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Research Article

ANALYSIS OF PRODUCTIVITY AND ITS DETERMINANTS IN THE SPANISH MANUFACTURING SECTOR

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ABSTRACT

This work focuses on analyzing the differences in productivity and the explanatory factors from a microeconomic perspective on a panel data over the period 2000-2010 in 30 Spanish industrial sectors NACE three-digit. The semiparametric methodology it's proposed to estimate productivity that has allowed to consider the simultaneity of inputs and productivity. The main results show intra-and intersectoral differences in total factor productivity. Regarding the determinants of productivity, size is usually related to higher levels of productivity in parametric methods but in the case of semi-parametric methods this relationship is diverse (U-shape, inverted U-shape, wave-shape). The skills and capital intensity are related positively and negatively respectively.

INTRODUCTION

The debate on improving productivity of the Spanish economy is an opportunity to recognize the capacity of Spanish companies to create wealth and employment and facilitate social progress (Huerta and Garcia Olaverri 2014). In Spain, the analysis of productivity becomes more relevant if possible because of the current international financial crisis that began in the summer of 2007 until now has had a major impact on the Spanish economy. An important part of the literature indicates that the main evidence in the analysis of the literature on productivity, focus on the important productivity differences that exist in each sector (Barstelman and Doms 2000, Barstelman, Haltiwanger and Scarpetta 2009). Often mentioned that productivity differences between firms are persistent over time and that the movements of aggregate productivity usually respond greatly to the mobility of productive resources between companies in the same sector. As Fernandez, de Guevara (2011) indicates the search for a more productive growth pattern based on the replacement of traditional, labor-intensive sectors by others with higher technological content and lower human resource requirement also poses problems for an economy as the Spanish where the work factor is a factor surplus as is clear from the high rate of unemployment (Doménech and Garcia 2010). This paper focuses on analyzing the differences in productivity and the explanatory factors from a microeconomic perspective on a panel data over the period 2000-2010 in 30 Spanish industrial sectors NACE three-digit. This goal is especially important, given the characteristics of Spanish production that later addressed with small companies and therefore fewer resources available where there may be greater restrictions on the use of economies of scale while impeding the realization of research, development and innovation, outsourcing of activities or access to international markets. Authors analyzing the evolution of productivity from a sectoral perspective such as Mas and Robledo (2010) indicate that in Spain the productivity growth is slow due to specialization in sectors with low productivity and minimal progress in the use of new technologies of information and communication technologies (ICT). (Felgueroso and Jimenez Martin 2009) mention the mismatch between human capital accumulated and which require the adoption of new technologies. Other authors suggest that the high temporality no takes advantage of human capital (Doménech and Garcia 2010) or excess installed capacity, due to financial factors and earnings expectations (Perez and Robledo 2010). This work is like those posed by Farinas and Ruano (2005), Lopez-Garcia, Bridge and Gomez (2007), Escribano and Stucchi (2008),

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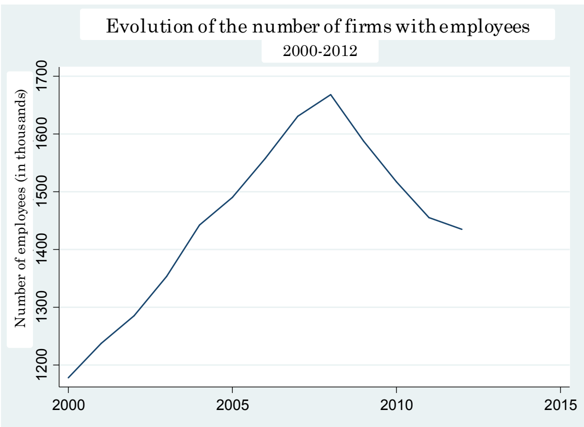
Alonso Borrego (2010) and Fernández de Guevara (2011), Doraszelski and Jaumandreu (2013) approaches. Particular, it SABI database (Commercial Register in Spain) although the latter work for a period and different methodology and focused on the industrial sector is used. It also differs in the second stage analysis regarding the determinants of productivity since the sector by sector analysis.

Overview of the Spanish manufacturing sector

This sub section raises two issues considered relevant to understanding the sectoral structure, aspects related to the demographics of industrial enterprises in context and characteristics relating to enterprise size. Regarding the first question, the differences of the Spanish business with other neighboring countries, are seen in that in Spain the number of births in the years before the crisis was more intense than in the UK, Germany and Italy even lower than in France. In the crisis years for which Eurostat has information (2007-2010), Spain is the country where more number of companies, -5%, along with Italy, -1% and the UK fell, - 3%, compared to growth in other countries (6% in Germany and 15% in France). Regarding entrepreneurship Spain has gone from being the country where most companies were born at least.Figure 1 show the evolution of firms with employees.As can be seen the trend changes from 2009.



Source: DIRCE (INE 2012) and own elaboration

Fig. 1. Evolution of firms with employees

Regarding the second question of the Spanish business, this focuses on the weight smaller than larger companies have in our economy compared to other countries.Both in terms of number of enterprises and employment. The percentage of companies with 10 or more workers is lower in Spain than in other neighboring countries, except Italy.Furthermore, in the crisis years has increased the weight of businesses without employees and reduced the percentage of firms in sections 5-9 and 10 or more employees, as reflected in Table 1.

Table 1. Structure percentages of Spanish business

	2000	2007	2008	2009	2010
with employees	54,4	52,6	52,8	55	55,8
1 to 4	33,5	35,2	35,9	34,5	34,0
5 to 9	6,6	6,6	6,2	6,0	5,9
10 and more	5,5	5,5	5,0	4,5	4,3
	100	100	100	100	100

Source: Eurostat and own elaboration

This paper is organized as follows, section two presented the databases. In section three we show the methodology used in the analysis of productivity and its determinants. In section four we show results. Finally, section five presents the main conclusions.

