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Local spillovers, production technology and the choice to make and/or buy. Empirical evidence from Emilia Romagna mechanical industry*

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Abstract

By exploiting a new rich firm–level dataset, this paper investigates the decision to subcontract production activities (outsourcing) with respect to vertically integrate them. In particular, we aim at identifying the main factors underlying the decision to either fully or partially decentralise production activities by mechanical firms located in Emilia Romagna (Italy). In so doing, we first account for firm characteristics, such as size, age and the skill composition of the labour force, then we focus on labour costs per employee, product diversity and the presence of the firm on international markets. Finally, and differently from previous research, we include in the analysis both the qualitative composition of the production process, as given by the stages of production potentially developed by the firm, and the industrial composition of the local market. On this last purpose, we estimate the relationship between the propensity and the intensity of concurrent and total sourcing and the main sources of agglomeration economies identified in the literature: specialisation economies, variety and urbanisation economies. Our estimates show a particularly strong and positive relation between the intensity of 'pure' outsourcing and our measure of variety, workforce skill intensity and the internal composition of production, while a negative relation emerges with respect to firm size, age and labour cost. Results concerning concurrent sourcing, instead, appear weaker, but, differently from the case of full outsourcing, we find a positive relationship with firm size and product diversity.

1 Introduction

The topic of making or buying is at the core of any theory of the firm as it contributes to the definition of the boundaries of the firm (Coase, 1937). According to transaction cost economics (Williamson, 1975), the choice between producing internally or through outsourcing on the market is based on a cost-benefit analysis, in which benefits basically arise in terms of production cost savings, while costs primarily concern the costs of writing and enforcing contracts with suppliers. These latter are particularly relevant since they involve hold up problems, which, in turn, depend on asset specificity and on the uncertainty of transactions.

Other forms of benefits and costs of outsourcing versus vertical integration emerge from other theories of the firm (Gulati and Puranam, 2006; Parmigiani, 2007; Parmigiani and Mitchell, 2009). Some works related to neoclassical economics (Adelman, 1949; Porter, 1980; Abraham and Taylor, 1996), for instance, point to the positive effect of outsourcing in terms of reducing the volatility of market demand or of increasing the flexibility of the firm in smoothing the workload during peak periods, or in terms of the ability to keep track of technological change in production in order to take a higher control over suppliers. The resources and competencies theory of the firm (Teece, Pisano, and Shuen, 1997), instead, emphasises the role of outsourcing in dealing with technological uncertainty and in allowing access to external expertise *vis-a-vis* the risk of transferring part of the knowledge base of the firm to suppliers.

Other factors related to the decision to make or buy can be also identified in Mazzanti, Montresor, and Pini (2007a,b): union density (Abraham and Taylor, 1996), industrial relations (Benson and Ieronimo, 1996), R&D intensity (Tomiura, 2005) as well as investments in information and communication technologies (Abramovsky and Griffith, 2006), output heterogeneity and geographical dispersion, or, finally, the intangible nature of the assets used by the firm in storing the knowledge required to manage transactions (Gonzalez-Diaz, Arruñada, and Fernandez, 2000).

The factors just mentioned not only affect the decision to fully contract out production or service activities, but they also apply to one important aspect which has often been neglected in the empirical literature, namely concurrent sourcing, i.e. firms jointly making and subcontracting the same activity (Gulati and Puranam, 2006; Parmigiani, 2007; Parmigiani and Mitchell, 2009). In this case, the decision to concurrently source production to external suppliers seems to be still driven by demand uncertainty, the need to better monitor suppliers, the possibility to share cost and learning opportunities among buyers and suppliers, the degree of complementarity among production technologies and the sharing of interfirm expertise.

In the present work we focus the attention on two aspects that have been scantily investigated in the literature. First, we study if both the decision and the intensity of outsourcing are related to firm-specific characteristics, like size, age, product complexity and qualitative composition of the production process. Secondly, we focus on the industrial composition surrounding the outsourcing firms, and we try to see if such a business strategy can be related to the main sources of agglomeration economies at the local level, namely specialisation versus variety-based economies.

The choice of a suitable statistical instrument to investigate the firms' outsourcing behaviour has been driven by the nature of our outcome variable, i.e. the number of phases totally or partially outsourced. As this variable represent the (discrete) number of occurrence of an event, we decide to adopt a count regression model. In this framework, the excess of zeros characterising the outcome variable leads us to select the Zero Inflated Negative Binomial that allows us to jointly model the decision to outsource (i.e. a "yes/no" variable) and the incidence of the number of phases contracted out by the firm with respect to the total number of the performed phases.

In so doing, we exploit a unique dataset which collects a large number of information on mechanical firms located in the Emilia Romagna region of Italy in year 2005. For each firm, a detailed set of information is available both on the type of production activities operated and on the way these activities are developed. Moreover, we calculate our spatial agglomeration variables by merging these information with census data at the level of Local Labour System (LLS) coming from the Italian Statistical Institute.

Our data concern only one region, Emilia Romagna and one industry, mechanics. This region is an interesting example of recovery and sustained growth since the post-war period, both in terms of employment and productivity. Particularly after the Second World War, "a wide range of new sectors emerged out of [its] pervasive and generic knowledge base one after the other. As such, these new applications made the regional economy to diversify into new directions. Examples are sectors like the *packaging industry*, the ceramic tiles sector, *luxury car manufacturers* (Maserati, Ferrari,among others), *robotics*, *agricultural machinery*, among other sectors. These new sectors not only built and expanded on this regional knowledge base, they also renewed and extended it, further broadening the economy of Emilia Romagna" (Asheim, Boschma, and Cooke, 2009, p. 6, emphasis added). In addition, Emilia Romagna also represents a dense basin of industrial district areas, as it is part of the so–called Third Italy (Brusco, 1982; Becattini, 1990). This fact allow us to devote a particular attention to the role played by spatial agglomeration, as firms typically locate in these areas in order to benefit from knowledge spillovers coming from the geographical and social proximity to other firms. In this sense, outsourcing is a strategy that can both affect and can be affected by the actual industrial composition of the region.

The relevance of the industry under examination, i.e. mechanics, is due to the fact that it represents one of the most dynamic specialisations not only for the Italian manufacturing system as a whole, but, in particular, for the manufacturing system of Emilia Romagna and its industrial districts.[1] Recent studies, in particular, show that, in the 1981-2001 period, while the mechanical employment at the national level has decreased, the mechanical employment in the North-East of Italy has increased, particularly in the Provinces of the Emilia Romagna region located along the so–called *via Emilia* (Russo and Pirani, 2006; Russo, Pirani, and Paterlini, 2006).

The main novelties of this paper are three. First, our data allow us to provide information not only on the decision to outsource, but also on the intensity of outsourcing, as given by the share of production stages contracted out by each single firm. We also examine the decision, and relative intensity, to partially subcontract production activities. Second, we exploit the detailed information on the phases actually operated by each firm in order to expand the set of firm-specific characteristics that can affect the outsourcing decision and intensity. Third, we also provide some results on the link between outsourcing and the local environment in which firms operate. Moreover, the nature of the data and the context we investigate also allow us to focus on small and medium firms, rather than on large business companies.

The paper is organised as follows. Section 2 briefly reviews the recent literature about the determinants of outsourcing and concurrent sourcing. In particular, we look at works analysing the role of firm characteristics and of the scale of the local context surrounding the outsourcing firms. Section 3 describes the data we use in the empirical analysis, which represent a new source of information on firms' activities. Section 4 presents the methodology adopted for the econometric exercise. Section 5 shows the estimation results on the propensity to totally or partially outsource and on the intensity of outsourcing. Finally, Section 6 concludes.

