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Product and process innovations in subcontracting: empirical evidence from the French 'Sillon Alpin'

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ABSTRACT. This paper investigates the role that the type of subcontracting relationships (collaborative outsourcing versus traditional subcontracting) can have on a subcontractor's ability to innovate in process and product. In order to measure the "full" impact of subcontracting relationships on innovation, we make the distinction between process and product innovations, taking into account their possible interaction. The empirical test is based on 93 small firms operating in "pure subcontracting industries" meaning that their turnover is carried out minimum 80% in this field (Sessi, 2006). Using a bivariate probit model, we have made several advances. Firstly, in line with previous empirical studies, we give evidence that process and product innovations are not independent choices. Secondly, the test confirms the positive impact of collaborative outsourcing agreement on the subcontractor's probability to innovate whatever the type of innovation. Finally, the results show that process and product innovations are reinforced by different inter-organizational practices and tools as well as distinct absorptive capabilities. This suggests important implications for subcontractors' competitive position.

KEY WORDS: Subcontracting relationships, small firms, product and process innovations.
JEL: L24, L26, 031, L61

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1. Introduction

The new context of knowledge-based economy has important implications for companies operating in “pure subcontracting industries”[2] (Amesse and Cohendet, 2001, Amesse *et al.* 2001, Smith and Tranfield, 2005, Lehtinen, 1999, Lamming, 1993). Due to new outsourcing practices that no longer involve exclusively the external boundary functions of the firm, subcontracting relationships have changed. Subcontractors are not required to simply produce what they are asked to. Often, they are urged to generate the technological knowledge which fuels new product and process development. Since the early 90’s, a growing body of research has endeavoured to depict this new “collaborative outsourcing mode” based on interdependent and long-term relationships (Cohendet and Llerena 2005; Baudry 2004, Takeishi 2002; Amesse *et al.* 2001; Amesse and Cohendet 2001; Nonaka and Takeichi 1995; Langlois and Foss 1996; Foss 1993). Quite surprisingly, there are very few empirical studies which provide direct information on innovation and technology transfer capabilities of subcontractors associated with this new mode (Takeishi 2002; Dyer *et al.* 1998; Amesse *et al.* 2001, Baudry 2003). In this paper, we would like to assess to what extent “talented suppliers” (Smith and Transfield 2005; Lamming 1993) that are placed in collaborative relationships might be more innovative or at least more actively involved in innovation than traditional subcontractors.

Besides, we know very little about the type of innovation (process and/or product) although it may be a key aspect for a better understanding of firms’ competitive position (Weiss, 2003). With that in mind, what is the “true” potential of collaborative outsourcing and its consequences for subcontractors: process innovations or product innovations, or both? This study takes into consideration the possible interaction between product and process innovations. In this way, it differs from a great number of studies that focus only on product innovation or sometimes on process innovation.

The objective of the paper is to assess the full impact of the type of subcontracting relationships on the ability of a subcontractor to innovate in process and product. To do so, we first specify two types of subcontractors according to the nature of their subcontracting agreements, their inter-organizational practices and tools, and their absorptive capacities (Cohen and Levinthal 1990). Secondly, we measure this impact according to the type of subcontractors’ innovation (process and/or product). Like many studies, we define innovation in a comprehensive way (OECD/Eurostat 1997, Smith 2004). There will be innovation when the firm considers that it has made an improvement or a development on a product or process in the last three years.

The empirical analysis is based on data collected from subcontracting firms in May 2007 with a specially designed questionnaire. All firms were operating in “pure subcontracting industries”. In these industries, firms are by nature *quasi-firms* insofar they are more or less dependent on other firms. Pure subcontracting industries are also made up of a large number of small independent companies operating in traditional or low-tech activities (Sessi 2007). If the application of data from these particular industries reduces the number of observations, the advantage is that firms are relatively homogeneous. The study was conducted in a region of the French Alps, the “Sillon Alpin”, which is the biggest industrial subcontracting region in France.

Estimating a bivariate probit model we have made several advances. Firstly, in line with previous empirical studies, results show that process and product innovations are not independent of each other. Secondly, the test confirms the positive impact of collaborative outsourcing agreement on the subcontractor’s probability to innovate whatever the type of

[2] Pure subcontracting industries are considered those in which 80% of the turnover derives from subcontracting activity (Sessi 2006). These industries are not delineated according to a sectoral base (nature of the final output) but to a destination base (volume of the collected activity).

innovation. Finally, we give evidence that product and process innovations are associated with differentiated inter-organizational practices and tools and distinctive absorptive capabilities.

The paper is organized as follows: Section 2 presents the theoretical foundations of the research; Section 3 sets out the empirical procedure and describes the dataset; Section 4 discusses the empirical results. In Section 5 we conclude with some theoretical implications and primary conclusions for policy makers.

2. Innovation in subcontracting firms

To provide a better understanding of the innovative activity of subcontracting firms on two main aspects, we start to discuss two theoretical types of subcontracting relationships (traditional subcontracting versus collaborative outsourcing) and their potential impact on subcontractors' innovation (2.1). Then, we precise the "true" impact of subcontracting relationships by differentiating product and process innovations, taking into consideration their possible interaction (2.2).

2.1. Subcontracting relationships and innovation

A close examination of the transactional and the knowledge-based perspectives allows us to differentiate two types of subcontracting relationships (2.2.1) and indicate how they can be linked to a subcontractor's innovative activities (2.2.2).

2.2.1. Subcontracting considered as a mere contract

In transaction cost theory (Williamson 1975 1985 1999), subcontracting is merely a practice driven by reducing costs. This interpretation does not mean that there is no room for knowledge creation or innovation but as these processes are a by-product of the division of labour (Williamson 1999; Cohendet and Llerena 2005) subcontractors are left with little incentive to make the effort to innovate.

According to Baudry (2003), two types of "*traditional*" subcontractors can be determined from this view: subcontractors of economy and subcontractors of specialization, which differ mainly in their degree of dependence and the uncertainty level of their relationship. However, both types share the same objective of producing goods and services under the guidance of large firms that have a detailed knowledge of specifications. Traditional subcontractors produce peripheral products that do not involve specific assets. This makes it more cost effective for a contractor to outsource if market incentives can be maintained and bureaucratic distortion avoided (Williamson 1991). The challenge for the contractor is to avoid any situation of dependence for capacity. Subcontracting relationships are therefore based on arm's length contracts which are uncertain by nature and dependent on the subcontractor's performance. Furthermore, the degree of interdependence is generally low because the activities in question are peripheral. In this way, transaction cost theory is useful to describe non innovative or less innovative subcontracting firms. As suggested by Cohendet and Llerena (2005), "*in terms of technology transfer, what is at stake in this zone (of quasi-market relations) is the exchange of artefacts, rather than innovative ideas or new tacit knowledge*" (Op. Cit., 182-183). In most cases, subcontractors are rarely in charge of product design, which is too specific or risky to be subcontracted, although their advice is sometimes called upon. Thus, if we consider the nature of this inter-firm relationship, subcontractors have no incentive to innovate in process or product. Nevertheless, subcontractors might be able to improve their processes because of passive learning effects.