DATA

The empirical analysis conducted in this paper uses information from the SABI database. This database collects information from more than 180,000 registered in the Official Mercantile Register firms through balance sheets, income statements and other relevant information that companies recorded annually in accordance with Spanish law. The information covers all sectors and is statistically representative of the 17 Spanish regions. The database was created with 7021 business year on average. The sectors we have been able to work were 30 following NACE-2009 classification to three digits for the period 2000-2010. The sample was restricted firms with more than 3 employees because of incorrect information on the group of companies with fewer employees as indicated (Coad et al., 2012). The variables used in the empirical analysis are: Output: we used the added value (VA) of each company. This is defined as turnover plus / minus changes in inventories of finished goods and work in progress plus other operating income; less procurements.Employment: the number of employed is used because it does not exist in SABI other available information. Capital: we used the value of fixed asset inventory. All variables have been deflated using the price index of the Spanish National Statistics Institute (INE) using the nearest sector activity deflator.

METHODOLOGY

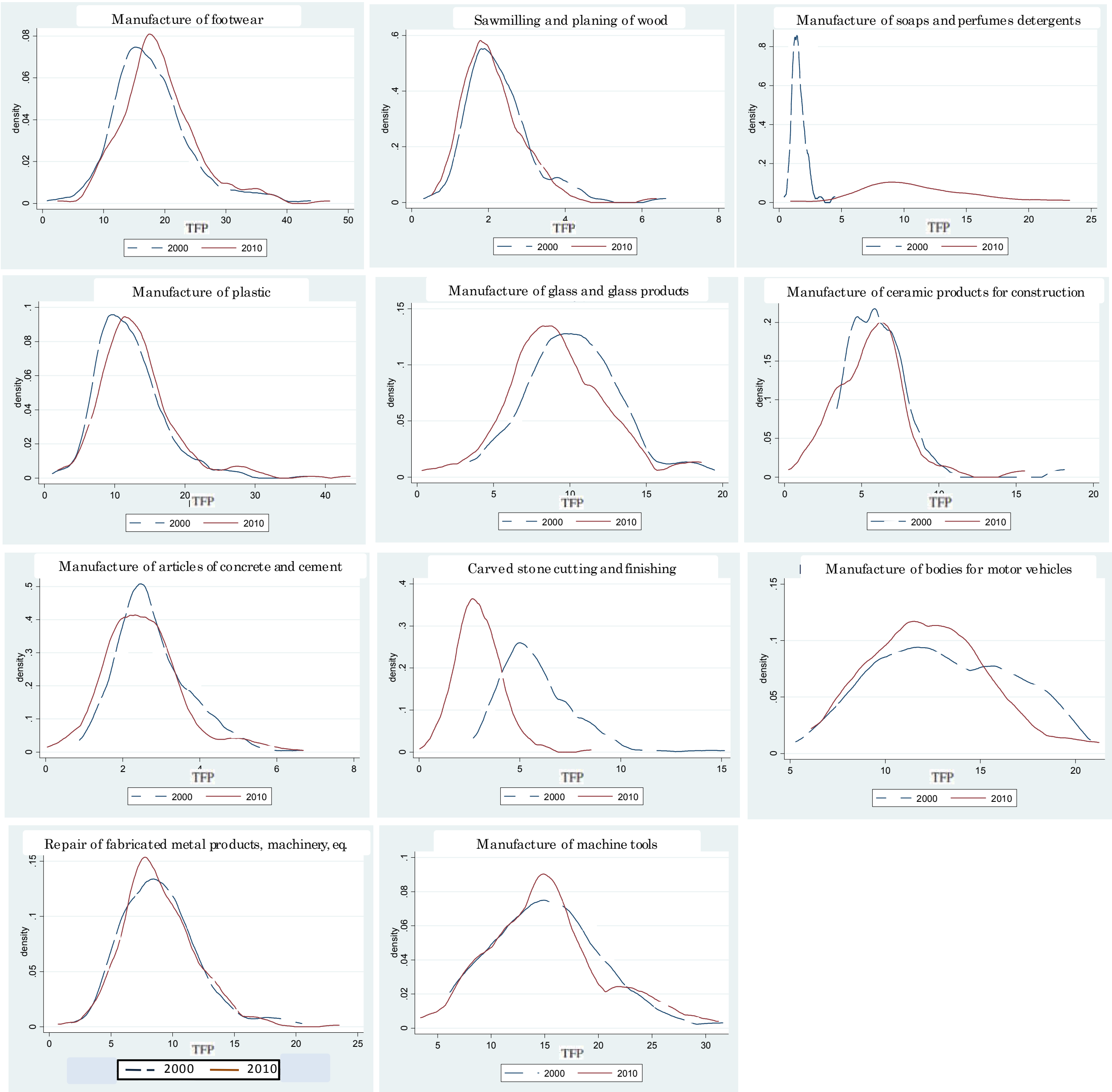
In this paper, we used a method in two stages. In the first stage, total factor productivity (TFP hereafter) is estimated using the method of Wooldridge, Levinsohn and Petrin (WLP hereafter).The estimation of TFP based on the WLP method is a modification of Wooldridge (2009) on the methodology of Levinsohn-Petrin (2003) (hereafter LP). WLP estimator takes into account the simultaneity of inputs and productivity by presenting robustness to criticisms made by (Ackerberg et al. 2006).In the second stage, the estimate of TFP for each company as dependent variable and the determinants of this will be used; size, skills, capital intensity, and time. Section 4.3 elaborates on the choice of these variables and their use in the literature.

Measure of total factor productivity

In this paper we use a Cobb-Douglass production function that in logarithms, we shown in equation 1(Añon et al. 2014: 223)[1]:

$$y_{it} = \beta_o + \beta_k k_{it} + \beta_l l_{it} + \beta_m m_{it} + w_{it} + \mu_t + \eta_{it} \quad (1)$$

Where y_{it} is the log of output of firm i in t period corresponding to the value added, $k_{it}$is the logarithm of capital factor expressed by the asset, l_{it} is the logarithm of labor and m_{it} is the logarithm of intermediate consumption. The term w_{it} is unobservable and represents the productivity of the company (which is supposed to be observable by the company but not by the researcher) and $\eta_{it}$is a term standard error is not observable or predictable by the company. Finally, $u_t$is a vector of dummy variables that capture the time.



