Foreign Direct Investment and technical progress in Spanish manufacturing

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Abstract

The aim of this paper is to analyze the effects of foreign direct investment on technical progress in Spanish manufacturing. Particularly, we study its differential contribution depending on the economic structure of the industry. Results show that most FDI directs to capital-intensive sectors, specially when they are also intensive in R&D expenditures. 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 what seems to be related to a dynamic capabilities explanation or to complementarities with R&D expenditures.

Key words: Knowledge and productivity, Foreign direct investment, capital intensity, R&D intensity.

1. Introduction.

It is well known that foreign direct investment (FDI) is a powerful driver of growth in developing countries whose low wages attract investments that bring knowledge and technical progress to their economies. Such was the case of Spain years ago, when multinational automotive corporations and other industries brought striking development to Spanish manufacturing. At present, the Spanish economy is considered among the developed countries 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 is the role that FDI has played in recent years in the low technical progress rates of Spanish manufacturing?. ¿What is the relation of FDI and R&D expenditures to the performance of industries?, ¿and the relation between FDI and R&D contribution to technical progress?

The present paper is inspired in the avenue of research concerning FDI spillovers. Foreign Direct Investment (FDI) influence in host countries through technology transfers and increase the intensity of competition, (Caves, 1974). It is generally agreed that spillovers are generated by nonmarket transactions when resources, in particular, knowledge, are spread without a contractual relationship (Meyer, 2004). Spillovers arise in improved productivity, or other benefits, in the local industry. Such improvements should be different in particular sectors, depending on the intensity of labour and R&D, (Buckley et al., 2007). According to many studies, if the technology gap between foreign affiliates and local firms is low, potential positive gains from spillovers would be facilitated.

The relationship between R&D and productivity is a key to generate economic growth, (Griliches, 1979, 1988; Grossman and Helpman, 1991; Coe and Helpman, 1995). The aforementioned economic growth could be originated by increasing investment and production (Arrow, 1962), accumulation of human capital (Uzawa, 1965), or the acquisition of quality improved inputs (Goto and Suzuki, 1989).

The aim of this paper is to estimate the role of FDI on technical progress in Spanish manufacturing, accounting for other determinants of technical progress like R&D expenditure. It is an industry-level analysis, on which we also study the interaction between the economic structure of the industries, its innovation intensity and the attraction of foreign investment. We search for differences in the manner in which industries profit from foreign investments. We propose this investigation as a previous step to analyse spillovers, that is, we believe that the existence of a technical progress effect derived from FDI should be determined.

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

2. Foreign direct investment and the economic structure of industries.

There is an avenue of research about the relation between FDI and productivity or learning of locally owned firms. It is assumed that foreign firm has distinctive factor demands for labour in comparison with domestic firm, even within the same industry (Conyon et al., 2002). Foreign firms train their employees, who may later move to domestic firms with acquired skills (Tian, 2007). At the same time, foreign firms steals the most productive employees to local firms and make the process of assimilating foreign technology harder (Wang and Yu, 2007). Besides, foreign firms will use a more skill - intensive technology than the typical domestic investors and hence raise the wages of skilled workers (Feestra and Hanson, 1997), (Mody, 2004). However, is found that inward FDI in the host country produces a labour - displacing effect. This arises because the technology transfer brought in by FDI causes an excess supply of labour, creating downward pressure on labour costs, (Chakraborty and Basu, 2002).

Domestic firms may learn from observing foreign firms when there are close relationships between them, and may benefit from the technical support, the demand, and the supply provided by the foreign firms with which they have a relationship in the business chains (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).

An industry-level reading of these results suggest that every sector may present a different sensibility to profit from foreign investment, depending on its previous skills or even its economic structure. As a first approximation to the problem, we present the FDI evolution in Spanish manufacturing between 1993 and 2006, in figure 1. In general, interannual variability is remarkable, and it is possible to recognize two different parts. As it is shown FDI has an upward trend during the period 1993 – 2001, whereas it has a downward trend since 2001. The out of range value corresponding to 2001, is due to some singular operations. In this year, an important ammount of FDI is explained by the investment of Mexican cement firm called “CEMEX” in “Valenciana de Cementos” and in “La Auxiliar de la Construcción Sanson”. In fact, the FDI weight on manufacture of cement, lime and plaster industrial sector is 12,24 %.

[Insert Figure 1 about here]

We analyze 100 Spanish manufacturing industries for the fourteen years from 1993 to 2006. The data source is the Industrial Companies Survey by the National Statistics Institute (INE). We analyze the FDI destination industry attending to two main characteristics, the capital intensivity level and R & D level or R&D effort. Capital has traditionally been considered the main driver of technology progress and productivity gains, that is, the incorporation of more capital is linked to the incorporation of technology progress. In this way, there are evidences of interaction between capital investment and R&D investment, but the latter, are also responsible, according to many studies (Arrow, 1962, Bernstein and Nadiri, 1989, Jaffe, 1986), Bresnahan, 1986, and Coe and Helpman, 1993), of the incorporation of new knowledge, skills and therefore productivity improvement.

