OUTSOURCING BEHAVIOUR: AN EMPIRICAL APPROACH COMBINING DECISION AND INTENSITY

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Abstract:

This paper studies the determinants of outsourcing intensity using firm-level panel data for Spanish manufacturing industries. Outsourcing refers to contract out the manufacturing of custom-made finished products or parts and components. Following the theoretical framework of Grossman and Helpman (2002), we take into account the presence of sunk entry costs as well as other firm, industry and market characteristics that influence the level of outsourcing. Moreover, we consider firstly that the company decides to outsourcing or not, and once outsourcing has been the chosen option, the firm establishes the volume of production to be subcontracted. Although the problem of sample selection is typically ignored in panel data settings, we use the Heckman procedure to eliminate the effect of selection bias from the estimated results. Our results show that some variables influencing the outsourcing intensity are different from those that affect decision of outsourcing.

JEL classification: D21, L23, L60.

Keywords: Outsourcing, Firm-level panel data, Determinants, Selection bias, Persistence.

1. INTRODUCTION.

In the current economic climate where companies operate more and more in global markets, one of the priorities for them is to gain efficiency. Outsourcing has emerged as a necessary strategy to enhance firm competitiveness and performance. Outsourcing is when a company contracts with a third party to carry out a function that were previously performed internally. In the manufacturing area, functions capable of being outsourced include technology systems, component manufacturing, product assembly, training and testing.

The term outsourcing refers to external to the boundaries of the company, that is, it is opposed to vertically integrated production. Furthermore, 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 (main contractor) and external provider (subcontractor) is long-term and it usually implies sharing information about the product. Therefore, closer relationships between main contractor and subcontractor/supplier are developed[1].

Nowadays, many firms are making the decision to outsource. The increasing competition and complexity of production processes have led to firms to leave the non-core activities providing them through outsourcing. Moreover, the progress in trade liberalization, the reducing of transport costs and the IT revolution have encouraged outsourcing activities. Outsourcing, which may be of domestic or international dimension, has made itself accessible to many companies in today's global marketplace.

This study is an empirical contribution to the literature on factors that determine both the propensity and the intensity of outsourcing using firm-level panel data. The importance of the phenomenon is well understood, but much less is known about firm level determinants to contract out: why do some firms decide subcontracting and why the subcontracting intensity is higher in some firms than in others. As far as authors know, the existing empirical studies neither offer a wide consensus about the determinants nor study in a simultaneously way what variables determines who contract out and how much production is outsourced. By one hand, empirical research about the determinants of outsourcing intensity is done in Tomiura (2005, 2006) for Japanese manufacturing industry, Görg and Hanley (2004) for Irish electronics industry, Girma

[1] Outsourcing and subcontracting are considered to be synonymous.

and Görg (2004) for some UK manufacturing industries and Diaz-Mora (2007) for Spanish manufacturing industries[2]. By other hand, works such as Kimura (2001), Holl (2007) and Diaz-Mora and Triguero (2007) study which factors affect the firm's likelihood to outsource using Japanese data, in the first case, and Spanish data in the two others.

In this work we consider, firstly, that the company decides to outsourcing or not and, once outsourcing has been the chosen option, the firm establishes the volume of production to be subcontracted. Although the problem of sample selection is typically ignored in panel data settings, we take into account it in this paper. It requires using the Heckman procedure to eliminate the effect of selection bias from the estimated results[3]. So, our work tries to identify which factors influence the outsourcing intensity using a panel of Spanish manufacturing firms and considering prior decision. Based on the theoretical approach of Grossman and Helpman (2002), the presence of sunk entry costs and diverse firm, industry and market characteristics are contemplated in our model.

The organization of this paper is as follows. Section 1 is an introduction. Section 2 presents data and a descriptive analysis of subcontracting intensity. A simple conceptual framework for the analysis using the existing literature is provided in Section 3. Section 4 presents the model and justifies the econometrical technique used in this work. Section 5 shows the main empirical findings. Finally, section 6 concludes.

2. DATA AND DESCRIPTIVE ANALYSIS.

Our empirical work is based on establishment level data between 1991 and 2002. Although outsourcing is generally difficult to measure, we have information on which parts of the production stage have been contracted out. Specifically, our measure of outsourcing includes the manufacturing of custom-made finished products or parts and components which have been contracted out to third parties. It is important to emphasize that the processing of the segmented production is carried out following the main contractor's specifications. That is, purchases of standardized intermediate inputs through a usual marketing channel are not regarded as outsourcing in our measure. Outsourcing involves transferring a production stage to an outside supplier, which means a high degree of two-way information exchange, coordination and trust

[2] This last work uses industry-level instead of firm-level data.
[3] Tomiura (2005) also introduces a selection equation as the first-stage in Heckman's two-step estimation procedure. But he uses cross-section data and the persistence in outsourcing behaviour is not taken into account.

between the main contractor and the subcontractor firm. Such a relationship between economic entities implicated in outsourcing is qualitatively different from traditional relationships between buyer and seller. So, our work uses an adjusted measure of outsourcing.

All the data used for this paper are from the Survey of Business Strategy (Encuesta sobre Estrategias Empresariales in Spanish, ESEE hereafter). It provides panel data on many relevant firm characteristics such as activity and manufacturing processes, customers and suppliers, costs and prices, markets, technological activities, foreign trade and employment from 1990 onward. The ESEE is a representative sample of Spanish manufacturing firms with 10 or more employees classified by two firm size categories. 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. The Survey covered 2,188 firms in 1990. Efforts to avoid the reduction of the firms' collaboration have been made in order to maintain the representativeness with regard to the population of reference. As well as efforts to include each year into the sample all the newly incorporated firms which employ over 200 workers, and a randomly selected sample which represents around 5% of the newly incorporated firms which have between 10 and 200 employees[4].

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. We select exclusively those firms that respond the questions about outsourcing. Afterwards, we focus only on outsourcing firms to analyse the intensity of subcontracting from a sectoral and time perspective. Outsourcing intensity is computed as the ratio of production activities contracted out to other firms to the value of the total intermediate purchases.

