The Effects of Externalities on Value Added and Productivity Growth in Spanish Industry*

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Abstract

The paper discusses the role of externalities in promoting industrial growth in Spanish regions. We try to identify whether the so called dynamic externalities (technological spillovers) come from outside the industry (Jacobs type externalities) or whether they are generated between firms inside the industry (Marshall-Arrow-Romer or MAR type externalities). Moreover, this study attempts to test the effects of competition on innovation and growth (Porter type external effects). Related to earlier work by the authors on static and dynamic externalities analysis, this paper restricts the analysis to dynamic externalities using real value added and productivity, instead of labour, in order to test the robustness of our previous results.

The empirical analysis is based on data from the Spanish Industry Survey from 1978 to 1992 for 26 manufacturing branches. The evidence presented in this paper, obtained following Glaeser's et al. (1992) approach, suggests the presence of diversity (Jacobs) and competition (Porter) externalities. We also find mixed evidence of dynamic economies due to specialization (MAR) depending on the level of this variable. According to these results, technological spillovers take place through cross fertilization between industries stemming out of their diversity, and among firms of the same industry once a certain level of specialization is reached, all case being in a competitive environment . These findings coincide with those obtained previously by Glaeser et al. (1992) for the USA and by de Lucio, Herce and Goicolea (1996) for Spain and reconciles them with other evidence presented by Henderson (1994). However, these studies use employment as the dependent variable in the estimation equation as a proxy for industrial growth.

JEL: R11, O30, O41,
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1. Introduction

This paper applies to Spanish manufacturing data the kind of analysis carried out in Glaeser, Kallal, Scheinkman and Shleifer (1992) and Henderson, Kuncoro and Turner (1995) to find evidence about the role of dynamic externalities[1] influencing the growth of economic activities in the territory. However, we have overcome various limitations of these papers: first we have used productivity and value added instead of labour to measure industrial growth; second we have endogenously derived the indexes that measure external effects. Also, we include capital in the production function based model we use, and finally, we do not focus on a few specific industries but on a full range of industries and regions. The empirical analysis is carried out using up to 26 large industrial branches for the fifty Spanish provinces between 1978 and 1992.

What we basically find is evidence of a positive role for diversity and competition external effects (Jacobs and Porter type externalities, respectively) and mixed evidence for technological spillovers based on specialization (Marshal-Arrow-Romer or MAR type externalities). These results reconcile what was previously considered opposite evidence, see for instance Glaeser et al. (1992), that finds evidence of diversity externalities, or Henderson (1994), that supports the idea that specialization is better for growth. This paper also provides similar results to those found in the literature when employment is used instead of value added or productivity as we do in this paper.

The rest of the paper is organized as follows. In section 2.1, we elaborate on the notion of externality as it is not obvious what the appropriate definition is, and we propose a simple typology that guides the rest of the paper. Section 2.2 derives the indexes used to identify externalities and presents the model from which estimation equations are obtained. Section 3.1 contains a brief description of the data and a discussion of the province-industry trends that emerge after the first exploitation of this data. In section 3.2 we discuss the specifications used in our empirical search for externalities. The main results are offered in section 3.3. Finally, section 4 provides some concluding comments.

2. Externalities

[1] We will refer to externalities, in the rest of the paper, or to dynamic externalities alternatively. See Glaeser et al. (1992) for a tentative exploration of the presence of static externalities. We used and extended their approach to test for static externalities in de Lucio, Herce and Goicolea (1996). There we find evidence of static (contemporaneous) urbanization economies, we also find evidence of crowding-in between the biggest industries in each territory and the rest of the industries but we fail to find any static localization economies. By localization economies we mean advantages due to the presence of specialised inputs markets while urbanization economies refer to large output markets.

