EFFECTS OF HUMAN CAPITAL AND INFRASTRUCTURES ON BUSINESS SECTOR INVESTMENT IN SPANISH REGIONS: 1980 TO 2003

F. J. Escribá [a]
M. J. Murgui [a]

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[a] University of Valencia, Spain

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Observations to be addressed to:
Maria.j.murgui@ uv.es
Francisco.j.escriba@uv.es

Abstract

The purpose of this paper is to analyse the effect of government expenditure on human capital and infrastructures on business sector investment in Spanish regions. We estimate a structural investment function that is not only broken down into regions, but also into 17 different branches of activity. Our results confirm that investment became increasingly sensitive to the effect of regional investment in human capital over the period dating from 1980 to 2003, while infrastructure was only observed to have an impact in the 1980s.

JEL: C23, E22, R42, R58.

Keywords: Panel data; investment, regions.

1. Introduction

The purpose of this paper is to evaluate the relative effects regional human capital and infrastructure endowment policy on private sector investment. This paper is an empirical investigation into the effects of government policy on business sector investment (17 branches of industrial activity, from the NACE R-25) in the 17 Spanish regions over the period dating from 1980 to 2003. The aim of this paper is to analyse the effect of public policies within a basic theoretical framework of determining investment.

In a previous paper (Escribá and Murgui, 2009), a theoretical framework is built in order to analyse the effect of such policies[1] on regional industry accumulation rates, but confined to the manufacturing sector. However, the Spanish economy has undergone a significant structural change in favour of services and construction over this period. The manufacturing sector did not even account for a quarter of the business sector as a whole in terms of value added, employment, fixed investment and even capital[2]. It is therefore necessary to determine the effect of infrastructure and human capital endowment policies on investment in the total business sector.

Indeed, there is widespread agreement regarding the importance of the role played by capital endowment in infrastructures and improvements in human capital endowment in relation to economic growth and productivity. Since Spain became a member of the European Union, these policies have been the mainstays of the policy applied to Spanish regions. Notwithstanding, endogenous growth in regions depends on just how much these policies stimulate business capital accumulation - generate industrial fabric- the latter having received much less attention from researchers. In the paper by Escribá and Murgui (2009), human capital was found to have more of an impact on the manufacturing sector in both the 1980s and 1990s. In contrast, infrastructure only influenced investment in manufacturing in the 1980s. It is as if infrastructures lose their influence after a certain threshold is exceeded, whereas professional training and work skills are becoming increasingly important in the knowledge society. It is therefore worth analysing whether these results hold true for a much larger sample of sectors and period of time[3].

[1] Escribá and Murgui (2009) also considered the effect of R&D capital endowment, which was found to have no effect whatsoever on manufacturing investment. This is possibly due to the fact that Spain registered very low levels of R&D expenditure at the time.

[2] See Figure A.1.1 in Appendix 1. The graph also shows how the percentage of all variables decreases over the period dating from 1980 to 2003.

[3] Some papers using production functions (García-Milá and Marimón, 1996) or cost functions (Boscá, Dabán and Escribá, 1999) obtained less optimistic results of the impact of infrastructures on the manufacturing sector than on the business sector as a whole.

This paper uses a new version of the BD.MORES data base[4], which for the first time breaks down the services sector into branches. This was possible due to the *Instituto Nacional de Estadística (INE)*[5] providing regional fixed investment data, which allowed these branches to be treated similarly to the branches of the manufacturing industry in previous versions of the data base. This has made it possible to also prolong the data set until 2003 and express data in euros from 2000.

The theoretical framework used in this research is similar to that in Escribá and Murgui (2009). We derive and estimate a structural investment function that is not only broken down into regions, but also into 17 different branches of activity. This function is estimated using the Generalised Method of Moments (Arellano and Bover, 1995, and Blundell and Bond, 1998) in order to deal with explanatory variable endogeneity and sample heterogeneity accordingly. The paper is organised as follows. Section 2 defines the theoretical framework and the econometric approach used. Section 3 presents the data and analyses the results obtained and Section 4 concludes.

2. Model and Methodology

In this section we present a structural model in which these dynamic elements appear explicitly in the optimisation problem and the estimated coefficients are linked explicitly to the underlying technology and expectation parameters. We will use an approach that combines the Euler equation and adjustment cost technology[6].

The version of the Euler equation model we estimate is based on Bond and Meghir (1994) and has been adapted to include the effects of human capital and infrastructure in Escribá and Murgui (2009).