2 Related literature

When dealing with the identification of firm boundaries, transaction costs economics (TCE) can be considered as the dominant approach. In this theory,

[1]Actually, the mechanical sector in Emilia Romagna has to be seen rather as a meta–district, as it covers several areas (*Province*) and different sub–specialisations.

firms solve the problem of whether to produce internally or externally by comparing the costs associated to the two distinct governance structures, i.e. a vertically integrated and a 'disintegrated' one. Factors that are supposed to affect such a decision are the degree of asset specificity, the level of uncertainty and the frequency of transactions (Williamson, 1975). In particular, a high level of volume and performance uncertainty, associated to a relatively high level of asset specificity, is supposed to drive the firm to integrate production in order to minimise risks and exploit a higher level of internal co-ordination.

However, at least other two strands of the economic literature can be considered when dealing with outsourcing and concurrent sourcing, i.e. neoclassical economics and the firm capabilities approach. For instance, in contrast with TCE, the former (Adelman, 1949; Porter, 1980; Abraham and Taylor, 1996) predicts that higher volume and performance uncertainty lead the firm to outsource production activities in order to keep the production cycle as stable as possible over time, i.e. for flexibility in meeting demand, or in order to enhance its understanding of the core production activities. On the contrary, the desire to exploit the potential for internal scope economies may induce the firm to integrate production activities, the opposite being true in presence of scope economies for suppliers: in this case, the possibility to face lower prices may lead the firm to contract out the production of goods and services. Finally, the desire to reduce production costs and to get access to lacking, otherwise specialised, skills can also induce the firm to outsource production.

Concurrent sourcing, instead, is a governance choice that, according to TCE, firms select in presence of a moderate level of volume and performance uncertainty, whereas, according to neoclassical economics, the opposite is true, as firms select concurrent sourcing when facing higher volumes, performance uncertainty, and greater scope economies for both the firm and its suppliers.

Finally, the capability view of the firm (Teece, Pisano, and Shuen, 1997) stresses the level of expertise of both the firm and its suppliers — as well as a high level of technological uncertainty and a higher possibility to increase the number of knowledge sources from external suppliers — as the main determinants of concurrent sourcing.

Moreover, while the previous theories put the emphasis on the characteristics of transactions, of the market, and of firms involved in the make-or-buy choice respectively, we here stress two other sets of variables as being potentially involved in defining the boundaries of the firm: (i) the technology of the production process, i.e. its qualitative composition and the diversity of production offerings, as part of a broader set of firm-specific characteristics, and (ii) the industrial composition of the LLS where the firm is located. In particular, we first ask if, along with other relevant firm characteristics like size, age and skill intensity, there are certain types of activities that are, by nature or by design, more prone to be partially/totally outsourced or operated in-house than others: secondly, we ask if outsourcing is related with the structural composition of the local context in which firms operate.

With respect to the former issue, few works have empirically studied the relationship between production complexity and the make or buy decision. This relationship has been first investigated in a transaction cost economics approach (Masten, 1984), in which product complexity is conceived in terms of product diversity, namely the number of different products that a firm is able to offer in the market. In general, the relationship between outsourcing and complexity has a negative sign: greater product diversity is supposed to increase the complexity of contractual arrangements, thus increasing transaction costs and reducing the propensity to outsource.

However, the sign of the relationship may depend on the size of the firm: looking at US credit unions financial activities over a decade, Ono and Stango (2005) find, for instance, that greater product complexity is associated with more outsourcing in the case of small and medium firms, whereas for larger firms this relationship turns to be negative. This positive relationship may be explained by the will of small firms to reduce fixed costs in production and to exploit suppliers' superior expertise, while not having sufficient internal scale economies for handling complex phases of production.

A greater product variety is also associated to increasing economies of scope that can reduce the cost of current activities when firms gain efficiency through the joint co-ordination of multiple activities. In this respect, Parmigiani and Mitchell (2009) find that scope economies are positively associated with a greater propensity to vertically integrate complementary activities rather than concurrently source them.

With respect to the latter issue, i.e. outsourcing and the structural composition of the local system, the little empirical literature available is primarily based on the subcontracting decisions taken by US firms with respect to white-collar business services. The basic theoretical framework dates back to Stigler (1951), who claims that a higher concentration of industry may induce firms to vertically disintegrate production, so to obtain cheaper inputs from specialised suppliers.

In this respect, Holmes (1999), for instance, looking at 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 contained in Ono (2001, 2006). Using data from the 1992 Annual Survey on Manufacturers, she 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 its 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%.

With respect to the Italian case, few papers have focused on outsourcing and the industrial composition of the local system of production. Relying on a cross-sectional sample of 166 manufacturing firms located in the Province of Reggio Emilia (Italy), Mazzanti, Montresor, and Pini (2007b) find that the outsourcing decisions of geographically embedded firms are weakly related to traditional TCE aspects, but, on the contrary, they are related to the organisational structure of the firm and to the quality of industrial relations which characterise the local system of production. In particular, they find that a higher propensity to outsource production is negatively linked to union density, the belonging to a business group and a more hierarchical governance organisation, and positively related to unions involvement in the outsourcing decision process as well as a more divisional organisation of production.

Finally, looking at Italian manufacturing firms over the period 1998-2003, Antonietti and Cainelli (2008) find that the outsourcing of knowledge-intensive business services is particularly driven by ICT usage and by the interplay between firms R&D intensity and their location within a dense local production system. This finding allows them to stress 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.

In the present work, we extend the analysis and we look at the role of spatial agglomeration variables, as measured by the level of specialisation, variety and urbanisation of a LLS (Glaeser, Kallal, Scheinkman, and Shleifer, 1992; Henderson, Kuncoro, and Turner, 1995; Ciccone and Hall, 1996) as the main sources of local knowledge spillovers.

Since Marshall, agglomeration economies have been seen as a type of externalities which affects firms for the fact of being located one closed to the other, so that a continuous exchange of knowledge flows may help them reaching high productivity growth, lower unemployment and higher propensity to innovation

(Frenken, van Oort, and Verburg, 2007). In particular, different sources of local spillovers may arise from spatial agglomeration: (i) external economies coming from the geographical proximity of firms operating within the same industry (*localisation economies*); (ii) external economies available to all firms irrespective of industry and arising from urbanisation and a high density of different types of activities within a certain area (*urbanisation economies*).[2]

The evolutionary economics literature has recently gone beyond the traditional distinction between localisation economies and Jacobs' externalities by introducing the concept of *related variety* (Boschma, 2004; Frenken, van Oort, and Verburg, 2007; Boschma and Iammarino, 2009; Asheim, Boschma, and Cooke, 2009), as a key source of regional branching and growth deriving from knowledge spillovers across complementary sectors. According to Frenken, van Oort, and Verburg (2007), the degree of related variety of a region can be identified by looking at 5-digit sectors which share the same 2-digit sector of the same type.

Given this, we expect that full and concurrent sourcing can be significantly related to spatial agglomeration variables, and, in particular, to an industrial composition characterised by a high degree of related variety. On the one hand, the increasing complexity and modularisation of products may induce manufacturing firms to increase the local demand for a wide variety of supplying services, thus attracting firms of different types and increasing the variety of the knowledge base of the region. On the other hand, the spatial concentration of a wide variety of suppliers that specialise on different stages of the production process may induce firms to fragment the value chain and subcontract the activities in which it lacks expertise.

3 Data and variables description

3.1 The dataset

Data come from the so–called *Studi di Settore* (Sector Studies), introduced in 1993 and developed by the Italian Fiscal Authority (*Agenzia delle Entrate*) with the aim of establishing a benchmark of relevant information on firms for fiscal purposes. Therefore, the primary scope of these Studies is to systematically collect information on the main activities of Italian small and medium firms and the economic context in which they operate, in order to evaluate the proper capacity of those firms to create income and to avoid the possibility of tax evasion.

[2]For an empirical analysis of the Italian case, see Cainelli and Leoncini (1999).