2.1. Definitions

Although the analysis of innovation has usually been confined to the interior of the firm, the idea that external sources of knowledge are important has gradually gained acceptance. In an uncertain environment, the capacity to innovate is fostered through the transfer of knowledge. Endogenous growth models emphasize the role of knowledge spillovers for growth [Romer (1986 and 1990) and Grossman and Helpman (1991)]. Additionally, relatively recent literature has emerged that focuses on the geographic dimension of knowledge externalities [Jaffe, Trajtenberg and Henderson (1993); Audretsch and Feldman (1996); Glaeser, Kallal and Sheinkman (1992); Henderson (1992 and 1994); Henderson et al. (1995)]. This literature suggests that not only do knowledge spillovers generate externalities, but that they also tend to be geographically bounded. In other words, proximity is important for the flow of knowledge. As Henderson (1992) argues, "close firms engage in networks that facilitate communication and knowledge spilling". These networks are most often local and are the reflection of interpersonal contacts and mutual trust that develop through the years. Proximity does not guarantee the transmission of knowledge, but it makes it easier.

Although there seems to be widespread agreement on the importance of technological externalities, there is an on-going debate about where this knowledge comes from. One view which Glaeser, Kallal and Sheinkman (1992) attribute to Marshall-Arrow-Romer (MAR), suggests that knowledge comes from firms of the same industry, so we would expect that an increase in an industry's concentration would facilitate knowledge spillovers. On the contrary, Jacobs (1969) argues that the most important knowledge spillovers come from firms in diverse industries. According to Jacobs diversity is better for growth.

MAR and Jacobs' externalities also differ on the effects of local competition on the transmission of knowledge across firms. MAR's view is that monopoly is better for innovation and growth since it permits the innovator to internalize the benefits derived. On the other hand, Jacobs (1969) argues that a highly competitive climate induces firms to innovate in order to remain competitive. This distinction between the degree of concurrency leads to a third type of externality we can attribute to Porter (1990) who agrees with Jacobs that competition is better for growth. However, he believes that knowledge spillovers take place mainly among firms belonging to the same vertically integrated industry. Table 1 presents a compact classification of the externalities just described.

Table 1. Typology of externalities			
		Type of market	
		High competition	**Low competition**
Predominant source of knowledge	**Intra-industry (specialization)**	Porter externalities Porter (1990)	MAR externalities Marshall (1890) Arrow (1962) Romer(1986, 1990)
	Inter-industry (diversity)	Jacobs externalities Jacobs (1969)	

2.2. The model

This section introduces the theoretical framework to study the presence of external effects associated with the economic structure of the industry-territory. Our model includes both capital in the production function and an endogenous derivation of the indexes used to measure externalities, thus going beyond the *ad hoc* measures used by Glaeser et al. (1992) and de Lucio et al. (1996). We also use productivity and value added instead of employment to measure industry growth. This allows us to compare our results with those of other studies, in order to confirm the effects of knowledge externalities on industry growth measured both by productivity or value added.

We consider a Cobb-Douglas production function. The firms produce Y, or value added, using labour L and capital K, with a technology level given by A:

$$Y_{i,j,t} = A_{i,j,t}\, L^{\alpha}_{i,j,t}\, K^{\beta}_{i,j,t} \tag{1}$$

where i is the industry subscript, j the territory subscript and t stands for time.

Firms, when deciding the amount of capital and labour to use, equal the ratio of capital expenses over the wage bill to the ratio of the production function coefficients of capital, β, and labour, α, in the Cobb-Douglas production function that we assume to be constant:

$$\frac{K_{i,j,t}\, r_t}{L_{i,j,t}\, w_{i,j,t}} = \frac{\beta}{\alpha} \tag{2}$$

Where r is the interest rate, as a crude proxy for firm's capital user cost, and w is the wage rate. Therefore, the first order condition for profit maximization, as expressed in equation (2), provides us with an expression for capital that we can substitute into equation (1). Taking logarithms in the resulting equation we have:

$$Ln\ Y_{i,jt} = Ln\ A_{i,j,t} + \alpha\ Ln\ L_{i,j,t} + \beta\ (Ln\ w_{i,j,t} + Ln\ L_{i,j,t} + Ln\ \beta - Ln\ \alpha - Ln\ r_t) \tag{3}$$

We can then subtract from equation (3) the same equation lagged one period to obtain the growth rate between two consecutive years as:

$$Ln\left(\frac{Y_{i,j,t}}{Y_{i,j,t-1}}\right) = Ln\left(\frac{A_{i,j,t}}{A_{i,j,t-1}}\right) + (\alpha+\beta)Ln\left(\frac{L_{i,j,t}}{L_{i,j,t-1}}\right) + \beta Ln\left(\frac{W_{i,j,t}}{W_{i,j,t-1}}\right) - \beta Ln\left(\frac{r_t}{r_{t-1}}\right) \tag{4}$$