A regional industry i maximises the present discounted value of current and future net dividends (R). Let L_{it} the amount of hired labour, I_{it} gross investment, K_{it} denote capital stock, ω_{it} the price of labour, p_{it}^{I} the price of investment goods, p_{it} the price of output, δ the depreciation rate and E(.) the expectations operator conditional on information available in period t. Defining r_t to be the rate of return and $\beta_{t+j}^{t} = \prod_{i=0}^{j-1}(1+r_{t+i})^{-1}$ the discount factor, the regional industry solves

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[4] See De Bustos et al (2008). In previous versions (Dabán et al, 2002), the market services sector was not broken down and was treated as a residual in the fixed investment and capital variables, which made it impossible to cover a larger group of sectors. INE Regional Accounts currently provide disaggregated data sets for fixed investment in the services sector, which saw BD.MORES make an effort to backdate them as far as possible. Therefore, apart from 11 branches of the manufacturing, agriculture, energy and construction industries, retail trade and restaurants and hotels, transport and communications and other market services are now included. The public sector, finances and residential sector are therefore still excluded.

[5] Spanish National Institute of Statistics, hereafter referred to as INE.

[6] According to Chirinko (1993), the literature can be divided into two categories depending on whether dynamics are treated implicitly or explicitly.

$$
\begin{aligned}
&Max\ \mathrm{E}_t\left[\sum_{j=0}^{\infty}\beta_{t+j}^{t}\ R\left(K_{i,t+j},L_{i,t+j},I_{i,t+j}\right)\right]\\
&s.t.\quad K_{it}=(1-\delta)K_{i,t-1}+I_{it}
\end{aligned}
\tag{1}
$$

where $R_{it}=p_{it}\,Q_{it}-\omega_{it}\,L_{it}-p_{it}^{I}\,I_{it}$ and $Q_{it}=A_{it}\,F(K_{it},L_{it})-Z(K_{it},I_{it})$ is the net output of adjustment costs $Z(K_{it},I_{it})$ and depends on the level of efficiency (A_{it}).

The Euler equation characterizing the optimal path of investment is given by

$$
-(1-\delta)\beta_{t+1}^{t}\mathrm{E}_t\left(\frac{\partial R_{i,t+1}}{\partial I_{i,t+1}}\right)=-\left(\frac{\partial R_{it}}{\partial I_{it}}\right)-\left(\frac{\partial R_{it}}{\partial K_{it}}\right)
\tag{2}
$$

To allow for imperfect competition we let p_{it} depend on output, while the price elasticity of demand is assumed constant (η>1). Assuming that $F(K_{it},L_{it})$ is constant returns to scale and the adjustment cost function, $Z(K_{it},I_{it})=b/2\,[I_{it}/K_{it}-a]^2\,K_{it}$ is linearly homogeneous in investment and capital. To implement this model, we evaluate the expectation $\mathrm{E}_t\left({I_{i,t+1}}/{K_{i,t+1}}\right)$ at realized value $\left({I_{i,t+1}}/{K_{i,t+1}}\right)$ plus a forecast error. The resulting empirical Euler equation under the null of no financial regimes is

$$
\left(\frac{I_{i,t+1}}{K_{i,t+1}}\right)=\alpha_1+\alpha_2\left(\frac{I_{it}}{K_{it}}\right)-\alpha_3\left(\frac{I_{it}}{K_{it}}\right)^2-\alpha_4\left(\frac{B_{it}}{K_{it}}\right)+\alpha_5\left(\frac{Q_{it}}{K_{it}}\right)+u_{i,t+1}
\tag{3}
$$

where $\alpha_1=a\,(1-\varphi)$; $\alpha_2=\varphi\,(1+a)$; $\alpha_3=\varphi$; $\alpha_4=\varphi\left(\frac{1}{\vartheta b}\right)$; $\alpha_5=\varphi\left(\frac{1}{(\eta-1)b}\right)$; $\vartheta=1-{1}/{\eta}>0$,

$\varphi=(1+r)/(1-\delta)(p_{i,t+1}/p_{it})$ and $\left(\frac{B_{it}}{K_{it}}\right)=\left(\frac{Q_{it}}{K_{it}}\right)-\frac{\omega_{it}}{p_{it}}\left(\frac{L_{it}}{K_{it}}\right)-\frac{c_{it}}{p_{it}}$ is the gross economic profit rate and c_{it} is the nominal user cost of capital.

