ORGANIZATIONAL INNOVATION AND PRODUCTIVITY GROWTH: ASSESSING THE IMPACT OF OUTSOURCING ON FIRM PERFORMANCE

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Organizational innovation and productivity growth: Assessing the impact of outsourcing on firm performance*

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Abstract

It is widely accepted that innovation is a primary source of productivity growth. This paper is aimed at analyzing the relationship between organizational innovation and productivity. I focus on the role of one of the most relevant organizational methods, outsourcing. Specifically, this paper deals with outsourcing at the firm level and focuses on the role of contracting out of manufacturing activities. To address it, I develop and estimate a simple theoretical framework justifying the addition of outsourcing measures to the specification of a "traditional" production function. Using an unbalanced panel of Spanish manufacturing firms, I find that for manufacturing as a whole, both the outsourcing decision and its intensity have a positive effect on productivity. When analyzing industry level results, I find that outsourcing intensity has a positive effect on productivity, mainly for firms belonging to light industries, while the decision of starting (stopping) outsourcing has the expected positive (negative) effect on productivity.

Key words: Organizational innovation, outsourcing, productivity growth
JEL Classification: D24, D21, L60

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1. Introduction

It is widely accepted that innovation is a primary source of productivity growth. Literature on this topic has focused on the impact of investment on knowledge and the role of technological innovations. Since Griliches (1979), many empirical studies have focused on the link between R&D and productivity[1] and on the role of technological process and product innovations as productivity shifters[2].

However, as it is pointed out in the Oslo Manual (OECD, 2005): "In order to identify the full range of changes that firms undertake to improve performance and their success in improving economic outcomes, a framework broader than technological product and process innovation is needed. Including marketing and organizational innovations gives a more complete framework that is better able to capture the changes that affect firm performance and contribute to the accumulation of knowledge".

Organizational innovations can have an important effect on productivity on their own. In this sense, organizational innovations can increase the quality and efficiency of work and improve the information sharing and the ability of the firm to use new technologies, as such increasing the productivity of investment in knowledge. Years ago, Feenstra (1998) argued that trade in intermediate inputs has an impact on employment and wages that is "observationally equivalent" to the changes induced by technological innovation.

Broadly speaking, an organizational innovation is defined as the adoption of a new idea or behavior by an organization (see Daft, 1978). More precisely, and following the Oslo Manual (OECD, 2005) "organizational innovations refer to the implementation of new organisational methods. These can be changes in business practices, in workplace organisation or in the firm's external relations". Among the most relevant organizational methods in firms' external relations is outsourcing.

Outsourcing is a make or buy decision and implies the modification of the boundaries of the firm. It must be seen as part of the organizational innovation process, carried out in the search for increasing flexibility and efficiency.

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[1] See Griliches (1995) for a survey.

[2] Crépon et al. (1998) propose a structural model that describes the link between R&D expenditure, innovation output and productivity. This model, widely used, has been recently applied by Griffith et al. (2006) using internationally comparable firm-level data from four major European countries, France, Germany, Spain and the UK.

Since Williamson (1985) and Grossman and Hart (1986), a body of literature has focused on the role of transaction costs, asset specificity, and incomplete contracts in the make or buy decision. Most of this literature has treated the industry environment as given and has focused on the relation between a single producer and a potential supplier (see, among others, Kamien, Li and Samet, 1989; Lewis and Sappington, 1991; and Spiegel, 1993). Recently, Grossman and Helpman (2002) developed a model in which integration and outsourcing are treated as equilibrium phenomena (taking into account the interdependence among the firms' choices). These authors focus on the trade-off between the costs of running a larger and less specialized firm and the costs of search frictions and imperfect contracting. Subsequently, Grossman and Helpman (2003) develop a model in which firms in an industry choose their organization structures and the location of their suppliers, and Grossman and Helpman (2005) study the determinants of the location of subcontracted activity in a general equilibrium model of outsourcing and trade.

There is no standardized definition of the term outsourcing. A general definition of outsourcing refers to those material inputs or services necessary to produce a final output obtained outside the firm. One strand of literature focuses on the outsourcing of materials. In this sense, McMillan (1995) enumerates the main changes introduced by U.S. firms in their supplier relationships. Among the most relevant changes is the increment in the contracting out of manufacturing activities or production subcontracting. Several papers analyze the evolution of material outsourcing. See, for example, Feenstra and Hanson (1996), Campa and Goldberg (1997), Hummels et al. (2001), Yeats (2001), Hanson et al. (2004), and Borga and Zeile (2004). In another strand of literature, several papers address the substantial growth in service outsourcing. See, among others, Abraham and Taylor (1996), Goodman and Steadman (2002), Abramovsky et al. (2004) and Amiti and Wei (2005).

In addition, outsourcing can be local (an external supplier in the domestic market) or international (a leading example is the outsourcing by firms in developed countries to firms located in low-wage countries).

What is more, from an empirical perspective outsourcing is too broad a concept. In this sense, outsourcing has been measured in many different ways and using different perspectives. Most of the measures collect information at the industry level and from input-output tables, rather than firm-level data. Moreover, many of them are rough measures.

Among the most used measures of outsourcing is Feenstra and Hanson's (1996) approach[3]. These authors define outsourcing share for each industry as the share of imported intermediate inputs (services) over total non-energy inputs. Other measures of outsourcing used are, among others, imported intermediate inputs within each industry obtained from input-output tables, expenditure on a number of specific services purchased on the market, fraction of the work in business services contracted out, material inputs relative to internal labor costs and external contract work.

The aim of this paper is to analyze the relationship between organizational innovation and productivity. In doing this, I focus on the role of one of the most relevant organizational methods: outsourcing. Specifically, this paper deals with outsourcing at the firm level and focuses on the role of contracting out of manufacturing activities (production subcontracting). I adopt an econometric approach, i.e., I focus on the econometric estimation of production functions. In this sense, firstly, I introduce a simple framework that specifies a production function considering the possibility of production subcontracting. The framework developed leads to the estimation of a production function depending on traditional inputs (labor, capital and materials) and an index of production subcontracting. Specifically, both the effect of first-time outsourcing on productivity and the effect of the intensity of production subcontracting can be analyzed.

Estimation is carried out using an unbalanced panel survey of Spanish manufacturing firms. The main equation is estimated using a sample of 1,728 firms, observed during the period 1990-1999. This sample is representative of the manufacturing population of firms.