Table 1 displays basic descriptive statistics on the outsourcing behaviour of Spanish manufacturing firms by firm size. Our results reveal that less than half of Spanish manufacturing firms are engaged in outsourcing strategy. The percentage of outsourcers has even decreased from the beginning of the nineties. The average subcontracting intensity is around 20 per cent of intermediate consumption for those firms that decide to outsource production in 2002. This average level of outsourcing has remained quite stable over the last years, hardly two percentage points higher than at the beginning of the 90's. With regard to the firm size, our data show a

[4] See Fariñas and Jaumandreu (1999) and www.funep.es for further details about ESEE.

positive correlation between firm size and the probability to be outsourcer but negative between firm size and subcontracting intensity. Outsourcers tend to be larger than non-outsourcers. However, the smaller the firm, the more intensive is the subcontracting strategy. That is, the influence of firm size on subcontracting behaviour needs to be taken into account.

Table 1: Outsourcing behaviour by firm-size, 1991-2002

	Total number of firms		Percentage share of outsourcing firms		Average Outsourcing intensity (in outsourcing firms)	
	1991	2002	1991	2002	1991	2002
All manufacturing firms	1.992	1.684	47.5	42.9	17.9	20.4
Small (less than 25 employees)	664	486	36.4	32.7	21.5	23.1
Medium (between 25 and 200 employees)	579	663	45.8	41.2	21.3	21.1
Large (more than 200 employees)	749	535	58.6	54.4	13.5	18.1

Source: ESEE

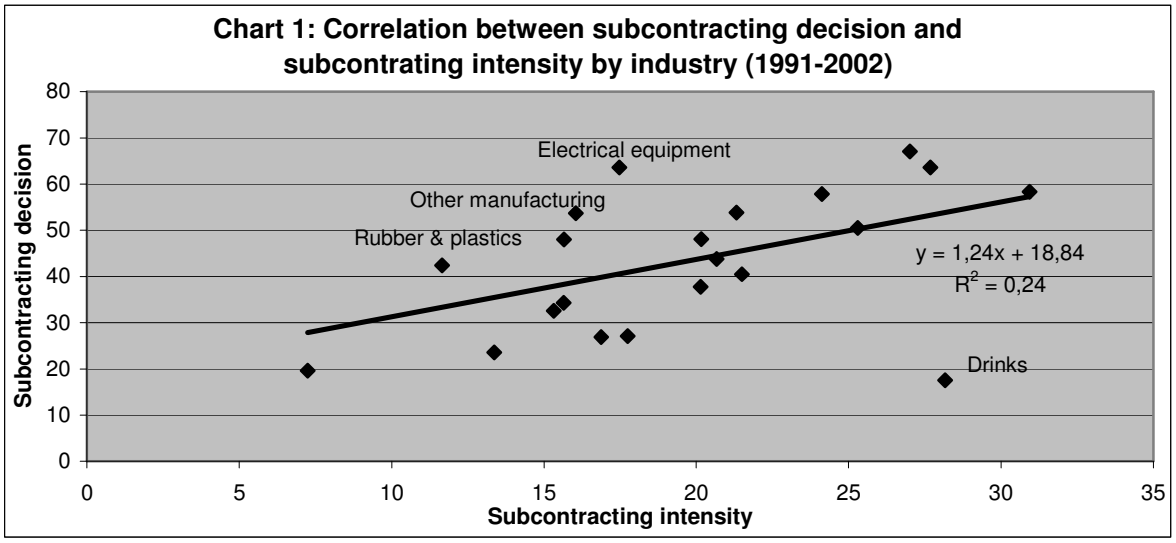
The cross-industry variability of subcontracting behaviour is very high. Sectors such as drinks, textiles and clothing, editing and printing, machinery and other transport material subcontract around 25 per cent of intermediate inputs at the end of the period, which is a percentage above the industry average (Table 2). Meat products, other food and tobacco and paper are the industries with lower share of subcontracted production. So, outsourcing behaviour seems to be clearly affected by industry-specific factors. Nevertheless, sectors using more intensively outsourcing strategy are not always coincident with those with higher propensity to outsource. Hence, we can infer that factors determining subcontracting decision and subcontracting intensity could differ.

A correlation chart shows that subcontracting propensity and intensity are not closely related from a sectoral perspective (Chart 1). There are branches such as rubber and plastics, electrical equipment and other manufacturing industries where subcontracting is a widespread practice among firms whereas the outsourcing intensity is low. On the contrary side, drink industry is the second branch with higher subcontracting intensity but hardly 15 per cent of firms are engaged in subcontracting production during the period 1991-2002.

Table 2: Outsourcing behaviour by manufacturing industry, 1991-2002

	Percentage share of outsourcing firms		Outsourcing intensity (in outsourcing firms)	
	1991	2002	1991	2002
Meat products	17.5	18.2	4.8	5.1
Other food and tobacco	26.3	25.3	14.1	8.5
Drinks	19.6	19.2	20.5	30.9
Textiles and clothing	52.6	49.4	21.9	28.4
Leather and footware	50.0	47.9	18.3	20.9
Wood industry	34.0	29.3	28.1	14.4
Paper	39.3	24.6	20.2	7.1
Editing and printing	60.0	53.1	24.8	35.8
Chemical industry	44.8	48.6	8.8	20.7
Rubber and plastics	50.0	47.1	14.7	12.2
Minerals products	28.4	27.4	14.4	15.1
Iron and steel	43.6	33.3	11.5	17.4
Metallic products	54.2	45.2	17.7	22.1
Machinery and mechanical goods	76.2	61.5	19.7	24.6
Office equipment	63.2	42.9	23.8	21.5
Electrical equipment	61.7	65.5	12.3	18.6
Motor vehicles	58.9	51.6	22.7	13.4
Other transport material	70.0	61.3	17.8	23.7
Furniture	43.0	35.7	20.8	18.9
Other manufacturing	60.8	42.4	15.8	10.8

