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Foreign direct investment and technical progress in Spanish manufacturing

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This paper analyzes the effects of foreign direct investment on technical progress in Spanish manufacturing. Particularly, we study how foreign direct investment (FDI)'s contributions vary depending on the economic structure of the industry. The results show that most FDI goes to capital-intensive sectors, especially when those sectors are also research and development (R&D)-intensive. Our estimates of the Solow residual show that the positive effect of contemporaneous and lagged FDI on manufacturing productivity is only attributable to capital- and R&D-intensive industries in what seems to be related to a dynamic capabilities explanation or to complementarities with R&D expenditures.

I. Introduction

It is well known that foreign direct investment (FDI) is a powerful driver of growth in developing countries. The mechanism through which FDI causes growth works differently across countries and reverse causality from growth to FDI exists for some countries (Duttaray *et al.*, 2008). So, FDI inflows and exports are elements to explain the economic growth in different regions (Liu et al., 2009; Yao, 2006).

In Spain some years ago, low wages attracted investments that brought knowledge and technical progress to their economies. In fact, multinational automotive corporations and other industries brought striking development to Spanish manufacturing. Today, Spain is considered a developed country and is no longer competitive in wages when attracting FDI compared to most developing countries. Also, Spain is no longer a net receiver of foreign investment.

In this context, some questions arise: What role did FDI play in Spanish manufacturing's low rates of technical progress in recent years? How do FDI and research and development (R&D) expenditures relate to industry performance? How do FDI and R&D contribute to technical progress?

Previous studies evaluate FDI spillovers in the Spanish economy (Varela and Rodríguez de Pablo, 1974; Donges, 1976; Bajo, 1991; Egea and López, 1991; Felipe and Fernández, 1991; Bajo and Sosvilla, 1991, 1992; Muñoz, 1999; Díaz, 2001; Hernández, 2008; Rodríguez and Pallas, 2008). Among other things, many studies find that firms and industries with FDI are more productive than locally funded ones (Caves, 1974; Globerman, 1979; Blomström, 1986; Blomström and Wolff, 1989; Haddad and Harrison, 1993; Doms and Jensen, 1998; Aitken and Harrison, 1999) and others find that FDI and trade are the most important paths to domestic advances in technology (Grossman and Helpman, 1991; Coe and Helpman, 1995; Blomström and Kokko, 1998; Xu, 2000; Buckley *et al.*, 2002; Keller and Yeaple, 2003; Liu and Wang, 2003; Sinani and Meyer, 2004).

Many studies also find that FDI influences host countries through technology transfers and increases in the intensity of competition (Caves, 1974; Wang and Blomström, 1992; Glass and Saggi, 2002). The research generally finds that nonmarket transactions generate spillovers, which refers to the spread of resources (in particular, knowledge) without contractual relationships (Meyer, 2004). Spillovers result in improved productivity, or other benefits, in the local industry (Perez, 1998; Griffith *et al.*, 2002; Aghion *et al.*, 2004; Haskel *et al.*, 2007). However, such improvements are different in particular sectors, depending on the intensity of labour and R&D (Buckley *et al.*, 2007).

This relationship between R&D and productivity is a key factor in economic growth (Griliches, 1979, 1988; Grossman and Helpman, 1991; Coe and Helpman, 1995). So, FDI is a mover of production efficiency in the host country (Chuang and Hsu, 2004; Yao *et al.,* 2008). In fact, innovation is crucial to developing an economic structure (Schumpeter, 1934, 1939) and increasing investment and production (Arrow, 1962), adding human capital (Uzawa, 1965), or acquiring better inputs (Goto and Suzuki, 1989) can facilitate this growth. Considering the relationship between R&D and FDI, FDI is a noteworthy technology-transfer mechanism (Hubert and Pain, 2000; van Pottelsberghe de la Potterie and Lichtenberg, 2001; Cecchini and Lai-Tong, 2008; Managi and Bwalya, 2010).

The aim of this paper is to estimate the role of FDI in technical progress in Spanish manufacturing, accounting for other determinants of technical progress such as R&D expenditures. Including R&D expenditures in the measure of technical progress is consistent with Nadiri (1993) and Sinani and Mayer (2004).

Many studies at the manufacturing level explain the influence of physical inputs on outputs (Todd, 1984; Hazledine, 1985; Baldwin and Rafiquzzaman, 1994; Oulton and O'Mahony, 1994). Inward FDI in the manufacturing sector plays a very important role in enhancing the economic growth, but FDI in non manufacturing sectors does not (Wang, 2009). The industry level, however, is where we study the interaction among the economic structure of the industries, innovation intensity, and the attraction of foreign investment. Accordingly, we search for differences in the manner in which industries profit from foreign investments. The analysis identifying FDI's technical-progress effect and it is a precursor to analyzing spillovers.

This paper is structured as follows: Section 2 provides a brief overview of the theoretical background as well as a descriptive approach to FDI in Spanish manufacturing. Section 3 presents the model, the data, and the methodology to estimate the technical progress associated to FDI. Section 4 contains a discussion of the estimations. The paper ends with some concluding remarks.

II. Foreign Direct Investment and the Economic Structure of Industries

A significant avenue of research exists regarding FDI and the productivity of local firms. The common view is that foreign-owned firms have distinct labour demands compared with domestic firms, even within the same industry (Conyon *et al.*, 2002). Also, foreign-owned enterprises usually have better technologies and organizational skills than locally owned enterprises, which enhances their knowledge (Smarzynska, 2003).