2.1.2. Subcontracting considered as a process

From the knowledge-based approach, subcontractors are seen as partners or suppliers (collaborative outsourcing) characterized by a new role in knowledge creation. Subcontracting relations are derived from the needs of contractors to access the complementary knowledge required to make their own skills valuable. This perspective emphasizes the dynamic efficiency of capability building rather than the static efficiency of individual transactions. Subcontracting relations no longer involve the external boundary functions of the contractor. Subcontractors are considered as "*talented suppliers*" (Smith and Transfield 2005; Lamming 1993) that produce components or systems that are strategic for the contractor. They contribute to build the knowledge base of the contractors and benefit from their accumulated absorptive capabilities (Cohendet and Llerena 2005). Since the subcontractor's resources are essential, the innovation is also derived from the internal organization of the firm (Nelson and Winter 1982; Teece 1996). Here, competence have a social nature and they are contained in routines that "*may extend outside the firm to embrace partners*" (Teece *et al.* 1997). The key point here is that the learning process is intrinsically social and collective. It occurs not only through imitation, but also because of joint contributions to the understanding of complex problems which are based on relational long term-contracts and coordinative routines for an efficient circulation of creative ideas and knowledge. Teece (1996) has shown that these kinds of external links are major determinants of innovation. "*Compared to arm's length market contracts, such an arrangement is more structured, involves constant interaction between participants, more open information channels, greater trust and reliance and puts less emphasis on price*" (Op. cit, p. 207).

At this stage, three main arguments should be retained for the present discussion. The first, which differs drastically from both interpretations, concerns *the type of contractual agreement*, which in the case of collaborative outsourcing is not a matter of dependence but of *co-specialization* (Teece 1996). Contractual mechanisms have to guarantee incentives necessary for innovation. Then, *the length of the contract* (middle/long term) and *its explicit character* becomes a guarantee if compared to a short-term open, repetitive order, which characterizes traditional subcontracting contracts. The subcontractor will be encouraged to innovate in order to reap future benefits over time and especially benefit from the renewal of the contract to enjoy the fruit of the quasi-rent.

The second argument relates to the weakness of the contractual dimension to qualify the full potential of subcontracting relationships. The knowledge-based approach to subcontracting is comparable to a process rather than a contract, and depends both on the type of agreement and the quality of interaction between the contractor and subcontractor. Learning is not an automatic process. In order for it to be accumulated and coordinated, it is necessary to build routines as well as incentive schemes and information sharing rules. From this perspective, characterization must include *inter-organizational practices and tools and absorptive capabilities of firms* (Cohen and Levinthal 1990).

Two types of practices and tools can be considered as determinants of the "*innovation learning process*" (Lundvall 1988), insofar as they guarantee the integration of activities and flow of knowledge between subcontractors and contractors. The first are practices dedicated to the coordination of quality, such as insurance-quality procedures, just-in-time or lean supply (Baudry 2003). Since the outcome of the exchange is difficult to predict, these practices are defined as necessary to make sure that a product or process will meet quality requirements. Although this sometimes involves the need for modernization, training and human resources, they also facilitate the renewal of contracts and promote the subcontractor's technological potential. Therefore, they do not only aim at reducing costs or improving efficiency. In the case of the network-firm, Baudry (1995) shows that the closest subcontractors are characterized by coordination mechanisms that *"are no longer reduced to price mechanisms but require practices and tools that reveal the ability of a subcontractor to deliver goods in due quality and time and to innovate"* (p. 106). Studying the case of the lean supply model, Lamming (1993) suggests that these new practices and tools foster the ability of the subcontractor to innovate.

Logistical integration tools, such as Electronic Data Interchange (EDI) or Enterprise Resource Planning software (ERP), have become strategic resources in the development of new forms of subcontracting that include the sharing and diffusion of knowledge, especially in a network firm (Baudry 2003; Raymond and Blili 1997). According to Information System literature, EDI and ERP are interdependent technologies. EDI implementation helps the sharing of data and applications (such as ERP) among users in different organizations (Iacovou Charalambos *et al.* 1995). According to Zhu (2002), EDI is often conducted over propriety value-added networks and controlled by one large firm. An IT application such as EDI crosses organizational boundaries, linking individual value chains to create a virtual or meta-value chain. The presence of an EDI can be interpreted as the signal of a network organization in which a "hub" firm decentralizes activities to subcontracting firms (Baudry 1993; Raymond and Blili 1993). Andersen (1999) shows that the use of EDI depends on the subcontracting type. On the basis of 445 subcontractors in the Danish industry, he gives evidence that development-oriented subcontractors (in both product and process) are more likely to use EDI than other types of subcontractors (non innovating firms).