Our data concern only the 'mechanical' sector (ATECO 1991 2-digit code 29 'Manufacture of machinery and equipment not elsewhere classified'). For each observation, a detailed set of information is available both on the type of production activities and on the way these activities are operated. Of particular interest is the possibility to identify which phases characterise the production process of each firm and which of them are developed internally, externally or through concurrent sourcing.

In building our final sample, we started from a set of about 4,500 firms located in Emilia Romagna region in year 2005. While the Sector Studies focus on business units with less than 100 employees (more precisely, with an annual turnover less than 5,164,169), we cleaned those observations with missing values in the dependent or in the explanatory variables, and with inconsistencies. Moreover we refer to firms with less than 50 employee as after this threshold the universe of firms is substantially not covered. We obtain a final sample of 3,289 firms. In Table 1 we compare the employment size composition of our sample with official 2001 Census data provided by the Italian Statistical Office (ISTAT, 2001).

Table 1: Frequency distribution of firms by class of employees

class of employees	Census 2001	%	Sector Studies	%
$1-9$	4,560	75.4	2328	70.8
10-15	638	10.5	412	12.5
16-19	252	4.2	194	5.9
20-49	599	9.9	355	10.8
total	6,049	100	3,289	100

As stated before, our data concern firms operating in the mechanical industry that compiled the Sector Study questionnaire in year 2005. Over the last five decades, this sector has shown particularly high growth rates, both in terms of productivity and in terms of employment, so that now it can be considered as one of the leading industries in Italy. The areas of highest employment concentration are mainly in the North of Italy, particularly in regions like Piedmont, Lombardy, Emilia Romagna and Veneto (ISTAT, 2001; Russo, Pirani, and Paterlini, 2006). When disaggregating the Italian territory by Local Labour Systems (LLS) (ISTAT, 2001),[3] we see that the largest mechanical firms are mainly concentrated in the areas of Milan and Turin, whereas the small and medium sized firms are located around the Provinces of Bologna (Emilia Romagna, with more than 60,000 employees), Bergamo

[3]A Local Labour System is defined as a geographical area grouping different neighbouring Municipalities and identified on the base of daily commuting.

and Brescia (Lombardy, around 59,000 and 40,000 employees respectively), Lecco (Lombardy, 35,000 employees), Padua (Veneto, around 35,000 employees) and Modena (Emilia Romagna, around 26,000 employees) (Russo, Pirani, and Paterlini, 2006).

In Emilia Romagna, the bulk of small and medium mechanical firms lies primarily along a central line running from the Province of Rimini in the South East part of the region to the Province of Piacenza in the North West (the so–called *via Emilia*) and involving primarily the cities of Bologna, Imola and Modena, and, secondly, the LLS of Cento (Ferrara), Guastalla (Reggio Emilia) and Porretta (Bologna). Next to this, a cluster of LLS with different manufacturing specialisations includes the cities of Correggio (Reggio Emilia), Sassuolo, Carpi, Mirandola (Modena) and the Province of Parma in the North-West and the Provinces of Ravenna, Forl-Cesena and Ferrara in the South-East. A cluster of manufacturing LLS finally includes the cities of Copparo and Comacchio and is linked with the manufacturing belt of firms in the South of Veneto region.

Within the 2-digit mechanical industry, the main specialisation concern the production of machinery for the following sectors: robotics (Piacenza), food (Parma), agriculture, motor vehicles and oleo dynamics (Reggio Emilia), motor vehicles, automobile, food packaging and electro-medical equipment (Bologna), ceramics (Sassuolo), wood (from Carpi to Rimini), shipbuilding (from Ravenna to Rimini) among the others. The high presence of small and medium sized firms is primarily due to the technology of the mechanical production process, the decomposability of which allows a high division of labour and a high specialisation of firms on single stages of the value chain. The high fragmentation of the production process and a high degree of specialisation mainly contribute to the efficiency of these firms in the presence of strong network relationships and a strong degree of complementarity (Russo and Bigarelli, 2009).

With respect to this last aspect, firms operating in the mechanical districts of Emilia Romagna can be classified into two typologies: final firms (*conto proprio*) and subcontracting firms (*conto terzi*). While the former are firms producing goods on their own, the latter are firms producing on behalf of other firms. Final firms realise final goods in small series, are larger and oriented to national and international markets; subcontracting firms, instead, are generally smaller, more specialised on the production of components and focused on serving mainly the local demand by final firms.

Interestingly, the outsourcing of production activities may also involve subcontracting firms. However, while final firms tend to fully outsource the production of components, up to including the purchase of the inputs, subcontracting firms tend to jointly source their activities to even more specialised suppliers (Russo and Bigarelli, 2009).

Moreover, in our data we can identify around thirty different activities characterising the mechanical production process, and in particular the transformation stages of raw materials and ideas into finite goods, i.e. from the phase of design to the phase of final assembly. For convenience, we group all these phases into eight categories: project and design (phase 1), treatments of mechanical parts, including sintering, heat and cold treatments and surface treatments (phase 2), assembly of mechanical parts (phase 3), the development of software programs for quality control (phase 4), treatment of non mechanical parts as rubber and plastic, glass and wood (phase 5), checking and testing (phase 6), finishing, which includes packing, spraying, sand-blasting and washing (phase 7), installing/repairing and maintenance (phase 8).

We reasonably consider Design to be the most knowledge-intensive phase, as it involves projecting and the creation of new ideas. Phases 2 and 3, instead, group the 'core' activities of a mechanical firm, namely those involving the manufacturing of mechanical components. Phase 4, instead, can be considered as a 'transversal' phase, since not all firms develop a quality control system and because such a control may involve horizontally more than one stage of the manufacturing process. On this purpose, together with phase 5, 6 and 8, it can be defined as an 'ancillary' phase. Phases from 5 to 8, represent also the downstream stages of the production process, whereas phases from 1 to 3 constitute the upstream and central ones.

Table 2 shows the distribution of each group of phases with respect to the decision of firms to operate them fully in-house, through full outsourcing, and through concurrent sourcing. From the Table it is easy to see that, while phases 3 and 8 are the mostly operated, phases 1, 4 and 5 are the less present. *Moreover firms tend to operate phases 3, 6 and 8 mainly in-house, while phase 2 and 4 are the most outsourced and phases 2, 3 and 8 are the most concurrently sourced. It is also interesting to note that, except for phases 4 and 5, the number of firms which choose to concurrently source production is higher than the number of firms choosing to fully outsource production. In addition, when looking only at the most present phases (i.e. 3 and 8), full outsourcing is never the dominant choice among firms. Concurrent sourcing, instead, dominates in phases 2 and 7.*

3.2 The variables

In the empirical analysis, we are interested in identifying the sign and the relevance of the relationship between the choice to make and/or buy and three main sets of variables: one concerning some firm-specific characteristics, one related to the composition and complexity of the production process and one related to spatial agglomeration economies.