Foreign-owned firms tend to put more effort toward training employees who may later take their acquired skills to domestic firms (Görg and Strobl, 2001; Görg and Greenaway, 2004; Tian, 2007). At the same time, foreign firms tend to steal the most productive employees away from local firms and make the process of assimilating foreign technology harder (Wang and Yu, 2007). Foreign firms also use more skill-intensive technology than domestic companies, and they are more likely to attract and retain highly qualified personnel by raising wages (Aitken *et al.*, 1997; Feenstra and Hanson, 1997; Fosfuri *et al.*, 2001; Glass and Saggi, 2002; Mody, 2004). Nonetheless, FDI in the host country produces a labour-displacing effect because it creates a technology transfer, a corresponding excess supply of labour, and subsequent downward pressure on labour costs (Chakraborty and Basu, 2002).

Domestic firms may learn from the foreign firms with which they have close relationships, and they may even benefit from the technical support, as well as the supply and demand from those firms (Aitken and Harrison, 1999; Buckley *et al.*, 2002). In this way, foreign firms must leverage special advantages, often information-based intangibles, in order to compete in these markets (Morck and Yeung, 1991, 1992).

At the industry level, these results suggest that every sector may present a different sensibility toward profiting from FDI, depending on the skills in that sector or even its economic structure. As a first approximation of the problem, in Figure 1 we present the FDI evolution in Spanish manufacturing between 1993 and 2006. In general, the interannual variability is remarkable, so two trends appear: an upward trend during 1993–2001 and a downward trend after 2001. The 2001 value includes some unusual deals, including the Mexican cement firm Cemex's significant FDI in Valenciana de Cementos and in La Auxiliar de la Construcción Sanson. The manufacture of cement, lime, and plaster industrial sector is 12.24% of FDI weight.

[Insert Figure 1 about here]

We analyze 100 Spanish manufacturing industries for the 14 years from 1993 to 2006. The data source is the Industrial Companies Survey by the National Statistics Institute (INE). We analyze the industries receiving FDI for two main characteristics: capital intensity and R&D intensity. We do this because capital is traditionally the main driver of technological progress and productivity gains, supporting the relationship between capital investment and the incorporation of technology progress. However, many studies also find that the interaction between capital investment and R&D investment drives productivity (Arrow, 1962;

Bresnahan, 1986; Jaffe, 1986; Bernstein and Nadiri, 1989; Coe and Helpman, 1995) because it facilitates the incorporation of new knowledge and skills.

Thus, the sample is divided into four subsamples (see tables 1, 2, 3, and 4) according to how companies rate in two areas. On one hand is capital intensity, which equals the accumulation of capital stock per worked hour during all years versus the median value in all the industrial sectors. On the other hand is R&D intensity, which measures R&D expenditures during all years versus the median value in all industrial sectors. After categorizing all the industrial sectors, we rank them according to their FDI. Our taxonomy gains inspiration from Basant and Fikkert (1996), Peneder (2001), Hu *et al.* (2005), Bin (2008), and O`Mahony (2009), which study the technological dimension of sectors.

As tables 1, 2, 3 and 4 show, FDI is higher in capital-intensive sectors. In fact, 83.5% of FDI went to capital-intensive sectors during the sample period. At the same time, sectors that are both capital-intensive and low-R&D (Table 2) receive more FDI than sectors that are capital-intensive and R&D-intensive (Table 1). It verifies for FDI weight (48,94% is higher than 34,56%) as well as for FDI over value added (26,58% versus 23,49%). However, labour-intensive, low-R&D sectors (Table 4) receive less FDI than labour-intensive, R&D-intensive sectors (Table 3). It verifies for FDI weight (6,88% is lower than 9,62%) as well as for FDI over value added (8,81% versus 11,52%). FDI is concentrated in a few sectors. In the end, only 21 capital-intensive sectors and only four labour-intensive sectors have FDI weights greater than 1%.

Some sectors are notable for their high FDI. Within the capital-intensive and R&D-intensive sectors (Table 1), FDI over value added for manufacture of aircraft, pharmaceutical products, and of motorcycles reaches 80.8%, 39.7%, and 36.6%, respectively, whereas FDI weight for manufacture of chemical products, motor vehicles, and pharmaceutical products and publishing reaches 5.62%, 5.44%, 5.19%, and 4.26%, respectively.

On the other hand, in the capital-intensive, low-R&D sectors (Table 2), the aforementioned manufacture of cement, lime, and plaster have the highest FDI. In addition, manufacture of manmade fibers, cleaning, and paper receive 130.9%, 55.5%, and 54.4%, respectively, of FDI over value added, whereas production of electricity, cleaning, and alcoholic beverages reach 9.89%, 4.06%, and 3.36%, respectively, of FDI weight. However, in labour-intensive and R&D-intensive sectors (Table 3), the FDI over value added for television and radio, as well as manufacture of machine tools, other textile industries, accumulators, and railway reaches 96.5%, 32%, 28.4%, 26.5%, and 25.9%) respectively, whereas the FDI weight for television and radio and accumulators reach 2,47% and 1,66% respectively.