The coefficient α_2 is positive and greater than one. The coefficient ($-\alpha_3$) is negative and greater than one in absolute value. The coefficient ($-\alpha_4$) is negative under the assumption that investment is not overly sensitive to cash flow. The output term (α_5) controls for imperfect competition and the coefficient is positive. In the empirical literature with microeconomic data which uses the Bond and Meghir (2004) model, equation (3) is estimated, as in Bond et al (2003) or in Spain, Estrada and Vallés (1998) and Hernando and Tiomo (2002). In this paper we are interested in analysing the effect of public endowment of human capital and infrastructures on investment in the business sector in Spanish regions. This is the reason for enlarging the Euler equation, in order to include these variables as in Escribá and Murgui (2009), although we also present the estimation of equation 3 in Table 1.

Therefore, following Escribá and Murgui (2009), we assume that regional industry output depends on typically sectoral variables and on region-specific variables. In the first place, and in reference to sectorial variables: the output/capital ratio depends positively on the labour/capital ratio and negatively on the investment/capital ratio in regional industry.

In the second place, regional industrial output also depends on region-specific variables which affect the productivity of the private factors used in regional industry (A_{it}). It is a region-specific technology parameter which reflects the technical efficiency of all factor inputs included in the regional industry production function.

Furthermore, we assume business technical efficiency in a region depends positively on capital availability in public infrastructure (G_{it}) and skilled labour or human capital (H_{it}) that is, $A_{it} = A(G_{it}, H_{it})$. By using Taylor's expansion, we obtain the following empirical specification:

$$\left(\frac{I_{i,t+1}}{K_{i,t+1}}\right) = \beta_0 + \beta_1\left(\frac{I_{it}}{K_{it}}\right) - \beta_2\left(\frac{I_{it}}{K_{it}}\right)^2 - \beta_3\left(\frac{B_{it}}{K_{it}}\right) + \beta_4\left(\frac{L_{it}}{K_{it}}\right) + \beta_5 \ln G_{it} + \beta_6 \ln H_{it} + \upsilon_{i,t+1} \quad (4)$$

Based on equation (4), the basic empirical specification we consider can be written as:

$$\left(\frac{I_{it}}{K_{it}}\right) = \beta_1\left(\frac{I_{it-1}}{K_{it-1}}\right) - \beta_2\left(\frac{I_{it-1}}{K_{it-1}}\right)^2 - \beta_3\left(\frac{B_{it-1}}{K_{it-1}}\right) + \beta_4\left(\frac{L_{it-1}}{K_{it-1}}\right) + \beta_5 \ln G_{it-1} + \\ + \beta_6 \ln H_{it-1} + \mu_i + d_t + \varepsilon_{it} \quad (5)$$

Bearing in mind that subscript *i* denotes regional industries and μ_i refers to industry/region-specific effects that remain unchanged over time (geographical allocation, region and industry-specific idiosyncratic features, etc.) and that d_t captures the time effects that have an impact on all regional industries (national policymaking, growth in technical efficiency on a national scale, etc.). We will treat such time effects as fixed – unknown constants – by including a set of time dummies in all regressions[7]. ε_{it} represents random disturbances.

Dynamic panel data regressions are known to have several econometric problems. The first main problem is the heterogeneity of the sample (in our case unobservable variations among regional industries). Unless these specific effects are dealt with correctly, inconsistent estimators will be obtained. The second problem is

[7] It would also be possible to express the variables in deviations from their average over time, which makes including time dummies unnecessary.

the presence of the lagged endogenous variable as a regressor, which means that it is correlated to the errors, so that the OLS estimator is biased and inconsistent.

To avoid these problems, our main results (equation (5)) are estimated using panel data techniques, both in levels and first differences. Our joint estimation is carried out using the Arellano and Bover (1995) and Blundell and Bond (1998) System Estimator (hereafter SYS-GMM). When there is a high degree of persistence and few time observations, SYS-GMM is shown to yield potentially large efficiency gains vis-à-vis the pure First-Difference[8]. This estimator treats the model as a system of equations, one for each time period. The endogenous variables in first differences are instrumented with suitable lags of their own levels and the endogenous variables in levels are instrumented with suitable lags of their own first differences. The consistency of the SYS-GMM estimator lies in how valid moment conditions are, that is, residuals must be serially uncorrelated and explanatory variables must be exogenous. The over identification test proposed by Sargan (1958) and Hansen (1982) is used to discern the validity of orthogonality conditions – providing the instruments as a group are exogenous - and also to assess whether or not additional moment conditions for level equations are valid using the Hansen-difference test. The statistics proposed by Arellano and Bond (1991) are used to test the presence of serially correlated residuals and the null hypothesis is that of no residual autocorrelation[9].

The set of instruments used in each of the regressions presented later in this paper is reported in the notes to the corresponding table and the validity of instruments has been checked via Sargan's or Hansen's Test of over identifying restrictions.