Table 2: Distribution of production phases

Phase carried out:		only internally	only externally	both	not present	Total
1 – Design	freq.	889	154	235	2011	3289
	%	27,0	4,7	7,1	61,1	100
	%	69,6	12,1	18,4		100
2 – Manufacturing of mechanical parts	freq.	437	445	1010	1397	3289
	%	13,3	13,5	30,7	42,5	100
	%	23,1	23,5	53,4		100
3 – Assembling	freq.	1159	206	1132	792	3289
	%	35,2	6,3	34,4	24,1	100
	%	46,4	8,2	45,3		100
4 – Software development	freq.	196	398	104	2591	3289
	%	6,0	12,1	3,2	78,8	100
	%	28,1	57,0	14,9		100
5 – Manufacturing of non-mechanical parts	freq.	114	236	58	2881	3289
	%	3,5	7,2	1,8	87,6	100
	%	27,9	57,8	14,2		100
6 – Testing	freq.	1570	127	160	1432	3289
	%	47,7	3,9	4,9	43,5	100
	%	84,5	6,8	8,6		100
7 – Finishing	freq.	603	340	806	1540	3289
	%	18,3	10,3	24,5	46,8	100
	%	34,5	19,4	46,1		100
8 – Installing, repairing maintenance	freq.	1541	165	944	639	3289
	%	46,9	5,0	28,7	19,4	100
	%	58,2	6,2	35,6		100

Among firm characteristics we include: (i) size, as captured by two employment dummies for small (11-20) and small-medium firms (21-50); (ii) age at year 2005; (iii) skill intensity of the workforce, as measured by the share of white collars (managers, executives and administrative); (iv) labour cost per employee; (v) the market in which the firm operates, and in particular if the firm is active on foreign markets, either in the European Union or outside. This last variable aims at capturing the degree of market competitiveness and uncertainty surrounding the firm, under the reasonable assumption that firms operating only on national, or even local, markets face a lower number of competitors and are less subject to international fluctuations of demand.

We then capture the complexity of the production process by looking both at the input and at the output side. From the input side, we include eight dummies grouping the main phases that each firm declared to be included in the production process: these dummies are equal to 1 if a firm operates at least one activity contained in each of the eight groups, independently on the decision to operate it in-house or externally. From the output side, we include a variable measuring the number of products offered by each firm: the higher the value of this variable the wider the range of products offered and, thus, the higher the level of product complexity (Ono and Stango, 2005). A higher value of such a variable can also be interpreted in terms of potential scope economies, namely the capacity of the firm to save on production costs when jointly producing two or more goods.

In line with previous empirical literature, the variables referring to spatial agglomeration economies are given by: (i) the localisation index $L_{ik} = \frac{l_{ik}/l_k}{l_{ir}/l_r}$, where l_{ik} represents the number of employees in the i-th sector (3-digit ATECO) and in the k-th LLS, l_{ir} is the number of employees in i-th sector at the regional level, and $l_k = \sum_i l_{ik}$ and $l_r = \sum_i l_{ir}$)[4]; (ii) the related variety index obtained as $1/H_{ik}$, being H_{ik} the Herfindahl index defined as: $H_{ik} = \sum_h (l_{hik}/l_{ik})^2$ where l_{hik} is the number of employees of the h-th firm in the i-th sector located in the k-th LLS[5]; (iii) the density index $D_{ik} = \frac{l_{ik}/sup_k}{l_{ir}/sup_r}$, in which sup_k represents the area (in squared metres) of the k-th LLS and sup_r represents the area of the Emilia Romagna region.

4 Methodology

4.1 Modelling count data

To investigate the outsourcing decision, we estimate which factors among the ones selected, and to what extent, are associated with the intensity of the outsourcing decision, as measured by the number of activities contracted out by the firm with respect to the total number of phases performed by the firm..

Since our dependent variable measures a discrete number of non-negative events, and it has an asymmetric distribution, we use a Poisson model (Cameron and Trivedi, 1998; Winkelmann, 2003) defined by the probability distribution:

[4]If the index is higher than 1 it implies that the region is specialised in the sector under examination (Glaeser, Kallal, Scheinkman, and Shleifer, 1992)

[5]As far as the index is computed, an increase in the degree of (related) diversification around the firm is reflected by an increase of the ratio $1/H$ (Henderson, Kuncoro, and Turner, 1995). Note that, since we have only one sector at the 2-digit level, we take the 3-digit level as the base reference for computing our variety measure; this measure is slightly different from the original indicator of related variety developed by Frenken, van Oort, and Verburg (2007), but is in line with the *neighbour related* index developed by Holmes (1999).

$Pr[Y = y_i] = \frac{\mu^{y_i} exp(-\mu)}{y_i!}$, $y_i = 0, 1, 2, \ldots$, with $E(y) = V(y) = \mu$, $\mu \geq 0$. The intensity (or rate) parameter (μ_i) represents both mean and variance.

4.1.1 Poisson and negative binomial regression models to model counts or proportions of counts

In the Poisson regression model (P) the mean μ is modelled as a function of covariates. Given n independent observations $(y_i, \mathbf{x_i})$ where y_i denotes the number of occurrences of the event of interest, and $\mathbf{x_i}$ is the vector of regressors, a Poisson regression model is derived from the Poisson distribution by allowing the μ parameter to depend on the regressors. That is y_i given $\mathbf{x_i}$ is Poisson-distributed with density:

$$f(y_i|\mathbf{x_i}) = \frac{\mu_i^{y_i} exp(-\mu_i)}{y_i!}, \quad y_i = 0, 1, 2, \ldots$$

with the logarithm of the systematic component modelled as a linear function of the covariates: $E(y_i|\mathbf{x_i}) = \mu_i = exp(\mathbf{x_i'}\beta)$ or equivalently $ln(\mu_i) = x_i^T \beta$ that ensures $\mu_i \geq 0$.

Such a relationship ensures the positiveness of the dependent variable, no matter what are the values taken by the explanatory variables. Considering that $E(y_i|\mathbf{x_i}) = V(y_i|\mathbf{x_i}) = \mu_i$, the regression is intrinsically heteroskedastic.

The method of maximum likelihood (iterative methods) is used to estimate the parameter.[6]

If it is more suitable to analyse the ‘event count’ in the form of proportions or ratios of counts (incidence of an event), where count are divided by some measure of exposure (t_i) , the model becomes: $E(z_i|\mathbf{x_i}) = exp(\mathbf{x_i'}\beta) = \gamma_i$ with $\gamma_i = \mu_i/t_i$, and $ln\left(\frac{\mu_i}{t_i}\right) = \mathbf{x_i'}\beta$ or, equivalently, $ln(\mu_i) = ln(t_i) + \mathbf{x_i'}\beta$. The quantity $ln(t_i)$ — defined as offset — has a coefficient equal to 1, and is used to standardise counts from populations of different sizes.

If the estimate of dispersion after fitting, as measured by the deviance or Pearson’s chi-square, divided by the degrees of freedom, is not near 1, then the data may be over–dispersed, that is $V(y_i|\mathbf{x_i}) > E(y_i|\mathbf{x_i})$. In this case, alternative models may provide a better fit. When the model for the mean is correct but the true distribution is not Poisson, the maximum likelihood estimates of the model parameters are still consistent, but the standard errors

[6]Problems related to simple OLS estimation method are the following: it ignores the restricted support for the outcome variables to non–negative values (prediction could be negatives); it relies on the assumption that the outcome variable is continuous; it assumes a symmetric Normal distribution of residuals (whereas Poisson distribution is skewed, and highly skewed for small mean values); it is based on the homoskedasticity assumption.

are incorrect. In fact, over–dispersion leads to underestimates of the standard errors and overestimates of the chi-square statistics.

A simple way to account for over–dispersion is to introduce in the model a more flexible distribution with respect to the Poisson one that permits the variance to exceed the mean, as the negative binomial distribution. This distribution is a conjugate mixture distribution for count data and a generalisation of the Poisson distribution. The negative binomial distribution assumes that the conditional distribution of the response variable is Poisson, but the mean parameter for the subjects follows a gamma distribution (Agresti, 2002). It follows that the gamma mixture of Poisson distributions yields a marginal distribution for the response variable, that is negative binomial.

A functional form generally used for modelling over–dispersion is expressed as $V(y_i|\mathbf{x_i}) = \phi\mu_i + k\mu_i^2$, where $k > 0$ is a scalar and ϕ is the dispersion parameter. This assumption leads to the Negative Binomial model that is defined by two parameters, one of which allows for different mean and variance, while the Poisson model is characterised by one parameter (the NB2 model, as in Cameron and Trivedi (1998)).