Source: ESEE



3. LITERATURE BACKGROUND.

Our empirical research on the determinants of outsourcing intensity follows the theoretical work by Grossman and Helpman (2002). They examine the firm's choice between in-house production and outsourcing (make or buy decision) within a theoretical framework that allows for the interdependence between firm's decision and market structure. The form of industrial organization depends on the trade off between the costs that arise from vertical disintegration such as search frictions and imperfect contracting and the costs of running a larger and less specialized organization. Building on the transaction cost theory (Williamson, 1975, 1985) and property right theory (Grossman and Hart, 1986), Grossman and Helpman model assumes that outsourcing entails a variety of transaction costs associated with various aspects of inter-firm transactions. Search costs to find a suitable supplier, negotiation costs, costs to design the contract and the incomplete contracts problem, production coordination costs, technology transfer risks, etc. have to be considered. On the contrary side, outsourcing increases the flexibility in the production process as well as it allows to benefit from provider cost advantages derived from specialization, experience, economies of scale and location. When these benefits exceed transaction costs from outsourcing, firms will opt for contracting out production.

With regard to the costs, we believe that some of the transaction costs related to outsourcing initiative will be irrecoverable for the firm. So, outsourcing decisions are not only costly but also difficult to reverse[5]. That is, they involve a significant sunk cost component, for example the search costs in finding a reliable provider. Sunk entry costs represent a barrier to a firm adopting the outsourcing strategy. They are proxied by the lagged dependent variable which may also capture the previous outsourcing experience of a firm and the persistence in outsourcing behaviour. Those firms that have outsourced in the past year and have learnt from their preceding experiences tend to outsource again in the current year. The existence of sunk entry costs and the dynamic aspect of outsourcing have been narrowly used in prior 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). In order to asses the importance of sunk costs and

[5] McIvor (2005).

previous experience, we use a lag structure for past outsourcing decision and for outsourcing level in this work.

Supporting the hypothesis of sunk entry costs in outsourcing, a notable persistence of participation decision in outsourcing from one year to the next can be observed in Spanish manufacturing firms (Table 3). According to our data, 82 per cent of firms that outsource production continue to outsource in the following year, while this ratio is 14 per cent among non-outsourcing firms. That is, outsourcing firms in the current year are 5.9 times more likely to outsource in the following year than a currently non-outsourcing firm. The persistence is even higher for those firms that do not outsource in a particular year: 86 per cent of them remain inactive in the following year. The pattern of persistence is also clear at industry-level[6]. Therefore, our findings corroborate the importance of sunk entry costs in outsourcing strategy.

Table 3: Outsourcing transition probabilities

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

One of these sunk entry costs are just the search costs in finding a reliable provider. Grossman and Helpman (2002) model search as a matching process which is costly and is not always successful. So the expected profits for outsourcing depend positively on the probability of finding a suitable partner. In this point, they consider the influence of industry environment on outsourcing dynamics in two ways. By one hand, the attractiveness of outsourcing depends on whether other firms in the same industry have chosen to be vertically integrated or to outsource. The expected profits of a main contractor firm decline with the entry of other firms like it, "because additional firms on the same side of the market reduce the likelihood of matching"[7]. Moreover, potential outsourcers "find more attractive to outsource the thicker the market for the input is, in the sense that there exist more sellers to serve the buyers' needs"[8]. By this way, Grossman and Helpman explore the possibility of interactions between firms' organization decisions. For this reason, two industry variables are included in the model: the amount of main

[6] For the outsourcing transition probabilities by industry, see Díaz-Mora and Triguero (2007).
[7] Grossman and Helpman (2002), page 96.
[8] Helpman (2006), pages 615-616.

contractor firms in the industry (same-side market thickness) and the amount of specialized providers in the industry (other-side market thickness).

By other hand, outsourcing is more likely to exist in large industries due to the benefits of having a thicker market. That is, the larger the industry, the greater the number of main contractors and providers that enters the industry. But industry size favours outsourcing only with increasing returns to scale in matching, i.e. when the chances for a firm of finding a good match grow as the number of firms on each side of the market rises. Size does not matter when there are constant returns to matching. In that case, there could be no influence of industry size on outsourcing. The industry size is measured by the number of firms in each industry. McLaren (2000) also considers the effects of market thickness on the outsourcing of intermediate inputs in a transaction cost model where the trade off between vertical integration and outsourcing is considered. He argues that an increase in the thickness market can lead to outsourcing. As international trade increases the thickness of the market, outsourcing will be more viable in firms operating in markets and economies open to international trade (McLaren, 2000). It could be argued that the significance of international openness will be greater in firms where foreign outsourcing prevails. The ESEE does not provide information on whether production is outsourced to firms abroad or in the domestic economy. But recent studies for Spanish economy using input-output data show that international dimension of fragmentation of production is becoming more and more important, particularly in sectors with higher export propensity (Gandoy and Díaz-Mora, 2007). Taking into account the increasing relevance of international outsourcing, we try to estimate the role of exports on outsourcing behaviour. A dummy variable is included in the model. It takes the value 1 if the firm shows positive export behaviour and 0 otherwise. Empirical works such as Kimura (2001) and Görg and Hanley (2004) introduce an export variable and they obtain a significant and positive effect on outsourcing.

Besides that, we consider the influence of industry environment on outsourcing in an additional mode: specific industry characteristics could ease the disintegration of production process, and consequently favour outsourcing. That is, belonging to a specific industry may condition the firm's outsourcing strategy. The introduction of industry dummies allows us to control the permanent differences across industries.

On the benefit side, efficiency considerations mix with flexibility considerations. The primary motivation for outsourcing emerging from opinion surveys is to cut costs. Outsourcing can help to improve the efficiency of the production process when the main contractor can take advantage of lower wages in subcontractor firm. So, wages are considered as a key determinant of outsourcing strategy. We expect that those firms where the wages are higher will be more dynamic in outsourcing strategy. In the review literature, the sign of this labour variable varies depending on the manufacturing industry and on the estimation technique (Girma and Görg, 2004; Görg and Hanley, 2004). Only Holl (2007) and Diaz-Mora (2007) do obtain a positive and significant coefficient using Spanish manufacturing data.