3. Data and Estimation Results

3.1 Data.

This paper analyses the non financial private sector as the aggregate. In order to do so, the residential, financial and public sectors are excluded, both where the value of production is concerned, which excludes rent and non retail services, and also employment and capital, which excludes the public sector, financial intermediation and the residential sector. In this article a sample of 17 sectors or industries in all 17 Spanish regions over a period dating from 1980 to 2003 is used. All the data used are from the BD.MORES b-2000 data base (De Bustos et al, 2008) except for human capital (De la Fuente and Doménech, 2006).

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[8] See Blundell and Bond (1998). In this paper we use SYS-GMM estimator as most of the variables used display a high degree of persistence, that is, they vary significantly from one regional industry to another or from one region to another, should this be the case, but appear to be relatively stable over time, as can be appreciated in Table A.1 of Appendix 1.

[9] Therefore, first order autocorrelation, AR(1), is expected as $\Delta\varepsilon_{it} = \varepsilon_{it} - \varepsilon_{it-1}$ will be correlated to $\Delta\varepsilon_{it-1} = \varepsilon_{it-1} - \varepsilon_{it-2}$, but not higher order autocorrelation.

The regional data base BD.MORES b-2000 is compiled by the Dirección General de Presupuestos del Ministerio de Economía y Hacienda (Ministry of Economic and Financial Affairs Budget Office in English)[10]. This data base serves regional studies and is for assessing the economic impact of regional policies. Since its first version, compiled in 1995, the data base uses official statistics, units of measurement and sector and regional definitions and classifications. This applies to all GDP items, in current and constant prices.

This data base structures its core regional economic information using the figures from the various data sets of the *Contabilidad Regional de España*[11] *(INE)*, taking national figures for economic aggregates as an obligatory reference, starting with the latest estimations (data set base 2000 CRE) which date back to the year of origin of the data sets (1980).

The variables that make up the data base can be classified in three groups: *Demand* (fixed investment and consumption); *Supply* (output, population, employment and physical, technological and human capital); *Income* (wages and gross operating surplus). At present, the BD.MORES b-2000 is the most complete data base on a regional level available for Spain: most variables have been disaggregated into 20 branches of activity since 1980 and some since 1964.

The variables used in the analysis are: Accumulation rate -Investment and capital stock ratio in each regional industry (I_{it}/K_{it}) - as the endogenous variable. The explanatory variables are: Profit rate - rate of real profit to capital in each regional industry (B_{it}/K_{it})-; Output-capital stock ratio in each regional industry (Q_{it}/K_{it}); Labour capital stock ratio in each regional industry (L_{it}/K_{it}); Regional public capital stock in transport infrastructure (roads, ports, railways and airports) and urban infrastructure (G_{it})[12] and Human capital (H_{it}) average school enrolment data series for Spanish regions. As regards regional infrastructure endowment, this depends on the size of the region. As a result, the productivity of regional investment will depend on how scarce it is in relative terms when compared to public regional capital endowment. This will be relatively congested in light of its relationship to that of the sector in the region. In contrast, human capital in years of schooling is unaffected by the size of the region. More detail about how they were estimated and the description of other variables is included in Appendix 2.

[10] The BD.MORES b-2000 data base can be accessed for free at http://www.sgpg.pap.meh.es/SGPG/Cln_Principal/Presupuestos/Documentacion/Basesdatosestudiosregionales.htm

[11] Regional Accounts of Spain, hereafter referred to as CRE.

[12] The measure of regional infrastructure endowment is computed in Escribá and Murgui (2009) as only transport infrastructure.

3.2 Estimation Results.

Results are reported in Tables 1 and 2. Table 1 presents the results of estimating the determinants of business investment in accordance with the specification obtained from the Bond and Meghir (1994) model and estimated in the best part of microeconometric research. That is, the investment rate according to this lagged rate, the lagged squared rate, the lagged profit rate and the lagged output-capital ratio, as described in equation (3). The second table displays the estimates of equation (5) where, apart from those listed above, the determinants of the private investment rate were capital endowments in both transport and urban infrastructure, as well as human capital in Spanish regions.

Before commenting on the results, one clarification is necessary. The number of observations available (289 regional industries and 24 years) cover a relatively large period of time, T=24, which does not leave enough degrees of freedom in the estimation, when using SYS-GMM, if the entire sample period (1980-2003) is taken into account. Therefore, although the estimation of equation (3) for the entire sample period is presented in the first column of Table 1, the degrees of freedom are minimal. In fact, as detailed in the footnote below the table, only variables lagged two or three periods were used as instruments for the equations in differences. Hence, in order to make the most of the advantages of this estimation method – which controls for biases due to unobserved specific effects and endogenous explanatory variables, as indicated in the previous section – estimations will be performed for two sub samples: 1980-1990 and 1991-2003[13].