The probability function of a Negative Binomial random variable is:

$$f(y_i, \mu_i, k) = \frac{\Gamma(y_i + k^{-1})}{\Gamma(y_i + 1)\Gamma(k^{-1})} \frac{(k\mu_i)^k}{(1 + k\mu_i)^{y_i + k^{-1}}} \quad k \geq 0 \quad y_i = 0, 1, 2, \ldots$$

that reduces to the Poisson distribution if $k = 0$. The Negative Binomial regression model is then obtained assuming the mentioned variance function and maintaining the assumption on the expected value $E(y_i|\mathbf{x_i}) = \mu_i = exp(\mathbf{x_i'}\beta)$.

4.1.2 Excess of zeros

When data are characterised by an excess of zero observations – in the sense that the observed distribution exhibits a large number of zeros with respect to that which would be expected in standard Poisson or Negative Binomial – two main alternative solutions have been proposed in the literature: (i) the zero-inflated model leading to the Zero-Inflated Poisson (ZIP) regression or the Zero-Inflated Negative Binomial (ZINB) regression; (ii) the hurdle regression model leading to the Hurdle Poisson (HP) regression or to the Hurdle Negative Binomial (HNB) regression.

In this framework the data generating process operates in a dual regime: the first in which the count moves from zero to some discrete event-count distribution and the second that generates the observed count (for a review see Cameron and Trivedi (1998)).

In the zero-inflated Poisson and Negative Binomial regression models we have that $y_i = 0$ with probability φ_i and $y_i \sim Poisson(\mu_i)$ with probability

$(1 - \varphi_i)$. The model is then:

$$Pr[y_i = 0] = \varphi_i + (1 - \varphi_i)e^{-\mu_i}.$$

$$Pr[y_i = r] = (1 - \varphi_i)e^{-\mu_i}\mu_i^r/r! \quad r = 1, 2, \ldots$$

In this data-generating process we have two sources of zeros: zeros may come from both the point mass and from the count component. This distribution can be interpreted as a finite mixture of a degenerate distribution, whose mass is concentrated at zero, and of a Poisson distribution.

In the Zero-Inflated Poisson (ZIP) regression model, the probability φ_i can be defined as a logistic function of the vector of covariates $\mathbf{z}$:

$$\varphi_i = exp(\mathbf{z_i'}\gamma)/[1 + exp(\mathbf{z_i'}\gamma)]$$

The ZIP model can be extended to the negative binomial case leading to the Zero-Inflated Negative Binomial (ZINB) regression models.

The basic idea behind the Hurdle Poisson and Negative binomial regression models is that a binomial probability governs the binary outcome of whether a count variate has a zero or a positive realisation. If the realisation is positive, "the hurdle is crossed" and the conditional distribution of the positives is governed by a truncated-at-zero count data model.

The hurdle specification in the Poisson case is that $y_i = 0$ with probability φ_i and $y_i \sim$ truncated $Poisson(\mu_i)$ with probability $(1 - \varphi_i)$. The Hurdle Poisson (HP) regression model is defined as follows:

$$Pr[y_i = 0] = \varphi_i$$

$$Pr[y_i = r] = (1 - \varphi_i)e^{-\mu_i}\mu_i^r/[r!(1 - e^{-\mu_i})] \quad r = 1, 2, \ldots$$

where, as for the ZIP model, φ_i and μ_i can be modelled by logit and log-linear functions, respectively.

A hurdle version of the Negative Binomial regression model can be obtained by substituting the truncated Negative Binomial distribution to the to the truncated Poisson one, this leading to the Hurdle Negative Binomial (HNB) regression model.

The difference between hurdle models and zero-inflated models are is that the hurdle model keeps the zero-class separate from the non-zero class while the zero-inflated model has two sources of zeros, as they may come from both the point mass and from the count component.

The choice between the two models should depend on whether or not the zeros are truly distinct from non-zeros between the two parameters. However often the two models produce very similar results and, in absence of strong considerations in favour of one over the other, the choice can be based largely on reasons of convenience.

In order to select the best–fit model a test can be used: if the compared models are nested, a LR test is to be performed, while if they are non–nested, a Vuong test is preferred.

5 Empirical estimation

Since we aim at modelling the intensity of outsourcing we use the total number of phases performed by the firm as offset. The proportion of zeros is about the 35% for the first variable (1159 on 3289 obs.) and the 46% for the second one (1529 on 3289 obs.), whereas under Poisson assumptions we would expect 3289 $exp(-1.25) = 942$ zeros in partially outsourced and 3289 $exp(-2.47) = 278$ zeros in totally outsourced, thus confirming the choice of a model dealing with an excess of zeros.

5.1 Model choice

As said before, two models are eligible for the empirical analysis, the zero inflated and the hurdle one. The aim here is to select the best model between those estimated. At first, to test the need of the hurdle or of the zero-inflation components we have to compare that models to the basic Poisson or Negative Binomial. Secondly we compare the hurdle formulation with the zero-inflated one. As a large part of these comparisons contains non nested models, we use the Vuong test, the results of which lead to select the Zero Inflated Negative Binomial model for both totally (Table 3) and partially (Table 4) outsourced phases of production.

For each of the two different modalities of outsourcing (total and partial) we therefore estimated a Zero Inflated Negative binomial (ZINB). It must be noted that, in interpreting the results, in the in zero inflated models, the zero inflation component predicts the probability of observing a zero count from the point mass component (whereas, for instance, in the hurdle negative binomial, the zero hurdle component describes the probability of observing a positive counts).

An important caveat must be put forward in interpreting the results. Due to the cross-sectional nature of our data, and since we observe only one year, we must be aware that our findings do not imply a clear relation of causality among the variables. Rather, we should interpret them in terms of association among outcome variable and covariates.

Table 3: Model choice statistics for totally outsourced phases of production

models	Z/χ^2 value	p-value	Preferred model
P – ZIP	-11,6 0	0,000	ZIP
NB – ZINB	-11,13	0,000	ZINB
ZIP – ZINB (nested)	209,95	0,000	ZINB
P – HP	-10,70	0,000	HP
NB – HNB	-9,12	0,000	HNB
HP – HNB (nested)	201,10	0,000	HNB
ZINB – HNB	5,47	0,000	ZINB

Vuong test are used to compare non-nested models (Z statistic)
LR test are used to compare nested models (χ^2 statistics)

Table 4: Model choice for partially outsourced phases of production

models	Z/χ^2 value	p-value	Preferred model
P – ZIP	-15,21	0,000	ZIP
NB – ZINB	-10,42	0,000	ZINB
ZIP – ZINB (nested)	202,44	0,000	ZINB
P – HP	-14,86	0,000	HP
NB – HNB	-8,91	0,002	HNB
HP – HNB (nested)	200,67	0,000	HNB
ZINB – HNB	1,95	0,250	ZINB

Vuong test are used to compare non-nested models (Z statistics)
LR test are used to compare nested models (χ^2 statistic)

5.2 Estimation results

The estimated selected model shows a very good fit for both total (see Figure 1) and partial (Figure 2) outsourcing. In the following discussion we rely on the model choice statistics (see Table 3 and 4) and we present the results pertaining to the ZINB estimates; however, in the Appendix we also present the results obtained through the HNB model as a robustness check.