Alternatively, in labour-intensive, low-R&D sectors (Table 4), FDI over value added for companies in the textile fibres industries, bread, and cork sectors reaches 48.5%, 30.9%, and 20.4%, respectively, whereas FDI weight for bread and textile fibres reach 2,68% and 1,06%.

[Insert Tables 1, 2, 3, 4 about here]

III. Model and Methodology

Solow (1957) proposes the most common way to estimate technical progress. We suppose the production function to be a Cobb-Douglas that, using natural logarithms, is expressed as:

$$lnX_t = ln\ A + alnK_t + blnL_t \qquad (1)$$

where X is the output, K is the capital input, and L is the labour input. The Solow residual is the constant term in the equation and represents the growth of output unexplained by the growth of inputs, when variables are expressed in relative increases. In this formulation, the constant represents the technical level. The coefficients of inputs, a and b, are the output elasticity to the corresponding input. If constant returns to scale exist, the sum of these coefficients is one. If increasing (decreasing) returns to scale exist, the sum of a and b is bigger (smaller) than one.

The expression (1) is true under certain conditions, particularly constant input prices. In an environment of decreasing prices, the demand for factors could generate smaller marginal values of input productivity. For that reason, the equation calls for a term that reflects the cost of inputs.

Another implicit condition in the expression is that only one type of capital input exists; that is, no heterogeneity exists in marginal productivity. In this paper, we aim to identify the role of FDI and its interaction with R&D as it relates to productivity and technical progress. The estimates of capital inputs make no distinction about the origin of the capital; thus, the equation introduces them in a redundant manner.

We use the Industrial Companies Survey from the Instituto Nacional de Estadistica (INE), which includes comprehensive data for the manufacturing sector in Spain. The data contains homogeneous information from 1994 to 2006 for 100 subsectors within manufacturing. FDI data are from the Spanish Ministry of Industry's DataInvex Foreign Investment Statistics database, and price data comes from INE's Industrial Price Index.

Output is measured by value added (revenues minus external purchases) in constant prices (by every industry production deflator). Capital use equals the estimated depreciation of fixed assets (calculated using the average depreciation rate from the Central Balance Sheet Data Office from the Bank of Spain and expressed in constant terms via the gross fixed capital formation deflator). Labour inputs equal the number of worked hours. Cost of inputs is a proxy of the average wage in constant terms. FDI is gross foreign direct investment expressed in constant prices using the gross fixed capital formation deflator. R&D equals capitalized R&D expenditures, expressed in constant terms using a gross fixed capital formation deflator.

The estimation model is usually expressed as a log-linear regression (Bajo and Sosvilla, 1992; Muñoz, 1999; Rodríguez and Pallas, 2008). We propose a model that relates the natural logarithm of the value added for the manufacturing industry *i* in year *t*, $x_{i,t}$ to a number of variables in the following way:

$$x_{i,t} = \alpha + \beta_0 x_{i,t-1} + \beta_1 w_{i,t} + \beta_2 k_{i,t} + \beta_3 l_{i,t} + \beta_4 g_{i,t} + \beta_5 f_{i,t} + \beta_6 f_{i,t-1} + \tau_t + \varepsilon_{i,t} \qquad (2)$$

where α is the natural logarithm of technical level, w is the natural logarithm of labour cost, k is the natural logarithm of capital stock, l is the natural logarithm of worked hours, g is the natural logarithm of R&D expenditures, f is the natural logarithm of gross FDI, τ_t is time effect evaluated through a series of time dummies, and $\varepsilon_{i,t}$ is an independent and identically distributed (i.i.d.) error term.

We also allow for persistence in value added by specifying a dynamic production function including the lagged value of x as the regressor. In addition, we introduce a lagged value of f as a regressor to address the question of causality with respect to value added. We have been considered a panel data analysis (Meliciani, 2000). Estimation is carried out by the Generalized Method of Moments (GMM) for dynamic panel data, proposed by Arellano and Bond (1991), which gives a consistent estimation in the presence of heteroskedasticity of unknown form. This model is consistent with theoretical considerations as well as existing empirical evidence in Crepon, *et al.* (1998), Blundell *et al.* (1999), Aghion *et al.* (2005), Jefferson, *et al.* (2006) and Girma *et al.* (2009).

Tables 5 and 6 provide a correlation matrix and descriptive statistics (mean, standard deviation, minimum, and maximum) for the independent and dependent variables to facilitate the interpretation of the regression results. Value added has a very high correlation with capital and labour inputs, but a modest correlation exists among the inputs themselves, suggesting a kind of input substitution during this period of time. As expected, the correlation with the labour input is negative but is positive with capital, which also suggests input substitution in these years. In general, significant correlations point to some common covariance.

[Insert Tables 5 and 6 about here]

IV. Estimation and Discussion

All the estimations were obtained from Stata 9.0 and are shown in Table 7. The first column contains the estimations for the complete model (2), with time dummies and for the whole manufacturing sector. The second column is the same estimation excluding time dummy variables. The remaining columns are the estimations for the partial datasets: capital-intensive and R&D-intensive industries; capital-intensive and low-R&D industries; labour-intensive and R&D-intensive industries; and labour-intensive and low-R&D industries.

In general, Wald tests indicate that the global significance of the model is high. Differentiated residuals behave in most estimations as white noise, and the null of correct specification of the restrictions (Sargan test) is not rejected.