Source: Own elaboration

Fig. 2. Density Functions 2000 and 2010

It is assumed that capital is not directly related to contemporary productivity shocks (this is a variable state). Regarding the variables labor and intermediate inputs are variable inputs, the company can adjust in response to productivity shocks. With these assumptions Levinsohn and Petrin (2003) propose the use of a semi-parametric model based on Olley and Pakes proposal (1996) (hereinafter OP). The LP model differs in the use of intermediate consumption rather than investment using OP. LP propose the use of materials demand, $m_{it} = m\ (k_{it}, w_{it})$ instead of investment demand as control function to retrieve the unobserved by the company, however productivity, as already discussed this paper adopts the WLP proposal. The contribution of Wooldridge (2009) is based on the use of generalized method of moments (GMM), where the first equation solves the problem of endogeneity of the variable inputs and the second takes into account the assumptions about the evolution of productivity.

If the demand function for intermediate consumption is monotonically increasing in w_{it}, given the capital can be invested to generate the following inverse demand consumption:

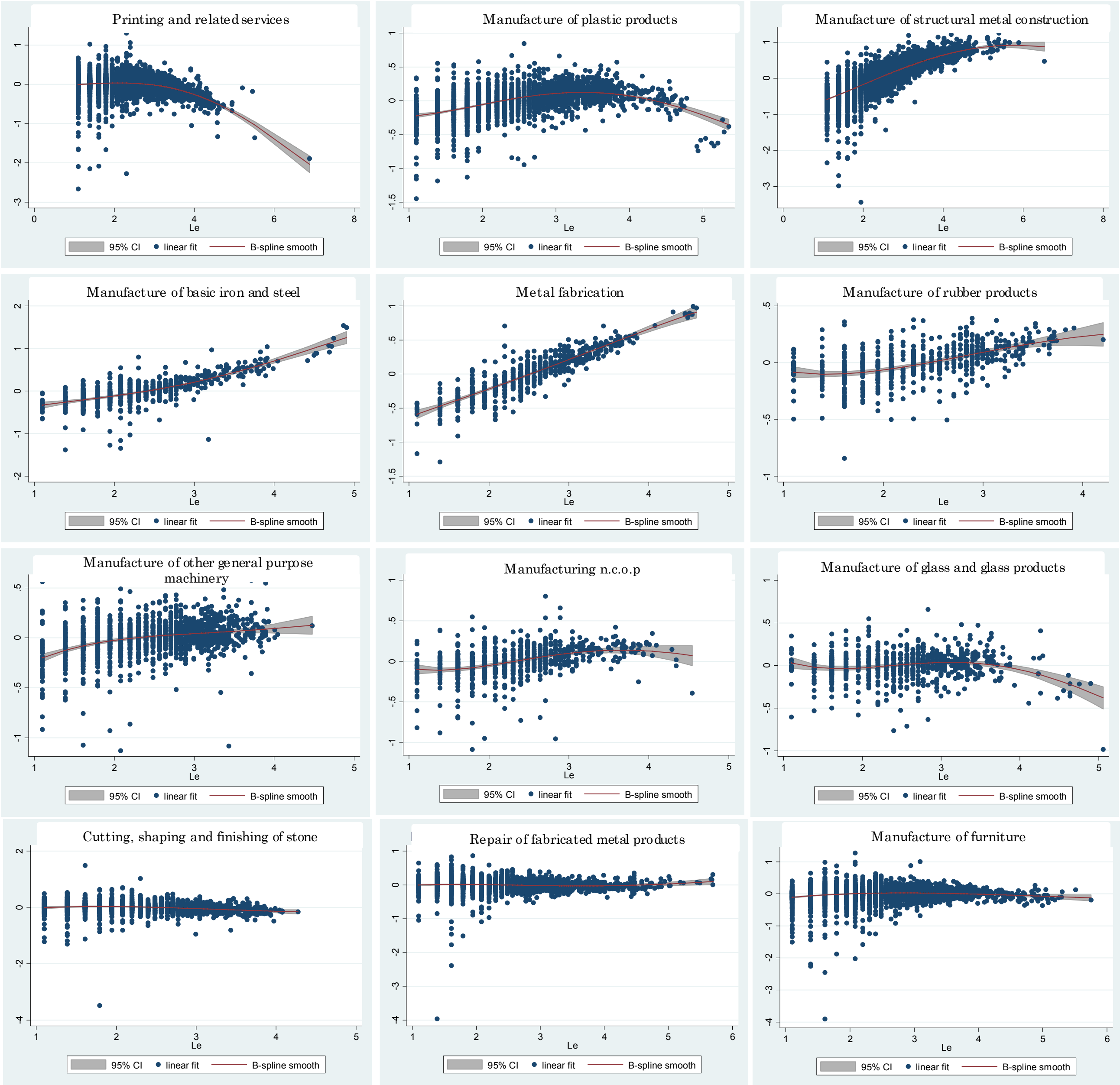
$$w_{it} = m\ (k_{it}, m_{it}) \qquad (2)$$

where m (•) is an unknown function kit, m_{it}. Substituting the inverse of the demand for intermediate consumption (2) in equation (1) we obtain:

$$y_{it} = \beta_o + \beta_k k_{it} + \beta_l l_{it} + \beta_m m_{it} + m\ (k_{it}, m_{it}) + \mu_t + \eta_{it} \qquad (3)$$

Following the standard focus, we assume that productivity approach evolves exogenous following a Markov process:

$$w_{it} = E(w_{it}|\ w_{it-1}) + \xi_{it} = f(w_{it-1}) + \xi_{it} \qquad (4)$$



Source: Own elaboration

Fig. 3. Nonparametric relationship between productivity and size

Where f (•) is an unknown function relating productivity to $t$with productivity in t-1 and ξ_{it} ,is an error term, which by definition is not correlated with w_{it}. For a discussion on this approach see Wooldridge (2009).

Methodology for determining the factors explaining productivity

Often used estimation techniques with parametric panel data between the endogenous variable and the explanatory variables (see eg Arellano and Honoré, 2001). Thus,assumed linear relationships. Some authors indicate rigidity problems in the relationship of variables specification problems with reaching some cases result in erroneous inferences. Non-parametric methods may be more flexible and robust, because they do not impose a priori functional form (see for example Lee and Kondo, 2002).