In the following Tables from 5 to 8 showing the estimated models, are split into two parts. The results on the "yes/no" choice (the "no" choice corresponding to zero phases outsourced) are shown in the first two columns, while the second two columns show the results about the intensity with which the outsourcing strategy has been implemented (i.e. the "how many" choice) once the decision to outsource has been taken. Therefore, we show the regression

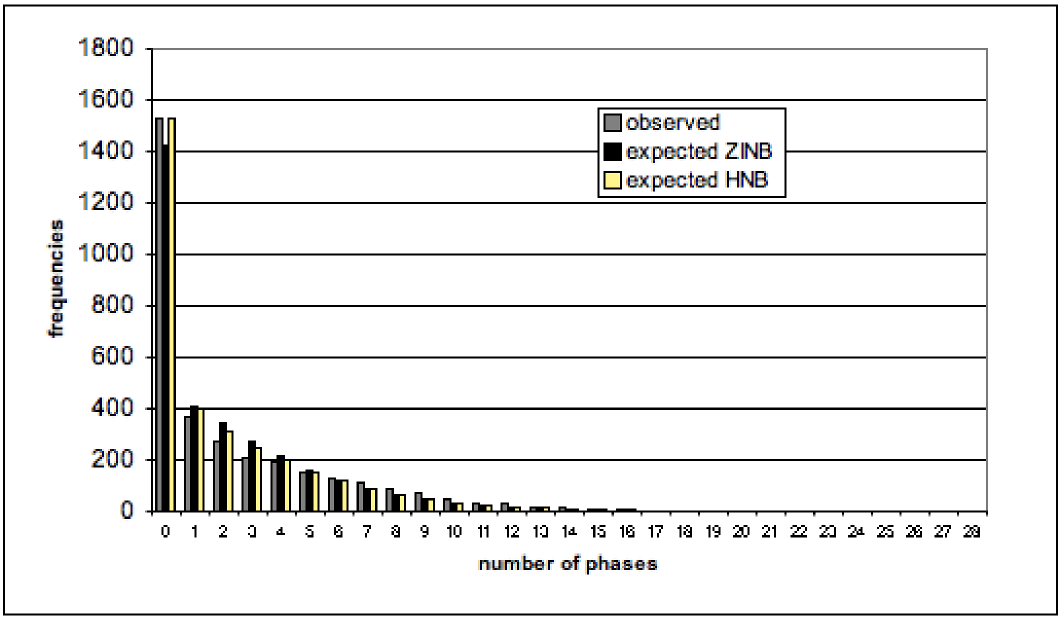

Figure 1: Fully outsourced phases: expected vs. observed frequency distribution

results for the propensity to outsource and the intensity of outsourcing, this latter measured by the number of production activities that the firm actually contracted out in 2005.

Note that for each estimated model the dispersion parameter(log(theta)) is significantly different from zero. This suggests that the outcome variable is over-dispersed and that a Negative Binomial model is more appropriated than a Poisson model.

With respect to the total outsourcing, we find that the probability to full outsource production is positively associated with the presence of the firm on international markets and with unit labour cost, whereas is is negatively associated (although the coefficient is not very significant) with our measure of localisation economies and with the number of products delivered. In a sense, having international customers, and thus facing a higher level of competition, may induce the firm to devote more resources to its 'core' activities, thus subcontracting the redundant stages of production or relying on the expertise provided by specialised suppliers in order to deliver a high-quality product. The expected positive association with unit labour costs, instead, confirms that firms use outsourcing mainly as a cost-saving strategy.

When looking at the composition of the transformation process, we find a positive relationship between the propensity to outsource and the potential

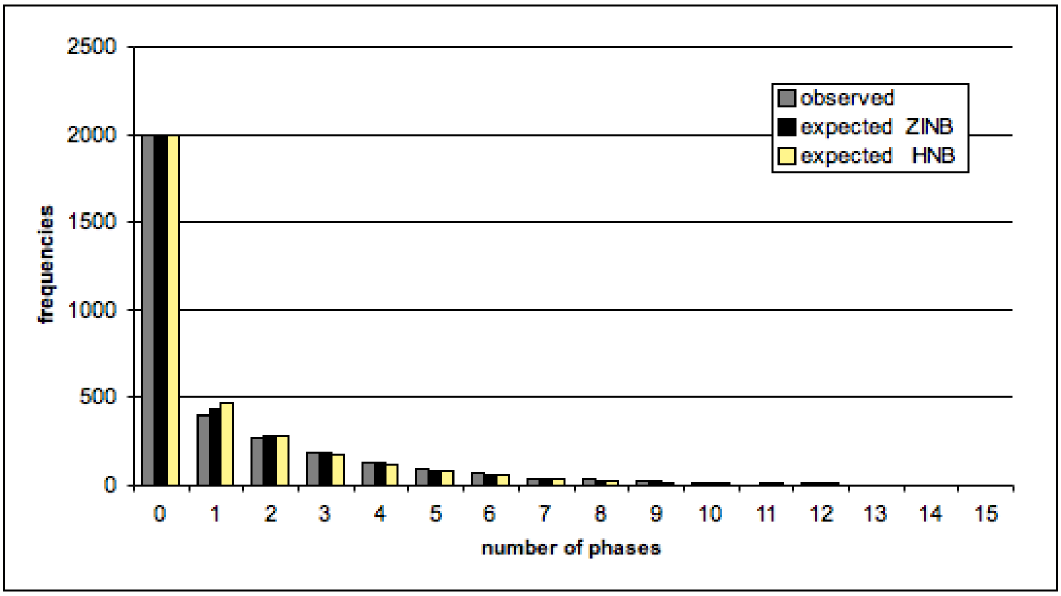

Figure 2: Concurrently sourced phases: expected vs. observed frequency distribution

operation of phases 1, 2, 4, 6 and 7, whereas coefficients of phase 8 is negative. First of all, the structure of the production process influences the decision to make-or-buy. Second, being a firm which operates skill-intensive (design and software development) and core mechanical activities (processing of mechanical components) increases the propensity to subcontract other non-core activities. The negative coefficient for phase 8, instead, may be interpreted as capturing the answer of possible 'service' firms (e.g. Russo and Bigarelli, 2009), namely firms which provide installing and repairing services and that, for this reason, are mainly suppliers.

With respect to the intensity of outsourcing, we find a significant and positive association with the workforce skill level, with the presence of the firm on international markets, and with our measure of related variety, while the association turns to be negative with firm size, age and unit labour cost. Hence, once controlled for the qualitative composition of the production process, we find that the most outsourcing intensive firms are relatively small, young, and technologically advanced, as shown by the skill intensity of their workforce and by their presence on foreign markets.

Interestingly, while spatial agglomeration variables do not seem to affect - or to be affected by - the subcontracting choice of firms, they turn to be significant with respect to the intensity of outsourcing. In particular, as we expected, the higher the share of stages contracted out, the higher the possibility to attract different types of suppliers, thus increasing the degree of related variety of the LLS. Alternatively, a higher related variety, i.e. a higher presence of firms operating in related 3-digit sectors, may be the base for a higher probability to match specialised suppliers over different stages of the production process.

Table 5: Number of phases of the productive process totally outsourced

Zero-inflation model	Zero-inflation model coeff. (binomial with logit link)		Count model coeff. (negbin with log link)	
	Estimate		Estimate	
Intercept	1,439	***	-0,881	***
11-20 empl.	-0,181		-0,164	***
21-50 empl.	-0,253		-0,230	***
Age	-0,009		-0,009	***
Share of white collars	-0,218		0,555	***
UE & extraUE mkt	-0,505	**	0,086	*
Num. products	0,075	+	0,002	
Labour cost per empl.	-2,235	*	-0,932	***
Localisation	0,089	+	0,005	
Variety	-0,072		0,056	**
Density	-0,023		0,008	
1 - Design	-0,893	***	-0,044	
2 - Mech. parts processing	-1,109	***	0,165	**
3 - Assembly	-0,173		-0,085	
4 - Software development	-0,844	***	0,173	***
5 - Non–mech. parts proc.	-0,335		0,158	***
6 - Testing	-0,367	*	0,023	
7 - Finishing	-1,086	***	-0,048	
8 - Installing, rep., maint.	0,439	*	-0,153	***
Log(theta)			1,953	***
	Log lik = -5056 (df = 39)			

*** p<0.001; ** p<0.01; * p<0.05; + p<0.1

Table 6 presents the econometric results for the choice to concurrently source. In this case, the picture seems to be simpler. In particular, we find a strong positive association only with firm's age, size and labour cost per employee, while the relationship with our density variable is positive but weak. In addition, we find only one phase to be linked with such a strategic decision, namely the core activity 2.