The contribution of this paper to the empirical literature on outsourcing and productivity is three-fold. First, I analyze both the effect of the decision to outsource and the effect of outsourcing intensity. In doing this, I develop a simple theoretical framework justifying the addition of outsourcing measures to the estimation of a "traditional" production function. Second, my analysis is performed at the firm level and uses panel data. Panel data allows us to account for unobserved heterogeneity and analyze temporal effects. Third, I use a "direct" measure for outsourcing of manufacturing activities. In this sense, I have information on firms' purchases of elaborated products and customized components from external suppliers. Outsourcing

[3] For example, see Feenstra and Hanson (1999), Amiti and Wei (2005, 2006), and Canals (2006a, 2006b).

of intermediate inputs takes on greater importance when the products being exchanged are not raw materials, but have some degree of elaboration. In this case, it is plausible that outsourcing of manufacturing activities implies the externalization of stages of the production process (potentially increasing flexibility and efficiency). But this practice will also involve the costs of finding a suitable supplier and imperfect contracting.

The rest of the paper is organized as follows. Section 2 deals with the related literature. Section 3 introduces the theoretical framework. Section 4 details the econometric equation to be estimated. Section 5 introduces the data set and the variables, and describes the main facts about production subcontracting for Spanish manufacturing firms during the 1990s. Section 6 presents the empirical results and Section 7 concludes. Appendix A gives details on the variables employed. Appendix B reports the details on the industry breakdown used to define industry dummies.

2. Related literature

This section focuses on two strands of empirical literature: (i) Literature studying the effect of (the broad concept of) organizational innovation on productivity, and (ii) Literature focused on productivity effects of outsourcing.

Organizational innovation and productivity growth

There are an increasing number of studies that suggest a significant and positive effect of various measures of organizational innovation on productivity. A strand of literature focuses on the effect of the adoption of alternative human resource management practices, such as flexible job definitions, training, work teams, and incentive pay[4]. Most of these studies find that the adoption of a coherent system of human resource management practices results in substantially higher levels of productivity than more traditional human resource management practices. Moreover, the existence of synergies among workplace practices is also found.

Black and Lynch (2001, 2004) also examine the impact of workplace practices on the productivity of firms. These authors define organizational innovation as including human resource management practices such as organizing workers in teams, job

[4] See Ichniowski and Shaw (2003) for a recent review of this literature.

rotation, training for non-managerial workers, and re-engineering. They find for the manufacturing sector that implementing these organizational innovations in a unionized setting resulted in higher productivity than doing the same thing in a non-unionized setting. They also find that what is more important for productivity is the diffusion of a practice inside an organization rather than the simple adoption of the practice.

Most interesting, Black and Lynch (2004) use the estimates of the impact of organizational innovation on productivity in a growth accounting framework to see how much of the growth in output from 1993-1996 in US manufacturing might be accounted for by organizational practices. It appears that workplace practices and re-engineering efforts accounted for as much as 30 percent of output growth over this period of time.

Using firm level data from the U.S., Bresnahan et al. (2002) find that investments in certain specific types of work organization[5] are associated with high measured productivity. Moreover, these authors find that information technology, complementary workplace reorganization and human capital are positively correlated.

Gera and Gu (2004), using micro data from Canada, find that three organizational changes (the restructuring of production processes, human resource management practices and product/service quality-related practices) are positively related to productivity performance.

Finally, a large body of literature focuses on the "indirect" effect of organizational changes on firm performance through investment in information technology. In this sense, Brynjolfsson and Hitt (2000) review the evidence on how organizational innovations (such as new business processes, new skills or new organizational structures) are major drivers of the contribution of information technology to productivity.

Outsourcing and productivity growth

Although it has not received much attention, outsourcing and its productivity effect is a growing research topic. Heshmati (2003) and Olsen (2006) present detailed surveys of recent contributions to the relationship between outsourcing and productivity growth in manufacturing and services.

[5] Variables measuring organization are related to team-based work organization (for example, use of self-managing teams, use of team-building activities) and individual decision authority (who decides the pace of work and who decides the method of work).

Therefore, at this point, and given the existence of these surveys, I just stress the main issues and findings in this literature. First, the empirical literature has traditionally focused on productivity effects at the industry and country levels (see, among others, Baumol (1967), Siegel and Griliches (1992), Feenstra and Hanson (1996), Fixler and Siegel (1999), Ten Raa and Wolff (2001), Amiti and Wei (2006)). Evidence on the relationship between outsourcing and productivity growth is not conclusive. For example, Siegel and Griliches (1992), in assessing whether outsourcing leads to an overstatement of manufacturing productivity growth, find a weak correlation in the use of selected purchased services during the 1980s. Meanwhile, Ten Raa and Wolff (2001) find a positive association between the rate of outsourcing and productivity growth in the goods sector. And Amiti and Wei (2006) find that both service outsourcing and material outsourcing have a positive and significant effect on productivity in the U.S. and that the effect of service outsourcing is greater in magnitude.

Second, some of the earliest papers estimating the relationship between outsourcing and productivity use firm-level data. Using a panel data of German manufacturing firms, Görzig and Stephan (2002) estimate the effect of three measures of outsourcing on firm performance (measured by both the returns per employee and the returns on sales). The three measures of outsourcing are: (i) material inputs relative to internal labor costs, (ii) external contract work relative to internal labor costs, and (iii) other costs not related to production relative to internal labor costs. These authors find a positive and significant effect of all three measures of outsourcing on returns per employee, and a negative effect on returns on sales.

Another example of firm-level evidence is Girma and Görg (2004). These authors use manufacturing establishment level data for the U.K. and define outsourcing as the cost of industrial services[6] received by an establishment. They find that an establishment's outsourcing intensity is positively related to its labor productivity and total factor productivity growth.

Thirdly, existing empirical literature on outsourcing deals in good part with other topics. Many papers focus on labor market issues (see, among others, Feenstra and Hanson (1995, 1996, 1999), Estevao and Lach (1999), Anderton and Brenton (1999), Falk and Koebel (2000)), while another strand of literature analyzes the determinants of

[6] These industrial services includes activities such as processing of inputs which are then sent back to the establishment for final assembly or sales, maintenance of production machinery, and engineering or drafting services.

outsourcing. For example, Abraham and Taylor (1996) report empirical findings of employers' motives for contracting out business services in U.S. industry. These authors find empirical evidence supporting the influence of wage savings, economies of scale and smoothening production cycles on the decision to outsource.

3. Theoretical framework

This section is aimed at introducing a simple framework to be used when specifying a production function considering the possibility of production subcontracting. As I said before, I start from the econometric estimation of a production function, and I need some theoretical background to justify the changes in the "traditional" production function due to the introduction of variables measuring outsourcing.

For simplicity, I assume a Cobb-Douglas production function with constant returns to scale:

$$Y = AK^{\delta} L^{\alpha} I^{1-\alpha-\delta} \qquad (1)$$

A is an index of Hicks-neutral technical progress. *K* represents the capital stock and *L* the labour input. Given technology, it is necessary to use an input *I*. This input can be produced within the firm (I_f) or can be purchased (I_s).