Or, in productivity terms, as:

$$Ln\left(\frac{Y_{i,j,t}/L_{i,j,t}}{Y_{i,j,t-1}/L_{i,j,t-1}}\right) = Ln\left(\frac{A_{i,j,t}}{A_{i,j,t-1}}\right) - (1-\alpha-\beta)Ln\left(\frac{L_{i,j,t}}{L_{i,j,t-1}}\right) + \beta Ln\left(\frac{W_{i,j,t}}{W_{i,j,t-1}}\right) - \beta Ln\left(\frac{r_t}{r_{t-1}}\right) \tag{5}$$

Now, the growth rate of the technology level A_t is assumed to depend on a global component, A_{global} and on a local component A_{local}. The global component captures the exogenous changes in technology that affect industry, so we consider productivity growth in any industry outside the territory to be a reliable measure for the global industry technological change:

$$Ln\left(\frac{A_{i,j,t}}{A_{i,j,t-1}}\right)_{global} = Ln\left(\frac{\dfrac{Y_{i,t}-Y_{i,j,t}}{L_{i,t}-L_{i,j,t}}}{\dfrac{Y_{i,t-1}-Y_{i,j,t-1}}{L_{i,t-1}-L_{i,j,t-1}}}\right) \tag{6}$$

Following the purpose of this paper we will endogenize the local component of the technological factor, A_{local}, using the distribution of economic activity across all industries and regions. Following de Lucio (1997) we build a model with endogenous determination of the indexes used to measure the technological external effects. We will thus assume that innovation is distributed according to the distribution of activity both across territories and across industries. Following Grossman and Helpman (1991) and Martin and Ottaviano (1996) we consider that this distribution of innovation is a linear and increasing function of the share (of whatever variable of interest we consider determines innovation), that each firm of an industry in a territory has of the total value of this variable in the same industry or region. We will use value added growth as the proxy variable for the innovation process. In accordance with this model, when the firms of a given industry-territory have a greater percentage of the total value added, the territory will also enjoy a greater share of innovations.

As we are considering three different dimensions, for besides the time dimension we also have a regional and a sectorial perspective, we need to introduce two different kinds of percentages. On the one hand we consider industry percentages and on the other we consider regional percentages. Therefore the firms of an industry in a territory will have a proportion γ_i of the innovations in the industry, multiplied by the percentage of value added of these firms in the concerned industry:

$$\gamma_i N_{i,j,t} \frac{X_{i,j,t}/N_{i,j,t}}{X_{i,t}} = \gamma_i \frac{X_{i,j,t}}{X_{i,t}} \tag{7}$$

and proportion γ_j multiplied by the percentage of value added in the territory of the innovations in the region:

$$\gamma_j N_{i,j,t} \frac{X_{i,j,t}/N_{i,j,t}}{X_{j,t}} = \gamma_j \frac{X_{i,j,t}}{X_{j,t}} \tag{8}$$

Note that in our data set we only have totals, for the different variables, for each industry-territory but not detailed information by firm. According to the model, however, we should include firm sizes, and therefore we decided to use the average establishment size on each group, $X_{i,j,t}/N_{i,j,t}$, as proxy variable where X is the variable of interest and N is the number of establishments. Finally, as the unit of analysis is the industry-territory, we multiplied this average size by the number of equivalent establishments on each unit.

Additionally we will consider that there is a diffusion process taking place in the considered industry-region, among regions and across industries. We assume that a proportion θ_i and θ_j of the total innovations of the rest of the industries in the region and of the rest of regions in the industry diffuses to other industries and regions respectively. Therefore we have the following components in the innovation process:

$$\theta_i \sum_{k \neq j} \left(\gamma_i \frac{X_{i,k,t}}{X_{i,t}} \right) \quad and \quad \theta_j \sum_{k \neq i} \left(\gamma_j \frac{X_{k,j,t}}{X_{j,t}} \right) \tag{9}$$

Finally, in order to consider non-linearities in the process of innovation, and following Henderson (1994), we also include a quadratic effect of the innovation shares mentioned before, with parameters γ'_j, γ'_j, θ'_j, and θ'_j.

