WHY DO SOME FIRMS CONTRACT OUT PRODUCTION?

Evidence from firm-level panel data[1]

Carmen Díaz-Mora
University of Castilla-La Mancha
Department of International Economics
Faculty of Juridical and Social Sciences
45071-Toledo (SPAIN)
Phone/fax: +34 925 26 88 78
E-mail: Carmen.DíazMora@uclm.es

Angela Triguero-Cano
University of Castilla-La Mancha
Department of International Economics
Faculty of Economics and Business
02071- Albacete (SPAIN)
Phone/fax: +34 967 59 92 00 (ext. 2380)
E-mail: Angela.Triguero@uclm.es

Abstract:

The present paper examines which factors determine outsourcing decision using firm-level panel data for Spanish manufacturing industries. Outsourcing is measured as the manufacture of custom-made finished products or parts and components which have been contracted out to third parties. Moreover, we distinguish whether the main contractor provides the materials to the external supplier or not. Following the theoretical framework of Grossman and Helpman (2002), we take into account the persistence of outsourcing decision as well as other firm, industry and market characteristics that influence the likelihood of contracting out. Using a dynamic panel data probit model, our results show that previous subcontracting decision, wages, market changes, R&D activities, product and process innovation, product differentiation, industry-size and exporter status affect positively the current subcontracting decision.

JEL classification: D21, L23, L60.

Key words: Outsourcing, Subcontracting Decision, Firm-level panel data, Determinants, Persistence, dynamic probit model.

January 2007

[1] We are indebted to Rosario Gandoy for helpful suggestions. Financial support by the Consejería de Educación y Ciencia of the Junta de Comunidades de Castilla-La Mancha under the project PBI-05-021, cofinanced by FEDER funds, is gratefully acknowledged.

1. INTRODUCTION

Nowadays there is a broad consensus in academic literature about the meaning of outsourcing which is defined as the act of transferring some of the company's recurring interval activities to outside providers through a contractual arrangement (WTO, 2005). By this way, firms can concentrate on their innermost core competences. The term outside refers to external to the boundaries of the company, that is, outsourcing is opposed to vertically integrated production. Moreover, as Grossman and Helpman (2005) note "outsourcing means more than just the purchases of raw materials and standardized intermediate goods" because a specific characteristic of outsourcing is that the relationship between the firm which contracts out production and external provider is long-term and it usually implies sharing information about the product. For this reason, purchases of intermediate inputs through a usual marketing channel have not to be regarded as outsourcing.

Outsourcing is not a new phenomenon. During the last decades, the increasing competition and complexity of production processes have led to firms, particularly those belonging to particular sectors such as car or electronic industry, to identify and focus on the strategic core competences. But in the recent period, the quantity of tasks and competences which are considered non-core and are purchased from independent suppliers have dramatically grown. Moreover, outsourcing strategy has extended to other industries and acquired a global dimension.

The object of this paper is to study the determinants of outsourcing production using firm-level panel data for Spanish manufacturing industries. Although both academic literature and business press have paid great attention to the increasing relevance of this strategy in the world economy, empirical research about the determinants using firm-level data remains limited: Kimura (2001) and Tomiura (2005, 2006) for Japanese manufacturing industry, Görg and Hanley (2004) for Irish electronics industry, Girma and Görg (2004) for some UK manufacturing industries and Holl (2004) and Diaz-Mora (2007) for Spanish economy[2]. The first two works are cross-section analysis whereas the remainders use panel data. What is more, the existing empirical studies do not offer a wide consensus about the determinants.

Our work contributes to the academic literature analyzing empirically which factors influence the choice of outsourcing using a panel of Spanish manufacturing industries from

[2] These works define as outsourcing the contracting out of material production, except Girma and Görg (2004) who defines it as the processing of inputs as well as industrial services received. Diaz-Mora (2007) uses industry-level instead of firm-level data.

1990 to 2002. A standard discrete variable of outsourcing presence/absence is urged by the nature of our sample where more than half of the surveyed firms do not contract out production. Moreover, since a high proportion of firms are inactive in outsourcing, we must consider the existence of fixed entry costs for this strategy. According to the theoretical model by Grossman and Helpman (2002), transaction costs are a key difficulty in adopting outsourcing strategy and the presence of them would imply persistence in the outsourcing decision. So, the impact of previous outsourcing decision on current outsourcing decision is taken into account in our model about determinants. And finally, as far as the authors know, it is the first paper which distinguishes if the main contractor provides or not the materials to the subcontracting firm.

The paper is organized in the following way. In the next section, we describe the data set used and we provide the main results from the empirical analysis. Section III examines the determinants of outsourcing following previous theoretical and empirical literature. In section IV we develop the econometric model to be estimated while results are presented in section IV. Finally, some conclusions are made in the last section.

2. DATA AND DESCRIPTIVE ANALYSIS.

Our work focus on outsourcing of production which here includes the manufacturing of custom-made finished products or parts and components which have been contracted out to third parties. The processing of the segmented production is carried out following the main contractor's specifications. This definition corresponds to a particular type of outsourcing, the subcontracting, where the relationship developed between the principal and the third-party company is of a "dominant/dominated" nature. Nevertheless, outsourcing could also imply a more strict collaboration between firms involved, that is, create a partnership. Therefore, among outsourcing transactions, different degrees of managerial controllability over outsourced production exist; whereas subcontracting usually implies certain level of controllability, in other outsourcing arrangements the controllability is weaker (Kimura and Ando, 2005).

Outsourcing data are obtained from the Survey of Business Strategy (*Encuesta sobre Estrategias Empresariales* in Spanish, ESEE hereafter), a panel survey which offers information about Spanish firms' strategies for the period 1990-2002. The Survey provides data on many relevant firm characteristics. The ESEE is a representative sample of the population of Spanish manufacturing firms with 10 or more employees and belonging to the

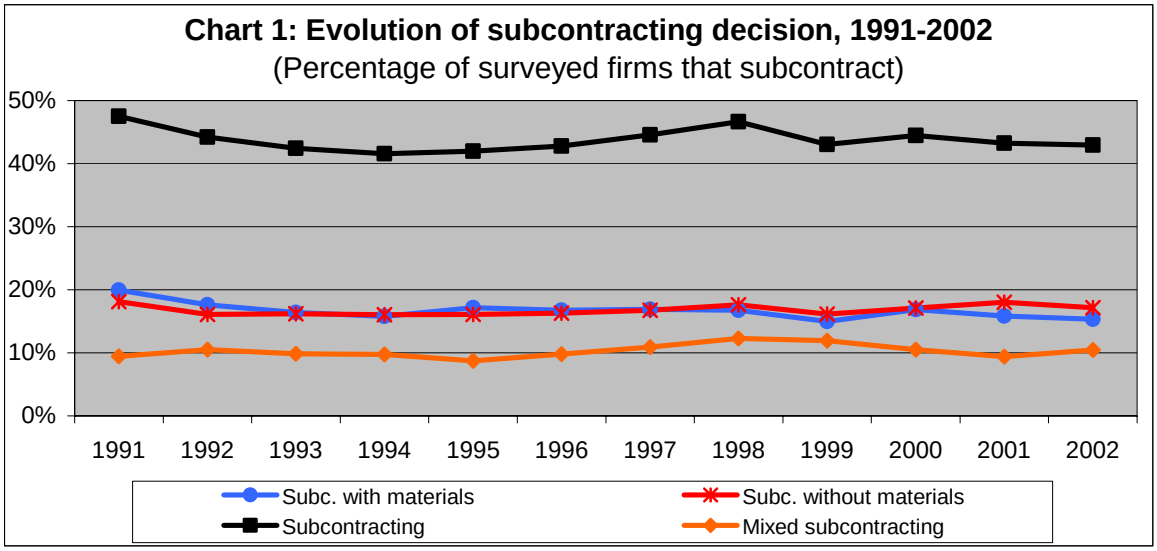
manufacturing industry. The selection is carried out combining exhaustiveness in the case of firms which have over 200 employees and random sampling criteria for firms which employ between 10 and 200 workers. In the first year, 1990, 2,188 firms were interviewed along the above mentioned criteria (1,724 firms in 2002). In order to maintain its representativeness with regard to the population of reference, particular efforts have been made. On the one hand, efforts to reduce as far as possible the deterioration of the initial sample, trying to avoid the reduction of the firms' collaboration. And on the other, efforts to include each year into the sample all the newly incorporated firms which employ over 200 workers, as well as a randomly selected sample which represents around 5% of the newly incorporated firms which have between 10 and 200 employees[3].