Input *I* can also be obtained combining in-house production and outside sources. To control for substitution between I_f and I_s, I express the procurement of *I* as follows:

$$I = I_s^{\lambda} I_f^{1-\lambda} \qquad (2)$$

Parameter λ determines the substitutability between in-house production and production subcontracting of the intermediate input *I*.

Finally, production within the firm of input *I* can be written as:

$$I_f = L^{\gamma} M^{1-\gamma} \qquad (3)$$

where L represents labour input and M row materials plus external services (intermediate consumptions excluding subcontracted purchases). For simplicity, the capital input (K) is not included in the internal production of I.

Given equation (2) I can write that:

$$I = I_f \left(\frac{sr}{1 - sr} \right)^{\lambda} \tag{4}$$

where $sr = \dfrac{I_s}{I_f + I_s}$. The variable sr represents the proportion of intermediate input I that is subcontracted. Therefore, ratio $\dfrac{sr}{1 - sr}$ is an index of production subcontracting. The higher sr is, the higher $\dfrac{sr}{1 - sr}$ is, and hence the higher the intensity of production subcontracting is. This index is one measure of the "relative" importance of production subcontracting ("relative" in the sense that it is not a direct measure of subcontracted purchases. It is a measure of the importance of subcontracted purchases with respect to total intermediate consumptions).

Given (2) and (4) I can write

$$I = \begin{cases} I_f, \text{ if there is no outsourcing} \\ I_f \left(\dfrac{sr}{1 - sr} \right)^{\lambda}, \text{ if there is outsourcing} \end{cases} \tag{5}$$

Substituting (3) and (5) in (1), I can write:

$$Y = \begin{cases} AK^{\delta} L^{\phi_1} M^{\phi_2}, \text{ if there is no outsourcing} \\ AK^{\delta} L^{\phi_1} M^{\phi_2} \left(\dfrac{sr}{1 - sr} \right)^{\phi_3}, \text{ if there is outsourcing} \end{cases} \tag{6}$$

where $\phi_1 = \alpha + \gamma(1 - \alpha - \delta)$, $\phi_2 = (1 - \gamma)(1 - \alpha - \delta)$ *and* $\phi_3 = \lambda(1 - \alpha - \delta)$. Show that $\delta + \phi_1 + \phi_2 + \phi_3 = 1 + \phi_3$. And hence $\delta + \phi_1 + \phi_2 = 1$. This constraint implies constant returns to scale in the conventional inputs (K, L, M).

Note that the term $\left(\frac{sr}{1-sr}\right)^{\phi_3}$ is the only difference between the specification of a production function with and without production subcontracting.

4. Econometric model

Taking logarithms in expression (6), I can write:

$$\log Y = \begin{cases} \log A + \delta \log K + \phi_1 \log L + \phi_2 \log M, \; if \; there \; is \; no \; outsourcing \\ \log A + \delta \log K + \phi_1 \log L + \phi_2 \log M + \phi_3 \log\left(\frac{sr}{1-sr}\right), \; if \; there \; is \; outsourcing \end{cases} \quad (7)$$

To estimate a production function for firms with and without production subcontracting simultaneously, I write the production function adding a dummy variable indicating non-outsourcing. Now, I can write:

$$\log Y = \log A + \delta \log K + \phi_1 \log L + \phi_2 \log M + \phi_3 \log SUB + \beta subdum \quad (8)$$

where:

$$\log SUB = \begin{cases} 0, \; if \; there \; is \; no \; outsourcing \\ \log\left(\frac{sr}{1-sr}\right), \; if \; there \; is \; outsourcing \end{cases} \quad (9)$$

$$subdum = \begin{cases} 1, \; if \; there \; is \; no \; outsourcing \\ 0, \; if \; there \; is \; outsourcing \end{cases} \quad (10)$$

I carry out all estimates in differences. Therefore, variables are in log differences. The specification in log differences or rates of growth implies that any level time-invariant individual or heterogeneous effects are differenced out. Taking differences in expression (8), two caveats should be noted:

1. log*SUB* is not a continuous variable. And hence, the rate of growth (i.e., log differences) corresponding to a change in the outsourcing decision is not defined.

2. Differences of variable *subdum* (*ddums*) takes the values:

$$ddums = \begin{cases} 1, if\ \ the\ \ firm\ stops\ outsourcing\ (with\ respect\ to\ the\ \ previous\ \ period) \\ 0,\ period\ \ without\ change\ in\ the\ outsourcing\ \ decision \\ -1, if\ \ the\ \ firm\ starts\ outsourcing\ (with\ respect\ to\ the\ \ previous\ \ period) \end{cases} \quad (11)$$

Solving these problems, firstly, a rate of growth for $\frac{sr}{1-sr}$ equal to zero is assigned to those observations corresponding to periods with changes in the outsourcing decision.

$$sub = \begin{cases} \log\left(\frac{sr}{1-sr}\right)_t - \log\left(\frac{sr}{1-sr}\right)_{t-1},\ \ if\ \ there\ \ is\ \ outsourcing\ \ at\ t\ and\ at\ t-1 \\ 0,\ otherwise \end{cases} \quad (12)$$

Secondly, to identify changes in the outsourcing decision, two dummy variables (*substop, substart*) are considered:

$$substop = \begin{cases} 1, if\ \ ddums = 1 \\ 0, otherwise \end{cases} \quad (13)$$

$$substart = \begin{cases} 1, if\ \ ddums = -1 \\ 0, otherwise \end{cases} \quad (14)$$

Using lowercase letters to represent log differences, the relevant equation to be estimated may be expressed as follows:

$$y = a + \delta k + \phi_1 l + \phi_2 m + \phi_3 sub + \beta_1 substop + \beta_2 substart + \varphi cu + D\rho + \tilde{v} \quad (15)$$

where *y, k, l* and *m* are, respectively, the rates of growth or log differences of output, capital, labor and intermediate consumptions (excluding subcontracted purchases). The variable *sub* is the rate of growth of the index of production subcontracting (see expression (12)).

Equations in levels are assumed to present an error term (u) that can be decomposed as $u_{it} = \mu_i + v_{it}$, where μ_i is the time-invariant term that accounts for the heterogeneity across firms. As I said before, the specification in first differences implies that the term μ_i is eliminated from the residual. The term v is assumed to be an uncorrelated zero mean error term, and $\tilde{v} = v_{it} - v_{it-1}$.

The estimation of a production function makes it important to control for input utilization, and hence the inclusion of the capacity utilization variable[7] (*cu*). *D* represents the set of dummy variables included (industry dummies, year dummies, dummies for entering and exiting firms, and dummies for mergers and scissions). Theoretical constraint $\delta + \phi_1 + \phi_2 = 1$ can either be tested or imposed on the estimation in order to gain efficiency.