We also mention that the sample is divided into four subsamples, (Tables 1, 2, 3 and 4). The subsamples are defined depending on two dimensions. On the one hand the capital intensity which is measured as the accumulation of capital stock per worked hour during all the years, is higher or lower than the median value in all the industrial sectors. On the other hand, the R&D intensity are characterized considering if the accumulation of R & D expenditures over capital during all the years, is higher or lower than the median value in all the industrial sectors. After all the industrial sectors are classified into their subsamples, the table place of industrial sector is arranged higher and lower FDI weight order. Our taxonomy gain inspiration from the works of Peneder, 2001 and O`Mahony, 2009, who study the technological dimension of sectors.

FDI is higher in capital intensive sectors. In fact, the 83,5 % of FDI reach this kind of sectors. At the same time, capital intensive and low R & D sectors (Table 2) receive more FDI than capital intensive and R & D intensive sectors (Table 1). It happens as FDI weight (48,94 % is higher than 34,56 %) as FDI over value added (26,58 % is higher than 23,49 %). However, labour intensive and low R & D sectors (Table 4) receive less FDI than labour intensive and R & D intensive sectors (table 3). It occurs as FDI weight (6,88 % is lower than 9,62 %) as FDI over value added (8,81 % is lower than 11,52 %). FDI is concentrated in a few sectors. There are 21 capital intensive sectors, and only 4 labour intensive sectors where FDI weight is more than 1 %.

There are some remarkable sectors for their high FDI. So, in capital intensive and R & D intensive sectors (Table 1), manufacture of aircraft, of pharmaceutical products and of motorcycles reach (80,8 %, 39,7 % and 36,6 %) FDI over value added, whereas manufacture of chemical products, motor vehicles, pharmaceutical products and publishing get (5,62 %, 5,44 %, 5,19 % and 4,26 %) FDI weight.

On the other hand, in capital intensive and low R & D sectors (Table 2), the aforementioned manufacture of cement, lime and plaster sector get the highest FDI. In addition, manufacture of man-made fibres, cleaning and paper receive (130,9 %, 55,5 % and 54,4 %) FDI over value added, whereas production of electricity, cleaning and alcoholic beverages reach (9,89 %, 4,06 % and 3,36 %) FDI weight. However, in labour intensive and R & D intensive sectors (Table 3), television and radio, manufacture of machine – tools, other textile industries, accumulators and railway get (96,5 %, 32 %, 28,4 %, 26,5 % and 25,9 %) FDI over value added, whereas television and radio and accumulators receive (2,47 % and 1,66 %).

On the other side, in labour intensive and low R & D sectors (Table 4), textile fibres industries, bread and cork reach (48,5 %, 30,9 % and 20,4 %) FDI over value added, whereas bread and textile fibres get (2,68 % and 1,06 %).

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

3. Model, data and methodology

The most common way to estimate technical progress is the one proposed by Solow (1957). We suppose the production function to be a Cobb-Douglas, that transformed in logarithms is expressed as:

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

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

The expression (1) is true under certain conditions, particularly under constant prices of inputs. In an environment of decreasing prices the demand for factors could reach smaller marginal value of input productivity. For that reason, when estimating the equation a term of cost of inputs should be introduced.

Another implicit condition is that there are no different types of capital input, that is, no heterogeneity in its marginal productivity. In this paper we aim to identify the role of FDI and its interaction with R&D to productivity and technical progress. The estimates of input capital make no distinction about its origin, so it should be introduced in the equation in a redundant manner.

Data

We use the dataset *Industrial Companies Survey*, from *INE*, which is comprehensive of the manufacturing sector in Spain. It contains homogeneous information for the period from 1994 to 2006 of 100 sectors. Data of FDI, are obtained from DataInvex: Foreign Investment Statistics in Spain from Ministry of Industry, and data about prices come from *Industrial Price Index* from *INE*.

Output is measured by value added (revenues minus external purchases) in constant prices (by every industry production deflator). Services of capital are the estimated depreciation of fixed assets (transformed to a stock variable through the average depreciation rate obtained from *Central Balance Sheet Data Office from the Bank of Spain* and expressed in constant terms by the gross fixed capital formation deflator). Services of labour input are the number of worked hours. Cost of inputs is proxied by the average wage in constant terms. FDI is gross foreign direct investment expressed in constant prices by the gross fixed capital formation deflator. R&D is the R&D expenditures of the year considered to be fixed assets, expressed in constant terms by gross fixed capital formation deflator.