In relation to outsourcing, surveyed firms give information firstly about if they outsource production or not and secondly about the value of the contracted out production. The Survey distinguishes two types of outsourcing depending whether the main contractor provides the materials to the supplier or not. The second type implies a greater independence of the subcontracting firm which has a higher degree of control over the materials.

With this information, we select exclusively those firms that respond the questions about outsourcing (about 1,800 firms each year). In an additional step, our sample is split into three groups: firms involved in subcontracting only providing the materials, firms involved in subcontracting only without providing the materials, and firms involved in both types of subcontracting at the same time (mixed subcontracting). As cited above, previous works that analyse subcontracting behaviour do not distinguish by type of subcontracting arrangement.

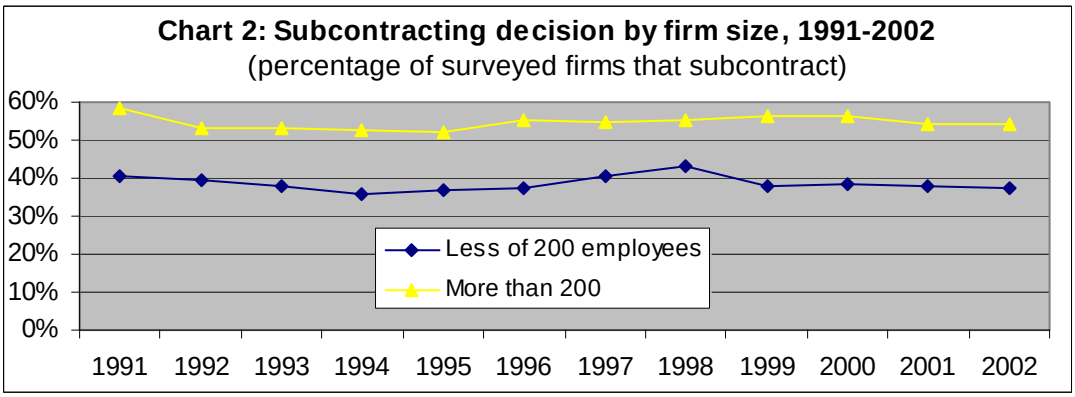
Chart 1 reflects the evolution of outsourcing decision in 1991-2002[4]. Our results do not show a growing trend in the proportion of firms that decide to outsource production. The percentage of firms engaged in subcontracting is about 45% along the period. That is, almost one of every two Spanish manufacturing firms has contracted out parts, components or finished products to independent providers. The stability in the proportion of firms active in subcontracting is not a question of type of subcontracting because it is common to all of them. Moreover, there are not differences when we distinguish between subcontracting providing and without providing materials: around 20 per cent of surveyed firms get involved in any type of subcontracting arrangement. Lastly, 10 per cent of firms use both types of subcontracting at the same time.

[3] See Fariñas and Jaumandreu (1999) and www.funep.es for further details about ESEE.
[4] We have decided to omit the first year of the ESEE, 1990, due to the lack of data on the value of production which has been contracted out.



Source: Survey on Business Strategies (ESEE)

Chart 2 presents the subcontracting decision by firm size. It can be observed that outsourcing strategy is more relevant in larger firms (more than 200 workers), where around 55 percent of them contracted out production. Relative to smaller firms (less than 200 workers), nearly 40 percent of them do outsourcing. This positive relationship between firm size and subcontracting behavior has been found in previous works (Kimura, 2001; Holl, 2004; Tomiura, 2005 and 2006). To explain this result, it can be argued that large firms face lower fixed entry cost for outsourcing. The changes along the period in the proportion of firms by size involved in subcontracting are minor.

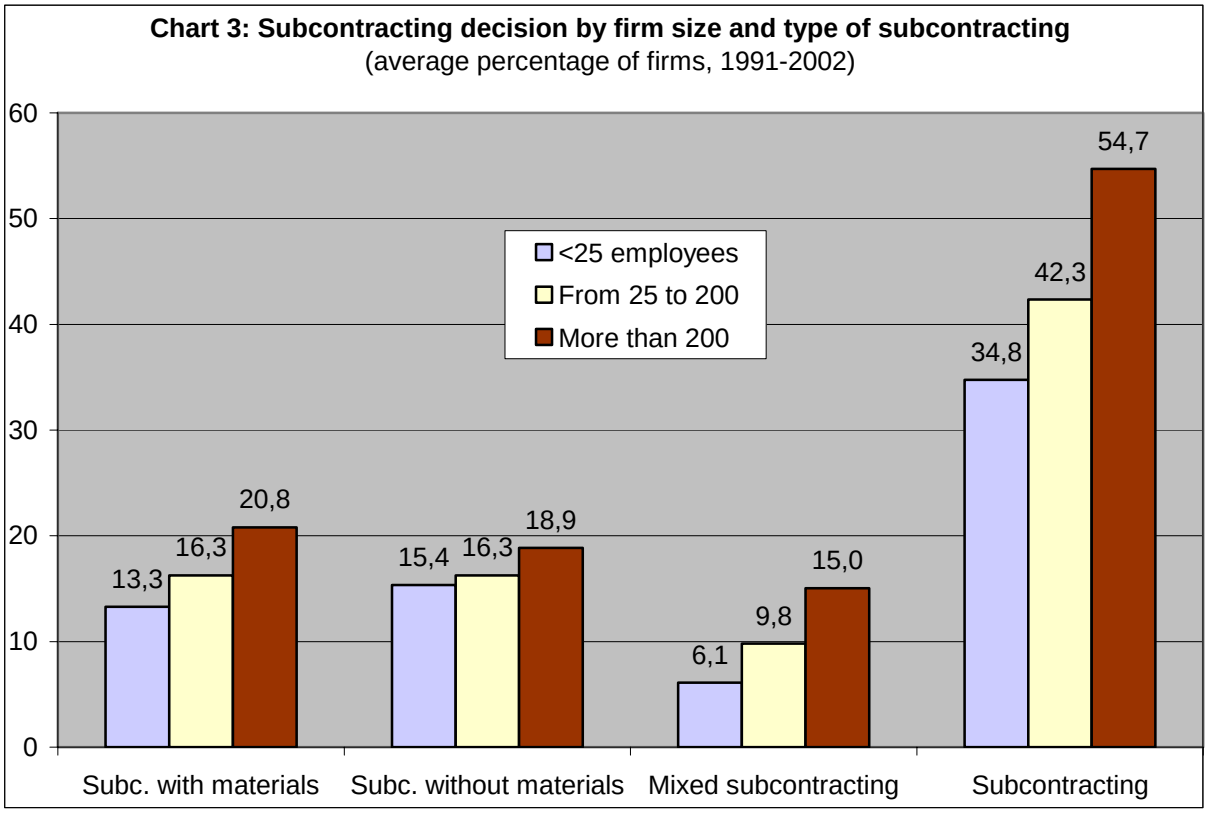


Source: Survey on Business Strategies (ESEE)

When the type of outsourcing is introduced, the firm size and the percentage of firms active in contracting out production are also positively correlated (chart 3). Taking into account the stable tendency in the proportion of the firms that subcontract, we use the average in the period 1991-2002. The larger the firm, the more likely to contract out production in subcontracting providing materials and mixed subcontracting. The differences by firm size in the proportion of outsourcers are less clear in the case of subcontracting without providing

materials.. In any case, the decision to outsource production seems to be clearly influenced by firm size.