In its claim for a re-thinking of subcontracting, the knowledge-based literature considers the subcontractors' absorptive capacity as a key factor for successful partnership. The absorptive capacity of firms, defined by their ability to absorb outside knowledge, reflects the cumulative nature of knowledge which is largely a function of prior related knowledge (Cohen and Levinthal 1990). At its lowest level, this prior knowledge includes basic abilities or shared language, but also refers to an awareness of the most recent technological advances in a given field. In the case of collaborative outsourcing, a supplier's absorptive capacity is seen as a pre-requisite to building the knowledge base of its contractors. But, as suggested by Cohendet and Llerena (2005), "*it is also important for the firm to enhance absorptive capacities of the suppliers themselves*" (p.182). This poses that a contractor does not only assist in the areas of cost reduction, quality, factory layout and inventory management but also in increasing technological competence and research. In contrast, Bruce and Moger (1999) argue that an excessively close relationship between supplier and contractor may limit a supplier's absorptive capacity, leading to a failure to absorb and benefit from external sources that should lead to innovation. Though "talented", suppliers can find themselves in a vicious circle situation where technological opportunities are missed. Therefore, it is important to concentrate on the "*way communication between the firm and its external environment*" is organized (Cohen and Levinthal 1990, p. 544). In this perspective, the use of external links to extend a firm's base has been frequently related to successful innovation. This is particularly important for smaller firms, "*which have to compensate for small internal resources by being good at interacting with the outside world*" (Fagerberg 2005, p. 11). Empirical studies show that the use of external knowledge sources alone, without investing in internal factors, do not lead to better innovation. Some empirical studies suggest that some firm's characteristics, like being a subcontractor or a small firm, affect the sources of innovation. For instance, focusing on innovative activities in 143 small non-R&D-performing firms in Italy, Sterlacchini (1999) shows significant differences in internal technological sources of knowledge between firms working mainly as subcontractors and other firms. Subcontractors are smaller and spend less on design, engineering and trial production than other firms. Veugelers and Cassiman (1999) use data from the Eurostat Community Innovation Survey (CIS) in Belgium to study the decision of innovative firms to produce technology itself (make) and/or to source technology externally (buy). They give evidence that small firms are less likely to combine both internal and external technological sources of knowledge than larger companies in the sample. In the same vein, drawing upon a large-scale survey of small firms in Northern Britain, Freel and Harrison (2006) show that innovation is, primarily, a process built upon internal resources that can moderate the requirement to engage in external cooperations. In the case of manufacturing firms, novel innovativeness in both product and process (relative to incremental innovation) is significantly associated with the employment of technicians and with R&D expenditure (up to a point).

Another way to estimate the absorptive capacities of subcontractors is to consider the firm's strategic positioning as a determinant of its ability to learn (Fiol and Lyles 1985). Many authors state that strategy influences learning by setting limits on the decision making process. Most of the empirical studies on subcontracting emphasize that cost-driven objectives prevail in all types of subcontracting agreements and tend to blur all other objectives. In their qualitative study about subcontracting in the aeronautical industry in Quebec, Amesse *et al.* (2001) show that subcontractors perceive all agreements as a result of the main contractor's cost-driven strategy, although the latter is looking for technology transfer. They also observe that *"the absorptive capacity of a subcontractor is observed only in terms of control and maintenance of the technology transferred for most of the agreements"* (Op. Cit, p. 566). Their results are similar to those of Dyer *et al.* (1988) who show that partnering does not differ significantly from arm's length contracts because a cost-driven objective prevails. In her study of 18 Finnish subcontractors from 1988 to 1990 and 1995 to 1996, Lehtinen (1999) provides new evidence. Although she observes an increase of stable, commitment-based supplier-customer relationships, partnerships involving integrated R&D processes or mutual sharing strategic visions are still very few. The study by Smith and Tranfield (2005) in the UK aerospace industry provides further findings: new subcontracting practices based on lean supply give the opportunity to subcontractors to have a new status and role. They can use their expertise and experience to offer a broader range of services. But, their ability for innovation is less apparent as only two subcontractors out of ten are engaged in innovation.

To sum up, the few studies that deal with knowledge creation and innovation through subcontracting relationships tend to confirm that a new type of subcontractor does exist. Theoretically, these "suppliers" differ from traditional subcontractors because of the structure of the contractual agreement, the nature of their absorptive capabilities and the inter-organizational devices by which they are committed to the contractor. However, empirical results concerning the supplier's ability to innovate are still ambiguous. Some studies give evidence of the impact of certain practices and tools on innovation, while others are more pessimistic, concluding that the so-called "talented suppliers" are an ideal image rather than a reality (Amesse *et al.* 2001). In this perspective, we try to understand if and to what extent these suppliers are more talented when developing new processes as well as new products.

2.3. The ability to innovate in process and product

To assess the ability of subcontractors to innovate we now focus on the type of innovation: process and product. Innovation can be classified by basic purpose (innovation in products/services or production process) and degree of novelty (new to the firm and/or new to the industry) (Freel and Harisson 2006; OECD 1997). In our study we do not try to differentiate subcontractors by the intensity of innovation since this is mainly incremental in traditional and low-tech industries under study (Archibugi *et al*. 1991, Sessi 2007). Then, it is not essential for an innovation to be a true novelty for the industry as long as the corresponding product, service or process is declared new (or improved) by the subcontractor. We feel it more important to focus on product and process innovations and their potential interaction.

The clear-cut distinction between product and process innovations has important implications for a better understanding of the determinants of innovation and for firms' competitive position (Weiss 2003). Some empirical studies show that product and process innovations are closely interlinked in many firms but are driven by different industry and/or firm level variables (Vaona and Pianta, 2008, Rouvinen 2002) or different organizational capabilities (Ettlie *et al.* 1984, Damampour and Gopalakrishnan 2001). Using the SIEPI-CIS2 database, Vaona and Pianta (2008) provide evidence that product and process innovations are present together in many firms: 31% are both product and process innovators. In the case of small firms, they show that process innovation[3] is reinforced by strategies for production flexibility while product innovation[4] is explained by patenting. In their comparative study of small manufacturing firms in Germany and the United Kingdom, White *et al.* (1988) note that process innovation[5] tends to be pursued independently of product innovation[6] when the motive is likely to reduce costs. In contrast, process innovation tends to be more related to product innovation insofar as the level or intensity of the latter is high or requires similar technical expertise (this is often the case with products involving microelectronics).

Other empirical studies test if one type of innovation may drive the other type or if they may complement each other. Here, the objective is to assess the impact of process and product innovations on firms' competitive position since it may differ at company level. From the Milgrom et Roberts' (1990) complementarity hypothesis, Athey and Schmutzler (1995) built a two period model to test the complementarities between product and process innovations. They show that the returns to implement a product innovation are higher when the firm also implements a process innovation in the short run. They also demonstrate that these complementarities between product and process innovations (short-run decisions) lead to complementarities between the firm's long term choices of flexibility and research capabilities[7]. Other researchers assert a positive impact of product innovation on process innovation and vice versa. kraft (1990) estimates a simultaneous equation model using data from 56 German firms operating in metal-product industry. The results show that product innovation has a significant impact on process innovation but no evidence for the reverse can be found. In contrast, Martinez-Ros (2000) demonstrates that product and process innovations are complement after controlling for the presence of unobserved firm effects as managerial ability, experience, or other factors that remain constant along the period 1990-1993.

Despite the fact that these empirical studies use different methodologies, they show that product and process innovations may not be independent choices and the possibility of an interaction between the two types of innovations can not be rejected *a priori*. Besides, product and process innovations are driven by different factors. In the case of subcontracting firms, the pattern of interaction between product and process innovations is still unclear. The literature about subcontracting relationships is yet too conceptual (Takeishi 2002). One important question that remains is the "true" potential of collaborative outsourcing and its consequences for small manufacturers: process innovations or product innovations, or both ?