In all the estimations, the intercept is positive and highly significant, demonstrating the positive influence of productivity over value added. The lagged endogenous exhibits a quite low coefficient; that is, there is a low persistence in the endogenous variable. The highest value of this coefficient is 0.126; it is significant in the first estimation (with time dummies) and statistically equal to zero in the first, third, and fourth subsets.

The production-function parameters, output elasticity to labour and capital, are consistent with a hypothesis of constant returns to scale. The estimation for total sectors with time dummies gives a coefficient for capital of 0.216 and a coefficient for labour of 0.735 (worked hours)—a sum of about 0.95. This is rejected as statistically equal to one (the standard errors are very small, being a particularly efficient estimation), suggesting slightly decreasing returns to scale.

The second estimation, without time dummies, gives a sum of estimated coefficients of 0.97, very close to constant returns to scale. The estimations for the subsets of industries give a sum of about 0.95 (constant returns to scale would not be rejected now, with higher standard deviations of the coefficients), except for the subset of labour-intensive and R&D-intensive industries (the third subset), for which the sum of the coefficients of capital and labour is 0.82. However, this estimation warrants caution because tests for serial correlation indicate that the residuals are not white noise.

The coefficient of the labour control variable is positive and highly significant in all cases, representing a positive association between inputs costs and output. Its value ranges between 0.49 and 0.77 across estimations.

Time is important when measuring FDI spillover (Buckley *et al.* 2007; Altamonte and Pennings, 2009). The time variables tend to be positive and significant during the first years of the period, and they are generally negative and significant during last years. In this model, the time coefficients suggest decreases in productivity that reach a minimum in 2003. The evolution of input prices as control variables does not explain the change, consistent with some other estimations of total factor productivity for the Spanish economy in prior years.[1]

[1] See, for instance, estimations of the Bank of Spain.

In our proposed model, FDI is an explanatory variable for value added in a production function (Kokko, 1996; Narula and Marin, 2003; Ben Hamida and Gugler, 2009). R&D and FDI are redundantly included in the estimation of output. Both investments are included in capital input and estimated as a stock (proxy of capital services). If the coefficient of one of these variables is zero, this type of capital thus has the same elasticity as the rest of the assets. A positive coefficient indicates that the investment has a higher elasticity.

R&D expenditures offer a negative and significant coefficient in the two first estimations. That is, R&D expenditures have a negative contemporaneous effect on output. This result contradicts many studies that identify a positive effect of innovation on productivity, such as Coe and Helpman (1995), Eaton and Kortum (1996), Coe *et al.* (1997). In fact, R&D improves production technology, increases productivity, and increases return on investment at both the firm and industry levels, according to Griliches (1986, 1990), Mansfield (1988), Goto and Suzuki (1989), Meliciani (2000), Timmer (2003), Gonzalez and Gascon (2004). Besides, R&D is the largest contributor to the creation of knowledge and the increase of productivity (Griliches, 1958, 1973; Hulton, 1975; Scherer, 1982; Fagerber, 1988; Solow, 1988).

Thus, the measurement of R&D in the Industrial Companies Survey explains our particular result: R&D expenditures are only recognized when they are accounted for as fixed assets. That happens when innovation has been real, effective, and valuable. Implicitly, any amount of R&D in the data required a larger consumption of factors to become a valuable innovation. This negative coefficient reflects higher adjustment costs than in other assets. When estimating the model for the four subsets of data, we obtain a positive, significant sign for the coefficient of the group of capital-intensive and R&D-intensive industries in which the positive effects on productivity overcome the adjustment costs. For the rest of the subsets, we obtain a negative, contemporaneous, net effect. This finding is consistent with Ten Raa and Wolff (2000), which shows the relevance of technological spillovers for the growth of total factor productivity in high-tech sectors. We conclude that capital-intensive and R&D-intensive sectors offer the most convenient conditions for innovation to generate technical progress. In this regard, as illustrated in some research (Koo, 2005), knowledge-intensive industries are more likely to create spatially mediated technology spillovers. In fact, according to Castellani and Zanfei (2007), even R&D-intensive foreign subsidiaries generate positive spillovers in domestic firms.

Foreign direct investment has a positive, significant (at 90%) effect on contemporaneous output, according to the first column of results in Table 7. In the estimation with dummy time variables, however, maximum significance and a bigger positive value for the coefficient is obtained for the one-year lagged FDI. This result is equivalent to those obtained by Blomström (1989), Haskel *et al.* (2002), Alvarez and Molero (2005).

The second estimation offers some contradictory results. When time variables are not included in the model, the sign of the contemporaneous FDI is negative and significant at 95%, whereas the lagged variable has a positive and significant (at a 99% level) coefficient. The estimations for the four industry subsets give in all cases a contemporaneous coefficient that is not significant. The same happens with the lagged variable: it is statistically insignificant except for the subset of capital-intensive and R&D-intensive industries. In this particular case, FDI has a positive and significant effect on productivity with one year of delay.

As stated, in section 2 and now in empirical estimations, this subset of sectors exhibits different behaviour. This group of industries offers the opportunity to create or benefit from innovations and capital entries, and it offers the opportunity to transform them into value that exceeds the value obtained from existing investments.

Some new research questions arise from these results. First, what industry and firm conditions help organizations learn how to take the most advantage of innovations and foreign investments? Second, what are the spillovers of FDI and innovation, and how are they transmitted?