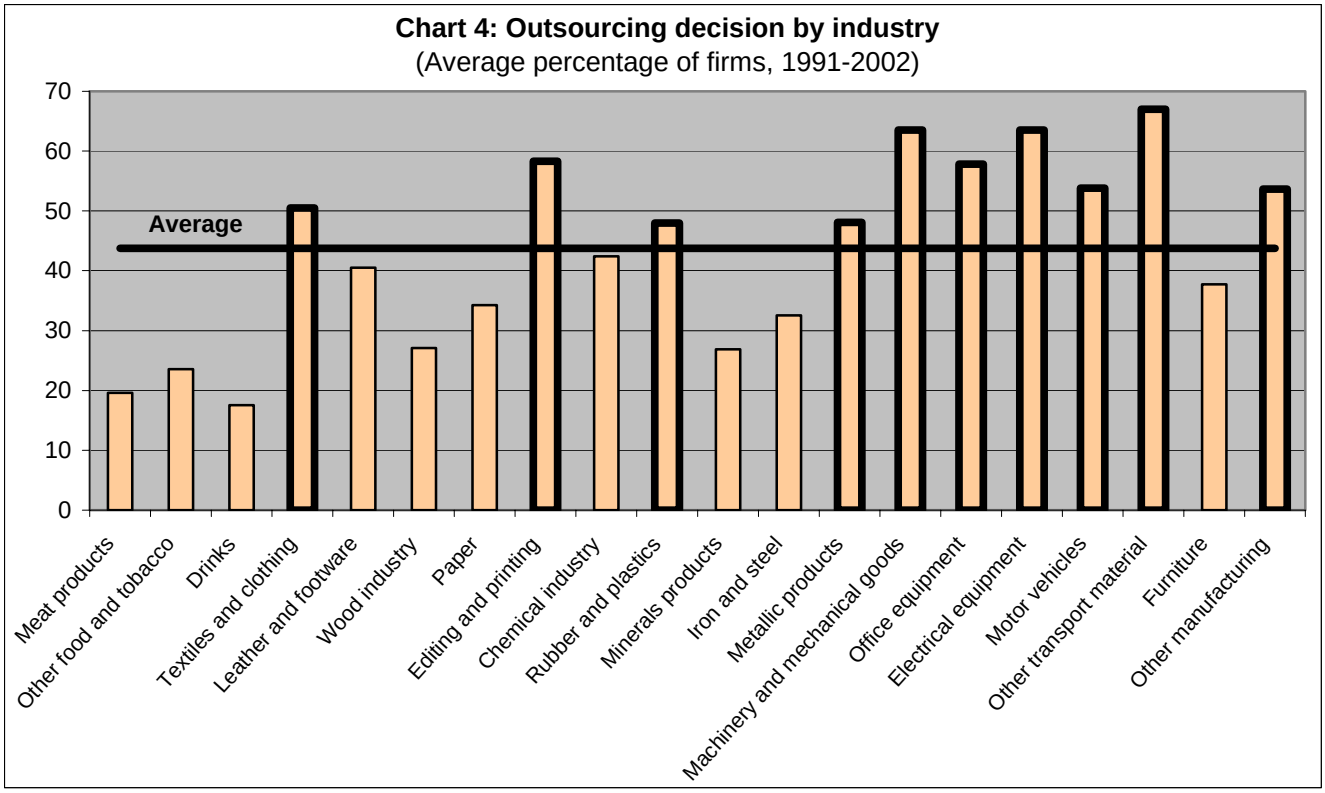
Chart 3: Subcontracting decision by firm size and type of subcontracting
(average percentage of firms, 1991-2002)



Source: Survey on Business Strategies (ESEE)

From a sectoral perspective, it can be observed that the decision of getting involved in subcontracting arrangements widely varies across industries[5]. Industries such as machinery and mechanical goods, electrical equipment and other transport material are extensively engaged in subcontracting (more than 60 per cent of firms have contracted out production in 1991-2002 period). Manufacturing industries subcontracting over the average are also textiles and clothing, editing and printing, rubber and plastic, metallic products, office equipment, motor vehicles and other manufacturing (Chart 4). These industries with the highest percentage of outsourcers are the same than in Japan according to Tomiura (2006). The similarity in industries more active in outsourcing between countries emphasizes the influence of sectoral-specific characteristics in the extent of outsourcing.

[5] The evolution of the percentage of firms that subcontract production by sectors can show erratic behaviour, partially due to changes in the number of firms that answer the Survey every year, mainly in those sectors where that number is especially low. The dispersion, measured by the variation coefficient, is more pronounced in branches such as meat products, drinks and wood industry. Nevertheless, those sectors with larger proportion of firms engaged in subcontracting are the same along the period. The Pearson correlation as well as Spearman correlation (which is based on ranking instead of values) between different years is high along the period. For this reason, we employ the time average in the sectoral analysis of subcontracting.