The first column in Table 1 presents the estimate for the entire sample period 1980-2003, while columns [2] and [3] display the two sub samples using the SYS-GMM estimator (Arellano and Bover, 1995 and Blundell and Bond, 1998). Therefore, by using the SYS-GMM consistent estimators would be obtained providing the validity of the orthogonality (Sargan or Hansen's over identification test) is accepted and there is no residual autocorrelation. As can be observed in the lower part of Table 1, the validity of the instruments chosen is accepted as there is no second-order correlation, the AR(2) test and the Hansen Difference Test are accepted.

Lagged investment coefficients are statistically significant and display the correct sign, although size depends on the sample period considered. Depending on the derivation of the model, this coefficient in absolute terms should be greater than one and this is only the case in the sample period referring to the 1980s in our estimate – see the first row of Table 1-. As regards the coefficient of lagged squared investment rate, the correct sign is also observed (negative) and is statistically significant in all cases. As in the case above, the coefficient is smaller in the first and third columns. The coefficients of the lagged profit rate display the negative sign

[13] As observed in Figure A.1.2, the two sub samples include: a period of recession followed by an expansion and another incipient recession.

expected - which is consistent to the theoretical prediction under the null of no financial constraints – and it is only statistically significant in the estimate of the entire sample period (Column [1]). The coefficient of the lagged output-capital ratio is positive and significant regardless of the sample period considered, which is consistent with the presence of imperfect competition in the product market.

TABLE 1. Results of the Estimation. The Euler Equation

Period	1980-2003	1980-1990	1991-2003
ESTIMATION	SYS-GMM [1]	SYS-GMM [2]	SYS-GMM [3]
$\left(\frac{I_{it}}{K_{it}}\right)_{-1}$	0.588*	1.243*	0.392*
	(0.119)	(0.095)	(0.142)
$\left(\frac{I_{it}}{K_{it}}\right)^2_{-1}$	-0.094*	-1.761*	-0.120**
	(0.026)	(0.493)	(0.071)
$\left(\frac{B_{it}}{K_{it}}\right)_{-1}$	-0.058*	-0.018	-0.011
	(0.024)	(0.011)	(0.020)
$\left(\frac{Q_{it}}{K_{it}}\right)_{-1}$	0.053*	0.014*	0.073*
	(0.016)	(0.006)	(0.007)
Time dummies	Yes	Yes	Yes
Obs.	6347	2595	3752
Ind-reg	289	289	289
Sargan o Hansen Test	[0.077]	[0.161]	[0.143]
Difference Hansen test	[0.613]	[0.996]	[0.995]
AR(1) Test	[0.000]	[0.000]	[0.000]
AR(2) Test	[0.676]	[0.051]	[0.483]

Note: Standard errors in brackets, for columns (1) to (3) the estimator is two-step and Standard errors have been adjusted in line with Windmeijer (2005). *Values significant at 5% and **values significant at 10% . The figures reported for the Hansen test and difference Hansen test are the *p-values* for the null hypotheses, valid specification. The figures reported for the AR(1) and AR(2) test are the *p-values* for the null hypotheses, zero first-order and second-order autocorrelation. In column (1) the instruments used for the estimation in first differences are the lagged levels of the endogenous explanatory variables [$(I_{it}/K_{it})_{-1}$; $(I_{it}/K_{it})^2_{-1}$; $(B_{it}/K_{it})_{-1}$; $(Q_{it}/K_{it})_{-1}$] two and three periods. The instruments used for the estimation in first differences (column (2)) are the levels of the endogenous explanatory variables lagged two periods and all the lags up to a maximum of six. In column (3) the instruments used for the estimation in first differences are the lagged levels of the endogenous explanatory variables two periods and all the lags up to a maximum of seven. Additional instruments used to estimate the equations in levels are the first differences of the endogenous explanatory variables lagged one period.

Table 2 presents the results of the estimations for the two sub samples of the determinants of the private accumulation rate according to the specification of equation (5). In this case, in view of the number of variables to be estimated and the number of years involved, the estimate cannot be performed for the entire sample period due to the estimate lacking degrees of freedom. This table displays the results of the estimates under two assumptions: firstly, we consider the variables that reflect public endowments in infrastructure and human capital to be exogenous (columns [1] and [3]). Secondly, we assume these variables are endogenous (columns [2] and [4]). In the two sub periods, the endogeneity of the variables that capture public investment in human capital and infrastructures is accepted –see Difference Hansen Test (endog) at the bottom of columns [2] and [4]. Moreover, the validity of the instruments chosen was accepted along with the non autocorrelation of second order – as can be appreciated at the bottom of Table 2. Hence, SYS-GMM estimators are consistent.