The intensity, in turn, seems to confirm this pattern as there is a positive association with firm size and product diversity, whereas a negative association emerges with phases 2 , 7 and 8. Surprisingly, spatial agglomeration economies again are not related with concurrent sourcing. What affects the industrial composition of the local context, then, is not the decision to outsource *per sè*, but, rather, the *number* of phases fully outsourced to specialised suppliers. These latter, in turn, may also decide to further sub-contract production, thus attracting other specialised suppliers.

Table 6: Number of phases of the productive process partially outsourced

Zero-inflation model	Zero-inflation model coeff. (binomial with logit link)		Count model coeff. (negbin with log link)	
	Estimate		Estimate	
Intercept	1,656	***	-1,164	***
11-20 empl.	-0,397	*	0,183	**
21-50 empl.	-0,465	+	0,308	***
Age	-0,020	***	-0,003	
Share of white collars	-0,313		0,113	
UE & extraUE mkt	-0,226		0,072	
Num. products	-0,011		0,048	**
Labour cost per empl.	-3,666	***	-0,274	
Localisation	0,015		-0,016	
Variety	0,090		-0,006	
Density	-0,102	+	0,004	
1 - Design	-0,238		-0,097	
2 - Mech. parts processing	-0,740	***	-0,364	***
3 - Assembly	-0,142		-0,049	
4 - Software development	-0,017		0,111	+
5 - Non–mech. parts proc.	-0,108		0,008	
6 - Testing	-0,203		-0,086	
7 - Finishing	-0,199		-0,337	***
8 - Installing, rep., maint.	0,311		0,256	**
Log(theta)			1,174	***
	Log lik = -4124 (df = 39)			
*** p<0.001; ** p<0.01; * p<0.05; + p<0.1				

5.3 Final vs. subcontracting firms

We now separately consider final firms (*conto proprio*) and subcontracting firms (*conto terzi*). The former are firms producing goods on their own, while the latter are firms producing on behalf of other firms. We define a firm as 'final' (subcontracting) if it declares to operated at least the 90% of its activities in-house (externally).[7] Our results show full outsourcing decisions

[7]Our results do not change if we set the volume of activities at 80% and 70%. The estimates are not reported here, but are available on request.

by both final (Table 7) and subcontracting firms (Table 8).

Table 7: Number of phases of the productive process fully outsourced by final firms (n=725)

Zero-inflation model	Zero-inflation model coeff. (binomial with logit link)		Count model coeff. (negbin with log link)	
	Estimate		Estimate	
Intercept	-0,006		-1,315	***
11-20 empl.	-0,717		-0,142	*
21-50 empl.	0,724		-0,249	**
Age	0,071	**	-0,007	**
Share of white collars	5,009	+	0,590	**
UE & extraUE mkt	-0,902		-0,059	
Num. products	-1,376		-0,001	
Labour cost per empl.	-1,347		-0,942	***
Localisation	-0,196		0,000	
Variety	-0,858	*	0,052	.
Density	-0,041		0,012	
1 - Design	0,079		-0,037	
2 - Mech. parts processing	0,402		0,612	***
3 - Assembly	1,219		-0,253	
4 - Software development	-4,234		0,123	*
5 - Non–mech. parts proc.	-0,645		0,178	**
6 - Testing	-1,274		0,035	
7 - Finishing	-1,995	**	0,248	*
8 - Installing, rep., maint.	0,184		-0,171	*
Log(theta)			2,221	***
	Log lik = -1484 (df = 39)			
*** p<0.001; ** p<0.01; * p<0.05; + p<0.1				

Regarding the choice of recurring to outsourcing, our results show marked differences between final and subcontracting firms. In the former case, while the outsourcing choice is significantly related only to the age of the firm (-) and our measure of related variety (+) (once controlled for the presence of the eight phases of product transformation), the intensity of outsourcing shows a negative association with firm size, age, unit labour cost, and a positive association with the skill intensity of the workforce as well as related variety (at 10% level).

Once accounting for the phases characterising their production process, subcontracting firms, instead, relate their outsourcing decision positively on age, their commitment on foreign markets and unit labour cost, while negatively with a more specialised industrial composition of the LLS. Once decided, the number of activities contracted out is negatively related to the age of the firm as well as labour cost per employee and positively to workforce skills.

Factors affecting the outsourcing strategies, therefore, seem to be slightly different between final and subcontracting firms. The main differences seem to emerge with respect to variables of size, age, labour cost and spatial agglomeration. In particular, the size of the firm is related only with the intensity of outsourcing by final firms, while the sign of the estimated coefficient of the age variable shows that outsourcing involves primarily younger final firms and older subcontracting firms. While the sign of labour cost coefficient is negative in both cases, its magnitude reveals that its importance in affecting - or in being affected by - outsourcing is much higher in the case of subcontracting firms. The relationship with spatial agglomeration variables, instead, is less clear: the significance of the three estimated coefficients is generally low, and only variety seems to be related with the decision to outsource by final firms. This means that the positive effect previously identified emerges only when we consider all the different types of firms operating on the regional territory. Finally, the make and/or buy strategy seems to involve different phases of product transformation: 2, 4, 5, 7 and 8 for final firms, being phase 5 the most significant, and 1, 2, 4 and 7 for subcontracting firms. This result, again, reveals that what firms actually do matters and that subcontracting firms outsource when they are involved in the polar phases of production, i.e. design and finishing, whereas final firms outsource when they operate the middle stages.

6 Concluding remarks

This paper represents a first exploration of the factors related to the firm decision to fully or partially outsource production activities. To our knowledge, this paper is the first and only attempt to use detailed firm-level data from the Italian Fiscal Authority in order to analyse such a kind of issues.

Our analysis is concerned with the identification of the key variables that affect the decision to make and/or buy by a set of mechanical firms located in Emilia Romagna (Italy). We improve the existing literature by adding variables capturing local externalities and variables measuring the type of activities operated by each plant. Due to the cross-sectional nature of our data, however, we are not able to clearly identify causal relationships between outsourcing and the other variables so that further research in this direction is needed.

The technology and composition of the production process is, for this purpose, a crucial aspect that, probably due to the lack of detailed data, has been often neglected in the literature. We tried to fill this gap by first including

Table 8: Number of phases of the productive process fully outsourced by subcontracting firms (n=924)

Zero-inflation model	Zero-inflation model coeff. (binomial with logit link)		Count model coeff. (negbin with log link)	
	Estimate		Estimate	
Intercept	1,908	***	-0,710	***
11-20 empl.	-0,571		-0,087	
21-50 empl.	-0,214		-0,009	
Age	-0,045	**	-0,016	***
Share of white collars	1,857		0,677	**
UE & extraUE mkt	-0,744	*	0,091	
Num. products	0,032		0,022	
Labour cost per empl.	-4,071	*	-1,396	***
Localisation	0,166	+	0,090	
Variety	-0,176		0,016	
Density	-0,041		-0,020	
1 - Design	-1,139	**	-0,236	**
2 - Mech. parts processing	-0,769	**	0,484	
3 - Assembly	0,100		0,074	
4 - Software development	-0,431		0,172	*
5 - Non–mech. parts proc.	-0,303		0,057	
6 - Testing	-0,227		0,162	.
7 - Finishing	-0,814	**	-0,198	*
8 - Installing, rep., maint.	0,209		0,020	
Log(theta)			2,143	***
	Log lik = -1225 (df = 39)			
*** p<0.001; ** p<0.01; * p<0.05; + p<0.1				

the stages actually operated by the firm as covariates in our firm-level estimates, and, second, by analysing the two different sets of firms constituting our sample in final and outsourcing firms.