According to this model, technology growth is driven by the generation of innovations and their diffusion, expressed as:

$$\frac{dA_{i,j,t}}{dt} = A_{i,j,t} * \left(\gamma_i \frac{X_{i,j,t}}{X_{i,t}} + \gamma_j \frac{X_{i,j,t}}{X_{j,t}} + \theta_i \sum_{k \neq j} \left(\gamma_i \frac{X_{i,j,t}}{X_{i,t}} \right) + \theta_j \sum_{k \neq i} \left(\gamma_i \frac{X_{i,j,t}}{X_{j,t}} \right) \right.$$
$$\left. + \gamma_i' \frac{X^2_{i,j,t}/N_{i,j,t}}{X^2_{i,t}} + \gamma_j' \frac{X^2_{i,j,t}/N_{i,j,t}}{X^2_{j,t}} + \theta_i' \sum_{k \neq j} \left(\gamma_i' \frac{X^2_{i,j,t}/N_{i,j,t}}{X^2_{i,t}} \right) + \theta_j' \sum_{k \neq i} \left(\gamma_j' \frac{X^2_{i,j,t}/N_{i,j,t}}{X^2_{j,t}} \right) \right) \quad \textbf{(10)}$$

We can reorganize the terms of the previous equation to obtain:

$$\frac{dA_{i,j,t}}{dt} = A_{i,j,t} * \left(\theta_i \gamma_i + \theta_j \gamma_j + \gamma_i (1-\theta_j) \frac{X_{i,j,t}}{X_{i,t}} + \gamma_j (1-\theta_i) \frac{X_{i,j,t}}{X_{j,t}} + \gamma_i' (1-\theta_j') \frac{X^2_{i,j,t}/N_{i,j,t}}{X^2_{i,t}} + \right.$$
$$\left. \gamma_j' (1-\theta_i') \frac{X^2_{i,j,t}/N_{i,j,t}}{X^2_{j,t}} + \theta_i' \gamma_i' \sum_{\forall j} \left(\frac{X^2_{i,j,t}/N_{i,j,t}}{X^2_{i,t}} \right) + \theta_j' \gamma_j' \sum_{\forall i} \left(\frac{X^2_{i,j,t}/N_{i,j,t}}{X^2_{j,t}} \right) \right) \quad \textbf{(11)}$$

This equation shows that the technology growth rate depends on the specialization of the industry-territory inside the territory, $espp_{i,j,t} = \frac{X_{i,j,t}}{X_{j,t}}$, specialization in the industry, $espi_{i,j,t} = \frac{X_{i,j,t}}{X_{j,t}}$, the squared terms of these coefficients divided by the number of firms, $espp^2_{i,j,t} = \frac{X^2_{i,j,t}}{X^2_{j,t}/N_{i,j,t}}$ and $espi^2_{i,j,t} = \frac{X^2_{i,j,t}}{X^2_{j,t}/N_{i,j,t}}$, the firm's diversity in the territory, $div_{j,t} = \sum_{\forall i} \left(\frac{X^2_{i,j,t}/N_{i,j,t}}{X^2_{j,t}} \right)$, and the firm competition inside the industry, $com_{i,t} = \sum_{\forall j} \left(\frac{X^2_{i,j,t}/N_{i,j,t}}{X^2_{i,t}} \right)$. The last two indexes are similar to the Hirschman-Herfindahl indexes frequently used in the Industrial Organization literature to measure the diversity of the territory and the level of competition inside an industry.

We can integrate the technology growth (equation 11) to obtain the value of the local component of the technology on each period:

$$A_{i,j,t} = A_{i,j,0} e^{g(espi_{i,j,0},\ espp_{i,j,0},\ espi^2_{i,j,0},\ espp^2_{i,j,0},\ com_{i,0},\ div_{j,0})} \quad \textbf{(12)}$$

Our main purpose at the empirical level is to clarify which external effects are more important globally, not to characterise the differences among industries and territories, thus we assume that the parameters mentioned before are equal across industries and territories.