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[3] measured as the share of firms introducing a process innovation from 1994 to 1996

[4] measured as the share of firms introducing a product innovation from 1994 to 1996

[5] measured by the use of Computer Numerically Controlled machine tools and/or the use of computers or robots in production

[6] measured as any change in products over the two years preceding the survey

[7] The firm makes long-term decisions in terms of product flexibility, product research process flexibility and process research.

3. Method

In this section, we present the data (3.1), the empirical procedure (3.2) and the variables used in this study (3.3).

3.1. Data

The empirical analysis is based on data collected from firms in May 2007 using a specially designed questionnaire[8], which was e-mailed to companies with more than 2 employees operating in "pure subcontracting industries" (Sessi 2006). In these industries, all firms are by nature *quasi-firms* insofar as they are in a state of dependence (more or less favourable) with regard to their contractors, particularly with regard to equipment and car manufacturers who constitute the main customer sector. In the sample the average volume of subcontracting activity collected by firms reaches 88%. Another common characteristic of the firms under study concerns their size. Pure subcontractors are mostly small (micro) independent firms. The sector-based data established on a national scale by Sessi (2007) reveal that a majority of them (59,8 %) have less than 10 employees. It is also the case in our sample of regional firms in which more than one subcontractor out of two is a micro firm.

The data was collected from firms situated in the "Sillon Alpin" region of the French Alps. This is the biggest industrial subcontracting region in France, employing 25% of the people working in the metal cutting and forming sector. 75% of the country's mechanical and bar turning industries are concentrated in this area, situated for the most part in "Technic Valley". In the sample, the great majority of subcontractors (80,6%) belongs to the metal cutting and forming sector[9]. In contrast, the other pure subcontracting industries do not use metal but plastic and rubber (See Table A1 in appendix). As Sessi (2007), we distinguish the activities of subcontracting according to the materials used by firms because the evolutions of production and employment are dissimilar, with a distance growing since the beginning of the decade in favour of the plastic (Sessi 2007).

Senior managers were asked to provide information about what type of subcontracting agreements they had, paying particular attention to the one with the most important contractor. We obtained details about their degree of dependence, their role in the subcontracting relationship and the level of uncertainty they face. Another part of the questionnaire was devoted to obtaining information about their ability to innovate in product and process, their organizational competencies, their strategic priorities and the different sources of technical knowledge they use to support innovative activities. We collected 93 exploitable questionnaires[10], and the final data is representative of subcontracting firms situated in the "Sillon Alpin" for the 3 sectors and the 2 size classes (See Tables A1 and A2 in Appendix).

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[8] The accuracy of the questionnaire was first tested during preliminary interviews with firms' managers. It enabled to clarify the questions, to detect possible vocabulary ambiguities and to identify the response biases that could arise from inappropriate question formulation.

[9] Metal cutting and forming sector (Bar Turning, Mechanical, Forge, Samping, Cuting) also represents the first group of subcontracting activities at the national level (1/5 of the total volume of subcontracting activity collected by firms) (Sessi 2006).

[10] The sampling ratio appears to be somewhat small. It can be explained by the strategic nature of the information collected and the culture of secrecy which is dominant in subcontracting activities.

3.2. Empirical procedure

Subcontracting firms innovate because it is profitable for them to do so (expected returns exceed associated costs). Expected profits of an innovator *i* must be higher with innovation (Π^I_i) than without innovation (Π^N_i), ie:

$$y^*_i = (\Pi^I_i) - (\Pi^N_i) > 0 \qquad (1)$$

A latent regression can be specified as:

$$y^*_i = \alpha + \beta'_C X_C + \beta'_O X_O + \beta'_S X_S + \beta'_{SO} X_{SO} + \beta'_{CO} X_{CO} + \varepsilon \qquad (2)$$

Where: X_C represents the types of the subcontracting agreements, X_O captures the organizational practices and tools stated in the subcontracting firm, X_S captures its strategic orientation, X_{SO} characterises the sources of knowledge used to support innovative activities, X_{CO} represents the control variables and ε is the error term which is assumed to be normally distributed.

Unfortunately, the subcontractors' profits with and without innovation can not be observed. We only observe whether it innovates or not. The observed counterpart to y^*_i is y_i, which takes a value of 0 (no innovation) or 1 (innovation), noted as follows:

$$y_i = \begin{cases} 1 \text{ if and only if } y^*_i > 0 \\ 0 \text{ otherwise} \end{cases} \qquad (3)$$

Table 1 indicates that 16 subcontractors (17%) qualify for the title of *highly innovating firms* as they have made innovations in both products and processes in the three years prior to the survey. However, estimating the probability to innovate using a probit model is restrictive as this supposes that the two processes are independent. As we have already shown this hypothesis is not adapted because previous empirical studies show that product and process innovations can be linked. It is therefore more appropriate to estimate a system of equations rather than separate estimations for each type of innovation.

Table 1. Product and process innovations of subcontractors

	INOPROC	
INOPROD	0	1
0	26	29
1	22	16

For the two types of innovation, process and product, respectively noted *j* and *k*, we have:

$$\begin{cases} P(y_{ij}=1) = \Phi(\beta'_j X_{ij} + \varepsilon_{ij}) \\ P(y_{ik}=1) = \Phi(\beta'_k X_{ik} + \varepsilon_{ik}) \end{cases} \qquad (4)$$

Where β is a vector of coefficient, X_i denotes the vector of explanatory variables, and ε_{ij} and ε_{ik} the error terms which follow a bivariate normal distribution with zero mean, unit variances and ρ is the correlation coefficient of the error terms. We used a bivariate analysis to test the correlation between the types of innovation. The test was carried out with a simple t test on the ρ coefficient. If ρ is statistically different from zero, the two innovation processes are not independent and cannot be estimated separately. Estimating this system of equations requires maximum likelihood techniques.

Before presenting the econometric results, we first describe the variables used in the regressions (see Table 4).

3.3. Measures

3.3.1 Dependent variables

Following the Oslo Manual and the Community Innovation Survey, we privilege the "subject" approach of innovation (Archibugi and Pianta 1996). The information is collected at the firm-level. Process innovation is examined as a binary measure (INOPROC) of whether or not new or modified production processes were introduced in the 3 years prior to the survey. Product innovation is measured by a binary variable (INOPROD) of whether or not new or modified products were introduced in the 3 years prior to the survey.