The labour-cost saving argument is not the only factor to take into account in outsourcing strategy. Cost cutting derived from specialized knowledge and exploitation of scale and scope[9] economies in the production of intermediate inputs and components also helps to improve firm efficiency. The existence of economies of scale and scope emphasizes the role of firm size variable as a determinant of outsourcing. Taking into account that small and medium enterprises have more difficulties to get the minimum efficient scale, out hypothesis is that they will opt more intensively for outsourcing. Larger firms are in better position to integrate their production processes while smaller can find outsourcing like a useful alternative to get scale and scope economies. But there are controversial arguments to expect a negative relation between firm size and outsourcing intensity. Since outsourcing increases firm's capacity for adaptation and flexibility, large firms are more likely to carry out the vertically de-integration of their production structures. In this sense, Görzig and Stephan (2002) points out that regarding the relationship between firm size and performance, there should be a trade-off between economies of scale on the one hand and increasing inefficiency on the other. Furthermore, larger firms must have better access to specific inputs and information which can facilitate the decision or the continuation of subcontracting arrangements. Thus, the sign of firm size becomes an empirical matter. A positive effect on outsourcing decision is found in Holl (2004) and a negative effect on outsourcing level in Görg and Hanley (2004) where firms with thirty or less employees are excluded.

[9] Jones and Kierzkowski (2001) argue that disintegration of vertical production processes can result in production blocks being sufficiently simple which are used in very different activity. An example is the computer chips which currently are incorporated into computers, but also in cameras, cars, micro-vans a and so on.

Reasons for outsourcing not merely include getting lower costs due to economies of scale and scope or lower labour rates. Subcontracting imply more flexibility by turning fixed costs into variable costs. The flexibility-enhancing motivation for outsourcing is even more necessary in a changing market environment. Therefore, changes in demand and other market conditions need to be considered (Demsetz, 1995; Abraham and Taylor, 1996; Shy and Stenbacka, 2003; Lin and Tsai, 2005 and Buehler and Haucap, 2006). For this motive, we include a variable measuring these changes in the market conditions. Specifically, we incorporate a dummy variable coded 1 if the surveyed firm shows changes in market conditions and 0 if does not.

Furthermore, outsourcing as a strategy to face a very dynamic market environment is even more necessary for firms in industries where innovation and rapid responsiveness to customer needs are key sources of comparative advantage (McIvor, 2005). Lin and Tsai (2005) also indicate that a changing market environment favours outsourcing activities, mainly in products characterized by a higher technological content[10]. Outsourcing is understood as a way of flexible mode of production which allows high-tech firms to focus on R&D, design and other skill intensive stages of production while the most of their physical production is contracting out. Subcontracting is becoming very important for firms producing sophisticated and high tech goods (Curzon Price, 2001). To take into account this argument, 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**.** We also introduce the proportion of R&D expenditures over total sales to explain the outsourcing intensity. Tomiura (2005, 2006) finds a positive coefficient for R&D intensity and he explains that outsourcing creates greater incentives for innovation by lowering production costs and raising profits.

Although the main drivers of outsourcing are reduced costs and increased flexibility, recent theoretical literature such as Shy and Stenbacka (2003), Buehler and Haucap (2006) and Leahy and Montagne (2007) introduce additional strategic considerations in determining the make or buy decision. Specifically, it is argued that firms may choose outsourcing strategically to influence the behaviour of competitors. In this sense, outsourcing is used as a strategic instrument to compete with their rivals in the industry where firms operate. On this basis, competitive

[10] Demsetz (1995) also mentions the role of technological factor. 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).

pressure will work in favour on strategic outsourcing. So, the increasing competition in global markets encourages outsourcing. To consider strategic outsourcing, a proxy for the degree of market competition is incorporated. It is a dummy variable which takes the value 1 if the firm has competitors with a significant quota in the own market and 0 otherwise.

Other firm characteristics are introduce as control variables in the model such as firm age and foreign ownership. With regard to firm age, we argue that subcontracting requires experience because mature firms could find appropriate partners easier than younger companies due to a "learning effect" (Ono, 2003). Moreover, the first ones could be more prone to focus on their core activities. 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[11].

The effect of foreign capital participation on outsourcing performance is also estimated. Previous works suggest a positive relation between international outsourcing and foreign ownership. Kimura (2001) and Girma and Görg (2004) found that foreign ownership has a positive and significant effect on outsourcing. They argue that firms that belong to a multinational group have a higher probability of contracting out to more efficient providers abroad. Nevertheless, for the Spanish case, Holl (2007) and Díaz-Mora (2007) obtained the opposite results. A possible explanation could be that, taking into account lower variable managerial costs such as monitoring and coordination production, a better option for multinational firms is sourcing production from an affiliate firm located abroad (intra-firm sourcing or captive offshoring) instead of an independent foreign supplier (offshore outsourcing)[12]. So, foreign affiliates could be less active in outsourcing strategy. Hence, our expectation regarding the sign of the relationship between foreign ownership and subcontracting pattern is ambiguous. 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.

At last, we control for other market conditions such as the concentration of sales in a few customers and the concentration of purchases in a few providers at the level firm.

[11] The year the company was created (firm age) is one of the questions which are only asked every four years in the survey. For this reason, we suppose that the age is the most recent answer given by the same firm.
[12] World Trade Organization (2005).

4. THE MODEL OF OUTSOURCING DETERMINANTS.

After revising the theoretical and empirical literature, we select a wide range of firm, industry and market characteristics to estimate their influence on outsourcing behaviour. Table 4 summarizes these variables.

Table 4: Dependent and explanatory variables: definition, measure and expected signs.