Model and methodology

The model to estimate is expressed as equation (2). It relates the natural logarithm value added for manufacturing industry i in year t, $x_{i,t}$ to a number of variables in the following way:

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

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 a i.i.d.

error term. We also allow for persistence in value added by specifying a dynamic production function including lagged value of x as regressor. In addition, we introduce lagged value of f as regressor to address the question of causality with respect to value added. Estimation is carried out by the Generalized Method of Moments (GMM) proposed by (Arellano and Bond, 1991), what gives a consistent estimation in the presence of heteroskedasticity of unknown form.

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

[Insert Tables 5 and 6 about here]

4. 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 inform that global significance of the model is high. Differentiated residuals behave in most estimations as a white noise, and the null of correct specification of the restrictions (Sargan test) is not rejected.

In all the estimations the intercept is significant. 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, significant in the first estimation (with time dummies) and statistically equal to zero in the first, third and fourth subsets.

Regarding the production function parameters, output elasticity to labour and capital, are normally considered consistent with a hypothesis of constant returns to scale. The estimation for total sectors with time dummies give a coefficient for capital of 0.216, and a coefficient of 0.735 for labour (worked hours), a sum of about 0.95 that is rejected to be statistically equal to one (standard errors are very small being a particularly efficient estimation) could be considered 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 be not rejected now, with higher standard deviations of the coefficients), except for the subset of labour intensive and R&D intensive industries (third subset), for which the sum of the coefficients of capital and labour are equal to 0.82. However, this estimation should be cautiously considered, since the tests of serial correlation reject in this case the residuals to be a white noise.

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

The time variables tend to be positive and significant the first years of the period, and generally negative and significant during most last years. Under this explicative model, this evolution of time coefficients show a decreasing tendency in productivity that would reach a minimum in 2003, not explained by the evolution of input prices as control variables. This is a result consistent with some other estimations of total factor productivity for the Spanish economy in last years[1].

R&D and FDI are redundantly included in the estimation of output. Both investments are included in capital input, estimated as a stock (proxy of capital services). If the coefficient of one of these variables is zero, this type of capital has the same elasticity to output as the rest of assets. A positive sign of the coefficient represents that such investment gives a higher elasticity of the output.

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 is contradictory to many studies that identify a positive effect of innovation on productivity. In fact, it is believed that R&D could be derived from improved production technology and also increase the productivity as well as of return on investment at both the firm and industry levels, (Griliches 1986, 1990), (Mansfield, 1988), (Goto and Suzuki, 1989), (Meliciani, 2000), (Timmer, 2003), and (Gonzalez and Gascon, 2004). Our particular result is probably explained by the measurement of R&D in *Industrial Companies Survey*: R&D expenditures are only computed when they have been accounted as fixed assets. That happens when innovation has been real, effective and valuable. Implicitly, a determinate amount of R&D in the data has required a bigger amount of consumption of factors to become a valuable innovation. This negative coefficient is reflecting higher adjustment costs that in the remaining of the assets.

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

When estimating the model for the four subsets of data, we obtain a positive significant sign of the coefficient for the group of capital intensive and R&D intensive industries where its positive effect in productivity overcomes the adjustment costs. For the rest of the subsets we obtain a negative contemporaneous net effect. We conclude that capital intensive and R&D intensive sectors offer the most convenient conditions for innovations 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.

Foreign direct investment has a positive significant (at 90%) effect on contemporaneous output, according to the first column 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 (Alvarez and Molero, 2005), (Haskel, Pereira and Slaughter, 2002)). 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 subsets of industries give in all cases a contemporaneous coefficient not significant. The same case happens with the lagged variable, it is statistically non significant 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.

Again, this subset of sectors has a differential behaviour, as we stated in section 2 and now in the empirical estimations. This group of industries offers the conditions to create or receive innovations and capital entries and to transform them in value created, in higher values than that obtained by present investments. Some new research questions arise from these results. First, what are the industry and firm conditions that favour organizational learning to take most advantage of innovations and foreign investments. Second what are the spillovers of FDI and innovation, and how they are transmitted.

[Insert Table 7 about here]

5. Concluding remarks.

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

First, we describe the behaviour of FDI in the Spanish manufacturing sector. We get evidences in favour to Spanish capital intensive industry as a receiver of most of the FDI as well as to have the highest FDI intensity, measured as FDI over value added by the sector. Our hypothesis is that this kind of FDI generates technology progress and productivity gains, what is in this paper evaluated.

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

The main results are the positive effect of contemporaneous and lagged FDI on manufacturing productivity especially in capital and R & D intensive industries. In fact, in this kind of sector, R & D expenditures gives a higher elasticity of the productivity than the rest of the assets. At the same time, this subset of sectors provides the requirements to generate or receive innovations and capital entries and to convert them in higher value added than the achieved by domestic investment. This results indicates some avenues for future research. First, to get an explanation about the industry and firm conditions that improves organizational learning from innovation and foreign investment. Second, to establish the reasons of the spillovers of FDI and innovation, and the way they are transmitted.