3.3.2 Independent variables

The covariates used in the regression correspond to four series of variables. The first series records the types of subcontracting contractual agreements (traditional subcontracting versus collaborative outsourcing). The second series describes the organizational practices and tools that guarantee the integration of activities and flow of knowledge between subcontractors and contractors. The third and fourth series represent the absorptive capabilities of subcontractors according to their strategic objectives and the sources of knowledge they use to support their innovative activities.
Types of subcontracting agreements. The type of contractual agreement is recorded from three dimensions derived from studying the literature (see section 2): the role played by the subcontractor in the relationship, the degree of dependence from its main contractor and the level of uncertainty. The operationalization of these dimensions has been accomplished with seven "core variables" that have been applied before and are defined in Table 2 below.

Table 2. Definition of the variables used in the cluster analysis

Variables	Définition
REAL	= 1 if the subcontractor manufactures products only (0= otherwise)
CONCEPT	= 1 if the subcontractor participates (even partially) in the development of the products / processes (0=otherwise)
NDO	= Total number of contractors
VOLP	= Part of the collected subcontracting activity from the main contractor / total volume of production of the subcontractor
CONTRACT	= 1 if the contract is written (= 0 otherwise)
DUREE1	= 1 if the duration of the agreement is less or equal to 1 year (= 0 otherwise)
RENEG	= 1 if the agreement is systematically submitted to renegotiation (= 0 otherwise)

A principal component analysis[11] (PCA) was conducted on these seven binary variables. To test if our variables were suitable for a PCA analysis, we calculated measures of sampling adequacy (MSA) for each variable (Hair *et al.* 1998). All the variables were good candidates for a PCA (MSA values>0.5). In addition, KMO and Bartlett's test of sphericity met common standards (KMO = 0.55 and p < 0.001). The PCA uncovered three factors giving a good

[11] All the results of the cluster analysis are available from the author on request.

summary of the theoretical dimensions (accounting for 59.8% of the total variance). A non-hierarchical cluster analysis (SUBC) was then carried out on the factor scores. To determine the final number of clusters, we used three usual criteria: (i) the statistical accuracy of the classification measured by the ratio of within and between cluster variances (Fisher's test), (ii) the number of firms per cluster, and (iii) the economic significance of the clusters identified. According to the criteria, the version with two clusters of subcontracting firms was preferred[12]. To interpret these two clusters, we calculated the mean of each indicator in each cluster (Table 3). The variable DUREE1 could not be used to describe the profile of clusters as there was no significant effect. The two clusters of subcontractors are defined as follows:

In Cluster 1, 41 subcontractors (44,1%) manufacture products only and do not have a free hand in product or process development. They are very dependent on their contractors (due to the small number of contractors, and the authority of the main one). The presence of arm's length contracts, which are continually in the balance, conforms to traditional subcontracting based on the authority of customers.

In Cluster 2, 52 subcontractors (55,9%) participate in product/process conception. Subcontractors are linked to a larger number of contractors and the weight of the main contractor is weaker than in Cluster 1, although it is still 22% of the total volume of production. Contracts are established (written) and less risky than traditional subcontractors (not systematically renegotiated), which reflects relationships based on trust and reciprocity. This type of agreement corresponds more to collaborative outsourcing based on incentive schemes as well as routines for the coordination of knowledge and learning process.

The two dummy variables (C1 for traditional subcontracting and C2 for collaborative outsourcing) used in the econometric analysis, result from this classification procedure. They represent the two types of subcontracting agreements between subcontractors and their contractors.

Table 3. Interpretation of the two subcontracting agreements

		NDO	VOLP	CONTRAT	CONCEPT	REAL	RENEG
C1: Traditional subcontracting	Mean	**28,00**	**37,88**	,02	,12	,**95**	**,71**
	N	41	41	41	41	41	41
C2: Collaborative outsourcing	Mean	86,90	22,33	,31	,37	,65	,54
	N	52	52	**52**	**52**	52	52
Total	Mean	60,94	29,18	,18	,26	,78	,61

Organizational practices and tools. In section 2, we have shown that organizational practices and tools can reveal how much integration there is between subcontractors and contractors using two series of variables. The first is related to the existence of a shared information system through the use of the EDI network and/or ERP applications. The second series of variables aims at identifying the presence of practices dedicated to the coordination of quality in new forms of subcontracting (Baudry 2003): FORM takes the value 1 if there are formal agreements between subcontractors and their suppliers or contractors (0 otherwise), QUALI equals 1 if subcontractors have adopted organizational practices centred on quality management (such as certification; Total Productive Maintenance or Value analysis) (0 otherwise); LPJAT equals 1 if subcontractors have implemented a "just-in-time" logistical organization (0 otherwise).

[12] For all comparisons of variances, Fisher's test is significant at the 0.000 level and indicates a good differentiation of the subcontracting firms.

Sources of knowledge. Like many authors, we consider the sources of knowledge used by subcontractors to support their innovative activities to be suitable proxies to measure their absorptive capabilities. This strategy seems particularly convenient for small firms since traditional R&D measures are not sufficient (Sterlacchini 1999, De Jong and Marsili, 2006). In our study most subcontractors are not involved in R&D themselves, and for this reason, our survey collected information on alternative measures. Four variables were used to make it possible to distinguish external sources from internal ones. The external sources are defined as follows: PREST stands for firms that collaborate with external providers to acquire new knowledge (private firms specialized or not in R&D and innovation, technical centres, public research centres, associations). ACTIFS identifies firms that buy specific assets to innovate such as patents, licences or machines. As far as internal sources are concerned, we distinguish firms that rely on their own R&D or engineering departments (BERD) from those that recruit new workers or train staff to support their innovative activities (RH).

Strategy variables. To complete the specification of the absorptive capabilities of subcontractors, we have included additional variables related to their strategic objectives. The questionnaire proposed a menu of classical strategies among which the respondents had to choose. This provides the following explanatory variables DEVINOV (development of R&D or innovation), RATION (cost-reduction), REDUCDEP (reduction of dependence from contractors), DIVER (market diversification).

Control variables. Two control variables have also been introduced: the size of the firm is measured by EFF1 (less than 10 employees) and EFF2 (from 10 or more employees). As far as industrial affiliation of subcontractors is concerned, we have undertaken some regrouping inside the SIC[13] four digit level, in order to acknowledge the two main activities of the metal cutting and forming sector in the "Sillon Alpin": bar turning (DEC) and mechanical (MECA). The other subcontracting activities are noted as APE2.