Disadvantages of nonparametric models are derived technical and other interpretative nature. Regarding the former, the nonparametric estimators are based on the idea of local weighted averages when there are high values observations are scattered, so that estimates can be unsatisfactory. Seconds relative to the results sometimes are focused to a graph may be little interpretive. This paper presents a semi-parametric or parametric model based on the test Härdle and Mammen's (1993) (See Verardi and Debarsy 2012) is chosen. This is intended to combine the advantages of the models (Moral-Arce and Maza 2010: 221). Equation 5

$$Y_{it} = X_{it}\beta + f(Z_{it}) + \varepsilon_{it}\, i= 1,...,n;\ t=1,...,T \qquad (5)$$

Where X_{it} β is the parametric component and $f(Z_{it})$ is the nonparametric. $X_{it} = (X_{1it}, ..., X_{pit})$ and $Z_{it} = (Z_{1it}, ..., X_{dit})$ are vectors of explanatory variables that are linear influence on the endogenous variable Y_{it} and Z_{it} is the explanatory variable that influences Y_{it} of unknown form. β is the vector of parameters associated with X_{it}, and f (·) is a nonparametric multivariate Z_{it}function. The term mean zero errors ε_{it} is assumed to be iid. For a discussion of the econometric approach and see Libois and Verardi (2013).

The model to be estimated in terms of the variables defined above would be:

Parametric form;

$$LnTPF_{it} = \beta_{1i}\ LnLabour + \beta_{2i}\ Skills + \beta_{3i}\ Int\_Capital + \sum_{j=1}^{11} \beta_{4it} T + \varepsilon_i \quad (6)$$

Semiparametric form;

$$LnPTF_{it} = f(Labour) + \beta_{1i}\ Skills + \beta_{2it} Int\_Capital + \sum_{j=1}^{11} \beta_{3i} 4T + \varepsilon_i \quad (7)$$

RESULTS

In this section the main results are presented. In subsection 4.1 the results of estimates of production functions are collected. In subsection 4.2 kernel density functions of initial productivity of 2000 and end in 2010. In the subsection 4.3 shows the results of the determinants of productivity are presented.

Table 2. Nº of observations/year

Year	Nº of observations	Aggregate
2000	6991	9,02
2001	7002	9,05
2002	7003	9,05
2003	6996	9,04
2004	6988	9,03
2005	6984	9,03
2006	6972	9,02
2007	7080	9,19
2008	7085	9,21
2009	7073	9,20
2010	7065	9,18
Total	77239	100

Source: SABI own elaboration

Table 3. Nº of observations/firms

Nº de obs/empresa	Nº of observations	Porcentaje	Agregate
2	26	0,03	0,03
3	115	0,15	0,18
4	256	0,33	0,51
5	179	0,23	0,74
6	256	0,33	1,07
7	358	0,46	1,54
8	410	0,53	2,07
9	576	0,75	2,81
10	2636	3,41	6,23
11	72427	93,77	100
Total	77239	100	

Estimating production functions

Table 4 shows the results of the production functions of each sector per Cobb Douglas production function. As can be seen all sectors assume this technology. In general, a greater contribution of labor (elasticity of labor) occurs to capital (elasticity of capital) as reflected in the coefficients of the variable $(LNL)^2$.

Despite this major contribution of the labor is uneven, for example the reduced contribution occurs in sectors 284 Manufacture of machine tools (β_l = 0.526); 236 Manufacture of concrete products (β_l = 0.553); 222 Manufacture of plastic products (β_l = 0.565). While most contributions are in the sectors 245 Casting of metals (β_l = 0.821); 331 Repair of fabricated metal products (β_l=0.769); 255 Forging, stamping and roll forming of materials (β_l = 0.744). Regarding returns to scale, only verified in 4 (13.3%) sectors constant returns to scale (CRS); 152 Manufacture of footwear, 181 Graphic Arts, 222 Manufacture of plastics and 236 Manufacture of concrete products; dividing equally the rest of increasing and decreasing returns of scale sectors.

In relation to the presence of technological progress, the coefficient of the variable t (proxy for technological progress) is positive and statistically significant in 13 sectors (43.3%). While in two sectors 233 Manufacture of clay and 236 Manufacture of concrete, the coefficient is negative and statistically significant, indicating technological regress, which probably implies that technological advances have not been incorporated into the production process or have carried out late. Finally, the remaining 50% there is no statistical significance.

Table 5 shows the average values of productivity, standard deviation (SD), 90-10 percentiles and comparison between percentiles. As shown, mean values and SD, fluctuate ostensibly by sector. For example, sectors 152, 289 and 292 with mean values and SD 15.7 (4.90) 14.6 (5.21) and 14.0 (4.10) respectively show high values compared with the sectors 205, 236 and values 204 0.96 (0.40), 2.13 (0.75) and 2.30 (0.73) respectively. Productivity values in the 90 percentiles are more than double and even triple in some sectors compared to productivity 10. percentile difference between the logarithms of the productivity in the 90 and 10 percentiles and its relationship relative to the PTF (sixth column of Table 5, D) according to the approach Syverson (2011) shows that firms in the 90th percentile of the distribution of productivity obtained, for example 1.62 times more output with the same input a firm located in the 10th percentile in the sector (201) Manufacture of basic chemicals.The lowest ratio is in the sector (172) Manufacture of paper and cardboard 1.32 times. The average for the 30 sectors is 1.53 times.

Analysis of productivity (average, kernel differences and modes)

Table 6 shows Test p values equal distribution functions Kolmogorov-Smirnov (second column) and p values Hartigan test for the existence of unimodality in 2000 and 2010 (third and fourth columns respectively). The test results equal distribution functions show that there are differences in kernel distributions in 2000 and 2010 by 30% of the sectors; 152, 162, 204, 222, 231, 236, 237, 292 and 310. In the case of the sectors 152 and 222 are seen improvements in productivity as shown in Figure 2, where the distribution 2010 shifts to higher values. However, in the sectors 231, 236 and 292 a given displacement distribution towards lower values 2010 shown worsening. Finally sectors 162 and 310 show stagnation. Regarding the existence of unimodality, is general in the 90% of the sectors as shown in the table 6. Only the sectors 233, 284 and 292 show multimodalities.