Note that we have data for a subset, albeit a large one, of the industries that belong the whole manufacturing sector. This has some consequences; first some indexes (those with squared terms) are only approximations to the real ones and, second, the estimated coefficients of regional specialization indexes in the specifications below are linear transformations of the real ones. The indexes obtained this way are similar to those included in previous papers [Glaeser et al. (1992) and Henderson et al. (1995)]. Finally, our model contains the full range of external effects presented in the literature and postulates appropriate indexes to measure them.

3. The Spanish Case

3.1. The data

The data source used in this study is the *Encuesta Industrial* (Industry Survey) produced by the *Instituto Nacional de Estadística* (INE, Spanish Statistical Office). This major source of Spanish industrial information contains reliable data of national totals for 89 manufacturing sectors. However, at the province level, which we use as the geographical unit of observation[2], this sectoral disagregation does not allow for reliable information. INE has provided us with data for 30 manufacturing groupings[3] which are directly surveyed by the Institute and do not represent the whole industry (some industrial sectors are excluded). The data set contains information on gross value added, production, employment, personnel costs and number of establishments by manufacturing sector and by province. The time period for the data goes from 1978 through 1992, the longest period available for the homogeneous industrial groupings we have chosen.

The transmission of data from INE to users must comply with the statistical secrecy guaranteed by the survey. Due to the high sectoral and regional disagregation of our data there are missing values for a considerable number of observations, those with less than 6 establishments per unit of observation. The percentage of missing values is thus 27,5% of the total number of observations for 1992, however, these represent only 3,1% of total

[2] The province is the smallest geographical unit for which there is data available. This is probably not the ideal unit of observation for the analysis of local externalities, it would be better to make the analysis with data at the city level or some standard urban economy level. However, provinces can be considered as a proxy of the relevant economic market.

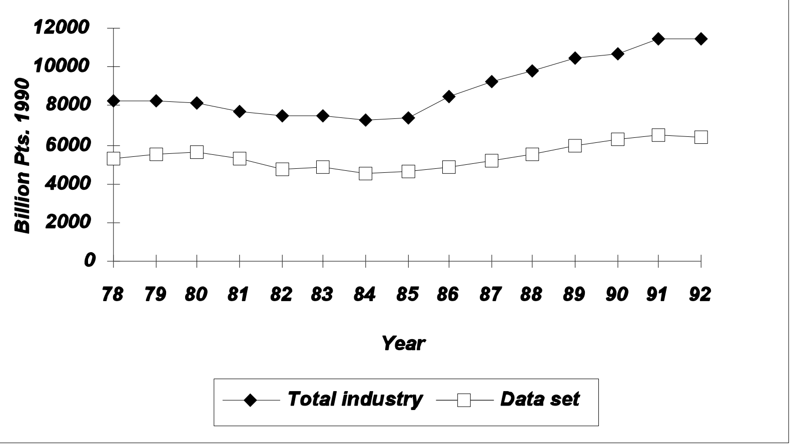
[3] The 30 industry groupings have been taken aggregating sectors that are horizontally integrated to obtain homogeneous industries.

employment and 4,8% of total value added. A more detailed description of the data set can be found in (de Lucio, Herce, and Goicolea, 1996).

Value added is transformed into real variables using industrial price indexes provided separately by the INE for homogeneous sectors, although price indexes are not available for four of our industry groupings in the data set, so these sectors have been omitted. The resulting industrial groupings contained in the data set can be seen in annex 1. Additionally, personnel costs have been deflated to obtain real labour costs using the nationwide consumer price index. All real variables are set at base year 1990.

The period analyzed in this study is marked by a deep structural change forced by the industrial crisis that lasted till the mid 80's. During the first part of the period, from 1978 to 1986, 613.4 thousand jobs were lost (-21% of industry employment). Value added in real terms also decreased slightly (see Figure 1), although it was less affected than employment. As a result productivity increased considerably. The completion of the structural adjustment around 1986, together with other factors such as the accession of Spain to the European Community and the large inflows of foreign direct investments, resulted in an intense growth in terms of value added as well as employment in the second half of the eighties. In 1991 manufacturing value-added reached a peak and began descending following a standard cycle. As can be observed in the figure below, the value added patterns followed by our data set and total manufacturing has been very similar.

Figure 1: Evolution of industrial value added.