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[13] Standard Industrial Classification

Table 4. Definition of variables

Dependent variables	Definition
INOPROC	= 1 if the firm has achieved a process improvement or development in the last three years (= 0 otherwise)
INOPROD	= 1 if the firm has achieved a product improvement or development in the last three years (=0 otherwise)
Independent variables	**Definition**
Subcontracting agreements (Ref. C1= 1 if the type of subcontracting agreement corresponds to traditional subcontracting)	
C2	= 1 if the type of subcontracting agreement corresponds to collaborative outsourcing (= 0 otherwise)
Organizational practices and tools	
QUALI	=1 if the firm has adopted organizational practices centred on quality management such as certification, total productive maintenance, value analysis (= 0 otherwise)
LPJAT	= 1 if the firm has adopted a “just-in-time” logistical organization (= 0 otherwise)
EDI	= 1 if the firm has adopted an Electronic Data Interchange (EDI) system (= 0 otherwise)
ERP	= 1 if the firm has adopted an Enterprise Resources Planning (ERP) software (= 0 otherwise)
EDI_ERP	=1 if the firm has adopted an EDI system and an ERP planning software (=0 otherwise)
Strategy variables	
DEVINOV	= 1 if the firm aims at developing R&D or innovation (= 0 otherwise)
RATION	= 1 if the firm aims at reducing costs (= 0 otherwise)
RATION_DEV	=1 if the firm aims at developing R&D or innovation and aims at reducing costs (=0 otherwise)
REDUCDEP	= 1 if the firm aims at reducing the dependence from its contractors (= 0 otherwise)
DIVER	= 1 if the firm aims at selling on new markets (= 0 otherwise)
Sources of knowledge to support innovative activities	
BERD	=1 if the firm resorts to its research or production engineering departments to innovate (= 0 otherwise)
PREST	= 1 if the firm turns to external providers to innovate (= 0 otherwise)
ACTIFS	= 1 if the firm buys specific assets to innovate (such as patents, licences, machines) (= 0 otherwise)
RH	= 1 if the firm recruits new competences or trains the staff to innovate (= 0 otherwise)
Control variables	
Firm size (ref. EFF2= 1 if the firm has 10 employees or more)	
EFF1	= 1 if the firm has less than 10 employees (= 0 otherwise)
Industrial sector (ref. MECA= 1 if the firm operates in the mechanical industry)	
DEC	= 1 if the firm operates in the bar turning industry (= 0 otherwise)
APE2	= 1 if the firm operates in other pure subcontracting industries (= 0 otherwise)

4. Results

We estimated the system of equations defined in Eq. 4, with a bivariate probit model. As far as the robustness of the model is concerned, we used the White’s procedure (1982) to deal with any potential heteroscedasticity problems. The percentage of correct predictions (60,2%) suggests that the model has a good explanatory power compared to the “naïve prediction ratio” of 25%[14].

[14] Four probability scores can be computed P_{00}= probability of no innovation; P_{01}= probability to innovate in product only; P_{10}= probability to innovate in process; P_{11}= probability to innovate in process and product.

Table 5. Results of the bivariate probit model.

	INOPROC-INOPROD							
	INOPROC (y_j)		INOPROD (y_k)		Marginal effects			
Variables (x)	β	σ_β	β	σ_β	y_{ij}=1 ; y_{ik}=0	y_{ij}=1 ; y_{ik}=1	y_{ik}=1 ; y_{ij}=0	y_{ik}=0 ; y_{ij}=0
Constant	-2.28***	*0.95*	-0.60	*0.78*				
C2	0.90**	*0.91*	0.69**	*0.30*	0.17	0.18***	0.07	-0.42***
QUALI	0.90**	*0.40*	-0.40	*0.37*	0.29**	0.04	-0.20	-0.14
LPJAT	0.05	*0.37*	0.39	*0.32*	-0.03	0.05	0.08	-0.10
EDI	-0.29	*0.42*	0.03	*0.41*	-0.08	-0.02	0.03	0.07
ERP	1.95***	*0.61*	-0.71	*0.55*	0.50***	0.09	-0.33***	-0.26***
EDI_ERP	-2.56***	*0.94*	2.44***	*0.82*	-0.47***	-0.04	0.70***	-0.18**
RATION	-0.46	*0.67*	-0.47	*0.53*	-0.03	-0.14	-0.03	0.21
DEVINOV	-2.31***	*0.78*	0.11	*0.58*	-0.54***	-0.18	0.22	0.50
RATION_DEV	2.67***	*0.89*	-0.50	*0.69*	0.48**	0.18	-0.35***	-0.31***
REDUCDEP	-0.82*	*0.45*	-0.45	*0.37*	-0.20	-0.10**	-0.06	0.37**
DIVER	-0.90	*0.61*	-0.25	*0.38*	-0.16	-0.24**	0.15	0.25***
BERD	2.66***	*0.38*	0.17	*0.42*	0.34**	0.37***	-0.31***	-0.40***
PREST	1.08**	*0.44*	0.16	*0.37*	0.20	0.19**	-0.13	-0.26***
ACTIFS	0.72	*0.50*	0.72	*0.52*	-0.02	0.30**	-0.02	-0.25***
RH	0.46	*0.33*	0.77**	*0.33*	0.05	0.13**	0.14	-0.32***
EFF1	1.52***	*0.43*	-0.42	*0.33*	0.44***	0.10*	-0.26***	-0.28**
DEC	1.02***	*0.38*	0.26	*0.40*	0.20	0.18*	-0.08	-0.30***
APE2	1.63***	*0.39*	0.46	*0.39*	0.27**	0.31***	-0.13	-0.44***
Ρ	-0.94** *(0.38)*							
Number of observations	93							
Log-likelihood	- 80.6							
Wald test of *ρ*	6.01**							
Rate of good predictions	60,2%							

Estimated coefficients are rounded to the second decimal number. Robust standard errors [using heteroscedastic-consistent errors from White's procedure] are reported in italics.
Estimated coefficients are statically different from 0 at 10% (*), at 5% (**), at 1% (***)

The first important result concerns the statistical link between the two innovation choices. As we can see in Table 5, the correlation coefficient *Rho* is significantly different from zero, suggesting that process and product innovations are not independent choices. Thus, the estimation of two separate models would lead to a loss of efficiency and possibly misleading results (Rouvinen 2001).