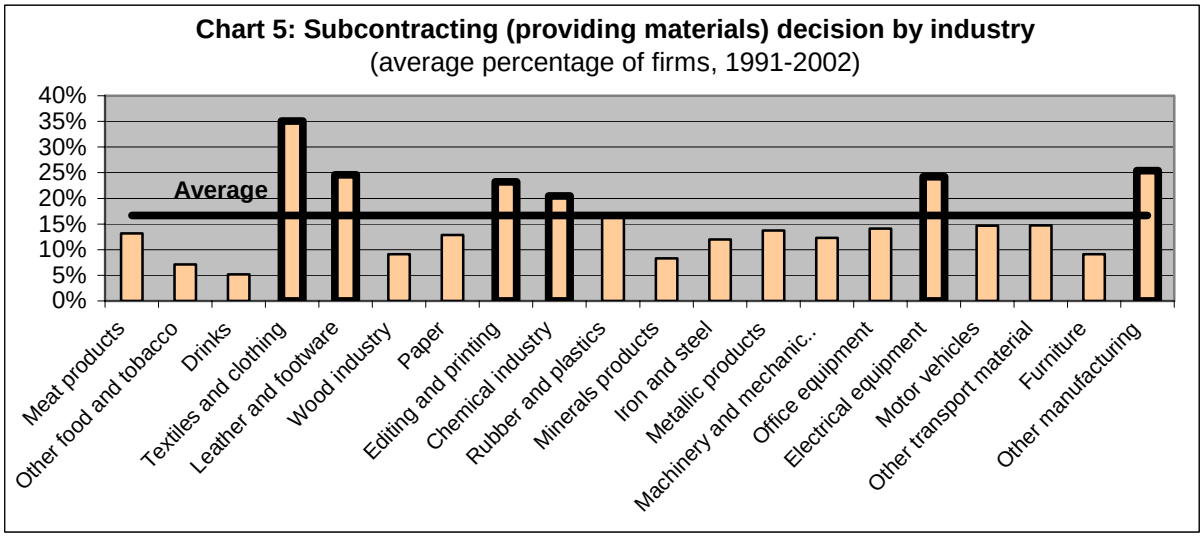


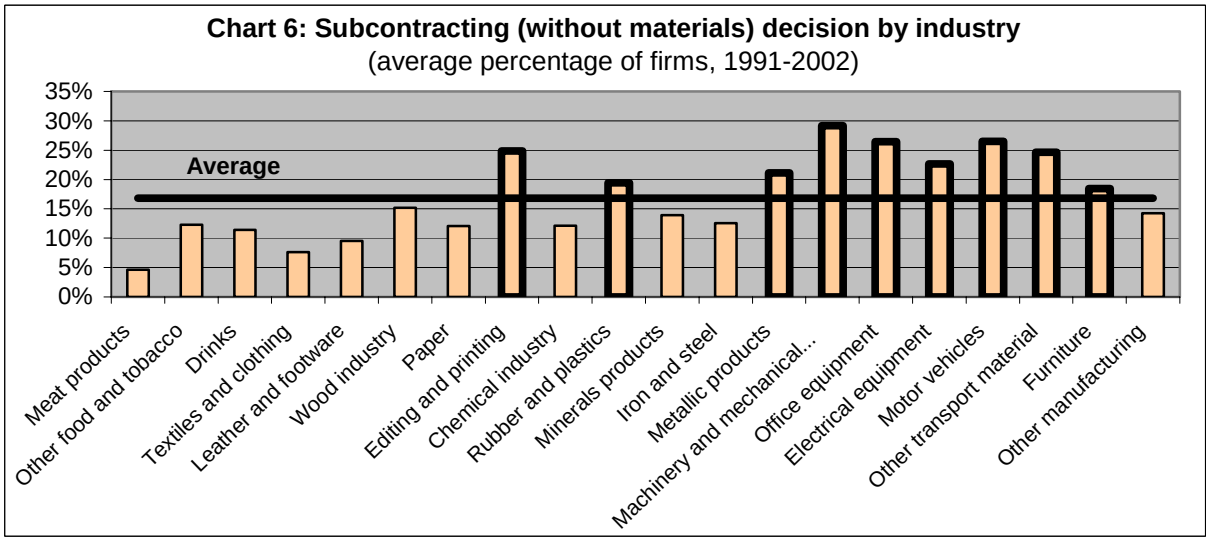
Source: Survey on Business Strategies (ESEE)

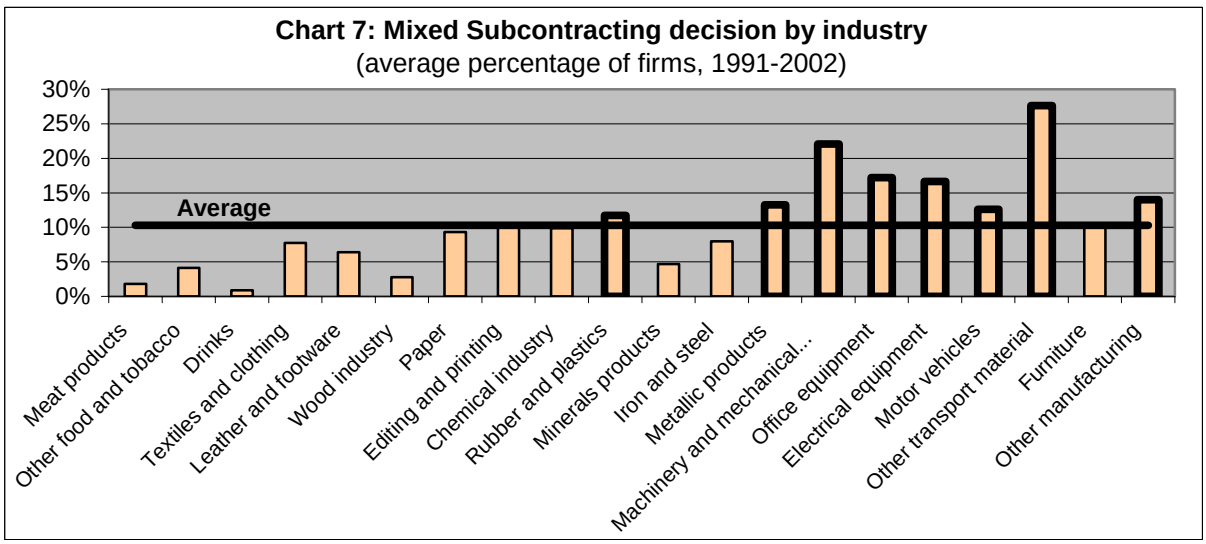
However, these branches where the percentage of firms doing outsourcing is more pronounced are not coincident in each type of subcontracting (Chart 5-7). Moreover, the sectoral correlation coefficient between subcontracting providing and without providing materials is almost null. That is, industry-specific characteristics seem to influence the mode of subcontracting as well as the extent of outsourcing.

The frequency of subcontracting providing materials is particularly large in textiles and clothing (35 per cent of firms) and in leather and shoes, editing and printing, chemistry, electrical equipment and other manufacturing industries (around 20-25 per cent). Related to subcontracting without providing materials, editing and printing, rubber and plastics, metallic products, machinery and mechanical goods, office equipment, electrical equipment, motor vehicles, other transport material and furniture are the branches with higher percentage of firms that decide subcontracting (20-25 per cent). So, only two sectors are common in two groups (editing and printing and electrical equipment). In the first case, editing and printing, firms are very active in the two modes of subcontracting (providing and without providing materials) which seem to be alternative strategies because firms choose one or another type but they hardly do mixed subcontracting. In the second case, electrical equipment, the percentage of outsourcers is over the average in the three subcontracting modes. In this

particular case, we can infer that there are not industry-specific characteristics which favor one particular mode of subcontracting.







Source: Survey on Business Strategies (ESEE)

Notable differences are found in textiles and clothing, leather and shoes, chemistry and other manufacturing where subcontracting decision is highly frequent but it is very biased to subcontracting providing materials. These branches, except chemistry, are labor intensive with low skill requirements. Here, the competition in prices is very important and competitive advantages are associated to the quality of materials, the design of products, etc. For this reason, it is very important to control the materials used and the main contractor prefers to provide them to the subcontracting firm. On the contrary, metallic products, machinery and mechanical goods, office equipment, motor vehicles and other transport material clearly show up in subcontracting without materials but do not in subcontracting with materials. These are industries with higher technological content where the most standardized production stages, which are not the core competences of the firm, are contracted out and the need to control the materials diminishes. On the other hand, there is a high correlation between mixed subcontracting and subcontracting without materials from a sectoral point of view. The same branches show up in both types although the percentage of firms that do mixed subcontracting is sensitively lower: only in machinery and mechanical goods and other transport equipment the proportion exceeds the threshold of 20 per cent. At last, firms belong to natural recourses intensive industries are the less prone to contract out production .

According to our analysis, the percentage of firms that subcontracts production is not coincident between large and small firms and among industries. So, the subcontracting decision depends on firm size as well as on particular characteristics of each industry. Furthermore the three modes of subcontracting differ in importance by industry. That is, industry-specific factors such as the productive process and market-specific characteristics seem to determine the type of subcontracting agreement.

3. DETERMINANTS OF SUBCONTRACTING DECISION

Our empirical research on the factors that favour the subcontracting decision follows the theoretical work by Grossman and Helpman (2002). They examine theoretically the decision between outsourcing or vertical integration of intermediate inputs (make or buy decision) taking into account the costs that arise from search frictions and imperfect contracting and the costs of running a larger and less specialized organization[6]. According to transaction cost theory (Coase, 1937; Williamson, 1975), outsourcing would entail a variety

[6] To consider the international dimension as well as the ownership dimension, Antras and Helpman (2004) develop a theoretical framework in which, based on productivity and sectoral characteristics, firms decide whether to integrate into the production of intermediate inputs or outsource them and firms also choose the location of inputs production (at home or abroad).

of transaction and managerial costs associated with various aspects of inter-firm transactions. Search costs to find the right supplier, negotiation costs, costs to design the contract and the incomplete contracts problem, coordination costs, technology transfer risks, etc. have to be considered. On the contrary side, outsourcing allows to take advantage of greater specialization and flexibility and to reduce some managerial costs and labour cost if external supplier have lower wages. When these costs savings exceed additional transaction and managerial from outsourcing, firms will opt for contracting out production. Grossman and Helpman (2002) consider that a fundamental determinant of the make-or-buy decision is the entity of production costs (transaction and managerial costs and labour costs) within the firm relative to outside suppliers. In this point, three aspects need to be considered.

First of all, the technological revolution that has taken place in last decades has allowed for a significant drop in the costs associated with finding information, transport communication and business coordination, lowering the transaction costs and augmenting the possibilities for outsourcing. This is one of the reasons why outsourcing is a booming form of industrial organization at present.