The difference in coefficients of FDI between the subsamples of industries also suggest that the heterogeneity do not only reside in the conditions of the industries to absorb the positive effects of foreign capital, but also that heterogeneity exists in the foreign investments, depending on the type of target industry. It is reasonable to state that FDI pointing at labour intensive and less innovative industries is searching for different competitive advantages that FDI pointing at capital intensive and innovative sectors.

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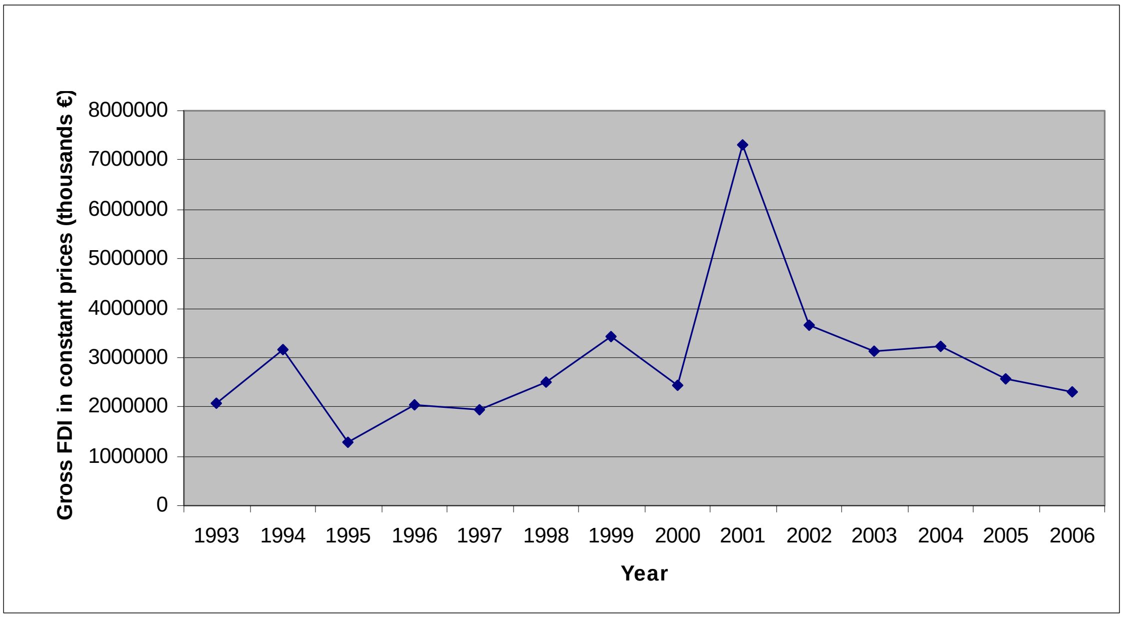
Figures and tables:

Figure 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 non-energy 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 non-metallic 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

Table 2: Capital intensive and low R & D 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)
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 non-ferrous 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 non-alcoholic 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

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)
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 4: Labour intensive and low R & D 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

(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 gross fixed capital formation deflator recordered by the Spanish National Accounts from INE. Capital stock in constant prices is the quotient between the annual asset amortization extracted by Industrial Companies Survey and the mean of the asset amortization rate in the period 1993-2004 recorded by Central Balance Sheet Data Office from the Bank of Spain. Asset amortization rate is the quotient between the annual asset amortization and the mean of the previous and the current year recorded by Central Balance Sheet Data Office.
(3) R & D expenditures over capital (%) is the addition of the quotient between the R&D expenditures in constant prices and the capital stock in constant prices previously described. The R&D expenditures in constant prices is the quotient between the R&D expenditures in current prices extracted by Industrial Companies Survey and the gross fixed capital formation deflator recorded by the Spanish National Accounts.
(4) FDI weight (%) is the quotient between the gross FDI in constant prices of the industrial sector and the gross FDI in constant prices of all the industrial sectors. Gross FDI in constant prices is the quotient between gross FDI in current prices extracted by DataInvex: Foreign Investment Statistics in Spain from Ministry of Industry and the gross fixed capital formation deflator recorded by the Spanish National Accounts.
(5) FDI over value added (%) is the quotient between the addition of the gross FDI in constant prices previously described and the mean of the value added in constant prices. Value added in constant prices is the quotient between the value added in current prices and the Industrial Price Index (IPRI) from INE. Value added in current prices is the subtraction between the total operating income and the consumption and work done by other companies. This data is extracted by 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 intensive sectors	Labour intensive and R & D intensive sectors	Labour intensive and low R & D intensive 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	116421.41	57617.21	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.