Clearly, product and process innovation are affected by different factors. This is conforms to the results obtained by previous empirical studies that make a clear distinction between the two types of innovation. We note that process and product innovations only have the type of subcontracting agreement in common. As predicted by the literature, the type of subcontracting agreement explains the ability a small manufacturer has to innovate. Suppliers (C2) are more likely to innovate than traditional subcontractors (C1, subcontractors of economy or specialization). The results show that the collaborative outsourcing agreement (established, not systematically renegotiated, on the basis of a more equal relationship) favours subcontractor's ability to innovate both in product and process. The fact that arrangements are long-term contracts plus the fact that suppliers are invited to play an active role in design introduce new critical components (trust and reciprocity) favourable to innovation.

As suggested by the knowledge-based perspective, the nature of the contract is not sufficient to assess the full role of subcontracting relationships on innovation patterns. Other factors are likely to impact the ability to innovate, like the presence of organizational practices and tools and the absorptive capacities of subcontractors. It is interesting to observe the positive impact of these variables on innovation. The likelihood to innovate is higher if subcontractors have adopted organizational practices centred on quality management (QUALI) and logistical tools (ERP and EDI_ERP). This establishes the importance of the "quality" of integration between contractor and subcontractor as argued by the literature on new forms of subcontracting. However, only a small number of variables have a positive effect, meaning that innovation capabilities are not necessarily sparked by all new practices. This result matches the conclusions found in research about new practices in subcontracting (including lean practices) which pinpoint their weak impact on transfer technology and subcontractors' innovation capabilities. Furthermore, and more interestingly, process and product innovations are not affected by the same organizational practices or IT tools.

Process innovation is helped by the presence of quality-oriented practices and ERP software while the use of both EDI and ERP (cross variable) diminishes the likelihood to innovate in process. In contrast, product innovation depends on the sole combination of both EDI and ERP technologies, and is not affected by quality oriented practices. If we consider the complementarity between ICT, we note that the fact of sharing an information system with a hub firm has a positive effect on product innovation and an opposite effect on process innovation. This result is in line with the recent developments relative to the new forms of subcontracting (in particular network forms). The presence of such a logistic integration, comparable to an irreversible organizational investment, consist in the implementation of a common language between principals and subcontractors. What is at stake here is the mutual exchange of complementary forms of knowledge (Cohendet and Llerena 2005) between firms for the co-conception of new products (Baudry 2003). By opposition, process innovation is associated with ERP and organizational practices centered on quality management mainly aiming at cost reduction. These devices do not concern the technological potential of the subcontractor.

As far as the impact of strategic variables is concerned, the formulation of a clear objective oriented towards the development of R&D or innovation (DEVINOV) decreases the probability to innovate in process. Besides, process innovation is not explained by cost-cutting strategic objectives (RATION), as this variable doesn't have a significant effect. As expected, process innovation is explained by a cross effect that measures the pursuit of cost-driven *and* innovation objectives. This result is in line with previous studies showing that "*even when the main contractor is concerned by technology transfer, cost-driven actions blur the technological objectives of any type of subcontracting agreement*" (Amesse *et al.* 2001, p. 568). Quite surprisingly, strategic objectives oriented towards the development of R&D and innovation are not positively associated with product innovation. We expected to find a positive impact of DEVINOV on product innovation. But, the effect of this variable is not significant. A candidate explanation for this result is that product innovation is a never ending improvement process rather than an asserted strategy of R&D or new product development. As noted by Pavitt (1984), and contrary to large firms, "*Competitive success* [of small specialized suppliers] *depends to a considerable degree on firm-specific skills reflected in continuous improvements in product design and in product reliability*" (p. 359). This explanation is reinforced if we consider the sources of knowledge which support the innovative activities of subcontractors. The role of firm-specific skills is captured by the significant and positive effects of the variable BERD (internal R&D and engineering activities) on process innovation and the variable RH (recruitment of new competence and staff training) on product innovation. Though different, the internal sources play a significant role on both types of innovation. The significant link between process innovation and BERD is well-explained by the fact that small subcontractors in metal manufacturing produce a relatively high proportion of their own process technology (Pavitt 1984). Process innovation is also driven by external sources of knowledge through the turning to external providers. This result supports the absorption capacity hypothesis (Cohen and Levinthal 1990). By opposition, product innovators solely rely on their main contractor as a source of innovation. Following Bruce and Moger (1999), the relationship between supplier and contractor seems too close. This leads to the perverse effect of reducing the subcontractor's absorptive capacity and a failure to absorb and benefit from external sources of innovation.

We note two clear-cut innovation paths for all "knowledge-based" variables. Process innovation is reinforced by the ability of a subcontractor to combine different objectives with different knowledge sources, and is based on information systems circumscribed to a dyadic relationship. Product innovation, on the other hand, needs a network information system (EDI) controlled by the contractor (proprietary system) and is not reinforced by external sources of knowledge.

Considering the control variables, some results emerge. Micro-firms (less than 10 employees) are more likely to innovate in process than small and medium sized firms. Consistent with the results of taxonomies of innovative small firms, sectoral variables are never related to product innovation only. Firms operating in metal manufacturing sectors belong to the cluster of "suppliers of intermediate goods" (Archibughi *and al.* 1991), or "supplier-dominated firms" (De Jong and Marsili 2006) which are mainly small process-oriented firms. The typology of De Jong and Marsili (2006) is particularly interesting since it is based on firm level data and does not neglect micro firms (from 1 to 9 employees) as it is usually the case in other empirical studies. From this typology, we observe that micro-firms are also over-represented among supplier-dominated firms. Moreover, the fact that process innovation is significantly associated with APE2 (rubber and plastic products) matches well to the behaviour of "science-based" firms. These firms innovate both in process and product, with a prevalence of process over product.

5. Conclusion

Innovation is seen as a crucial factor for the survival and competitive strength of small firms. This paper shows that a small subcontractor's ability to innovate is a complex phenomenon driven by multiple influences, including the type of subcontracting agreements, the nature of inter-organizational practices and tools, and the "quality" of the subcontractor's absorptive capabilities. In contrast to the majority of studies that focus either on product or process innovation, the results indicate that the interaction between the types of innovation themselves is also complex since they are not independent choices. The clear-cut distinction between product and process innovations in subcontracting relationships leads to important conclusions.

Firstly, this study has revealed the impact of the type of subcontracting agreement on the subcontractor's ability to innovate. Being a supplier (collaborative outsourcing agreement) rather than a traditional subcontractor (subcontracting of economy or specialization) increases the likelihood of innovation in both process and product. This supports the claim that subcontracting relationships are not only a mere practice driven by cost-reduction. Today subcontracting relationships are changing as contractual agreements give more scope for mutual commitment. Subcontractors can turn into talented suppliers looking to develop their ability to innovate. This result outlines both the role and the responsibility of the contractor in relation to the future of traditional subcontractors and their survival. Bearing in mind that 44,1% of subcontractors operate in uncertain conditions and strong dependence (arm's length contracts), it is not surprising that these subcontractors are less committed to innovation than suppliers since their contractual arrangements provide *per se* no incentive to innovate.