Secondly, we consider that transaction costs associated with outsourcing are higher in the first moments, when the outsourcing strategy is becoming to be used. Moreover, some of them would be sunk entry costs such as search costs in finding a suitable provider. For these motives, it seems reasonable that the decision about the outsourcing intensity in period t is related to the level of outsourcing in previous period t-1. Therefore, the lagged dependent variable is needed to be included in our model to account for this persistence in the outsourcing decision, although it has been scarcely used in preceding empirical works. Swenson (2004) shows that outsourcing exhibits hysteresis caused by sunk entry costs using data of the U.S. offshore assembly program. The influence of previous outsourcing is also considered by Girma and Görg (2004) and Díaz-Mora (2007).

According to theories of outsourcing that include entry sunk costs, it is notable the persistence of participation decision in subcontracting from one year to the next (Table 1). According to our data, 82 per cent of firms that subcontract production continue to subcontract in the following year. The persistence is even higher for those firms that do not subcontract in a particular year: 86 per cent of them remain inactive in the following year.

Table 1: Outsourcing transition probabilities

	Out t+1	No-Out t+1
Out t	81.65	18.35
No-Out t	13.73	86.27

The pattern of persistence is also clear at industry-level (table 2). Continued subcontracting is the norm for all industries that do subcontracting in the present year. The range of probabilities runs from 64% in drinks to 88% in electrical equipment. The probabilities of remain inactive in subcontracting in the following year are usually higher, running from 76% in editing and printing to 92% in other good and tobacco.

Table 2: Outsourcing transition probabilities by industry

Industries	Positive Subc. in current year t+1 probabilities		No Subc. in current year t+1 probabilities	
	Subc. t+1	No-Subc. t+1	Subc. t+1	No-Subc. t+1
Meat products	66.67	33.33	8.06	91.94
Other food and tobacco	76.20	23.80	7.44	92.56
Drinks	64.18	35.82	7.55	92.45
Textiles and clothing	85.71	14.29	13.88	86.12
Leather and footwear	77.92	22.08	13.99	86.01
Wood industry	65.08	34.92	12.80	87.20
Paper	79.35	20.65	9.79	90.21
Editing and printing	82.48	17.52	23.48	76.52
Chemical industry	83.52	16.48	11.59	88.41
Rubber and plastics	83.08	16.92	15.69	84.31
Minerals products	71.51	28.49	10.48	89.52
Iron and steel	77.08	22.92	10.53	89.47
Metallic products	77.81	22.19	18.05	81.95
Machinery and mechanical goods	86.51	13.49	21.67	78.33
Office equipment	85.88	14.12	19.17	80.83
Electrical equipment	88.09	11.91	22.08	77.92
Motor vehicles	84.08	15.92	17.39	82.61
Other transport material	83.87	16.13	27.97	72.03
Furniture	73.82	26.18	16.85	83.15
Other manufacturing	87.34	12.66	14.21	85.79

And thirdly, since we assume that labour cost are often lower with in-house production than with outsourcing making the last more attractive, we consider wages as determinant of outsourcing decision. So, the main contractor may seek to subcontract production to take advantage of lower wages in subcontracting firms. This is one of the motives for outsourcing most frequently mentioned by firms. If firms outsource in order to reduce costs relative to in-

house production, we would expect that those firms where the labor costs are higher were more active in outsourcing strategy. To test the relevance of the labor cost-saving motive for outsourcing, Girma and Görg (2004) include the wage rates for skilled and unskilled workers. However, they do not obtain conclusive results. The sign of the coefficient changes depending on the manufacturing industry and on the estimation technique and frequently the variable is statistically insignificant. Görg and Hanley (2004) introduce the average wage per employee and they also find that the effect of wages is statistically insignificant and not robust to different estimation techniques. Holl (2004) does obtain a positive and significant coefficient of the wages as well as Díaz-Mora (2007) who uses the unit labor costs.

Other determinants of outsourcing decision such as firm size, degree of product differentiation and industry size are proposed by Grossman and Helpman model.

Since intermediate producers and final-good producers have to search for each other, they have to pay additional costs. These search costs can be influenced by firm size of the final-good producer. In this sense, Tomiura (2005, 2006) suggest that smaller firms could face higher search costs, that is, due to stronger market power large firms might find contracting partners more easily. A positive relationship between firm size and outsourcing is therefore expected. Moreover, cost advantages can be partially due to economies of scale generated by the supplier (Abraham and Taylor, 1996). The existence of economies of scale in the production of intermediate inputs implies that the firm size variable have to be considered to control for this scale economies effect. Since small and medium enterprises will have more difficulties to reap the minimum efficient scale, they will opt more intensively for outsourcing. On the contrary, taking into account that outsourcing increases firm's capacity for adaptation and flexibility, it can be argued that large firms are more likely to carry out this process of vertically de-integration of production structures. As a consequence, the sign of firm size cannot be predicted a priori. Whereas empirical works such as Holl (2004) have obtained positive coefficients, the sign is negative in Görg and Hanley (2004). This last study, however, excludes small firms because it uses a Survey that provides information only for firms with thirty or more employees. Kimura (2001) and Díaz-Mora (2007) do not obtain a significant coefficient for firm size.

The degree of differentiation of the output plays a role in determining outsourcing decision, affecting the number of specialized intermediate producers that enter a specific industry. The less differentiated are the products elaborated by the final-good producer, the less knowledge the intermediate producer needs to have to provide components, the greater is

the chance to find the right partner and the more chance to emerge a stable outsourcing equilibrium[7]. To consider this argument, a product differentiation variable is considered. It is a dummy variable which takes the value 1 if the firm offers a product specifically designed for the customer (a differentiated product) or 0 otherwise.

Because of transaction costs are related to the search of suitable subcontracting partners, an important determinant of transaction costs is the thickness of the market (Spencer, 2005). So, according to theoretical models, the size or thickness of the market is related to outsourcing. Grossman and Helpman (2002) and McLaren (2000) consider the effects of market thickness on the outsourcing of intermediate inputs in their transaction cost models where the trade off between vertical integration and outsourcing is investigated. A thicker market increases the chance of finding a good external supplier and, therefore, the advantage of vertical integration over outsourcing reduces. The benefit of a thicker market makes outsourcing more viable in large industries (Grossman and Helpman, 2002)[8] and in firms operating in markets and economies open to international trade (McLaren, 2000). Greater internationalization of the firm and larger industry size raise the chance to find a specialized provider, increasing the chance to engage in outsourcing. The industry size is measured in two ways: by the number of firms in each industry (industry-size1) and by the employment in each industry (industry-size2). The level of internationalization is measured by a dummy variable which takes the value 1 if the firm shows positive export behaviour and 0 otherwise. Kimura (2001) and Görg and Hanley (2004) introduce in their models the export intensity obtaining a significant and positive coefficient.

Similar arguments can be used to consider the variable firm age as determinant of subcontracting. More mature firms could find suitable subcontractors easier due to a "learning effect" as well as a more incentive to focus on their core activities (Ono, 2003, Holl, 2004). Age variable is measured as the years the firm is operating. It is calculated as the difference between the year the firm was born up and the current year.

Although cost-savings motive, specialization and scale economies explain a wide part of the increasing outsourcing, changes in demand and other market conditions need to be considered to provide us a full perspective on what is happening (Demsetz, 1995; Abraham

[7] In fact, Grossman and Helpman (2002) point that there another way the degree of differentiation of the output can have an influence on outsourcing. But in this case, the effect on outsourcing can be positive or negative depending on other parameters. So, the net effect of product differentiation on outsourcing is not clear.