As can be observed in Table 2, the coefficients of both the lagged investment rate and its square display the expected sign and are statistically significant, albeit small in the sub period dating from 1990 to 2003 in regard to those derived from the model. As regards the coefficients of the lagged profit rate, unlike the estimate in Table 1, they were positive and statistically significant in both sub periods – as can be observed in the third row of Table 2 – which was not expected bearing in mind the derivation of the model, although it is common among the results of previous microeconometric research mentioned previously[14]. The coefficients of the labour-capital ratio are significant and display the positive sign as expected.

As regards the variables that capture the effects of public capital in infrastructure and human capital, different trends can be appreciated depending on the sample period in question. In the 1980s, as can be observed in columns [1] and [2] in Table 2, both regional endowment in infrastructure and the skills or professional training of labour appear to have a positive and significant influence on growth in regional efficiency and, therefore on the private investment rate – both when considering public investment in infrastructure and human capital exogenous and endogenous[15]. However, in the 1990s and the early 2000s, only regional human capital has a positive effect and is statistically significant, as can be observed in columns [3] and [4].

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[14] The coefficient of the lagged economic profit rate is negative under the assumption that investment is not overly sensitive to cash flow. However, if cash flow either brings closer or evidences liquidity restrictions or opportunities for future investment, the coefficient of the lagged economic profit rate will be positive. Future profitability, estimated by means of the profit rate, has a positive influence on the accumulation rate.

[15] Difference Hansen Test (endog) confirms the endogeneity of these public investment variables. See the bottom of columns [2] and [4].

TABLE 2. Results of the Estimation. Euler Equation

Period	1980-1990		1991-2003	
ESTIMATION	SYS-GMM [2]	SYS-GMM All Endog. [3]	SYS-GMM [4]	SYS-GMM All Endog. [5]
$\left(\frac{I_{it}}{K_{it}}\right)_{-1}$	0.763*	0.854*	0.163*	0.256*
	(0.109)	(0.106)	(0.083)	(0.110)
$\left(\frac{I_{it}}{K_{it}}\right)^2_{-1}$	-0.818*	-0.939*	-0.172*	-0.151*
	(0.244)	(0.244)	(0.075)	(0.062)
$\left(\frac{B_{it}}{K_{it}}\right)_{-1}$	0.013*	0.013*	0.075*	0.097*
	(0.005)	(0.005)	(0.028)	(0.045)
$\left(\frac{L_{it}}{K_{it}}\right)_{-1}$	0.028*	0.021*	0.063*	0.070*
	(0.009)	(0.009)	(0.021)	(0.026)
$Ln\ (G_{it})_{-1}$	0.003*	0.003*	0.000	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)
$Ln\ (H_{it})_{-1}$	0.018*	0.013*	0.035*	0.026*
	(0.005)	(0.005)	(0.009)	(0.006)
Time dummies	Yes	Yes	Yes	Yes
Obs.	2595	2595	3752	3752
Ind-reg	289	289	289	289
Sargan o Hansen Test	[0.145]	[0.080]	[0.052]	[0.061]
Difference Hansen test	[0.982]	[0.999]	[0.999]	[0.995]
Diff.Hansen test (endg)		[0.154]		[0.610]
AR(1) Test	[0.000]	[0.000]	[0.002]	[0.003]
AR(2) Test	[0.058]	[0.054]	[0.474]	[0.380]

Note: Standard errors in brackets, the estimator is two-step and Standard errors have been adjusted in line with Windmeijer (2005). *Values significant at 5%. The figures reported for the Hansen test and difference Hansen test are the *p-values* for the null hypotheses, valid specification. The figures reported for the AR(1) and AR(2) test are the *p-values* for the null hypotheses, zero first-order and second-order autocorrelation. In columns (1) and (3) the instruments used for the estimation in first differences are the lagged levels of the endogenous explanatory variables[$(I_{it}/K_{it})_{-1}$; $(I_{it}/K_{it})^2_{-1}$; $(B_{it}/K_{it})_{-1}$; $(L_{it}/K_{it})_{-1}$] two periods and all the lags up to a maximum of four and the exogenous explanatory variables[$\ln(G_{it})_{-1}$; $\ln(H_{it})_{-1}$] not lagged. Additional instruments used to estimate the equations in levels are the first differences of the endogenous explanatory variables lagged one period. In columns (2) and (4) the instruments used for the estimation in first differences are the lagged levels of the endogenous explanatory variables two periods and all the lags up to a maximum of four and additional instruments used to estimate the equations in levels are the first differences of the endogenous explanatory variables lagged one period.