Explanatory Variables	Definition and measure	Expected sign
$DOUT_{t-1}$	Dummy variable taking value 1 if firm subcontracts in year t-1 and 0 otherwise	+
$OUTCO_{it-1}$	Outsourcing intensity in year t-1	+
Same-side Market Thickness	Ratio of main contractor firms to total firms in the industry	-
Other-side Market Thickness	Ratio of specialized providers to total firms in the industry	+
Industry-size	Log of the number of firms in the industry	+
Export status	Dummy variable that takes the value 1 if the firm exported in t-1 and 0 otherwise	+
$Wage_{it-1}$	Log of the wage per employee in year t-1	+
Firm-Size	Firm size measured by the log of the number of employees	Undetermined
Market-changes	Dummy variable that takes the value 1 if the firm has suffered changes in market conditions and 0 otherwise	+
Process-innovation	Dummy variable that takes the value 1 if the firm does process innovation and 0 otherwise	+
Product-innovation	Dummy variable that takes the value 1 if the firm does product innovation and 0 otherwise	+
R&D status	Dummy variable that takes the value 1 if the firm does invest in R&D and 0 otherwise	+
R& D intensity	R&D expenditure normalized by sales (in %)	+
Market-competition	Dummy variable that takes the value 1 if the firm has competitors with a significant market quota and 0 otherwise	+
Firm Age	Firm's age measured by the log of the number of years since the firm was born	+
Foreign-own	Dummy variable taking value one if more than 50% of the firm shares are foreign and zero otherwise	Undetermined
Customers' Concentration	Total sales of the firm to the main three customers (in %)	Undetermined
Providers' Concentration	Total intermediate purchases of the firm to the main three providers (in %)	Undetermined
Dj	Industry dummies for 20 sectors of two-digit NACE	
Dt	Time dummies	

Table 5 reports the means of the explanatory variables for firms that subcontract and firms that do no subcontract along the period. Considerable differences between the two types of firms can be observed. Firms engaged in outsourcing on average pay higher wages, they are larger and more mature and they belong to larger industries than integrated firms. These companies have also less customers' and providers' concentration ratios. Moreover, the percentage of firms that face to changes in market conditions, do product and process innovation, invest in R&D activities, are exporting firms, have competitors with a significant market quota and have foreign capital participation is greater for firms active in outsourcing.

Table 5: Firm, industry and market characteristics depending outsourcing performance.

	Firms that outsource	Firms that do not outsource
Export status (% of exporting firms)	72.3%	51.5%
Wages	6,013	5,469
Firm size (number of employees)	357	208
Market changes (% of firms that face to them)	6.8%	5.9%
Process innovations (% of firms that do them)	42.3%	30.2%
Product innovations (% of firms that do them)	36.3%	20.3%
R&D status (% of firms that do R&D)	47.4%	29.1%
R&D intensity	1.05%	0.44%
Market competition (% of firms with competitors with a relevant market quota)	82.9%	77.5%
Firm age (number of years)	25.0	22.0
Foreign ownership (% of firms with foreign capital participation)	27.4%	19.9%
Customers´ Concentration (% of total sales to the main three customers)	41.3%	43.1%
Providers´ Concentration (% of total purchases to the main three providers)	43.1%	51.0%

We propose the next model which relates the outsourcing intensity with each of the firm, industry and market characteristics detailed above. These characteristics try to capture the main motives for firms to engage in production outsourcing in the selection equation (1) and settle on the amount contracted out in the objective equation (2):

Outsourcing decision:

$$DOUT_{it} = F (\beta_1 DOUT_{i,t-1} + \beta_2 \text{Same-side Market Thickness}_{jt} + \beta_3 \text{Other-side Market Thickness}_{jt} + \beta_4 \text{Industry-size}_{j,t} + \beta_5 \text{Export}_{i,t} + \beta_6 \text{Wage}_{i,t-1} + \beta_7 \text{Firm-Size}_{i,t} + \beta_8 \text{Market-changes}_{i,t} + \beta_9 \text{Process-innovation}_{i,t} + \beta_{10} \text{Product-innovation}_{i,t} + \beta_{11} R\&D_{i,t} + \beta_{12} \text{Market-competition}_{i,t} + \beta_{13} Age_{it} + \beta_{14} \text{Foreign-own}_{i,t} + \beta_{15} \text{Customers-con}_{i,t} + \beta_{16} \text{Providers-con}_{i,t} + \beta_{17} D_t + \beta_{18} D_j + u_{i1t}) \quad (1)$$

Intensity outsourcing:

$$OUTCO_{it} = F(\beta_1 OUTCO_{i,t-1} + +\beta_2 \text{Same-side Market Thickness}_{jt} + \beta_3 \text{Other-side Market Thickness}_{jt} + \beta_4 \text{Industry-size}_{j,t} + \beta_5 \text{Export}_{i,t} + \beta_6 \text{Wage}_{i,t-1} + \beta_7 \text{Firm-Size}_{i,t} + \beta_8 \text{Market-changes}_{i,t} + \beta_9 \text{Product-innovation}_{i,t} + \beta_{10} \text{R\&Dintensity}_{i,t} + \beta_{11} \text{Market-competition}_{i,t} + \beta_{12} \text{Age}_{it} + \beta_{13} \text{Foreign-own}_{i,t} + \beta_{14} \text{Customers-con}_{i,t} + \beta_{15} \text{Providers-con}_{i,t} + \beta_{16} D_t + \beta_{17} D_j + u_{i2t}) \quad (2)$$

Where i represents the firm and t is the year from 1991 to 2002. In the selection equation (1), DOUT is a dummy variable which takes the value 1 or 0 depending on whether the firm decide to contracted out production in period t or not. If $DOUT_{it} = 1$, then OUTCO is the outsourcing intensity measured as the value of production which have been outsourced to the value of the total intermediate purchases. When the error terms of Equations (1) and (2) are correlated (Correlation $(u_{i1t}, u_{i2t}) = \rho$), that is ρ is not 0, simple OLS estimation of outsourcing intensity could result in biased coefficients. With respect to the econometric modelling of subcontracting behaviour, we use a Heckman (1979) approach, which recognises that firms that contract out are not a random sub-set of all firms; rather, modelling outsourcing intensity needs to take account that those firms with non-zero outsourcing intensity levels have certain characteristics that are linked to how much is subcontracted. To correct for selection bias, we thus used the Heckman Full Information Maximum Likelihood (FIML) estimation procedure from STATA. This procedure yields unbiased estimates of coefficients.