Table 4. Estimates of production functions

Sector	152	161	162	172	181	201	203	204	205	221
	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t
t	0.014	0.010	0.008	0.007	0.005	0.005	0.007	0.014	0.008	0.0008
	(5.04)	(2.34)	(3.84)	(1.88)	(4.05)	(0.99)	(1.19)	(2.52)	(1.14)	(0.169
LnL	0.718	0.713	0.640	0.667	0.603	0.607	0.698	0.656	0.577	0.744
	(27.50)	(10.71)	(20.26)	(7.67)	(23.01)	(9.11)	(6.51)	(9.64)	(6.30)	(12.13)
LnK	0.159	0.402	0.310	0.324	0.329	0.343	0.462	0.513	0.688	0.370
	(4.19)	(4.24)	(8.90)	(4.45)	(11.77)	(3.82)	(5.08)	(3.88)	(5.77)	(3.41)
nº obs.	1921	1070	4472	974	7913	670	642	732	443	643
RCE (Chi2)	7.98	1.78	1.24	0.00	5.33	0.17	2.17	1.90	3.55	1.04
	(0.004)	(0.182)	(0.266)	(0.999)	(0.020)	(0.677)	(0.140)	(0.167)	(0.05)	(0.307)
Sector	222	231	233	236	237	241	245	251	255	257
	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t
t	0.0001	0.016	-0.025	-0.015	0.004	0.004	0.010	0.010	0.006	0.003
	(0.06)	(3.03)	(3.28)	(4.13)	(1.43)	(0.86)	(2.10)	(7.51)	(2.47)	(0.80)
LnL	0.565	0.584	0.600	0.553	0.696	0.662	0.821	0.701	0.744	0.674
	(17.74)	(6.55)	(10.48)	(14.98)	(15.70)	(12.35)	(14.08)	(32.80)	(16.37)	(13.64)
LnK	0.324	0.341	0.534	0.573	0.347	0.346	0.312	0.282	0.331	0.265
	(7.86)	(4.66)	(4.48)	(9.76)	(6.86)	(4.60)	(4.94)	(10.37)	(5.24)	(4.08)
nº obs.	3123	776	611	2826	2335	826	685	12091	1182	1225
RCE (Chi2)	8.96	0.41	0.97	5.69	0.99	0.03	3.58	0.05	2.16	1.01
	(0.002)	(0.520)	(0.325)	(0.017)	(0.32)	(0.868)	(0.058)	(0.830)	(0.142)	(0.316)
Sector	259	282	283	284	289	292	293	310	329	331
	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t
t	0.001	0.009	0.014	0.05	0.003	0.007	1.63	0.014	0.010	0.016
	(0.73)	(2.93)	(2.66)	(0.75)	(1.06)	(1.63)	(0.10)	(8.48)	(1.57)	(7.72)
LnL	0.602	0.647	0.751	0.526	0.700	0.593	0.734	0.712	0.688	0.769
	(20.10)	(17.11)	(10.25)	(8.99)	(19.82)	(7.59)	(16.34)	(27.44)	(10.0)	(28.4)
LnK	0.443	0.306	0.415	0.424	0.247	0.265	0.234	0.263	0.520	0.254
	(12.15)	(5.39)	(3.92)	(4.43)	(5.77)	(3.90)	(1.77)	(6.84)	(3.98)	(6.72)
nº obs.	3648	1737	567	557	195	757	841	6252	850	3837
RCE (Chi2)	1.11	0.39	3.23	0.20	1.09	2.19	0.03	0.05	2.90	1.24
	(0.291)	(0.534)	(0.07)	(0.653)	(0.297)	(0.139)	(0.852)	(0.824)	(0.088)	(0.265)

Source. Own elaboration

Table 5. Average values, standard deviation, percentiles and percentile distance between TFP

Designation of sectors	Mean	SD	90 p.	10 p.	D
152 Manufacture of footwear	15,70	4,90	21,42	10,68	1,35
161 Sawmilling and planing of wood	3,63	1,30	5,26	2,31	1,43
162 Manufacture of wood, cork, straw ..	8,53	2,67	11,77	4,38	1,54
172 Manufacture of paper and paperboard	8,21	2,43	10,71	5,62	1,32
181 Printing and service activities related to printing	9,55	3,18	13,45	5,97	1,42
201 Manufacture of basic chemicals	9,21	3,17	16,58	5,49	1,62
203 Manufacture of paints	2,77	0,89	10,35	3,55	1,59
204 Manufacture of soaps	2,30	0,73	3,89	1,53	1,50
205 Manufacture of other chemicals	0,96	0,40	2,27	0,82	1,56
221 Manufacture of rubber products	5,19	1,72	9,82	3,46	1,57
222 Manufacture of plastic products	11,44	4,15	15,40	5,32	1,59
231 Manufacture of glass and glass products	8,21	2,64	7,45	2,92	1,50
233 Manufacture of ceramic products for construction	2,59	0,92	7,99	3,20	1,49
236 Manufacture of articles of concrete, cement and plaster	2,13	0,75	2,55	0,94	1,54
237 Cutting, shaping and finishing of stone	6,27	2,00	6,07	2,35	1,51
241 Manufacture of basic iron and steel	7,70	2,62	7,98	3,11	1,51
245 Casting of metals	6,36	2,00	13,16	4,74	1,56
251 Manufacture of structural metal construction	9,43	3,12	11,13	4,00	1,56
255 Forging, stamping and roll forming of metal	7,31	2,24	12,87	4,81	1,53
257 Manufacture of cutlery	13,25	4,37	23,92	8,12	1,60
259 Manufacture of other fabricated metal products	5,09	1,57	8,28	3,29	1,49
282 Manufacture of other general purpose machinery	10,99	3,20	15,51	5,92	1,52
283 Manufacture of agricultural and forestry machinery	3,14	1,04	15,24	5,07	1,61
284 Manufacture of machine tools for working metal	7,75	2,35	8,44	3,48	1,47
289 Manufacture of other special purpose machinery	14,60	5,21	24,08	8,04	1,61
292 Manufacture of bodies for motor vehicles	14,00	4,10	20,40	7,78	1,52
293 Component Manufacture	13,87	4,73	7,68	2,72	1,57
310 Manufacture of furniture	8,88	2,70	14,11	4,85	1,59
329 Manufacturing n.c.o.p	2,31	0,93	9,49	3,34	1,57
331 Repair of fabricated metal products, machinery and equipment	10,43	3,54	12,38	4,22	1,60

Sources: Own elaboration

In the case of sector 233, multimodality presented in 2000 with the presence of two peaks in the lower area. In the sector 284, multimodality presented in 2010 with two modes that divide the distribution into two poles.