[8] In fact, these authors recall that the size of an industry favors outsourcing over vertical integration only when there are increasing returns to scale in matching, whereas with constant returns the industry size variable has no effect on the likelihood that outsourcing will be the equilibrium mode of organization.

and Taylor, 1996; Shy and Stenbacka, 2003; Lin and Tsai, 2005 and Buehler and Haucap, 2006). The more frequent these changes occur, the more necessary outsourcing strategy becomes in order to obtain higher flexibility. Outsourcing makes some fixed costs variable, allowing a greater flexibility for firms. For this reason, a variable measuring changes in the market conditions is introduced as factor that leads firms to subcontract. Specifically, the following variations are considered within changes in the market conditions: changes in own output prices, changes in national competitors' prices, changes in prices of similar imported products, changes in the market due to entry of new players, changes in the market due to increase or decrease in demand and changes in the market due to other motives. This is a dummy variable coded 1 if the surveyed firm shows a change in some of the above market conditions and 0 if does not. Holl (2004) includes a dummy variable to control for demand variations but she focus on the changes in the market share of the firm. The coefficient obtained is positive and significant.

Moreover, as Lin and Tsai (2005) point, a changing market environment increases the search for flexibility and the emphasis on core competences, offering an explanation for the growing outsourcing activities, in particular, when the products are characterized by a higher technological content[9]. In this sense, subcontracting is a way of flexible mode of production which allows them to take advantage of specialized producers. Firms concentrate on R&D, design and other skill intensive stages of production and they subcontract most of their physical production. Therefore, subcontracting is becoming very important in firms producing goods that are sophisticated and high tech (Curzon Price, 2001)[10]. To take into account this argument for subcontracting, we introduce dummy variables which take the value 1 if the firm does process innovation, product innovation and R&D activities, expecting a positive relation between these firm's characteristics and the propensity to contract out production. These variables are hardly included in previous empirical works about determinants of subcontracting. Only Tomiura (2005, 2006) considers the variable R&D expenditures obtaining that outsourcing is positively related to this variable used as proxy for technological complexity.

[9] Demsetz (1995) recalls the role of technological change and, therefore, of the uncertainty on outsourcing decisions. Outsourcing will be more significant in high-tech products (due to technological change) as well as in sectors such as wearing apparel (due to changing fashion).

[10] The author includes another type of firms where subcontracting is growing: firms producing goods not very sophisticated or difficult to make, where the labor-intensive stages of production are contracted out. These firms suffer a strong competence by low wage areas and they use subcontracting for cut-cutting motives. For them, wage is a determinant of subcontracting.

The subcontracting decision could also depend on other variables. Shy and Stenbacka (2003) and Buehler and Haucap (2006) argue that firms use outsourcing as a strategic instrument to compete with their rivals in the industry they operate. If outsourcing is considered as a competitive strategy, the higher the market competition, the more often the use of subcontracting. To proxy the market competition, we use a dummy variable which takes the value 1 if the firm has competitors with a significant quota in the own market and 0 otherwise. By other hand, taking into account the strategic motive for outsourcing, firms could be more prone to subcontracting in sectors where subcontracting is more frequent. Moreover, there can be specific sectoral characteristics which allow an easier disintegration of production process favouring subcontracting. The introduction of industry dummies allows us the possibility of controlling for technological heterogeneity as well as other permanent differences across industries.

An additional factor to consider in a model of the determinants of outsourcing is the foreign ownership that could affect the degree to which a firm engages in subcontracting. To control for nationality (foreign or domestic), we include the dummy variable Foreign Ownership which takes on value 1 if the firm has foreign ownership participation (at least 50%) and 0 otherwise. Previous works suggest a positive relation between international outsourcing and foreign ownership. They argue that since foreign firms are part of an international network competing in a global market, the potential to contract out to more efficient producers abroad increases (Görg and Hanley, 2004; Girma and Görg, 2004). However, preceding works based on total outsourcing (national and international) have obtained positive signs (Kimura, 2001; Girma and Görg, 2004) but also negative signs (Holl, 2004; Díaz-Mora, 2007). As the two last works suggest if foreign affiliates are located in a country just for doing production tasks for the parent company, the possibility from these manufacturing plants for using subcontractors could decrease. The effect of foreign ownership on subcontracting is ambiguous and will be an empirical matter.

4. THE EMPIRICAL MODEL

The definition, measure and expected sign of the variables included as determinants of subcontracting in our model are summarized in table 3.

Table 3: Explanatory variables: definition, measure and expected signs.

Variable	Definition and measure	Expected sign
$Subc_{t-1}$	Dummy variable that takes the value 1 if the firm subcontracted production in t-1 and 0 otherwise	+
Wage	Log of the wage per employee	+
Firm-Size	Firm size measured by the log of the number of workers	Undetermined
Product-differentiation	Dummy variable that takes the value 1 if the firm offers a differentiated product and 0 otherwise	Undetermined
Industry-Size	Log of the number of firms (or employees) in the industry	+
Export	Dummy variable that takes the value 1 if the firm exported in t-1 and 0 otherwise	+
Firm Age	Firm's age measured by the log of the number of years since the firm was born	+
Market-changes	Dummy variable that takes the value 1 if the firm has suffered changes in market conditions and 0 otherwise	+
Product-innovation	Dummy variable that takes the value 1 if the firm does product innovation and 0 otherwise	+
Process-innovation	Dummy variable that takes the value 1 if the firm does process innovation and 0 otherwise	+
R&D	Dummy variable that takes the value 1 if the firm does invest in R&D and 0 otherwise	+
Market-competition	Dummy variable that takes the value 1 if the firm has competitors with a significant market quota and 0 otherwise	+
Foreign-own	Dummy variable that takes the value 1 if the firm has foreign capital participation and 0 otherwise	Undetermined
Dj	Industry dummies for 20 sectors of two-digit NACE	
Dt	Time dummies	

Table 4 reports the means of the explanatory variables for firms that subcontract and firms that do no subcontract along the period. Substantial differences between the two types of firms can be observed. Firms which contract out production pay higher wages, are larger, more mature and they belong to larger industries than integrated firms. Moreover, the percentage of firms that face to changes in market conditions, do product and process innovation, invest in R&D, offer a differentiated product, are exporter firms, have competitors with a significant market quota and have foreign capital participation is higher for firms which decide to outsource material production. Differences across firms depending on the type of subcontracting arrangement are also shown.

Table 4: Firm, industry and market characteristics and subcontracting

	Firms that subcontract	Firms that subcontract providing materials	Firms that subcontract without materials	Firms that do mixed subcontracting	Firms that do not subcontract
Wages	6,013	5,657	6,036	6,553	5,469
Firm size (number of employees)	357	294	411	372	208
Product differentiation (% of firms that offer it)	42.7%	37.6%	46.5%	44.5%	33.0%
Industry-Size1 (number of firms)	119.9	126.5	115.5	116.4	118.8
Industry-Size2 (number of employees)	351,000	334,000	362,000	360,000	338,000
Export status (% of firms that export)	72.3%	71.7%	66.1%	83.3%	51.5%
Firm age (number of years)	25.0	24.2	23.9	28.2	22.0
Market changes (% of firms that face to them)	6.8%	6.5%	6.8%	7.2%	5.9%
Product innovations (% of firms that do them)	47.4%	43.0%	44.3%	59.7%	29.1%
Process innovations (% of firms that do them)	36.3%	32.4%	34.6%	45.5%	20.3%
R&D activities (% of firms that do them)	42.3%	38.9%	41.8%	48.7%	30.2%
Market competition (% of firms with competitors with a relevant market quota)	82.9%	81.8%	82.8%	85.0%	77.5%
Foreign ownership (% of firms with foreign capital participation)	27.4%	25.6%	26.2%	32.3%	19.9%

We propose the next model to estimate the influence of diverse plant, industry and market characteristics on firm's subcontracting behaviour. These characteristics try to capture the above motives for firms to engage in production subcontracting.

$$\Pr(SUBC_{it} = 1) = F(\beta_1 SUBC_{i,t-1} + \beta_2 Wage_{i,t-1} + \beta_3 Firm\text{-}Size_{i,t-1} + \beta_4 Product\text{-}differentiation_{i,t-1} + \beta_5 Industry\text{-}size_{i,t-1} + \beta_6 Export_{i,t-1} + \beta_7 Age_{it} + \beta_8 Market\text{-}changes_{i,t-1} + \beta_9 Product\text{-}innovation_{i,t-1} + \beta_{10} Process\text{-}innovation_{i,t-1} + \beta_{11} R\&D_{i,t-1} + \beta_{12} Market\text{-}competition_{i,t-1} + \beta_{13} Foreign\text{-}own_{i,t-1} + \beta_{14} D_t + \beta_{15} D_j + u_{it}) \quad (1)$$

Where i represents the firm and t is the year from 1991 to 2002. The dependant variable, the subcontracting decision (SUBC), is a dichotomous variable which takes the value 1 or 0 depending on whether the firm decide to contracted out production in period t or

not. Since the direction of causality could remain uncertain for some of the explanatory variables, we lag one period them to avoid a potential simultaneity problem.