To summarize, expression (15) is the relevant equation to be estimated. In addition to traditional "inputs", an index of outsourcing intensity and a couple of dummy variables representing changes in the outsourcing decision are taken into account. Since this paper is aimed at analyzing the relationship between outsourcing and productivity, I am interested in estimating parameters $\delta, \phi_1, \phi_2, \phi_3, \beta_1$ *and* β_2[8].

5. Data, variables and description

I present estimates based on an unbalanced sample of 1,728 Spanish manufacturing firms during the period 1990-1999. The data used correspond to the official survey "Encuesta sobre estrategias empresariales", ESEE, (Survey on Firm Strategies). ESEE is an unbalanced panel survey of Spanish manufacturing firms with 10 or more workers, starting in 1990 and sponsored by the Ministry of Industry. At the beginning of the survey, all firms with more than 200 workers were requested to participate, while a representative sample of 5% of the firms with fewer than 200 workers was randomly selected. The final sample employed depends on the data available and the number of consecutive time observations required. Table A1 shows the composition in terms of time observations of the unbalanced panel sample used. The sample employed to estimate equation (15) consists of all the firms that have been surveyed for at least three consecutive years after dropping all the time observations for which the data needed are not available.

ESEE provides detailed information on firms' output, capital, labor (measured through total hours of work) and intermediate consumptions. Moreover, the data provide information about the outsourcing of manufacturing activities (production subcontracting). Specifically, I have information indicating whether the firm

[7] This variable is defined as the yearly average rate of capacity utilization reported by the firm.

[8] The estimation of other parameters of the model (i.e., λ and γ) exceeds the purpose of this paper. In a companion paper, López (2007), I deal with this issue.

subcontracts production and information about subcontracted purchases (firms' purchases of elaborated products and customized components to external suppliers.). This information allows me to define the ratio between subcontracted purchases and (total) intermediate consumptions (which will be used as a proxy for the theoretical variable sr). Hence, the theoretical index of production subcontracting, $\frac{sr}{1-sr}$, can be constructed.

A unique feature of this data set is the availability of information on the changes in the prices set by the firm, and on the changes in the prices that the firm pays for its non-labor inputs. Detailed definitions of all employed variables can be found in Appendix A. Moreover, Table A2 gives some descriptive statistics of the key variables.

In what follows, I present the main facts regarding production subcontracting for Spanish manufacturing firms during the 1990s[9]. I analyze it along two dimensions: the percentage of firms that contract out manufacturing activities (Tables 1 and 2), and outsourcing intensity among performers (Tables 3 and 4).

Table 1 shows the percentage of firms contracting out manufacturing activities during the period 1990-99. Big firms are more likely to subcontract, and this gap does not decrease during the period. Moreover, it seems that there is a positive relationship between the decision of production subcontracting and the Spanish industrial cycle during the 1990s. The period analyzed coincides with a complete industrial cycle. In 1991, manufacturing experienced an important downturn. Recovery started in 1994 with only a minor halt in 1996 and in 1999. The percentage of firms contracting out manufacturing activities reflects a similar evolution (see Figure 1).

Regarding differences between industries[10], Table 2 shows that firms from Ind. and agric. machinery (industry 4), Office mach. and elec. goods (industry 5), Transport equipment (industry 6), and Other manufacturing products (industry 11) are highly active in outsourcing.

Four industries are in an intermediate position: Metals and metal products (industry 1), Chemical products (industry 3), Textile, leather and shoes (industry 8), and Paper and printing products (industry 10).

[9] See López (2002) for a more detailed description of production subcontracting and externalization of services by Spanish manufacturing firms during the 1990s.
[10] I consider 11 industries. Industry breakdown is defined in Appendix B.

Three industries -Non-metallic minerals (industry 2), Food, drink and tobacco (industry 7), and Timber and furniture (industry 9)- exhibit lower percentages.

To analyze the outsourcing intensity, I use the ratio between subcontracted purchases (a firm's purchases of elaborated products and customized components) and (total) intermediate consumptions (variable *sr*). I restrict my attention to those firms active in outsourcing. This ratio is 18.0% for firms with than 200 workers and 14.0% for firms with more than 200 workers (see Table 3). I find out that small firms are more intensive in production subcontracting than big ones. This result may be shown in the bidirectional relation between outsourcing and the firm's structure, specifically between outsourcing and firm size (measured by the number of workers). The higher the intensity in subcontracting is, the higher the substitution of intermediate consumptions for labor is.

Figure 2 shows the evolution of the ratio between subcontracted purchases and intermediate consumptions over time. In this case, there is not a straight relationship between the intensity of production subcontracting and the industrial cycle. Moreover, there appears to be differences between small-medium firms and big firms[11].

Table 4 shows intensity in production subcontracting by industry. There are differences between the share of firms active in outsourcing and outsourcing intensity. In this sense, the industries with the highest outsourcing intensity are: Ind. and agric. machinery (industry 4), Transport equipment (industry 6), Textile, leather and shoes (industry 8), Timber and furniture (industry 9) and Paper and printing products (industry 10). Industry 9, however, exhibits a low percentage of firms active in outsourcing.

Three industries are in an intermediate position: Metals and metal products (industry 1), Office mach. and elec. goods (industry 5) and Other manufacturing products (industry 11), and three industries -Non-metallic minerals (industry 2), Chemical products (industry 3), and Food, drink and tobacco (industry 7)- exhibit lower outsourcing intensities.

[11] See Delgado et al. (1999), and López (2002) for evidence on the relationship between outsourcing and the Spanish industrial cycle during the 1990s.

6. Empirical results

Equation (15) is a linear equation with predetermined and endogenous variables. GMM techniques[12] are applied for their estimation[13]. The instruments used in each estimate are detailed in the notes to the tables. Sargan tests of the overidentifying restrictions are reported for each estimate.

Equations in levels are supposed to present an uncorrelated zero mean disturbance, and hence, disturbances of the differenced equation are expected to show a significant negative first-order autocorrelation (i.e. $\widetilde{v}_{it} - \widetilde{v}_{it-1}$), but an absence of correlation of higher orders[14]. In this sense, each estimate includes m_1 and m_2 Arellano and Bond (1991) test statistics for first and second-order serial correlation[15].

Estimation of the production function is carried out taking capital as predetermined, and labor, non-subcontracted intermediate consumptions and subcontracted purchases as endogenous variables.

Equations include eighteen industry dummies and yearly time dummies. These industry and time dummies are included with their coefficients constrained to add up to zero (Suits method). I include a dummy indicating whether the firm was created during the period, and one dummy indicating whether the firm is going to exit during the period. Moreover, to control for discrete changes, dummies indicating merger/acquisition or scission are included.