[Insert Table 7 about here]

V. Concluding Remarks

The aim of this paper is to explain the relationship between foreign direct investment and technical progress in Spanish manufacturing. This study's sample data come from the Industrial Companies Survey and DataInvex: Foreign Investment Statistics in Spain.

First, we describe the behaviour of FDI in the Spanish manufacturing sector. We find that Spanish capital-intensive industries receive of most of the

FDI and have the highest FDI intensity, measured as FDI over value added by the sector. Our hypothesis is that this kind of FDI generates technological progress and productivity gains.

We estimate a model based on a production function that accounts for the effects of FDI and R&D on value added (output). We perform a GMM estimation on a balanced sample of 100 industries over 14 years. We also estimate the model for four subsamples (capital-intensive and R&D-intensive sectors; capital-intensive and low-R&D sectors; labour-intensive and R&D-intensive sectors; and labour-intensive and low-R&D sectors).

The results show that positive effects of contemporaneous and lagged FDI exist for manufacturing productivity, especially in capital- and R&D-intensive industries. In fact, in that subset, R&D expenditures are more elastic in terms of productivity than the other assets. At the same time, this subset is most able to generate or benefit from innovations and capital entries and to convert those things into higher value added than domestic investments can.

This suggests some avenues for future research. First, researchers might use this information to determine which industry and firm conditions improve organizational learning from innovation and foreign investments. Second, researchers might try to identify reasons for spillovers of FDI and innovation, as well as the way they are transmitted.

In addition, the difference in the coefficients of FDI among the subsamples suggests not only that heterogeneity resides in the industries' ability to absorb the positive effects of foreign capital, but also that heterogeneity exists in the foreign investments, depending on the type of target industry. Thus, FDI in labour-intensive and less innovative industries may be searching for different competitive advantages than FDI in capital-intensive, innovative sectors.

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Figures and Tables

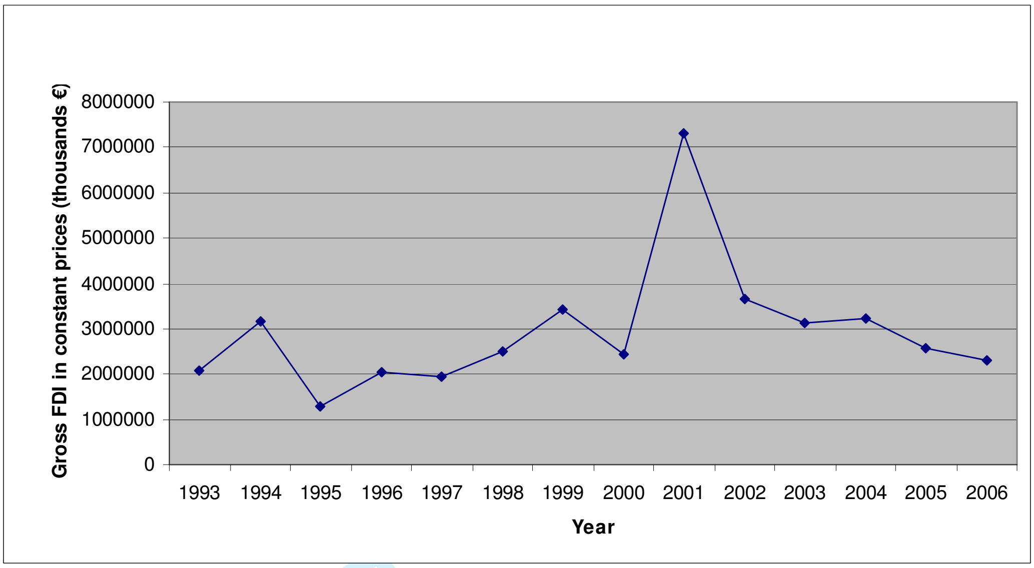

Fig. 1. FDI in Spanish manufacturing

Source: DataInvex: Foreign Investment Statistics in Spain and own elaboration

Table 1: Capital-intensive and R&D-intensive sectors

Industrial sector number (1)	Industrial sector name (1)	Capital stock per worked hour (thousands €/hour) (2)	R&D expenditures over capital (%) (3)	FDI weight (%) (4)	FDI over value added (%) (5)
39	Manufacture of basic chemical products	67.5	5.4	5.62	33.5
86	Manufacture of motor vehicles	33.6	20.1	5.44	24.0
42	Manufacture of pharmaceutical products	22.1	17.1	5.19	39.7
37	Publishing	16.4	9.4	4.26	32.3
88	Parts and accessories for motor vehicles and their engines	15.1	16.1	2.89	23.0
91	Manufacture of aircraft and spacecraft	22.1	140.4	2.14	80.8
47	Manufacture of plastic products	13.7	4.9	1.72	12.2
3	Extraction of nonenergy producing minerals	25.6	7.0	1.67	30.1
48	Manufacture of glass and glass products	19.4	6.0	1.08	25.3
44	Manufacture of other chemical products	24.3	15.5	1.02	26.5
57	Other first processing of iron and steel	28.2	6.4	0.60	37.6
59	Casting of metals	20.3	3.9	0.49	14.1
41	Paints, varnishes, printing ink and mastics	18.3	10.0	0.44	12.1
74	Manufacture of household appliances	13.1	8.6	0.43	12.3
78	Manufacture of insulated wire and cable	13.6	3.8	0.38	26.2
75	Manufacture of office machines and computers	14.7	35.6	0.32	12.4
2	Petroleum, natural gas and nuclear fuels	142.1	10.9	0.25	1.8
97	Recycling	17.6	4.1	0.20	36.6
92	Manufacture of motorcycles, bicycles and other transport equipment	17.3	24.8	0.14	15.9
95	Manufacture of sports goods, games and toys	14.3	18.2	0.11	7.1
1	Extraction and agglomeration of anthracite, coal, lignite and peat	23.7	10.6	0.10	3.1
54	Various nonmetallic ore products	22.6	14.5	0.04	2.5
40	Manufacture of pesticides and other agro-chemical products	24.0	4.4	0.03	3.6
	Total FDI weight per sector (%) / FDI intensive sectors over value added (%)			34.56	23.49