To test the determinants of subcontracting behaviour, we use a dynamic panel data probit model which includes the information available on the firm's probability to contract out production. It is a dynamic model because the lagged endogenous variable is included as explanatory variable. Moreover, unobserved characteristics are likely to affect the decision to contract out production by the firm. This means that the error term, u_{it}, comprises two components, a permanent unobserved plant-specific element (α_i) and the remainder disturbance (ν_{it}). The firm-specific unobserved heterogeneity must be taken into account because in the case of being permanent or being highly serially correlated, it can induce persistence in subcontracting behaviour, overestimating the coefficient on the lagged endogenous variable and thus incorrectly interpreting as high entry cost (Bernard and Jensen, 2004). For this reason, we use a random effects probit model as well as a pooled probit. The random effects model requires that the unobserved firm effects be uncorrelated with the regressors, that is, uncorrelated with those firm characteristics which are observed and included in our subcontracting decision model. Nevertheless, random effects model can be adequate when a large population of firms are being sampled. In this case, the random effects estimation assumes that the unobserved firm characteristics are randomly distributed among the different transversal observations (Greene, 2000).

Therefore, we test the equation (1) using pooled probit and random effects probit models and we compare the results.

5. ESTIMATION RESULTS

Table 5 displays the econometric results. Our data set consists of about 1,550 firms yielding 17,000 observations (depending of the specification). The results of the four first columns are based on the standard probit model where the observations are pooled over the sample period. Column 1 reports the results of the estimation of equation excluding the variable dummy for differentiated products. The coefficient estimates show signs and levels of significance in line with expectations.

Corresponding to the assumption that firms face entry costs when they decide to subcontract production, the coefficient for lagged subcontracting decision is positive and highly significant. The probability that firms decide to outsource this period depends on previous subcontracting behaviour.

Table 5: Regression results (Dynamic panel data probit estimation)

(Dependent variable: Subcontracting decision)

	Pooled probit				Random effects probit			
Coefficients	Column (1)	Column (2)	Column (3)	Column (4)	Column (1)	Column (2)	Column (3)	Column (4)
$Subc_{t-1}$	1.862***	1.861***	1.861***	1.725***	1.518***	1.517***	1.517***	1.855***
	(0.024)	(0.024)	(0.024)	(0.045)	(0.033)	(0.033)	(0.033)	(0.059)
$Wage_{t-1}$	0.143***	0.134***	0.134***	0.158**	0.222***	0.214***	0.215***	0.189**
	(0.037)	(0.036)	(0.036)	(0.067)	(0.049)	(0.049)	(0.049)	(0.079)
Firm-size	-0.003				0.013			
	(0.012)				(0.017)			
Dfirm-size1		0.002	0.001	0.003		0.027	0.026	0.016
		(0.032)	(0.021)	(0.053)		(0.044)	(0.044)	(0.067)
Dfirm-size2		0.045	0.043	0.072		0.104*	0.101*	0.100
		(0.044)	(0.043)	(0.081)		(0.061)	(0.060)	(0.096)
Product-Differentiation				0.163***				0.191***
				(0.051)				(0.060)
Industry-size1	-0.076	-0.082			-0.131	-0.138		
	(0.126)	(0.126)			(0.143)	(0.143)		
Industry-size2			0.188***	0.168*			0.300***	0.190*
			(0.047)	(0.091)			(0.071)	(0.108)
Export	0.203***	0.195***	0.195***	0.226***	0.251***	0.245***	0.245***	0.247***
	(0.030)	(0.030)	(0.030)	(0.056)	(0.040)	(0.040)	(0.040)	(0.065)
Firm age	0.013	0.010	0.011	0.004	0.020	0.017	0.017	0.008
	(0.014)	(0.014)	(0.014)	(0.023)	(0.019)	(0.019)	(0.019)	(0.028)
Market-changes	0.069***	0.067**	0.067**	-0.013	0.078**	0.077**	0.077**	-0.025
	(0.027)	(0.026)	(0.026)	(0.051)	(0.031)	(0.031)	(0.031)	(0.056)
Product innovation	0.178***	0.178***	0.178***	0.171***	0.199***	0.198***	0.198***	0.202***
	(0.030)	(0.030)	(0.030)	(0.055)	(0.036)	(0.036)	(0.036)	(0.063)
Process innovation	0.072***	0.068**	0.068**	0.076	0.078**	0.077**	0.076**	0.083
	(0.027)	(0.027)	(0.027)	(0.050)	(0.032)	(0.032)	(0.032)	(0.057)
R&D	0.087***	0.076**	0.076**	0.145**	0.139***	0.131***	0.132***	0.174***
	(0.032)	(0.031)	(0.031)	(0.058)	(0.040)	(0.040)	(0.040)	(0.067)
Market-competition	0.056*	0.056*	0.056*	0.121**	0.061	0.061	0.061	0.142*
	(0.031)	(0.031)	(0.031)	(0.057)	(0.039)	(0.039)	(0.039)	(0.065)
Foreign-own.	-0.039	-0.050	-0.050	-0.111*	-0.044	-0.053	-0.052	-0.117
	(0.034)	(0.034)	(0.034)	(0.063)	(0.048)	(0.048)	(0.047)	(0.074)
Constant	-2.542***	-2.456***	-5.015***	-4.995***	-3.115***	-3.007***	-7.114***	-5.732***
	(0.583)	(0.585)	(0.666)	-1.302	(0.691)	(0.695)	(0.999)	-1.562
Observations	16977	16977	16977	4846	16977	16977	16977	4846
Number of groups	-	-	-	-	2554	2554	2554	2428
Log likelihood	7055.41	7054.63	7054.84	2111.84	6932.96	6931.59	6932.05	2097.63
LR test (rho=0)	9198.21	9199.77	9199.34	2429.91	244.90	246.08	245.58	28.41
Prob>chi2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Pseudo R2	0.395	0.395	0.394	0.365				

Notes: Significant coefficients are indicated by *, **, ***, for significance at the 1%, 5% and 10% level, respectively. The figures in parenthesis are standard errors. All regressions include unreported sectoral dummies and annual time dummies. All variables, except the dummy, are in logarithm.

Moreover, in line with our prior expectations, firms with higher wages are more likely to engage in subcontracting[11]. These firms tend to use outsourcing as a defensive strategy trying to improve their competitiveness. The positive and significant coefficient of wages provides empirical evidence of the cost-cutting motive for outsourcing. Related to the variables used to capture the thickness of the market, only the exporter status shows positive and significant coefficients. Exporter firms have more possibilities to be main contractors[12]. The positive correlation is explained by a higher probability to find suitable providers. Neither the number of firms (industry-size1) nor the age variable are significant. Additionally, according to the positive link between the market changes and subcontracting behaviour, as the variations in market conditions are more frequent, the probability to outsource increases. This outcome confirms the hypothesis that outsourcing production is a strategy to gain flexibility in a context of rapid market changes. Our results confirm that firms involved in R&D activities, product and process innovations and differentiation products are more prone to contract out production. In this sense, producing high-tech, differentiated and innovator products increases the firm's probability of subcontracting. As it has been argued above, these firms need to concentrate in their innermost core competences due to they are faced to a changing market environment. Market-competition appears with a positive and significant coefficient. Nevertheless, variables such as firms' size and foreign ownership exhibit an absence of statistical significance[13]. At last, most of the time and industry dummy variables are highly significant although, in order to spare space, the coefficients are omitted from the results table.