Manufacturing level results

Table 5 presents the results for the estimation of equation (15) for manufacturing as a whole. Estimate a presents OLS results, while estimates b, c and d take into account the endogeneity of input choices and present GMM results. The preferred outcome is estimate d. Estimates b and c are used to check their robustness.

On the one hand, constant returns to scale in the conventional inputs -capital, labor and intermediate consumptions (excluding subcontracted purchases)- are accepted (see the Wald test for this restriction in estimate b). Estimates c and d impose this constraint.

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[12] See Arellano and Honoré (2002) for a recent review of this method.
[13] Results are obtained using DPD98 (see Arellano and Bond, 1998).
[14] See Arellano and Bond (1991, 1998) for further details.
[15] m_1 and m_2 test statistics are asymptotically distributed as a N(0,1) under the null hypothesis of no autocorrelation.

On the other hand, inclusion of capacity utilization does not change the coefficients of the other variables, but it is an important variable for explaining production shifts and it improves the result concerning second-order serial correlation (compare estimates c and d). The Sargan test allows me to accept the set of instruments employed.

Estimated elasticities for traditional inputs show plausible values. Low and insignificant capital coefficient in estimate b is consistent with traditional findings using GMM techniques[16].

As expected, the index of production subcontracting, $\frac{sr}{1-sr}$, appears to be significantly associated with productivity. All estimates show that intensity of outsourcing has a positive and significant effect on total factor productivity. In other words, keeping the "traditional" factors of production constant, increasing the share of production subcontracting (measured as firms' purchases of elaborated products and customized components over total intermediate consumptions) leads to higher output.

It is not only the intensity that has a positive effect on production, but also the subcontracting decision. The coefficient of the *substart* variable is positive and significant, saying that the decision to start production subcontracting has a positive effect on production. The *substop* variable goes the other way around. Moreover, these results are robust to the use of a different set of instruments (see Table A3).

Therefore, I find evidence supporting the importance of production subcontracting as a production shifter. This practice (viewed as an organizational innovation) increases flexibility and efficiency, having its final effect on firm-level productivity.

Results by industry

Production behavior and technology are very likely to vary across industries. Table 6 presents the results of estimating equation (15) using GMM techniques and under the assumption of constant returns to scale for each industry. The industry breakdown considered is defined in Appendix B. I exclude industry 11 because of a lack of observations (only 35 firms belong to this industry. See Table A1 for further details).

Before discussing the main industry level results, Table 7 reports specification tests to check the validity of the estimates by industry. First, constant returns to scale in the

[16] See Blundell and Bond (2000), and Griliches and Mairesse (1998) for a discussion about this problem. See García, Jaumandreu and Rodríguez (2002) for a similar result on capital coefficient using ESEE.

conventional inputs are accepted by a wide margin for industries 2, 4, 5, 6, 8 and 9. Constant returns to scale are accepted for industries 1, 3 and 7 with a little ground for concern.

Second, I test for overidentifying restrictions or validity of the moment conditions. The Sargan test very clearly indicates the validity of the moment conditions.

Industry level results indicate (see Table 6) that industry differences in the estimated factor elasticities are quite sizeable. Estimated elasticities of output with respect to labor go from 0.17 (industry 7. Food, drink and tobacco) to 0.66 (industry 8. Textile, leather and shoes), while materials elasticity estimates are spread over a narrower range, and go from 0.26 (industry 5. Office mach. and elec. goods) to 0.52 (industry 7. Food, drink and tobacco).

Regarding outsourcing variables, firstly, outsourcing intensity appears to be significantly associated with productivity for five industries (industry 1. Metals and metal products; industry 5. Office mach. and elec. goods; industry 7. Food, drink and tobacco; industry 9. Timber and furniture; and industry 10. Paper and printing products). Significant estimated coefficients of the sub variable are quite similar, and go from 0.08 to 0.14. Moreover, outsourcing intensity has a positive effect on productivity, mainly for firms belonging to light industries (industries 5, 7, 9 and 10).

This finding is not surprising since light industries are labor-intensive. For these industries, outsourcing intensity (substitution of intermediate consumptions for labor) has a greater effect on productivity growth (increasing flexibility and efficiency).

Secondly, dummy variables related to outsourcing decisions (*substop* and *substart*) are, in most of the cases, significant and have the expected effect on productivity. These variables have the greatest effect in Industry 6. Transport equipment. In this case, the negative effect of the decision to stop outsourcing is particularly important.

7. Conclusions

Innovation is a primary source of productivity growth, but a concept of innovation broader than technological product and process innovation is needed. As it is pointed out in the Oslo Manual (OECD, 2005), the concept of innovation should include marketing and organizational innovations. Organizational innovations on their own can have an important effect on productivity. In this sense, organizational innovations can increase the quality and efficiency of work, improve information sharing and the ability of the firm to use new technologies, as such increasing the productivity of investment in knowledge.

The aim of this paper is to analyze the relationship between organizational innovation and productivity growth. I focus on the role of one of the most relevant organizational methods, outsourcing. Specifically, this paper deals with outsourcing at the firm level and focuses on the role of contracting out manufacturing activities (production subcontracting).

In the existing empirical literature, outsourcing has been measured in many different ways. Most of the measures used are rough and there are few studies using data at the firm level. A feature of the firm-level data set that I use is the availability of a straight measure of production subcontracting. In this sense, I have information on firms' purchases of elaborated products and customized components from external suppliers.

In analyzing the effect of outsourcing on a firm's productivity, I first introduce a simple framework that specifies a production function considering the possibility of production subcontracting. The framework developed leads to the estimation of a production function depending on traditional inputs (labor, capital and materials) and an index of production subcontracting. Specifically, both the effect of first-time outsourcing on productivity and the effect of the intensity of production subcontracting can be analyzed.

Results for manufacturing as a whole show a positive effect of both the outsourcing decision and outsourcing intensity on productivity. When analyzing industry-level results, I find that outsourcing intensity has a positive effect on productivity, mainly for firms belonging to light industries (labor-intensive industries), while the decision to start (stop) outsourcing has, in most of the cases, the expected positive (negative) effect on productivity.

Appendix A: Definitions of Variables

Capacity utilization: Yearly average rate of capacity utilization reported by the firm.

Capital stock: Capital at current replacement values is computed recursively from an initial estimate and the data on firms' investments in equipment goods (but not buildings or financial assets), actualized by means of a price index of capital goods, and using sectorial estimates of the rates of depreciation. Real capital is then obtained by deflating the current replacement values. Details on this variable can be found in Martín-Marcos and Suárez (1997).