Finally, in the sector 292, multimodality is presented in both 2000 and 2010 with two modes, more clearly defined in 2010.

Determinants of productivity: In this section the determinants of productivity are analyzed.

Table 6. Test of differences in distributions kernel and the existence of unimodality

	Contrast	Contrast	Mode
Denominación sectores	Dif. Kernel	2000	2010
152 Manufacture of footwear	0,014*	0,020*	0,015*
161 Sawmilling and planing of wood	0,407	0,024*	0,028*
162 Manufacture of wood, cork, straw ..	0,000**	0,015*	0,013*
172 Manufacture of paper and paperboard	0,174	0,033*	0,032*
181 Printing and service activities related to printing	0,347	0,010*	0,011*
201 Manufacture of basic chemicals	0,476	0,031*	0,038*
203 Manufacture of paints	0,152	0,031*	0,034*
204 Manufacture of soaps	0,001**	0,038*	0,032*
205 Manufacture of other chemicals	0,208	0,042*	0,045*
221 Manufacture of rubber products	0,843	0,032*	0,032*
222 Manufacture of plastic products	0,040*	0,013*	0,013*
231 Manufacture of glass and glass products	0,012*	0,047*	0,042*
233 Manufacture of ceramic products for construction	0,271	0,057	0,033*
236 Manufacture of articles of concrete, cement and plaster	0,002**	0,015*	0,014*
237 Cutting, shaping and finishing of stone	0,001**	0,022*	0,017*
241 Manufacture of basic iron and steel	0,972	0,036*	0,027*
245 Casting of metals	0,176	0,048*	0,034*
251 Manufacture of structural metal construction	0,106	0,007**	0,011*
255 Forging, stamping and roll forming of metal	0,905	0,021*	0,041*
257 Manufacture of cutlery	0,091	0,020*	0,024*
259 Manufacture of other fabricated metal products	0,288	0,013*	0,010*
282 Manufacture of other general purpose machinery	0,315	0,017*	0,025*
283 Manufacture of agricultural and forestry machinery	0,068	0,018*	0,038*
284 Manufacture of machine tools for working metal	0,707	0,054*	0,085
289 Manufacture of other special purpose machinery	0,650	0,032*	0,039*
292 Manufacture of bodies for motor vehicles	0,021*	0,063	0,074
293 Component Manufacture	0,747	0,029*	0,052*
310 Manufacture of furniture	0,002**	0,013*	0,007**
329 Manufacturing n.c.o.p	0,603	0,028*	0,031*
331 Repair of fabricated metal products, machinery and equipment	0,834	0,016*	0,014*

(**), (*)statistically significant 99% y 95% respectively
Source: Own elaboration

Tabla 7. Test Härdle y Mammen´s (1993)

	Test	
	P vs NP	Order
Sectors name	Test(p_valor)	Polynomial
152 Manufacture of footwear	1.28(0.16)	1
161 Sawmilling and planing of wood	0.64(0.41)	1
162 Manufacture of wood, cork, straw ..	6.32(0.00)	-
172 Manufacture of paper and paperboard	1.02(0.28)	3
181 Printing and service activities related to printing	1.60(0.28)	3
201 Manufacture of basic chemicals	1.95(0.48)	1
203 Manufacture of paints	8.64(0.00)	-
204 Manufacture of soaps	3.72(0.00)	-
205 Manufacture of other chemicals	2.75(0.00)	-
221 Manufacture of rubber products	1.87(0.06)	1
222 Manufacture of plastic products	0.71(0.27)	1
231 Manufacture of glass and glass products	1.01(0.19)	1
233 Manufacture of ceramic products for construction	7.25(0.00)	-
236 Manufacture of articles of concrete, cement and plaster	0.14(0.96)	-
237 Cutting, shaping and finishing of stone	0.50(0.73)	1
241 Manufacture of basic iron and steel	0.98(0.29)	1
245 Casting of metals	1.94(0.06)	3
251 Manufacture of structural metal construction	1.94(0.15)	3
255 Forging, stamping and roll forming of metal	5.22(0.00)	-
257 Manufacture of cutlery	6.39(0.00)	-
259 Manufacture of other fabricated metal products	4.59(0.00)	-
282 Manufacture of other general purpose machinery	0.99(0.28)	3
283 Manufacture of agricultural and forestry machinery	7.20(0.00)	-
284 Manufacture of machine tools for working metal	0.97(0.27)	1
289 Manufacture of other special purpose machinery	1.40(0.13)	3
292 Manufacture of bodies for motor vehicles	4.37(0.00)	-
293 Component Manufacture	9.49(0.00)	-
310 Manufacture of furniture	1.13(0.29)	3
329 Manufacturing n.c.o.p	1.80(0.09)	1
331 Repair of fabricated metal products, machinery and equipment	0.64(0.59)	3