We have thus shown the results of zero-inflated negative binomial models in which we use the probability to fully outsource, the probability to partially outsource and the intensity of both of them as dependent variables. Our estimates seem to show that production activities, human capital composition and spatial agglomeration are important factors related to both the propensity and the intensity of outsourcing. However, marked differences seem to characterise the patterns with which full and partial outsourcing are carried out by the firms.

Indeed, it seems that, once controlled for the phase-composition of the production process, the choice to fully outsource is directly related to the exporting activity of firms and to their labour costs. The positioning on international markets and the need to cut on labour costs can be interpreted as a 'search–for–efficiency' strategy in the production of high-quality products. On this purpose, the significance of the estimated coefficients concerning the most skill-intensive and core activities (as design, the processing of mechanical parts and software development) seems to confirm our interpretation. Once the decision is taken, however, outsourcing seems to be related to a smaller size, a smaller age, a higher skill intensity, a lower average cost of labour and, more interestingly, a higher degree of related variety. Due to the nature of our data, this last result can be explained in two ways. On the one hand, the availability of local firms specialised on complementary stages of the production process may induce firms to rely more on outsourcing, due to lower prices as well as a higher level of trust and social interactions among the agents. On the other hand, a higher volume of activities outsourced - both in quantitative and qualitative terms - may modify the local production context by attracting a diversified range of suppliers, thus increasing the employment in related sectors. Finally, we distinguish between final and subcontracting firms and we find that their outsourcing strategies are related to different variables. In particular, final firms committed to outsourcing seem to be older and larger and relatively less based on labour cost saving objectives.

References

Abraham, K. G., and S. K. Taylor (1996): "Firms' use of outside contractors: theory and evidence," *Journal of Labor Economics*, 14, 394–424.

Abramovsky, L., and R. Griffith (2006): "Outsourcing and offshoring of business services: how important is ICT?," *Journal of the European Economic Association*, 4, 594–601.

Adelman, M. (1949): "The large firm and its suppliers," *Review of Economics and Statistics*, 31, 113–118.

Agresti, A. (2002): *Categorial Data Analysis. 2nd Edition*. John Wiley and Sons, New Jersey.

Antonietti, R., and G. Cainelli (2008): "Spatial agglomeration, technology and the outsourcing of knowledge-intensive business services: empirical insights from Italy," *International Journal of Services and Technology Management*, 10, 273–298.

Asheim, B., R. Boschma, and P. Cooke (2009): "Constructing regional advantage: platform policies based on related variety and differentiated knowledge bases," Papers in Evolutionary Economic Geography, 07.09.

Becattini, G. (1990): "The Marshallian industrial district as a socio–economic notion," in *Industrial Districts and Inter-Firm Co-Operation in Italy*, ed. by F. Pike, G. Becattini, and W. Sengerberger. ILO, Geneve.

Benson, J., and N. Ieronimo (1996): "Outsourcing decisions: evidence from Australia-based enterprises," *International Labour Review*, 135, 59–73.

Boschma, R. (2004): "Competitiveness of regions from an evolutionary perspective," *Regional Studies*, 38, 1001–1014.

Boschma, R., and S. Iammarino (2009): "Related variety, trade linkages and regional growth in Italy," *Economic Geography*, 85, 289–311.

Brusco, S. (1982): "The Emilian model: productive decentralization and social integration," *Cambridge Journal of Economics*, 6(2), 235–261.

Cainelli, G., and R. Leoncini (1999): "Externalities and long-term local industrial development. Some empirical evidence from Italy," *Revue d'Économie Industrielle*, 90, 25–39.

Cameron, A. C., and P. K. Trivedi (1998): *Regression Analysis of Count Data*. Cambridge University Press.

Ciccone, A., and R. Hall (1996): "Productivity and the density of economic activity," *American Economic Review*, 86, 54–70.

Coase, R. H. (1937): "The nature of the firm," *Economica*, 4(16), 386–405.

Frenken, K., F. van Oort, and T. Verburg (2007): "Related variety, unrelated variety and regional economic growth," *Regional Studies*, 41, 685–697.

Glaeser, E., H. Kallal, J. Scheinkman, and A. Shleifer (1992): "Growth in cities," *Journal of Political Economy*, 100, 1126–1152.

Gonzalez-Diaz, M., B. Arruñada, and A. Fernandez (2000): "Causes of subcontracting: evidence from panel data on construction firms," *Journal of Economic Behavior & Organization*, 42, 167–187.

Gulati, G., and P. Puranam (2006): "Complementarity and constraints: why firms both make and buy the same thing," mimeo.

Henderson, V., A. Kuncoro, and M. Turner (1995): "Industrial development in cities," *Journal of Political Economy*, 103, 1067–1090.

Holmes, T. (1999): "Localization of industry and vertical integration," *Review of Economics and Statistics*, 81, 314–325.

ISTAT (2001): *Censimento dell'industria e dei servizi.* ISTAT, Rome.

Masten, S. (1984): "The organization of production: evidence from the aerospace industry," *Journal of Law and Economics*, 27, 403–417.

Mazzanti, M., S. Montresor, and P. Pini (2007a): "Outsourcing and innovation: evidence for a local production system of Emilia Romagna," *Innovation: Managment, Policy, Practice*, 9, 324–343.

——— (2007b): "Outsourcing and transaction costs in "real" time and space: evidence for a province of Emilia-Romagna (Italy)," *The Icfai Journal of Industrial Economics*, IV, 7–23.

Ono, Y. (2001): "Outsourcing business service and the scope of local markets," Federal Reserve Bank of Chicago, Working Paper n. 09.

——— (2006): "Market thickness and outsourcing services," *Regional Science and Urban Economics*, 37, 220–238.

Ono, Y., and V. Stango (2005): "Outsourcing, firm size, and product complexity: evidence from credit unions," *Economic Perspectives, Federal Reserve Bank of Chicago*, Q1, 2–11.

Parmigiani, A. (2007): "Why do firms both make and buy? An investigation of concurrent sourcing," *Strategic Management Journal*, 28, 285–311.

Parmigiani, A., and W. Mitchell (2009): "Complementarity, capabilities, and the boundaries of the firm: the impact of within-firm and inter-firm expertise on concurrent courcing of complementary components," *Strategic Management Journal*, 30, 1065–1091.

Porter, M. (1980): *Competitive Strategy.* The Free Press, New York.

Russo, M., and D. Bigarelli (2009): "Specializzazioni e reti di relazioni nel sistema produttivo della meccanica a Modena," mimeo.

Russo, M., and E. Pirani (2006): "Le specializzazioni meccaniche in Italia: 1981-2001," Materiali di Discussione n. 528, University of Modena and Reggio Emilia.

Russo, M., E. Pirani, and S. Paterlini (2006): "L'industria meccanica in Italia: un'analisi cluster delle differenze territoriali," Materiali di Discussione n. 526, University of Modena and Reggio Emilia.

Stigler, G. J. (1951): "The division of labor is limited by the extent of the market," *The Journal of Political Economy*, 59, 185–193.

Teece, D., G. Pisano, and A. Shuen (1997): "Dynamic capabilities and strategic management," *Strategic Management Journal*, 18, 509–533.

Tomiura, E. (2005): "Foreign outsourcing and firm-level characteristics: evidence from Japanese manufacturers," *Journal of the Japanese and International Economies*, 19, 255–271.

Williamson, O. (1975): *Markets and Hierarchies: Analysis and Antitrust Implications.* Free Press, New York.

Winkelmann, R. (2003): *Econometric Analysis of Count Data, 4th ed.* Springer-Verlag, Berlin.