Entrant firm: Dummy variable that takes the value 1 when the firm has been created during the period.

Exiting firms: Dummy variable that takes the value 1 when the firm is going to exit during the period (stop activity or stop manufacturing).

Hours of work: Total normal hours of work plus overtime minus lost hours, computed by multiplying hours per worker by the number of workers.

Hours per worker: Normal hours of work plus overtime minus lost hours per worker.

Industry dummies: Eighteen industry dummies (ESEE Industries. See Appendix B).

Intermediate consumption: Sum of purchases of materials and external services minus the variation of intermediate inventories. Nominal intermediate consumption is deflated by the firm's specific price index of intermediate consumption.

Merger and acquisition: Dummy variable that takes the value 1 in the years subsequent to a merger or acquisition.

Output: Goods and services production. Sales plus the variation of inventories deflated by the firm's output price index.

Production subcontracting: Dummy variable that takes the value 1 if the firm subcontracts production.

Price: Paasche-type price index computed by starting from the percentage price changes that the firm reports to have made in the markets in which it operates.

Price of intermediate consumption: Paasche-type price index computed by starting from the percentage variations in the prices of purchased materials, energy and services reported by the firms.

Scission: Dummy variable that takes the value 1 in the years subsequent to a scission.

Size: Two size dummies (fewer than or equal to 200 workers; and more than 200 workers).

Subcontracted purchases: Purchases of elaborated products or customized components. Nominal subcontracted purchases are deflated by the firm's specific price index of intermediate consumption.

Workers: Approximation of the average number of workers during the year.

Appendix B: Industry definitions

NACE Code (3-digit)	ESEE Industries	Industry breakdown
221 to 224	Ferrous and non-ferrous metals	1. Metals and metal products
311 to 319	Metal products	
240 to 249	Non-metallic mineral products	2. Non-metallic minerals
251 to 255	Chemical products	3. Chemical products
481, 482	Rubber and plastic products	
321 to 329	Industrial and agricultural machinery	4. Ind. and agric. machinery
330, 391 to 399	Office and data processing machinery	5. Office mach. and elec. goods
341 to 347, 351 to 355	Electrical goods	
361 to 363	Motor vehicles	6. Transport equipment
371, 372, 381 to 389	Other transport equipment	
413	Meats, meat preparation	7. Food, drink and tobacco
411, 412, 414 to 423, 429	Food products and tobacco	
424 to 428	Beverages	
431 to 439, 453 to 456	Textiles and clothing	8. Textile, leather and shoes
441, 442, 451, 452	Leather and leather products	
461 to 468	Timber, wood products	9. Timber and furniture
471 to 475	Paper and printing products	10. Paper and printing products
491 to 495	Other manufacturing products	11. Other manufacturing products

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Table 1. Percentage of firms contracting out of manufacturing activities
Total manufacturing (by year)

	All firms	Up to 200 workers	More than 200 workers
1990	39.9	31.7	53.1
1991	50.6	42.9	65.3
1992	46.2	41.8	55.9
1993	44.0	39.2	55.9
1994	41.9	36.6	54.6
1995	42.6	37.3	54.8
1996	42.6	37.2	55.0
1997	45.6	41.1	55.8
1998	47.5	42.7	58.3
1999	43.7	36.9	58.8
Total[1]	44.7	39.9	55.6

[1]Average of period 1990-99

Table 2. Percentage of firms contracting out of manufacturing activities[1]
Total manufacturing (by industry)

	All firms	Up to 200 workers	More than 200 workers
1. Metals and metal products	47.0	46.3	48.5
2. Non-metallic minerals	26.5	24.1	36.5
3. Chemical products	43.6	35.3	59.3
4. Ind. and agric. machinery	65.4	65.2	64.1
5. Office mach. and elec. goods	61.5	55.2	66.1
6. Transport equipment	59.9	50.4	63.1
7. Food, drink and tobacco	21.5	13.4	39.8
8. Textile, leather and shoes	50.4	47.4	62.6
9. Timber and furniture	33.0	33.0	45.0
10. Paper and printing products	53.9	51.7	61.0
11. Other manufacturing products	63.6	62.7	77.4
Total manufacturing	44.7	39.9	55.6

[1]Average of period 1990-99

Table 3. Subcontracted purchases[1] over Intermediate consumptions (variable *sr*, %)
Firms contracting out of manufacturing activities (by year)

	All firms	Up to 200 workers	More than 200 workers
1990	16.9	17.4	16.4
1991	14.4	18.0	9.7
1992	16.6	19.0	12.6
1993	16.3	17.8	13.7
1994	15.3	17.3	12.0
1995	15.6	16.7	13.7
1996	17.5	19.8	14.0
1997	16.8	18.5	13.9
1998	16.7	18.0	14.6
1999	18.2	20.3	15.3
Total[2]	16.5	18.0	14.0

[1]Firm's purchases of elaborated products and customized components
[2]Average of period 1990-99

Table 4. Subcontracted purchases[1] over Intermediate consumptions[2] (variable *sr*, %)
Firms contracting out of manufacturing activities (by industry)

	All firms	Up to 200 workers	More than 200 workers
1. Metals and metal products	15.3	16.7	13.0
2. Non-metallic minerals	11.6	12.7	10.1
3. Chemical products	9.8	10.4	9.7
4. Ind. and agric. machinery	22.3	23.7	18.4
5. Office mach. and elec. goods	17.1	18.1	15.7
6. Transport equipment	19.8	21.4	18.8
7. Food, drink and tobacco	10.5	12.4	9.9
8. Textile, leather and shoes	18.7	19.5	15.5
9. Timber and furniture	19.8	20.0	15.9
10. Paper and printing products	21.5	24.2	13.2
11. Other manufacturing products	14.0	12.5	18.7
Total manufacturing	16.5	18.0	14.0

[1]Firm's purchases of elaborated products and customized components
[2]Average of period 1990-99

Table 5. Production function estimates

Sample period: 1992-1999 Nº of firms: 1728 Dependent variable: y				
Independent variables[2]	a (OLS)	b (GMM[1])	c (GMM[1])	d (GMM[1])
Constant	0.03(9.7)	0.02(2.0)	0.02(2.4)	0.02(2.2)
k	0.05(4.9)	0.13(1.38)	0.13	0.15
l	0.29(10.9)	0.36(3.8)	0.37(4.0)	0.36(3.8)
m	0.40(16.4)	0.49(7.2)	0.50(8.0)	0.49(8.0)
sub	0.07(10.7)	0.14(4.5)	0.14(4.7)	0.14(4.6)
substop	-0.07(-7.9)	-0.08(-7.2)	-0.08(-7.3)	-0.08(-7.4)
substart	0.06(6.5)	0.07(5.2)	0.07(5.4)	0.07(5.4)
cu	0.10(4.9)	0.06(2.5)	-	0.06(2.6)
Industry dummies[3]	Included	Included	Included	Included
Time dummies[3]	Included	Included	Included	Included
m_1	-	-9.0	-9.2	-9.3
m_2	-	-1.5	-1.67	-1.5
Sargan test (df)	-	21.7(22)	21.6(23)	21.6(23)
Wald test (df)	-	0.02(1)	-	-

Heteroskedasticity robust t-ratios shown in parentheses.