Source: Own elaboration

Table 8. Results of the estimated models

Sector	152	161	162	172	181	201	203	204	205	221	222
	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t
constant	-	-	0.372	-	-	-	0.965	0.477	-0.238	-	-
			(8.55)				(9.59)	(4.38)	(-1.58)		
Lnlabour	-	-	0.480	-	-	-	0.290	-0.190	-0.087	-	-
			(33.57)				(8.37)	(-5.04)	(-1.79)		
Skills	0.030	0.025	0.018	0.019	0.017	0.012	0.025	0.019	0.015	0.028	0.021
	(23.03)	(9.27)	(21.23)	(8.09)	(30.04)	(8.34)	(15.75)	(10.45)	(6.13)	(18.14)	(26.28)
Intensity_K	-0.0002	0.00005	-0.0001	-0.00003	-0.00003	0.00004	-0.0001	-0.0005	-0.0002	0.0002	-0.00009
	(-1.78)	(0.50)	(2.64)	(-0.65)	(2.49)	(0.81)	(-0.82)	(-4.27)	(-1.59)	(2.63)	(-1.71)
D_Time	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
D_Region	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
R^2	0.39	0.14	0.63	0.60	0.27	0.26	0.68	0.32	0.13	0.42	0.28
Nº Obs.	1716	966	4455	883	7106	601	633	732	440	575	2822
Sector	231	233	236	237	241	245	251	255	257	259	282
	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t
constant	-	-0.496	-1.033	-	-	-	-	1.551	1.703	1.499	-
		(-2.48)	(-15.45)					(20.31)	(25.03)	(32.62)	
Lnlabour	-	0.557	0.450	-	-	-	-	0.113	0.137	0.113	-
		(9.61)	(21.34)					(4.65)	(5.98)	(7.28)	
Skills	0.019	0.017	0.010	0.018	0.006	0.018	0.014	0.021	0.022	0.017	0.020
	(9.47)	(9.39)	(10.02)	(15.40)	(3.85)	(10.10)	(29.08)	(19.62)	(20.89)	(30.01)	(19.52)
Intensity_K	-0.0001	-0.0005	-0.00007	0.0002	3.3e-06	0.00009	-0.00007	-0.0003	-0.0001	-0.00004	-0.0001
	(-1.12)	(-7.97)	(-1.71)	(3.05)	(0.04)	(0.96)	(29.08)	(19.62)	(-1.43)	(-0.069)	(-1.78)
D_Time	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
D_Region	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
R^2	0.35	0.36	0.25	0.26	0.52	0.78	0.63	0.53	0.61	0.48	0.29
Nº Obs.	701	610	2828	2102	747	616	10879	1183	1219	3657	1560
Sector	283	284	289	292	293	310	329	331			
	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t	Coef. / t			
constant	0.365	-	-	1.529	1.341	-	-	-			
	(3.34)			(17.80)	(16.23)						
Lnlabour	0.557	-	-	0.228	0.197	-	-	-			
	(14.88)			(8.40)	(7,61)						
Skills	0.020	0.022	0.012	0.023	0.026	0.029	0.020	0.019			
	(9.92)	(14.99)	(18.58)	(16.67)	(19.50)	(31.80)	(14.14)	(23.65)			
Intensity_K	-0.0003	-0.00004	-0.0003	0.0001	-0.00006	-0.00002	-0.0001	0.00002			
	(-2.61)	(-0.58)	(-3.99)	(0.95)	(-0.62)	(-0.46)	(-1.12)	(0.48)			
D_Time	yes	yes	yes	yes	yes	yes	yes	yes			
D_Region	yes	yes	yes	yes	yes	yes	yes	yes			
R^2	0.69	0.44	0.28	0.58	0.47	0.26	0.34	0.25			
Nº Obs.	563	497	1920	753	837	5628	762	3441			

Source: Own elaboration

We study the extent to which differences in productivity levels relate to; the resources used by the firms in terms of capital / labor, relative wages and firm size relationship.Syverson (2011) performed an analysis of the work in recent years have studied the determinants of productivity. Classifies these into external and internal factors firms.

In the first refers to environmental and operating company level. Regarding the latter are subdivided into six blocks; i) management practices and management teams ii) quality of inputs iii) importance of ICT iv) the importance of experience and detecting business opportunities v) innovation and improvement of product and vi) decisions on organizational strategy.In this work given the characteristics of the database used as explanatory variables in productivity were: The variable intensity of capital, representative of the firm's resources. It has been used by Diaz and Sánchez (2008) or De Jorge-Moreno (2014) among others. The relative wage is included as a proxy of human capital in line with other studies that use data from the compensation of employees as the basis for calculating this (Le, Gibson and Oxeley 2003). At national level, Fernández de Guevara (2011) or De Jorge-Moreno (2013) uses this variable. The employment as size of the firm has been used in many studies. Table 7 shows the values of the test of Mammen's Härdle (1993) and statistical significance. For acceptation of semi-parametric model, column 3 shows the order of the polynomial accepted. The 60% of the estimated models are semi-parametric versus 40% parametric.

Table 8 presents the results of the estimated models. The following sectors are related to the semiparametric methodology; 152, 161, 172, 181, 201, 221, 222, 231, 237, 241, 245, 251, 282, 284, 289, 310, 329 and 331. The explanatory variable that captures the size in terms of number of employees has been considered in nonparametric form as was discussed and reflected in equation (7).The graphs of figure 3, shows the relationship between productivity and size. The relationship between productivity and size are; U-shaped, inverted U-shaped oscillatory. Some sectors have appearance of linear relationship (the omitted sectors have similar shapes). The parameter β_2 of skills variable is positive and statistically significant, implying that the higher skilled workers are related to higher levels of productivity. The result of the variable capital intensity (β_3) was counterintuitive. Most of the sectors (72.2%) with the semi-parametric estimation show that capital intensity is not significant, therefore higher levels of capital per worker are not related to higher levels of productivity. Even in three sectors 181, 251 and 289 the result is negative. This last result is related with those obtained by De Jorge-Moreno and Rojas (2015) with information from the SABI database and Diaz and Sanchez (2008) with ESEE data. As mentioned latter, a possible explanation could be related to changes in productivity generated by a technical innovation depend on its nature and dissemination. If it is easier for companies adopting these changes, then this change affects productivity positively, whereas if a major investment and the modification of the organizational structure is required, then it could cause a

Anex. Table A1. Descriptions of the variables used (mean and standard deviation)