The decision equation includes two variables that are not included in the objective equation, as an econometric device for identifying the selection equation. These variables are two dummies related with the technological level: process innovation and R&D activities. These variables are insignificant when we regress intensity outsourcing separately. Instead of them, we introduce R&D expenditure over sales after proving its lack of significance in the selection equation.

Furthermore, we include previous outsourcing decision in the selection equation and preceding outsourcing intensity in the objective equation as a proxy for the existence of sunk costs. The introduction of industry dummies allows us the possibility of controlling for differences across industries. Also, we introduce year dummies to capture macroeconomic and temporal changes.

Like mentioned above, we need to account this self-selection element to avoid selection bias when modelling subcontracting intensity. In a first step, the company decides to outsourcing or not and, once outsourcing has been chosen, the firm establishes the volume of production to be subcontracted. Consequently, inclusion in the second sample when we model intensity is not random. If the variables that determine whether a firm does outsourcing are unrelated to those that determine the amount of production contracted out, then the two stage approach to selecting cases does not likely introduce selection bias. However, the possibility of sample selection bias arises whenever a sub-sample is examined and the unobservable factors determining inclusion in the sub-sample are correlated with the unobservable variables influencing the variable of primary interest (Vella, 1998).

Maximum likelihood estimators have to be employed to obtain efficient and consistent coefficients and both equations are estimated simultaneously using the Full Information Maximum Likelihood (FIML) estimator. We use the Heckman sample selectivity approach based on a FIML simultaneous estimation of the model involving both who contracts out and how much is contract out. This means that the outsourcing decision and intensity are not separated into two stages. But since heteroscedasticity is a potential problem when the Heckman technique is applied to pooled data (Beck and Katz, 1995), we prefer to control this selection bias using the Huber/White standard error estimator[13]. The results from the Heckman selection model with robust estimators are comparable to which obtained from two-step procedure with separate probit and regression analyses[14].

5. ECONOMETRIC RESULTS.

Table 6 reports the econometric results of our estimations. We begin by discussing the results of the selection bias in the outsourcing performance model. The statistically significant Mills ratio coefficient confirms the existence of selection bias in the specified models. In all the

[13] By specifying robust, one may forgot model-based variance estimates in favour of the more model-agnostic "robust" variances. Robust variances give accurate assessments of the sample-to-sample variability of the parameter estimates even when the model is misspecified. The robust variance comes under various names and within Stata is known as the Huber/White/sandwich estimate of variance. The names Huber and White refer to the seminal references for this estimator (Huber, 1967; White, 1980).

[14] The model was also specified using a two-stage Heckman technique to correct for sampling effects. In this procedure, the selection equation (1) is firstly estimated through maximum likelihood estimation and the predicted probabilities from this estimation are saved and transformed into the reciprocal of the Mills ratio (IMR), known as the non-selection hazard rate or lambda. Secondly, the hazard rate is included as independent variable in the objective equation (2) summarizing the selectivity effect.

cases, we reject the null hypothesis at the 1 percent level of confidence that there is no sample selection problem. That is, the positive coefficient of the Mills ratio implies that a positive correlation exists between the decision to contract out -and therefore to engage in the outsourcing strategy- and the outsourcing intensity. All the regressions include industry dummies in order to control for industry-specific characteristics but we omit them because of space considerations.

The first two columns of table 6 (Specification 1) correspond to the regression estimates of our model using all the variables, except other-side market thickness due its high correlation with same-side market thickness. As expected, the coefficient for lagged outsourcing intensity is positive and highly significant. The probability of engaged in outsourcing this period also depends on previous subcontracting behaviour. Both results are related to sunk costs that firms have to face when they decide to subcontract production. So, outsourcing behaviour shows a high persistence.

Furthermore, we find good evidence that only a few variables that determine whether a firm does outsourcing are similar to those that determine the amount of subcontracted production. These variables are wages, product innovation and same-side market thickness. For the first two variables, the sign obtained is in line with previous expectations. Firms with higher wages and product-innovative firms are more likely to engage in subcontracting and also to show higher outsourcing intensity. As explained above, outsourcing may reduce the total wage bill when production in contracted out to lower wages providers. This result corroborates that cost-cutting is a key reason for outsourcing.

Contrary to expected, same-side market thickness influences positively on outsourcing decision and level. That is, the more the proportion of main contractors in an industry, the higher the likelihood of outsourcing and the subcontracting intensity. A possible explanation is that this variable also controls for strategic motives for outsourcing. Benefits of outsourcing such as improvements in efficiency and competitiveness will induce an increase in competitive pressure that, following Leahy and Montagna (2007), leads to a greater demand for outsourcing. Furthermore, firms can begin to outsource to achieve benefits from outsourcing obtained by competitors. Therefore, outsourcing would be a response to competitor actions (McIvor, 2005). From this perspective, an increase in the amount of outsourcing firms makes outsourcing more

attractive (and necessary) from non-outsourcing firms. However, the variable used to measure an increasing competition environment, market competition variable, is not significant.

The variable customers' concentration shows opposite signs in the two equations. A higher concentration of customers reduces the likelihood of using outsourcing but seems to favour the intensity of outsourcing.

The remaining explanatory variables included in both equations exhibit significant coefficients for only one equation. Only one variable exclusively affects intensity outsourcing, foreign ownership, which shows a negative sign. Firms with foreign participation tend to outsource less once they are engaged in outsourcing. Consistent with prior Spanish evidence, foreign ownership does not favour the decision about engaging in outsourcing since the coefficient in selection equation is not significant.