Industrial sector number (1)	Industrial sector name (1)	Capital stock per worked hour (thousands €/hour) (2)	R&D expenditures over capital (%) (3)	FDI weight (%) (4)	FDI over value added (%) (5)
	Table 2: Capital-intensive and low-R&D sectors				
51	Manufacture of cement, lime and plaster	67.5	0.1	12.24	209.5
98	Production and distribution of electricity	450.0	0.8	9.89	29.4
43	Manufacture of cleaning and polishing preparations, toilet preparations	19.1	1.6	4.06	55.5
14	Production of alcoholic beverages	38.0	0.6	3.36	25.2
55	Manufacture of basic iron and steel and of ferro-alloys ECSC	57.1	1.7	2.95	26.3
35	Manufacture of pulp, paper and cardboard	54.9	1.6	2.69	54.4
58	Manufacture and first processing basic precious and nonferrous metals	43.2	3.0	2.09	43.3
45	Manufacture of man-made fibres	40.4	2.9	1.65	130.9
13	Other food products	21.4	1.7	1.60	28.9
99	Production and distribution of gas, steam and hot water	410.6	0.8	1.03	21.0
100	Collection, treatment and distribution of water	122.4	0.4	1.01	18.6
4	Meat industry	13.8	2.2	0.91	9.0
52	Manufacture of articles of concrete, plaster and cement	16.4	0.8	0.84	9.2
36	Manufacture of articles of paper and cardboard	27.1	0.4	0.80	10.2
8	Dairy industries	26.0	2.3	0.74	8.0
15	Production of mineral waters and nonalcoholic beverages	40.2	0.2	0.61	10.0
46	Manufacture of rubber products	13.7	1.7	0.55	8.6
30	Veneer sheets; plywood, laminboard, fibre board, panels and boards	25.2	1.3	0.36	16.6
6	Processing and preserving of fruit and vegetables	17.5	1.6	0.27	5.1
9	Milling, starch and cereal products	29.5	0.6	0.23	9.4
16	Tobacco industry	22.3	0.3	0.21	6.0
56	Manufacture of tubes	27.3	1.8	0.20	10.1
7	Manufacture of fats and oils (vegetal and animal)	39.8	0.3	0.19	5.9
50	Ceramic tiles, slabs, bricks, roofing tiles and products in baked clay	23.2	2.3	0.19	2.9
12	Manufacture of sugar, cocoa and chocolate	20.6	2.5	0.14	3.4
10	Products for animal food	26.8	2.1	0.09	2.5
64	Forging, embossing and drawing of metals; dust metallurgy	14.6	1.6	0.05	1.1
	Total FDI weight per sector (%) / FDI intensive sectors over value added (%)			48.94	26.58

Industrial sector number (1)	Industrial sector name (1)	Capital stock per worked hour (thousands €/hour) (2)	R&D expenditures over capital (%) (3)	FDI weight (%) (4)	FDI over value added (%) (5)
82	Television and radio transmitters, line telephony and line telegraphy	11.5	112.7	2.47	96.5
80	Accumulators, primary cells primary batteries and electrical equipment	11.2	13.2	1.66	26.5
72	Manufacture of machine-tools	9.2	26.2	0.55	32.0
69	Manufacture of machinery and mechanical equipment	10.6	11.3	0.55	15.5
21	Other textile industries	9.6	4.3	0.51	28.4
70	Other general purpose machinery, equipment and mechanical material	6.2	21.3	0.50	5.5
73	Miscellaneous special purpose machinery. Weapons and ammunition	8.3	19.6	0.47	7.3
90	Manufacture of railway and tramway locomotives and rolling stock	10.3	38.8	0.42	25.9
60	Manufacture of metal structures and parts of structures	6.7	9.4	0.41	8.1
49	Ceramic goods other than for construction purposes	10.2	9.8	0.27	11.5
67	Manufacture of cutlery, tools and general hardware	9.9	4.2	0.26	7.2
81	Manufacture of electronic valves, tubes and other electronic components	12.4	15.1	0.23	13.0
77	Manufacture of electricity distribution and control apparatus	8.7	12.5	0.23	8.5
85	Measuring, control, optical and photographic appliances	8.0	58.9	0.22	7.4
83	Television and radio receivers, sound or video recording or reproducing	11.4	15.4	0.17	11.7
79	Manufacture of electric lamps and lighting equipment	7.2	5.9	0.15	9.2
76	Manufacture of electric motors, generators and transformers	9.9	36.2	0.13	4.4
93	Manufacture of furniture	4.8	4.5	0.12	1.0
89	Building and repairing of ships and boats	7.6	24.2	0.07	2.4
62	Tanks, large deposits, metal containers, central heating radiators, boilers	5.4	8.7	0.07	4.0
84	Medical surgical equipment and instruments and orthopaedic appliances	4.4	10.9	0.05	3.2
87	Bodies coachwork for motor vehicles; trailers and semi-trailers	5.8	51.8	0.04	2.3
22	Manufacture of knitted and crocheted fabrics	10.0	5.7	0.02	3.1
19	Textile finishings	10.3	4.7	0.01	0.5
63	Manufacture of steam generators	7.4	15.4	0.01	2.5
71	Manufacture of agricultural and forestry machinery	5.2	6.2	0.01	0.8
23	Manufacture of knitted and crocheted articles	5.8	4.1	0.00	0.1
Total FDI weight per sector (%) / FDI intensive sectors over value added (%)				9.62	11.52