Sectors name	Lva	Lact	Le	Lmat
152 Manufacture of footwear	5,719	6,357	2,676	6,366
	0,806	0,983	0,744	1,223
161 Sawmilling and planing of wood	5,609	6,675	2,296	6,113
	0,677	0,846	0,528	1,157
162 Manufacture of wood, cork, straw ..	5,640	6,403	2,365	5,981
	0,852	1,014	0,703	1,116
172 Manufacture of paper and paperboard	6,145	7,029	2,640	6,690
	0,992	1,111	0,797	1,222
181 Printing and service activities related to printing	5,716	6,445	2,268	5,590
	0,899	1,043	0,702	1,141
201 Manufacture of basic chemicals	5,964	6,901	2,319	6,314
	0,828	0,956	0,691	1,062
203 Manufacture of paints.	5,858	6,893	2,375	6,551
	0,926	0,945	0,705	1,148
204 Manufacture of soaps	5,817	6,613	2,391	6,039
	0,961	1,036	0,739	1,138
205 Manufacture of other chemicals	5,914	6,738	2,355	6,270
	1,151	1,293	0,791	1,432
221 Manufacture of rubber products	5,735	6,440	2,349	5,890
	0,798	0,918	0,654	1,244
222 Manufacture of plastic products	5,949	6,727	2,462	6,134
	0,878	1,020	0,752	1,237
231 Manufacture of glass and glass products	5,811	6,465	2,511	5,992
	0,840	0,968	0,713	0,957
233 Manufacture of ceramic products for construction	6,547	7,514	2,936	6,303
	1,006	1,289	0,761	1,412
236 Manufacture of articles of concrete, cement and plaster	6,275	7,319	2,630	6,826
	0,956	1,058	0,730	1,188
237 Cutting, shaping and finishing of stone	5,555	6,246	2,255	5,525
	0,854	1,003	0,656	1,078
241 Manufacture of basic iron and steel	5,778	6,476	2,309	5,899
	0,855	1,037	0,661	1,242
245 Casting of metals	5,969	6,595	2,498	6,226
	0,805	0,946	0,654	1,225
251 Manufacture of structural metal construction	5,704	6,314	2,389	5,986
	0,907	1,048	0,718	1,085
255 Forging, stamping and roll forming of metal	6,095	6,758	2,523	5,901
	0,813	0,980	0,693	1,239
257 Manufacture of cutlery.	5,886	6,557	2,366	5,823
	0,810	1,036	0,655	1,183
259 Manufacture of other fabricated metal products	5,947	6,591	2,384	5,799
	0,782	0,942	0,656	1,175
282 Manufacture of other general purpose machineryl	6,033	6,640	2,471	6,088
	0,770	0,913	0,655	1,136
283 Manufacture of agricultural and forestry machinery	5,586	6,570	2,244	6,225
	0,821	0,945	0,634	1,040
284 Manufacture of machine tools for working metal	6,068	6,527	2,417	5,522
	0,775	0,888	0,678	1,084
289 Manufacture of other special purpose machinery	5,968	6,632	2,411	6,006
	0,833	1,024	0,669	1,145
292 Manufacture of bodies for motor vehicles	5,763	6,446	2,383	6,260
	0,748	1,059	0,623	1,165
293 Component Manufacture	6,079	6,719	2,577	5,928
	0,835	0,947	0,740	1,349
310 Manufacture of furniture	5,543	6,224	2,375	5,793
	0,868	1,010	0,724	1,168
329 Manufacturing n.c.o.p	5,674	6,278	2,317	5,687
	0,772	0,876	0,662	1,187
331 Repair of fabricated metal products, machinery and equipment	5,695	6,201	2,268	5,682
	0,871	0,921	0,747	1,075

Source: Own elaboration

change in firms with an out best practices therefore less productive firms away from the leaders. This means that even if an increase in the capital stock increases productivity than at a different time than other companies, this could cause loss of productivity from capital adjustment in the short term (Diaz-Sanchez 2008: 321). The following sectors are related to the parametric methodology; 162, 203, 204, 205, 233, 236, 255, 257, 259, 283, 292 and 293. The parameter β_2 variable the logarithm of employment has been positive and statistically significant in 83.3% of the sectors (10). Thus, the larger firms are productive because of its advantages in economies of scale and scope. In the sector 204 are smaller firms more productive. Finally, in the 205 sector the size variable has not been proven to be significant. The relationship between productivity and skill is positive and statistically significant as in the case of semi-parametric methodology. The relationship between productivity and capital intensity has been equally counterintuitive with this methodology.In 41.6% of the sectors the relationship is negative while the other has not been significant.

The arguments made in the case of non-parametric estimates of these two variables are the same as those corresponding to the parametric models.

Conclusion

This paper focuses on analyzing the differences in productivity and the explanatory factors from a microeconomic perspective on a panel data over the period 2000-2010 in 30 Spanish industrial sectors NACE three-digit. To achieve the objectives proposed we used a two-step procedure. The first was used methodology Wooldridge, Levinsohn and Petrin (2009) to estimate productivity. This has considered the simultaneity of inputs and productivity. In the second stage, we have determined the determinants of productivity using estimates parametric and semi-parametric data panel. The main results show both differences intra- and intersectoral in total factor productivity. Regarding the determinants of productivity, we have seen, how as size is a source of productivity differences. The possibility to work with parametric and semi-parametric methods has allowed us to deepen this relationship. Thus, in the case of the sectors that accept parametric methodology (40%) the size is correlated with higher levels of productivity in 10 of the 12 sectors. Only in the Manufacture of soap the relationship between size and productivity sector is negative indicating that smaller firms are more productive.In 60% of sectors that have accepted semi-parametric methods, a graphical interpretation of the relationship between sample size and different patterns productivity, U-shaped, inverted U, and wave.

The qualification in terms of human capital has proven to be positive regardless of the methodology used implying that the higher skilled workers is related to higher levels of productivity. The result of the variable capital intensity was counterintuitive in line with the work of Diaz and Sanchez (2008) and De Jorge-Moreno and Rojas (2015).In general, the relationship between productivity and capital intensity or not is significant or negative. The need to carry out certain investments in businesses for productivity gains and the complexity arising from changes or innovations to realize they could be among the causes of that relationship in the short and medium term. Despite the wealth of information from the database used in relation to the possibility of working with a wide range of sectors of the Spanish business and their level of disaggregation, it would have been desirable to be able to count on additional variables relating to products manufactured, used and quality of management processes. Possible extensions of this work could be aimed in this direction.

NOTES

- For a more detailed estimate of TFP with WLP methodology, see Petrin and Levinsohn (2012). The author of this paper acknowledges the suggestions made by Amil Petrin in using stata code located on the website of the researcher.
- The intermediate consumption variable does not appear in Table 4, since it is the control variable, following the WLP methodology.

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