4. Conclusions.

The objective of this paper was to analyse the role played by regional investment in infrastructure and education when it comes to explaining the trend observed in investment in Spanish regional industries in the non financial business sector over the period dating from 1980 to 2003. This research is applied to the business sector in order to verify the influence of government policy regarding infrastructure and human capital on the Spanish manufacturing sector – a quarter of the total business sector – found in Escribá and Murgui (2009).

In order to achieve this, we proceeded- as in the case of the previous paper - to estimate a Euler-equation specification based on an extension of the version proposed by Bond and Meghir (1994) and using dynamic panel and GMM methods. The dynamic panel data model is estimated using panel data techniques, both in levels and first differences (Arellano and Bover, 1995 and Blundell and Bond, 1998) System-GMM. This method controls for biases due to unobserved specific effects and endogenous explanatory variables.

Once again, results coincide with the standard investment model of the Euler equation. When the influence on the technical efficiency of regional government capital availability is incorporated, standard variables display similar trends for the business sector as a whole to those observed in the manufacturing sector alone. Regional government productive physical and above all human capital has played a decisive role in private industry investment, the effect being even more positive over the period as a whole. In the case of regional infrastructure endowment, it was in the 1980s when this factor was most decisive, together with human capital.

The current crisis has demonstrated that we do not have the type of economy we would like. One important problem in our economy is the lack of dynamism when it comes to changing from low-skilled activities to those which are highly-skilled. This problem is due to several factors, of which it is worth highlighting the deficiencies in professional training and the minimal presence of technological capital. This paper's findings are aimed at shedding some light on the type of regional policy that could boost efficiency and in turn capital formation to generate a global industrial fabric in Spanish regions and not only in regional manufacturing industries.

7. References

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APPENDIX 1

In the first place, this appendix presents developments in participation in Investment, capital, output and employment in the manufacturing sector with respect to the total private business sector – Figure A.1.1 - and the trend displayed by the accumulation rate for the entire business sector – Figure A.1.2.

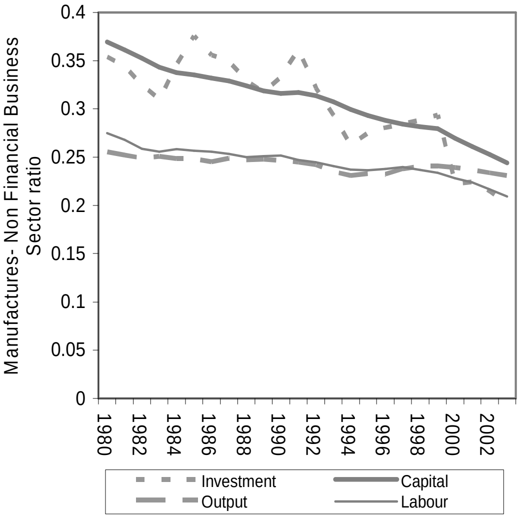

Figure A.1.1.

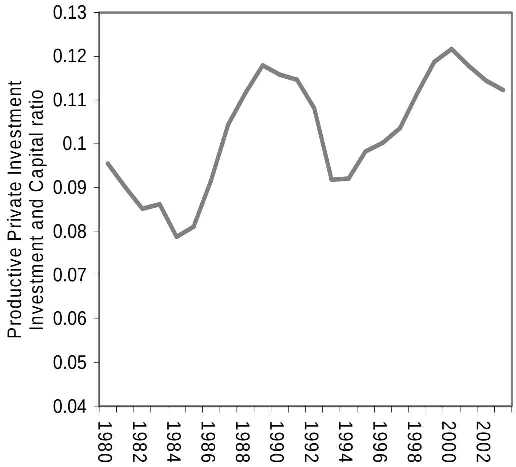

Figure A.1.2.

In the second place, Table A.1 displays the results of the persistence analysis. As can be observed in the table, some of the variables under consideration in the analysis display a high degree of persistence, that is, they vary significantly from one regional industry to another or from one region to another, should this be the case, but appear to be relatively stable over time. Therefore, more efficient estimators will be obtained from the estimation using the system of equations in differences and in levels (SYS-GMM).

