007
	(0.009)	(0.009)	(0.009)
Area	-0.027*	-0.026*	-0.027*
	(0.014)	(0.014)	(0.014)
Export	0.011	0.011	0.011
	(0.031)	(0.031)	(0.031)
Catalogue	0.024	0.024	0.024
	(0.042)	(0.042)	(0.042)
Client design	0.009	0.009	0.009
	(0.031)	(0.031)	(0.031)
Prod_own	0.121***	0.120***	0.120***
	(0.042)	(0.042)	(0.042)
Third party	0.053	0.052	0.050
	(0.034)	(0.034)	(0.034)
Density_1digit	0.070**		
	(0.029)		
- *Density_1digit_IV*	*0.179***		
	(0.078)		
Density_2digit		0.080***	
		(0.030)	
Density_3digit			0.075***
			(0.025)
Social capital	0.111**	0.073	0.076
	(0.052)	(0.050)	(0.050)
Industry dummies	Yes	Yes	Yes
Phase dummies	Yes	Yes	Yes
N	3241	3241	3241
Pseudo R^2	0.468	0.469	0.469
Corr. Class. (%)	84.23	84.26	84.23
Instrument: Density_Ndigit_1991	*0.950****	*0.831****	*0.842****
	(0.002)	*(0.003)*	*(0.006)*
Instrument: Social Capital_1960	*0.098****	*0.097****	*0.101****
	(0.020)	*(0.020)*	*(0.020)*
F (density)	188807.63	64302.82	17958.68
F (social capital)	22.94	23.04	24.40
Wald test (p-value): density	0.081	0.126	0.101
Wald test (p-value): SC	0.487	0.783	0.844

Notes: cluster-robust (at the firm level) standard error are reported in parentheses. *** significant at 1%; ** significant at 5%; * significant at 10%. Cells report marginal effects at the mean of continuous variables and for discrete change of dummy variables from 0 to 1.

Table 5. Concurrent sourcing: probit estimates, all sample

	(1)	(2)	(3)
Age	0.044***	0.044***	0.044***
	(0.015)	(0.015)	(0.015)
Size	0.112***	0.113***	0.112***
	(0.026)	(0.026)	(0.026)
HC	0.021	0.021	0.021
	(0.097)	(0.097)	(0.097)
LC	0.062***	0.062***	0.062***
	(0.010)	(0.010)	(0.010)
Nprod	0.009	0.009	0.009
	(0.007)	(0.007)	(0.007)
Area	-0.052***	-0.052***	-0.052***
	(0.014)	(0.014)	(0.014)
Export	0.027	0.027	0.027
	(0.025)	(0.025)	(0.025)
Catalogue	-0.018	-0.018	-0.018
	(0.032)	(0.032)	(0.032)
Client design	0.005	0.005	0.005
	(0.028)	(0.028)	(0.028)
Prod_own	-0.087**	-0.088**	-0.087**
	(0.038)	(0.038)	(0.038)
Third party	-0.041	-0.041	-0.041
	(0.032)	(0.032)	(0.032)
Density_1digit	0.037		
	(0.024)		
Density_2digit		0.038	
		(0.024)	
Density_3digit			0.047***
			(0.021)
- Density_3digit IV			*0.093**
			(0.054)
Social capital	-0.065	-0.085*	-0.084*
	(0.045)	(0.043)	(0.043)
Industry dummies	Yes	Yes	Yes
Phase dummies	Yes	Yes	Yes
N	3280	3280	3280
Pseudo R^2	0.232	0.232	0.232
Corr. Class. (%)	74.85	74.94	74.88
Instrument: Density_3digit1991			*0.843****
			(0.006)
Instrument-1: SC 1960			*0.106****
			(0.020)
F (density)			*18316.92*
F (Social capital)			*27.46*
Wald test (p-value): density			*0.003*
Wald test (p-value): social capital			*0.106*

Notes: cluster-robust (at the firm level) standard error are reported in parentheses. *** significant at 1%; ** significant at 5%; * significant at 10%. Cells report marginal effects at the mean of continuous variables and for discrete change of dummy variables from 0 to 1.

Table 6. Full outsourcing: probit estimates, by production phase

Type	Phase	Density_1digit	Density_2digit	Density_3digit	Social Capital
Design	1				
	3		(+)*	(+)**	
	4				(+)**
Early working	5				
	6			(-)**	
	7				(+)**
Treatments	8	(+)***	(+)***	(+)***	
	9	(+)***	(+)***	(+)***	
	10	(+)***	(+)***	(+)**	(+)***
	11				(+)*
Assembling	12				(+)***
	13				(+)***
	14				(+)**
Ancillary	15	(+)*	(+)**	(+)**	
	19				
	20	(-)***	(-)**		(+)***
Final stages	21				(+)***
	22	(+)**	(+)**	(+)***	(-)**
	23				
	24				(+)**
	25				(+)**
Post-production stages	26				(+)*
	27				
	28				(+)*
	29				

Notes: *** significant at 1%; ** significant at 5%; * significant at 10%. All the estimates include also the following controls: Age, Size, HC, LC, Nprod, Local, Export, Catalogue, Design, Prod_own, and Third party.

Table 7. Concurrent sourcing: probit estimates, by production phase

Type	Phase	Density_1digit	Density_2digit	Density_3digit	Social Capital
Design	1			(+)*	
Early working	6	(+)*	(+)**	(+)**	
Treatments	9	(-)**	(-)**		
Software	15	(-)**	(-)**	(-)**	
Post-production stages	24			(+)**	(-)**
	25	(+)**	(+)**	(+)***	(-)**
	26				
	27				
	28			(+)*	(-)**

Notes: *** significant at 1%; ** significant at 5%; * significant at 10%. All the estimates include also the following controls: Age, Size, HC, LC, Nprod, Local, Export, Catalogue, Design, Prod_own, and Third party.