By other hand, variables such as market changes, providers' concentration and export influence outsourcing decision. The significance of these effects, however, appears to be unimportant to set the amount of subcontracted production. Exporter firms and those firms faced to changes in market's conditions use outsourcing more frequently. The positive and significant effect of firm export status on outsourcing strategy allows us to think that a fraction of outsourcing goes beyond national borders adopting an international dimension. On the contrary side, the coefficient on provider concentration is negative. Therefore, the probability of a good match and, consequently, the probability of outsourcing increases as the number of providers grows.

With regard to technological variables, we find that process innovation and R&D activities affect positively the likelihood of being engaged in outsourcing. But, once a firm has decided to outsource, an increase in R&D intensity tends to decrease the amount of subcontracted production. At last, firm-size, industry-size and firm-age seem to have no influence in outsourcing strategy.

To check robustness of these results, we estimate additional specifications. First of all, in the Specification 2, the variable export status is replaced by the variable export intensity (firm's exports over sales) in the objective equation. The decision of outsource returns to be positively related to exporter status but the export intensity is not significant to explain the outsourcing

intensity. The sign and significance of the rest of the variables are similar to Specification 1, pointing to the consistency of estimates.

Secondly, taking into account the insignificance of firm size variable measured by the log of number of employees, two dummy variables are used to control for the size of the firm (Specification 3). 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. Exclusively the last one shows a significant coefficient but only in objective equation. Besides that, the sign is negative. That is, to be a big firm seems to influence negatively on outsourcing intensity but it does not determine the subcontracting decision. So, smaller firms show a higher level of subcontracting trying to exploit scale and scope economies of specialized providers. Other variables remain unchanged.

Due to the way of defining the variables size industry and the share of contractors, there is a likely relationship between them. For that, the variable size industry is removed from initial model and same-side market thickness is measured by the log of the number of main contractors in each industry (Specification 4). The results are basically the same as those in Specification 1, indicating that the results are robust. The more firms that outsource, the greater is the probability to outsource. The positive and significant coefficient supports the strategic use of outsourcing. With this variable, the effect of same-side market thickness on outsourcing intensity is not significant. Additionally, in Specification 5 we introduce the ratio of specialized providers to total firms in a sector (other-side market thickness). According to prior expectations, this variable is positive and significant in both equations. Matching process is easier, and therefore outsourcing is more extensive and intensive, the thicker is the other side of the market.

Finally, we run regressions using alternative measures to the size industry taking into account its lack of significance. Specifically, we employ the number of employees in each industry (Size-industry2) in the Specification 6. Industry size variable turns out statistically significant in both equations. As the industry-size increases, so do the likelihood and the intensity of outsourcing. The positive and significant sign of industry-size seems to confirm the existence of increasing scale returns in matching process and so large industries favour outsourcing strategy. And once more, the remainder regressors do not change.

Table 6: The Determinants of Outsourcing Intensity- A Heckman Model.

	Specification 1		Specification 2		Specification 3	
	Objective equation.	Selection equation	Objective equation.	Selection equation	Objective equation.	Selection equation
$DOUT_{t-1}$		1.836***		1.839***		1.836***
		(0.026)		(0.026)		(0.026)
$OUTCO_{it-1}$	0.682***		0.682***		0.682***	
	(0.0149)		(0.015)		(0.015)	
Same-side Market Thickness (1)	11.463**	2.714***	11.638**	2.714***	11.418**	2.717***
	(-5.532)	(0.331)	(-5.538)	(0.331)	(5.533)	(0.331)
Industry-Size (1)	0.200	0.011	0.232	0.009	0.295	0.006
	(-2.240)	(0.126)	-2.242	(0.126)	(2.239)	(0.126)
Export	0.352	0.175***		0.171***	0.380	0.168***
	(0.556)	(0.031)		(0.030)	(0.555)	(0.031)
Export intensity			0.009			
			(0.009)			
$Wage_{it-1}$	1.882***	0.142***	1.810**	0.142***	1.861***	0.134***
	(0.729)	(0.038)	(0.724)	(0.038)	(0.713)	(0.038)
Firm-Size	-0.301	-0.011	-0.313	-0.011		
	(0.205)	(0.011)	(0.204)	(0.011)		
Dfirm-Size1					-0.552	-0.003
					(0.579)	(0.032)
Dfirm-Size2					-1.172*	0.002
					(0.674)	(0.042)
Market-changes	0.074	0.071***	0.074	0.073***	0.063	0.069***
	(0.429)	(0.026)	(0.429)	(0.026)	(0.429)	(0.026)
Process-innovation		0.079***		0.080***		0.076***
		(0.026)		(0.026)		(0.026)
Product-innovation	0.911**	0.172***	0.885**	0.174***	0.881**	0.172***
	(0.441)	(0.029)	(0.442)	(0.029)	(0.440)	(0.029)
R&D		0.058*		0.057*		0.049
		(0.030)		(0.030)		(0.030)
R& D intensity	-0.002***		-0.002***		-0.002***	
	(0.001)		(0.001)		(0.001)	
Market-competition	-0.722	0.045	-0.700	0.043	-0.717	0.044
	(0.592)	(0.031)	(0.591)	(0.031)	(0.592)	(0.031)
Firm Age	0.116	-0.001	0.134	0.000	0.114	-0.003
	(0.238)	(0.014)	(0.238)	(0.014)	(0.239)	(0.014)
Foreign-own	-1.321**	-0.034	-1.318**	-0.032	-1.339**	-0.043
	(0.532)	(0.033)	(0.534)	(0.033)	(0.531)	(0.032)
Customers' Concentration	0.041***	-0.001*	0.040***	-0.001*	0.041***	-0.001*
	(0.009)	(0.001)	(0.009)	(0.001)	(0.008)	(0.001)
Providers' Concentration	0.011	-0.003***	0.011	-0.003***	0.011	-0.003***
	(0.010)	(0.001)	(0.010)	(0.001)	(0.010)	(0.001)
Constant	-20.637*	-3.075***	-19.939*	-3.193***	-21.600**	-3.028***
	-10.758	-5.287	(10.754)	(0.594)	(10.775)	(0.582)
Selection test –IMR (athrho)	0.508***		0.506***		0.508***	
	(0.031)		(0.031)		(0.031)	
Observations	16451	16451	16439	16439	16451	16451
Censored obs.	9239		9239		9231	
Uncensored obs.	7212		7200		7212	
Wald chi2	4173.74		4180.39		4221.89	
Prob>chi2	0.00		0.00		0.00	
Wald test of independent equs. (rho=0)	253.85		256.89		253.73	
Prob>chi2	0.00		0.00		0.00	

Table 6 (cont.): The Determinants of Outsourcing Intensity- A Heckman Model.