TABLE A.1

Adjusted R^2 from the regressions with time and regional industry dummies			
Dependent variable	*Time dummies*	*Regional industry dummies*	*Both*
(I_{it}/K_{it})	0.039	0.209	0.249
(B_{it}/K_{it})	0.036	0.499	0.536
(Q_{it}/K_{it})	0.019	0.684	0.704
(L_{it}/K_{it})	0.046	0.719	0.766
$\mathrm{Ln}(G_{it}/K_{it})$	0.002	0.957	0.960
$\mathrm{Ln}(H_{it})$	0.746	0.241	0.988

Note: OLS Estimation of pooled regional industry = 289 and sample period = 1980-2003.

APPENDIX 2

Basic data for the seventeen Spanish regions are taken from the BD.MORES b-2000 database. The level of regional disaggregation corresponds to NUTS2 in the Eurostat nomenclature of statistical territorial units and the level of industry disaggregation corresponds to NACE-CLIO R.25 (See De Bustos et al, 2008).

The series taken from this database are:

Output (Q_{it}). The gross value added in each regional industry valued in basic prices according to the European System of Accounts (ESA95)[16]. Data are expressed in constant 2000 prices.

Labour (L_{it})***:*** The number of employees in each regional industry. The concept used in the BDMORES b-2000 data base is that proposed by the *CRE* base 2000 and base 95 referring to employment: jobs (one person can simultaneously hold various posts), distinguishing between wage earners and employed population.

Private Capital (K_{it})***:*** Net capital stock for each regional industry. The method followed to estimate net capital stock is the permanent inventory method. ***Investment flows*** (I_{it}), data sets used are consistent both in terms of level and evolution with the main macroeconomic variables included in the National Accounts in current prices and 2000 euros. Individual deflators are used for each sector that have been constructed taking into account the composition of each sector as far as assets are concerned. As regards the method of depreciation, depreciation rates for each sector are based on the composition of assets in each productive sector, the average service life of the different assets in each sector (OECD, 2000) and the BEA declining balance rate for each type of asset (Hulten and Wykoff, 1981).

Wage $\left(\frac{\omega_{it}}{P_{it}}\right)$. The real wage in each regional industry is calculated as Gross earnings of each regional industry divided by the number of employees in each regional industry (L_{it}).

User cost* of *capital. The user cost in each industry is computed as $\left(\frac{c_{it}}{P_{it}} = \frac{p_{it}^{I}}{P_{it}}\left(r_t^n - \hat{p}_{it}^{I} + \delta_{it}\right)\right)$ where p_{it}^{I} is the industry capital investment deflator, p_{it} is the output deflator in each industry, r_t^n is a long run interest nominal rate, δ_{it} is the capital depreciation rate in each industry, and $\hat{p}_{it}^{I}$ is the rate of growth of the industry capital investment deflator.

Profit rate. The rate of real economic profit to capital in each regional industry is calculated as $\left(\frac{B_{it}}{K_{it}}\right) = \left(\frac{Q_{it}}{K_{it}}\right) - \frac{\omega_{it}}{p_{it}}\left(\frac{L_{it}}{K_{it}}\right) - \frac{c_{it}}{p_{it}}$.

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16 The ESA 95 is currently the obligatory method of reference in all countries in the European Union for the elaboration of their National Accounts.

Regional infrastructure endowment (G_{it}). The measure of regional infrastructure endowment is computed as the regional public capital stock in transport infrastructure regional (roads, ports, railways and airports) plus urban infrastructure divided by capital stock in each regional industry. These may be offered by government or government agencies, by regulated private or public enterprises, or by public or private organizations.

Human capital (H_{it}). The measure of human capital is computed as the average school enrolment by population over 25′ data series for Spanish regions. Data series are constructed from Census Data of INE (Statistic National Bureau) in De la Fuente and Doménech (2006). This series has been updated to 2003 and calculated on a yearly basis.

Disaggregation:

Industries	**R.20**		**Regions**
Agriculture and fisheries	01		Andalucía
Mining, quarrying and energy	02		Aragon
Food, beverages and tobacco	03		Asturias
Textiles, clothing, leather and footwear	04		Balearic Islands
Paper, printing and graphic design	05		Canary Islands
Chemical products	06		Cantabria
Rubber and plastic	07		Castille and Leon
Non metallic mineral products	08		Castille La Mancha
Metallurgy and metallic products	09		Catalonia
Machinery and mechanical equipment	10		Valencia
Electrical, Electronic and optical equipment	11		Extremadura
Transport equipment	12		Galicia
Other manufacturing industries	13		Madrid
Construction	14		Murcia
Retail trade and catering	15		Navarra
Transport and communications	16		Basque Country
Financial intermediation	17		La Rioja
House/flat rentals	18		
Other market services	19		
Non market services	20		

Note: Branches 17, 18 and 20 are not part of the non financial business sector.