Table 5 displays the estimations of three more specifications. In the second specification (column 2), the variable firm size measured by the log of number of employees is removed and it is substituted by two dummy variables. The first one (Dfirm-Size1) takes the value 1 if the firm has between 26 and 200 employees and 0 otherwise and the second one (Dfirm-Size2) takes the value 1 if the firm has more than 200 employees and 0 otherwise. Both of them show insignificant coefficients. Firms' size is not a determinant for the subcontracting decision. The sign and significance of the remainder regressors do not change.

[11] As we explained above, we use wage lagged one period. Nevertheless, since the subcontracting decision is already included lagged one period in the model, we have considered the value of wages in t-2 obtaining very similar estimation results.

[12] This argument is used by Görg, Hanley and Strobl (2004) who study the impact of international outsourcing on productivity employing plant-level data for Irish manufacturing. Their results show that exporting firms obtain more productivity gains from international outsourcing of materials inputs than non-exporter firms. The authors argue that exporting firms face lower costs of searching for potential suppliers abroad.

[13] We have also included the quadratic value of age and size in the regression to allow for a more flexible form, but the coefficients remain statistically insignificant.

Taking into account the lack of significance of the variable industry-size1 (number of firms in each industry), in the column 3 we introduce the variable industry-size2 (number of employees in each industry) which turns out statistically significant. As the industry-size increases, so do subcontracting decision. Again, the remainder regressors do not change.

The column 4 reports the results of the estimation adding the product differentiation variable. A substantially fewer number of surveyed firms has answer this question and the number of observations reduces a lot, diminishing the available information as well for the rest of the variables. The product differentiation affects positively and significantly to the probability to subcontract. Variables such as market-changes and process-innovation loose their statistical significance, whereas the coefficient for foreign ownership show a negative and significant sign. The rest of the coefficients hardly change.

The table 5 also reports the estimation results using random-effects probit techniques (four last columns). We again distinguish the same four specifications and the results are very similar to earlier results. The only difference is that the dummy variable for firm size which takes the value 1 if the firm has more than 200 employees turns out significant. That is, large firms are more prone to subcontracts production than medium and small firms.

Table 6 reports the marginal effects of the three specifications using pooled probit and random effects probit. That is, how marginal changes in the independent variables would affect the predicted probabilities to decide subcontracting. The results show that the marginal effects of lagged subcontracting decision on current subcontracting probabilities are particularly large: firms that decided to subcontract production in the previous year have at least a 55% greater probability of doing subcontracting in current period. Marginal increases in the others explanatory variables also raise the probability that a firm subcontracts but the effect is lower. To conserve space, we only report marginal effects for significant explanatory variables.

The regressions were also run separately for each subsample of firms: firms subcontracting providing materials and firms subcontracting without materials. The sign and significance of the coefficients of variables are too similar for the two types of subcontracting arrangement and too similar to those obtained for aggregate subcontracting. Two particularities need to be mentioned. First, the obtained estimates for subcontracting providing materials show that size has a significant and positive effect on subcontracting decision. For this type of subcontracting, the likelihood of subcontracting increases with the size of the

firm. Second, the econometric findings for subcontracting without materials suggest that age is an important factor in the propensity to engage in contracting out. More mature firms are more prone to subcontract production without providing materials.

Table 6: Marginal effects

(based on probit results of table 5)

	Pooled probit				Random effects probit			
Marginal effects	Column (1)	Column (2)	Column (3)	Column (4)	Column (1)	Column (2)	Column (3)	Column (4)
$Subc_{t-1}$	0.645***	0.645***	0.645***	0.609***	0.547***	0.547***	0.547***	0.643***
	(0.006)	(0.006)	(0.006)	(0.012)	(0.010)	(0.010)	(0.010)	(0.015)
$Wage_{t-1}$	0.056***	0.052***	0.052***	0.062**	0.086***	0.083***	0.084***	0.073**
	(0.014)	(0.014)	(0.014)	(0.026)	(0.019)	(0.019)	(0.019)	(0.030)
Dfirm-size2						0.041*	0.039*	
						(0.024)	(0.024)	
Product-Differentiation				0.064***				0.074***
				(0.020)				(0.023)
Industry-size2			0.073***	0.066*			0.116***	0.074*
			(0.018)	(0.035)			(0.028)	(0.042)
Export	0.079***	0.076***	0.076***	0.088***	0.096***	0.094***	0.094***	0.095***
	(0.012)	(0.012)	(0.012)	(0.021)	(0.015)	(0.015)	(0.015)	(0.025)
Market-changes	0.027***	0.026**	0.026**	-0.005	0.030**	0.030**	0.030**	
	(0.010)	(0.010)	(0.010)	(0.019)	(0.012)	(0.012)	(0.012)	
Product innovation	0.070***	0.070***	0.070***	0.067***	0.078***	0.077***	0.077***	0.079***
	(0.012)	(0.012)	(0.012)	(0.022)	(0.014)	(0.014)	(0.014)	(0.025)
Process innovation	0.028***	0.027**	0.027**	0.030	0.030**	0.030**	0.030**	
	(0.011)	(0.011)	(0.011)	(0.020)	((0.013)	((0.013)	((0.013)	
R&D	0.034***	0.030**	0.030**	0.057**	0.054***	0.051***	0.051***	0.068***
	(0.012)	(0.012)	(0.012)	(0.023)	(0.016)	(0.016)	(0.016)	(0.026)
Market-competition	0.022*	0.022*	0.022*	0.047**				0.055*
	(0.012)	(0.012)	(0.012)	(0.022)				(0.025)
Foreign-own.				-0.043*				
				(0.024)				

Notes: Significant coefficients are indicated by *, **, ***, for significance at the 1%, 5% and 10% level, respectively. The figures in parenthesis are standard errors.

6. FINAL CONSIDERATIONS

In this paper we have used firm-level manufacturing data from 1990 to 2002 to estimate a model of the determinants of outsourcing decision. Outsourcing is measured as the manufacture of custom-made finished products or parts and components which are been contracted out to third parties. Moreover, we distinguish whether the main contractor provides the materials to the external supplier or not.

Our empirical analysis shows that almost one of every two manufacturing firms have been contracting out production to independent providers along the period. Around 20 per

cent of surveyed firms are engaged in subcontracting providing materials, another 20 per cent in subcontracting without providing materials and 10 per cent use both types of subcontracting at the same time. We also point out that the outsourcing decision seems to be influenced by firm size and sectoral-specific characteristics. That is, our data show that outsourcing strategy is more frequent in large firms and in sectors such as machinery and mechanical goods, office and electrical equipment, transport equipment, textiles and clothing and editing and printing. Furthermore, industry-specific features influence the mode of subcontracting as well as the extent of subcontracting.

Our model on factors that influence the firm's choice of outsourcing follows the theoretical framework of Grossman and Helpman (2002). They consider that transaction costs are a key difficulty in adopting outsourcing strategy. Some of these costs are even sunk entry costs taking into account that around half of surveyed firms are inactive in subcontracting. The presence of these costs would imply persistence in the outsourcing decision. In effect, we observe a high persistence of participation decision in subcontracting from one year to the next. So, in our model we include as regressors the lagged dependant variable as well as other firm, industry and market characteristics that influence the likelihood of contracting out production. Using a dynamic panel data probit model, our results indicate that previous subcontracting decision, wages, product differentiation, industry-size, exporter status, market changes, R&D activities and product and process innovation affect positively the current subcontracting decision.

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