Table 3: Labour-intensive and R&D-intensive sectors

Industrial sector number (1)	Industrial sector name (1)	Capital stock per worked hour (thousands €/hour) (2)	R&D expenditures over capital (%) (3)	FDI weight (%) (4)	FDI over value added (%) (5)
11	Bread, biscuits, pastry goods and cakes	7.6	1.6	2.68	30.9
17	Preparation and spinning of textile fibres	13.0	2.5	1.06	48.5
68	Manufacture of other fabricated metal products, except furniture	11.4	3.1	0.98	13.8
38	Graphic arts and reproduction of recorded media	12.1	0.6	0.82	6.6
24	Manufacture of wearing apparel	3.6	1.8	0.24	3.0
96	Various other manufacturing industries	6.6	1.6	0.20	15.1
61	Manufacture of builders' carpentry and joinery of metal	3.0	1.2	0.17	2.8
18	Textile weaving	11.6	2.8	0.14	6.7
5	Production and preserving of fish and fish products	10.1	1.4	0.11	4.4
34	Manufacture of cork, straw and plaiting materials	8.4	2.1	0.09	20.4
27	Leather goods, luggage, saddlery and harness	2.7	0.9	0.09	13.1
20	Other made-up textile articles, except apparel	5.3	2.2	0.08	4.1
25	Fur industry	5.5	0.2	0.05	17.3
29	Sawmilling, planing and industrial preparation of wood	8.5	0.2	0.04	3.6
65	Treatment and coating of metals	9.1	1.3	0.04	1.4
33	Manufacture of other products of wood	5.0	0.1	0.04	3.8
94	Manufacture of jewellery and related articles	4.4	0.8	0.02	2.0
66	General mechanical engineering	8.2	1.8	0.02	0.3
28	Manufacture of footwear	4.0	1.5	0.01	0.3
26	Tanning and dressing of leather	9.5	3.2	0.01	0.9
53	Cutting, shaping and finishing of stone	10.1	1.8	0.01	0.1
32	Manufacture of wooden containers	6.4	0.7	0.00	0.1
31	Manufacture of builders' carpentry and joinery	4.7	1.1	0.00	0.0
Total FDI weight per sector (%) / FDI intensive sectors over value added (%)				6.88	8.81

Table 4: Labour-intensive and low-R&D sectors

(1) Industrial sector number is arranged in CNAE-93 Rev.1 code order, used by Industrial Companies Survey from INE.
(2) Capital stock per worked hour (thousands €/hour) is the mean of the quotient between capital stock in constant prices and the gross fixed capital formation deflator recorded by the Spanish National Accounts from INE. Capital stock in constant prices equals the annual asset amortization extracted from the Industrial Companies Survey divided by the mean of the asset amortization rate in the period 1993-2004, recorded by the Central Balance Sheet Data Office at the Bank of Spain. Asset amortization rate is the quotient of the annual asset amortization and the mean of the previous and the current year recorded by the Central Balance Sheet Data Office.
(3) R&D expenditures over capital (%) is R&D expenditures in constant prices divided by capital stock in constant prices. R&D expenditures in constant prices equals the quotient between the R&D expenditures in current prices from the Industrial Companies Survey and the gross fixed capital formation deflator recorded by the Spanish National Accounts.
(4) FDI weight (%) equals gross FDI in constant prices in the industrial sector divided by the gross FDI in constant prices of all industrial sectors. Gross FDI in constant prices equals gross FDI in current prices (from DataInvex: Foreign Investment Statistics in Spain, from the Ministry of Industry) divided by the gross fixed capital formation deflator recorded by the Spanish National Accounts.
(5) FDI over value added (%) equals the addition of the gross FDI in constant prices divided by the mean of the value added in constant prices. Value added in constant prices is the quotient of the value added in current prices and the Industrial Price Index (IPRI) from INE. Value added in current prices equals total operating income minus consumption and work done by other companies. This data is from the Industrial Companies Survey.