	Specification 4		Specification 5		Specification 6	
	Objective equation.	Selection equation	Objective equation.	Selection equation	Objective equation.	Selection equation
$DOUT_{t-1}$		1.838***		1.839***		1.834***
		(0.026)		(0.026)		(0.026)
$OUTCO_{it-1}$	0.682***		0.683***		0.683***	
	(0.149)		(0.149)		(0.149)	
Same-side Market Thickness (2)	2.205	0.561***	2.923	0.593***		
	(1.744)	(0.092)	(1.782)	(0.094)		
Other-side Market Thickness			13.339***	0.595**		
			(4.661)	(0.264)		
Industry-Size (2)					3.471***	0.223***
					(0.730)	(0.048)
Export	0.354	0.178***	0.333	0.177***	0.365	0.177***
	(0.556)	(0.031)	(0.556)	(0.031)	(0.556)	(0.031)
$Wage_{it-1}$	1.896***	0.147***	1.886***	0.147***	1.896***	0.147***
	(0.728)	(0.038)	(0.727)	(0.038)	(0.728)	(0.038)
Firm-Size	-0.313	-0.014	-0.313	-0.014	-0.304	-0.012
	(0.204)	(0.011)	(0.204)	(0.011)	(0.204)	(0.011)
Market-changes	0.072	0.071***	0.067	0.070***	0.072	0.070***
	(0.429)	(0.026)	(0.429)	(0.026)	(0.429)	(0.026)
Process-innovation		0.077***		0.077***		0.080***
		(0.026)		(0.026)		(0.026)
Product-innovation	0.920**	0.174***	0.915**	0.173***	0.921**	0.170***
	(0.441)	(0.029)	(0.441)	(0.029)	(0.441)	(0.029)
R&D		0.061**		0.061**		0.062**
		(0.030)		(0.030)		(0.030)
R& D intensity	-0.002***		-0.002***		-0.002***	
	(0.001)		(0.001)		(0.001)	
Market-competition	-0.715	0.046	-0.725	0.045	-0.716	0.045
	(0.592)	(0.031)	(0.591)	(0.031)	(0.592)	(0.031)
Firm Age	0.121	-0.000	0.130	-0.000	0.113	-0.002
	(0.238)	(0.014)	(0.238)	(0.014)	(0.238)	(0.014)
Foreign-own	-1.323**	-0.034	-1.322**	-0.035	-1.332**	-0.036
	(0.532)	(0.033)	(0.532)	(0.033)	(0.532)	(0.033)
Customers' Concentration	0.041***	-0.001*	0.041***	-0.001*	0.041***	-0.001*
	(0.008)	(0.001)	(0.008)	(0.001)	(0.008)	(0.001)
Providers' Concentration	0.011	-0.003***	0.012	-0.003***	0.011	-0.003***
	(0.010)	(0.001)	(0.010)	(0.001)	(0.010)	(0.001)
Constant	-22.835***	-3.795***	-29.571***	-4.087***	-58.775***	-5.184***
	(6.870)	(0.365)	(7.394)	(0.390)	(10.724)	(0.684)
Selection test –IMR (athrho)	0.506***		0.504***		0.510***	
	(0.031)		(0.031)		(0.031)	
Observations	16451	16451	16451	16451	16451	16451
Censored obs.	9239		9239		9239	
Uncensored obs.	7212		7212		7212	
Wald chi2	4170.34		4215.72		4173.93	
Prob>chi2	0.00		0.00		0.00	
Wald test of independent equs. (rho=0)	253.07		250.12		254.33	
Prob>chi2	0.00		0.00		0.00	

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

6. CONCLUSIONS.

In this paper we have used firm-level manufacturing data from 1991 to 2002 to estimate a model of the determinants of outsourcing intensity taking into account that before the firms decide contract out or not. In particular, we are interested on knowing if firms decide to contract out and the volume of subcontracting because of similar reasons. For doing that, the Heckman procedure is designed to eliminate the effect of selection bias from the estimated results. In fact, we determined that the coefficient on the Inverse Mills term was statistically significant, implying the existence of selection bias in the outsourcing performance. As a result, we have employed the estimates from the Heckman FIML procedure rather than the ordinary least squares results in our analysis. If decisions on subcontracting are correlated with the error terms in the intensity equations, the OLS estimates of the model parameters would be biased and inconsistent.

Our results show that some variables influencing the outsourcing intensity are different from those that affect decision of outsourcing. Foreign ownership and firm size affect the outsourcing intensity but the decision of subcontracting is independent of those variables. The sign of both variables are negative. Large firms and firms with foreign participation show lower outsourcing intensity. By other hand, variables such as market changes, providers' concentration and export merely influence outsourcing decision. In the case of providers' concentration the impact on outsourcing behaviour is negative but positive for the other two variables.

At last, wages, product innovation, size industry and variables related to thickness of the market (the amount of main contractors and specialized providers) positively influence both outsourcing decision and outsourcing intensity. Furthermore, outsourcing behaviour exhibits a high degree of persistence. This outcome confirms the importance of sunk costs in outsourcing strategy.

To check robustness, different specifications of the model have been estimated and the results have been very similar. The robustness of the results favours the validity of theoretical arguments about factors that influence outsourcing strategy.

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