[1]Instruments are: l, m and sub-lagged levels t-2; lagged log-differences of k; and one size dummy (>200 workers).

[2]Wald test allows us to accept $\delta+\phi_1+\phi_2=1$. Estimates c and d impose this constraint.

[3]18 industry dummies (ESEE Industries) and 8 year dummies, with the coefficients of each set constrained to add up to zero; dummies for entering and exiting firms, as well as mergers and scissions, also included.

Table 6. Production function estimates. Results by industry

Sample period: 1992-1999
Estimation method: GMM[1]
Dependent variable: y

Industry[2]	k	l	m	sub	substop	substart
1. Metals and metal products	0.35	0.24(1.6)	0.41(3.2)	0.12(2.2)	-0.09(-2.5)	0.06(1.6)
2. Non-metallic minerals	0.20	0.46(2.6)	0.34(2.6)	0.006(0.1)	-0.05(-1.8)	-0.01(-0.5)
3. Chemical products	0.29	0.40(2.0)	0.31(1.9)	-0.03(-0.6)	-0.05(-2.3)	0.04(1.7)
4. Ind. and agric. machinery	0.13	0.53(3.1)	0.34(3.7)	0.02(0.9)	-0.08(-2.2)	0.07(2.2)
5. Office mach. and elec. goods	0.21	0.53(3.4)	0.26(2.1)	0.08(2.2)	-0.03(-0.7)	0.006(0.15)
6. Transport equipment	0.09	0.50(2.8)	0.41(2.6)	0.02(0.5)	-0.17(-3.7)	0.11(2.0)
7. Food, drink and tobacco	0.31	0.17(1.4)	0.52(5.3)	0.14(1.9)	-0.07(-3.6)	0.03(2.0)
8. Textile, leather and shoes	0.02	0.66(4.1)	0.32(2.4)	0.02(0.5)	-0.05(-1.8)	0.07(2.1)
9. Timber and furniture	0.26	0.37(2.2)	0.37(2.9)	0.12(1.9)	-0.05(-1.7)	-0.005(-0.07)
10. Paper and printing products	0.20	0.30(2.1)	0.50(4.3)	0.14(2.2)	-0.10(-2.9)	0.10(2.9)

Heteroskedasticity robust t-ratios shown in parentheses.
[1]Instruments are: l, m and sub-lagged levels t-2; lagged log-differences of k; and one size dummy (>200 workers). The set of instruments for industry 3 does not include the size dummy.
[2]Estimates include 8 year dummies, with the coefficients of each set constrained to add up to zero .Dummies for entering and exiting firms, as well as mergers and scissions, also included. The estimate for industry 3 also includes one size dummy (>200 workers). The estimate for industry 8 does not include dummies for entering firm, exiting firm, merger and scission.

Table 7. Specification tests. Results by industry

Industry	Serial correlation		Constant returns to scale	Overidentifying restrictions
	m_1	m_2	Wald test (df)	Sargan test (df)
1. Metals and metal products	-3.0	-0.6	7.1(1)	21.3(23)
2. Non-metallic minerals	-3.7	-1.1	2.2(1)	21.8(23)
3. Chemical products	-2.9	-1.4	7.7(1)	20.5(22)
4. Ind. and agric. machinery	-3.4	0.4	0.4(1)	22.3(23)
5. Office mach. and elec. goods	-2.4	-0.9	0.1(1)	19.0(23)
6. Transport equipment	-2.6	-0.9	1.3(1)	22.1(23)
7. Food, drink and tobacco	-3.6	0.2	5.7(1)	20.9(23)
8. Textile, leather and shoes	-2.8	-0.06	0.4(1)	24.6(23)
9. Timber and furniture	-2.1	-0.8	1.1(1)	15.6(23)
10. Paper and printing products	-2.8	-0.5	2.4(1)	22.6(23)

Table A1. Firms by industry and number of observations

Industry breakdown	No. of observations								
	3	4	5	6	7	8	9	10	Total
1. Metals and metal products	40	23	37	13	21	25	13	36	208
2. Non-metallic minerals	22	12	22	12	9	15	6	24	122
3. Chemical products	42	29	35	25	26	26	16	29	228
4. Ind. and agric. machinery	23	15	9	11	11	7	5	15	96
5. Office mach. and elec. goods	29	26	20	18	14	8	7	29	151
6. Transport equipment	21	21	22	8	11	12	3	18	116
7. Food, drink and tobacco	37	42	32	35	35	22	16	55	274
8. Textile, leather and shoes	69	31	31	25	25	36	9	43	269
9. Timber and furniture	20	13	15	18	9	16	4	12	107
10. Paper and printing products	20	16	16	14	13	16	11	16	122
11. Other manufacturing products	3	3	4	5	4	8	0	8	35
Total Industry	326	231	243	184	178	191	90	285	1728

Table A2 Variable descriptive statistics

	Symbol	Mean	St. dev	Min	Max
Dependent variable:					
Output (growth rate)	y	0.038	0.259	-3.220	2.569
Explanatory variables:					
Capacity utilization (growth rate)	cu	0.001	0.194	-2.833	2.944
Capital stock (growth rate)	k	0.086	0.297	-2.619	4.362
Hours of work (growth rate)	l	-0.002	0.193	-2.833	1.758
Intermediate consumptions[1] (growth rate)	m	0.026	0.402	-4.375	3.682
Index of production subcontracting (growth rate)	sub	0.001	0.747	-8.650	9.171
Dummy indicating stopping outsourcing	substop	0.084		0	1
Dummy indicating starting outsourcing	substart	0.087		0	1
Industry dummies (ESEE Industries)					
Ferrous and non-ferrous metals		0.023		0	1
Metal products		0.100		0	1
Non-metallic mineral products		0.073		0	1
Chemical products		0.072		0	1
Rubber and plastic products		0.059		0	1
Industrial and agricultural machinery		0.054		0	1
Office and data processing machinery		0.008		0	1
Electrical goods		0.077		0	1
Motor vehicles		0.046		0	1
Other transport equipment		0.019		0	1
Meats, meat preparation		0.030		0	1
Food products and tobacco		0.114		0	1
Beverages		0.021		0	1
Textiles and clothing		0.119		0	1
Leather and leather goods		0.030		0	1
Timber, wood products		0.060		0	1
Paper and printing products		0.072		0	1
Other manufacturing products		0.023		0	1
Size dummies					
≤ 200 workers		0.690		0	1
> 200 workers		0.310		0	1
Time dummies					
1991		0.076		0	1
1992		0.088		0	1
1993		0.110		0	1
1994		0.120		0	1
1995		0.121		0	1
1996		0.125		0	1
1997		0.125		0	1
1998		0.126		0	1
1999		0.110		0	1