Table 5: Correlation matrix

Variables	Value added	Labour costs	Capital stock	Worked hours	R&D expenditures	Gross FDI
Value added	1	0.3626	0.9214	0.8069	0.5155	0.4320
Labour costs		1	0.4103	-0.1765	0.3605	0.2625
Capital stock			1	0.6503	0.4781	0.4165
Worked hours				1	0.3855	0.2845
R&D expenditures					1	0.2454
Gross FDI						1

Table 6: Descriptive statistics

Variables (in logs)	Mean	Standard deviation	Minimum	Maximum
Value added (thousands €)	13.82	0.97	11.00	16.33
Labour costs per worked hour (thousands €/hour)	2.63	0.36	1.76	3.61
Capital stock (thousands €)	12.98	1.21	9.53	17.32
Worked hours (hours)	10.32	0.88	7.69	12.39
R&D expenditures (thousands €)	6.43	2.80	-2.99	11.85
Gross FDI (thousands €)	6.07	5.15	-6.21	14.58

Table 7: Regression results FDI effects over value added

Dependent variable: (value added) $_t$	Total sectors	Total sectors	Capital-intensive and R&D-intensive sectors	Capital-intensive and low-R&D sectors	Labour-intensive and R&D-intensive sectors	Labour-intensive and low-R&D sectors
(Intercept) $_t$	0.0089023 [0.000746] (0.000)***	0.0092115 [0.0004428] (0.000)***	0.0109349 [0.0020668] (0.000)***	0.0122839 [0.0018534] (0.000)***	0.0174912 [0.0027235] (0.000)***	0.0050133 [0.0013522] (0.000)***
(Value added) $_{t-1}$	0.1256263 [0.0097076] (0.000)***	0.0817076 [0.0095845] (0.000)***	0.0313545 [80.053381] (0.557)	0.109769 [0.0330156] (0.001)***	0.0369202 [0.0520666] (0.478)	0.0052532 [0.0334485] (0.875)
(Labour costs) $_t$	0.6460303 [0.0169857] (0.000)***	0.5955753 [0.0118144] (0.000)***	0.769226 [0.0755731] (0.000)***	0.4939068 [0.029123] (0.000)***	0.5124983 [0.0700841] (0.000)***	0.6542559 [0.0311318] (0.000)***
(Capital stock) $_t$	0.2155042 [0.0060609] (0.000)***	0.2486073 [0.0049648] (0.000)***	0.3405142 [0.0329711] (0.000)***	0.165298 [0.0202116] (0.000)***	0.2039321 [0.0222996] (0.000)***	0.18841 [0.0162342] (0.000)***
(Worked hours) $_t$	0.7352108 [0.0094313] (0.000)***	0.7228263 [0.0088645] (0.000)***	0.6205922 [0.0402353] (0.000)***	0.7828534 [0.0419545] (0.000)***	0.6196423 [0.062584] (0.000)***	0.763898 [0.0308026] (0.000)***
(R&D expenditures) $_t$	-0.005041 [0.0005122] (0.000)***	-0.0049165 [0.0004375] (0.000)***	0.0074879 [0.0012641] (0.000)***	-0.0039058 [0.0009394] (0.000)***	-0.0060425 [0.0011875] (0.000)***	-0.003702 [0.0006075] (0.000)***
(Gross FDI) $_t$	0.0002764 [0.0001569] (0.078)*	-0.0003072 [0.0001419] (0.030)**	-0.0002569 [0.0004085] (0.529)	-0.0000365 [0.0002751] (0.895)	-0.0001058 [0.0003278] (0.747)	-0.0000501 [0.0002672] (0.851)
(Gross FDI) $_{t-1}$	0.0006483 [0.0001057] (0.000)***	0.0003409 [0.000096] (0.000)***	0.0020732 [0.0006112] (0.001)***	-0.000162 [0.000332] (0.626)	-0.0003951 [0.0003146] (0.209)	-0.0004601 [0.0002869] (0.109)
Time dummy 1995	0.013723 [0.0027796] (0.000)***	—	—	—	—	—
Time dummy 1996	0.022418 [0.0022345] (0.000)***	—	—	—	—	—
Time dummy 1997	0.021491 [0.0027114] (0.000)***	—	—	—	—	—
Time dummy 1998	0.0264603 [0.0023226] (0.000)***	—	—	—	—	—
Time dummy 1999	0.0170191 [0.0019535] (0.000)***	—	—	—	—	—
Time dummy 2000	0.0056828 [0.001532] (0.000)***	—	—	—	—	—
Time dummy 2002	-0.0089802 [0.0024035] (0.000)***	—	—	—	—	—
Time dummy 2003	-0.0174342 [0.0034033] (0.000)***	—	—	—	—	—
Time dummy 2004	-0.0127353 [0.0038235] (0.001)***	—	—	—	—	—
Time dummy 2005	-0.0035676 [0.0043875] (0.416)	—	—	—	—	—
Time dummy 2006	0.0019858 [0.0051022] (0.697)	—	—	—	—	—
Wald test	116 421.41	57 617.21	9537.49	8695.07	1257.02	6942.44
Sargan test (chi2)	78.97 (0.4164)	82.49 (0.3135)	14.19 (1.0000)	24.41 (1.0000)	22.92 (1.0000)	16.54 (1.0000)
Serial correlation first order	-2.67 (0.0075)	-2.47 (0.0133)	-1.68 (0.0932)	-2.38 (0.0173)	-1.23 (0.2196)	-2.15 (0.0312)
Serial correlation second order	0.29 (0.7744)	0.15 (0.8826)	0.30 (0.7635)	-1.55 (0.1223)	0.72 (0.4694)	-0.40 (0.6897)

Notes: Figures in [] are standard error and in () are *p*-value, *,**and***denote significance at the 10, 5 and 1% levels respectively.