Secondly, we have shown that subcontractors differ according to the type of innovation (process or product). Process innovation is supported by the pursuit of two objectives: cost reduction and innovation. Furthermore, subcontractors are more likely to innovate in process when their activities have been integrated with their contractors in quality and information sharing (QUAL and ERP). But, this operational integration is circumscribed to a dyadic relationship to foster process innovation. In contrast, product innovation is (only) influenced by EDI and ERP tools that play a crucial role in the sharing of information and diffusion of innovation in a network-organization (Raymond and Blili 1997). We also give evidence that product and process innovations are not affected by the same sources of knowledge. In the case of process innovation, subcontractors are more likely to innovate in process if they use formal R&D and other lower sources of technical knowledge such as engineering and external providers. Product innovation is reinforced by the recruitment of new competence and staff training. The fact that external providers do not affect product innovation means that subcontractors rely heavily on the sole understanding of contractors' need to innovate. Even though we must remain cautious, it seems that product innovation is more likely to emerge in a network-organization under the control of the prime contractor. In this case, close relationships may be a substitute rather than a complementary source to the innovation process, with some risks of lock-in for the supplier.

Thirdly, operating in pure subcontracting industries has a strong impact on innovation. Subcontractors are mostly process innovators, whatever the activity they may be working in, showing that cost-minimization and flexibility are still major sources of competitiveness for most small subcontracting firms.

The results of this explanatory research suggest primary conclusions for policy makers and further theoretical implications. In France, the setting up of "competitiveness poles" is an attempt to bridge the innovation gap of small firms, and in the area under study, new public policies are being implemented to help subcontractors to innovate. However, although these policies are useful, they often miss their goal. They are too often directed to subcontractors (without differentiating them) or certain contractors (the most involved), so neglecting the relationship itself. It is time that policy makers recognize that the ability of a subcontractor to innovate depends on the nature of the subcontracting relationship and requires an alignment of their organizational practices and tools (Cooke and Beh 2007). Every attempt to bring a contractor close to its subcontractors might prove a useful framework for creating true partnership relations based on shared representations. The study shows that there is still a real distance between the theoretical model of partnership described by the knowledge-based perspective and its practical expression in pure subcontracting industries. Contractors are still behaving cautiously, maybe for fear of becoming knowledge dependent on their subcontractors (Amesse *et al.* 2001).

The significant and positive impact of internal sources of knowledge on innovation is another key point from this study. As pointed by Freel and Harrison (2006), internal resources are crucial and "*networking is neither a sufficient nor, even, a necessary condition for innovation*" (Op. Cit, p. 301). This conclusion is strengthened in the case of collaborative outsourcing as far as the potential of innovation of the subcontractors is looked for. Following Freel and Harrison (2006), we think that policy makers should develop the internal learning and absorptive capabilities of subcontractors. Some actions in this way have already been conducted. For instance, to compensate for resource and capability shortages of micro-firms, diverse forms of groupings have been initiated (agreements of cooperation, economic interest group). They allow firms to propose global solutions to customers and to reach new (overseas) markets relying on their complementarities. Nevertheless, these policy initiatives are not sufficient because they neglect the most vulnerable subcontractors: the small traditional ones.

Finally, we acknowledge that there are some limitations in our study. Firstly, the specificity of the population under study reduces the number of observations. But it has also the advantage that firms are relatively homogeneous. Innovation in pure subcontracting industries has scarcely been a subject of interest. It would be interesting to confront these results with data from other regions which also depend on these particular industries since this question has important implications for their competitiveness. Secondly, we know that process innovation because of its cost-cutting nature may have ambiguous effects on firms' growth (Fagerberg 2005). The data collected are not sufficient to assess the impact of process and product innovations on subcontractors' competitive position. In the vein of the findings of Kraft (1990) from 56 German firms operating in metal-working industry, it would be worth to study thoroughly the interaction between process and product innovations and assess to what extent they may complement each other. Thirdly, since our study consists in a static cross-sectional analysis, we can not identify any changes in the subcontracting relationships over time as well as their impact on innovation. Further research is yet needed to study the interaction between product and process innovations so as to assess to what extent short term decisions lead to complementarities between the firm's long term choices of innovation capabilities.

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Appendix: Data descriptives

Table A1. Firms' Industrial affiliation (SIC: 4 –digit)

	Parent population	Sample
Subcontracting industries	**N (%)**	**n (%)**
Metal cutting and forming	870 (77,3)	75 (80,6)
Bar Turning (28.5)	*298 (26,5)*	*33 (35,5)*
Mechanical (28.5)	*355 (31,5)*	*24 (25,8)*
Forge, stamping, cutting (28.4)	*217 (19,3)*	*18 (19,4)*
Other subcontracting industries: Plastic and rubber	256 (22,7)	18 (19,4)
Technical pieces made of plastic (25.2), Moulds and models (29.5), Springs and manufacturing of other rubber items (25.1).		
Total	1126 (100,0)	93 (100,0)

Table A2. Firms' size

	Parent population	Sample
Size	**N (%)**	**n (%)**
Less than 10 employees	498 (44,2)	48 (51,6)
From 10 to 50 employees	505 (44,8)	38 (40,9)
More than 50 employees	123 (10,9)	7 (7,5)
Total	1126 (100,0)	93 (100,0)

Table A3. Descriptive statistics (%)

Variables	Full sample	INOPROC	INOPROD
Clusters of subcontractors			
C1	44.1	31.7	34.1
C2	55.9	59.6	48.1
Organizational practices and tools			
QUALI	60.2	58.9	42.8
LPJAT	30.1	53.6	53.6
EDI	19.4	38.9	55.6
ERP	18.3	58.8	41.2
Strategy variables			
DEVINOV	38.7	44.4	47.2
RATION	72.0	53.7	35.8
REDUCDEP	28.0	42.3	38.5
DIVER	84.9	38.7	40.5
Sources of knowledge supporting innovative activities			
BERD	22.6	76.2	54.0
PREST	23.7	63.6	45.5
ACTIFS	14.0	53.8	53.8
RH	60.2	58.2	50.9
Control variables			
EFF1	51.6	43.8	33.3
EFF2	48.4	53.3	48.9
DEC	35.4	51.6	39.4
APE2	38.7	55.6	50
MECA	25.9	33.0	29.2

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