[1]Without firm's purchases of elaborated products and customized components

Table A3. Production function estimates. Robustness checks

Sample period: 1992-1999
Nº of firms: 1728
Estimation method: GMM[1]
Dependent variable: y

	a		b		c	
Independent variables[2]	a.1	a.2	b.1	b.2	c.1	c.2
Constant	0.02(2.5)	0.02(2.5)	0.02(2.2)	0.02(2.2)	0.02(2.1)	0.01(1.96)
k	0.13(1.45)	0.17	0.15(1.6)	0.19	0.15(1.59)	0.20
l	0.39(4.1)	0.39(4.2)	0.38(4.0)	0.38(4.0)	0.39(4.2)	0.40(4.3)
m	0.42(5.6)	0.44(6.3)	0.42(5.1)	0.43(5.9)	0.37(5.2)	0.40(6.0)
sub	0.11(3.7)	0.12(2.9)	0.11(3.4)	0.11(3.6)	0.10(3.2)	0.10(3.4)
substop	-0.07(-6.3)	-0.07(-6.7)	-0.07(-6.0)	-0.07(-6.4)	-0.06(-5.8)	-0.07(-6.3)
substart	0.06(4.2)	0.06(4.4)	0.06(3.9)	0.06(4.2)	0.05(3.8)	0.05(4.1)
cu	0.08(3.0)	0.07(2.9)	0.08(2.9)	0.07(2.9)	0.09(3.4)	0.08(3.4)
Industry dummies[3]	Included	Included	Included	Included	Included	Included
Time dummies[3]	Included	Included	Included	Included	Included	Included
Size dummies[3]	Included	Included	Included	Included	Included	Included
m_1	-8.8	-9.2	-8.8	-9.2	-8.2	-8.6
m_2	-1.7	-1.6	-1.7	-1.6	-1.8	-1.7
Sargan test (df)	30.5(28)	30.6(29)	22.6(21)	22.2(22)	24.4(21)	24.0(22)
Wald test (df)	0.35(1)		0.22(1)		0.6(1)	

Heteroskedasticity robust t-ratios shown in parentheses.

[1]Instruments are:

Estimate (a): l lagged levels t-2 and t-3; m and sub-lagged levels t-2; and lagged log-differences of k.

Estimate (b): l, m and sub-lagged levels t-2; and lagged log-differences of k.

Estimate (c): l, m and sub-lagged levels t-2; lagged log-differences of k; and log of price of intermediate consumptions.

[2]Wald test allows us to accept $\delta+\phi_1+\phi_2=1$. Estimates a.2, b.2 and c.2 impose this constraint.

[3]18 industry dummies (ESEE Industries), 8 year dummies and 2 size dummies, with the coefficients of each set constrained to add up to zero; dummies for entering and exiting firms, as well as mergers and scissions, also included.

Figure 1. Percentage of firms contracting out of manufacturing activities

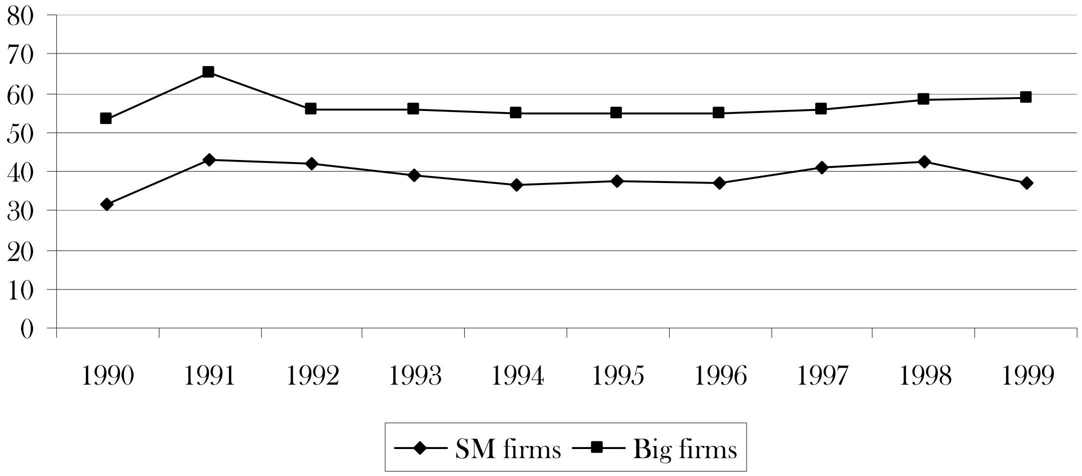
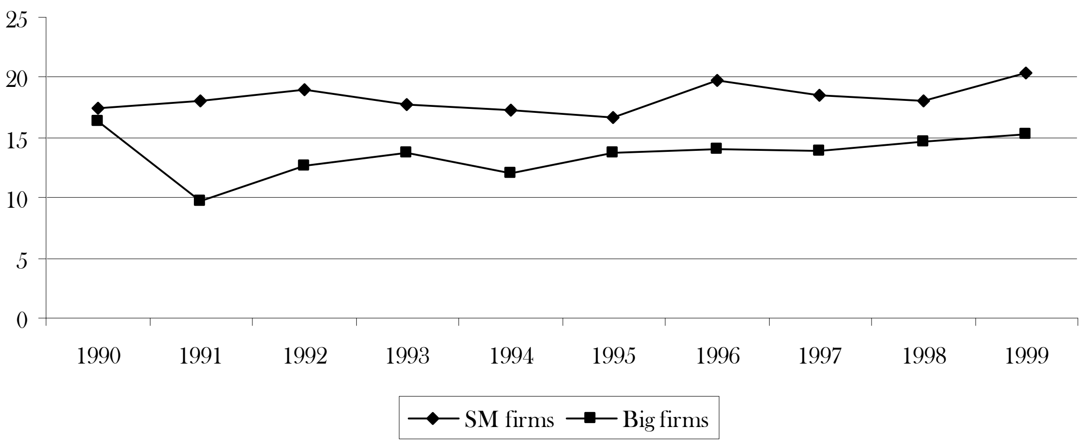


Figure 2. Subcontracted purchases over Intermediate consumptions



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