Source: Industrial Survey

Table 2 contains some summary statistics of the distribution of diversity, competition and specialization indexes, computed as defined in section 2.2 above, for the fastest and slowest growing province-industries in the 1978-1992 period. We observe that the relationship between industry growth and diversity, competition and specialization cannot be completely established from the data contained in Table 2, but more diversity (lower index) seems to be correlated with higher industry growth and more specialization and competition with industrial decline. The indexes in table 2 have been calculated using value-added, but similar observations can be derived when the indexes are calculated using employment.

Table 2.
Value-added growth (1978-1992), specialization, diversity and competition in the five fastest and slowest growing Spanish province-industries

	Nº Establ.	V.Added growth (1)	Industrial Special. in 1978	Regional Special. in 1978	Diversity in 1978 (2)	Compet. in 1978 (2)
Five fastest growing province-industries						
Huesca - Alcohol and drinks	19	10.2	0.000	0.003	0.001959	0.001695
Toledo - Other final cons. chemical products	23	7.7	0.006	0.014	0.000493	0.001863
Alicante -Other final cons. chemical products	25	7,0	0.001	0.001	0.000203	0.001863
Leon - Alcohol and drinks	105	6.9	0.002	0.018	0.000827	0.001695
Murcia - Other final cons. chemical products	48	5.8	0.002	0.002	0.000870	0.001863
Five slowest growing province-industries						
Huelva - Alcohol and drinks	7	0.14	0.002	0.017	0.025262	0.001695
Badajoz - Agric.-ind. machinery and equip.	93	0.13	0.007	0.148	0.001449	0.000216
Gerona - Furniture	164	0.08	0.091	0.153	0.001016	0.000129
Lugo - Apparel	420	0.08	0.001	0.038	0.001351	0.000166
Sta. Cruz de Tenerife - Apparel	73	0.07	0.001	0.016	0.006058	0.000166
Statistics						
Average	244	1.3	0.038	0.170	0.003	0.001
Standard deviation	386	0.9	0.073	0.076	0.004	0.002
Highest	4183	10.2	0.583	0.637	0.025	0.019
Lowest	6	0.07	0.000	0.001	0.000	0.000

(1) Value added in 1992/ value added in 1978.
(2) A higher value of the index means less competition or diversity.

3.2. Empirical specifications

Using equations (5) and (10) we derive the following empirical equations:

$$Ln\left(\frac{X_{i,j,t}}{X_{i,j,t-1}}\right) = \beta_0 + \beta_1\, Ln\left(\frac{L_{i,j,t}}{L_{i,j,t-1}}\right) + \beta_2\, Ln\left(\frac{W_{i,j,t}}{W_{i,j,t-1}}\right) + \beta_3\, Ln\left(\frac{Y_{i,t}-Y_{i,j,t}/L_{i,t}-L_{i,j,t}}{Y_{i,t-1}-Y_{i,j,t-1}/L_{i,t-1}-L_{i,j,t-1}}\right) + \beta_4\, Espp_{i,j,t-1}$$
$$+ \beta_5\, Espp^2_{i,j,t-1} + \beta_6\, Espi_{i,j,t-1} + \beta_7\, Espi^2_{i,j,t-1} + \beta_8\, Com_{i,j,t-1} + \beta_9\, Div_{i,j,t-1} + Time\ \ Dummies \qquad \textbf{(13)}$$

where the variable X stands both for productivity or value added.

If we assume that there is a nation-wide capital market where arbitrage opportunities have been exhausted, interest growth rate is constant across regions and industries, consequently its changes are captured by time dummies.

Given the structure of our data set we obtain panel data estimations of equation (13). According to MAR and Porter's theories, specialization has a positive effect on growth, so we would expect positive signs for coefficients, β_4 to β_7. A negative β_8 coefficient will confirm the presence of competition externalities given that the corresponding index measures the lack of competition. Finally, if β_9 were negative it would mean that the industrial diversity of a territory explains productivity or value added growth. Under the hypothesis of decreasing returns to scale we also expect to obtain a positive (negative) β_1 explaining value added (productivity) growth and a positive sign lower than one for β_2 . Finally, β_3 is also expected to be positive.

To perform our panel estimations we use DPD program [Arellano and Bond (1988)]. This program allows us to use unbalanced panel data sets, increasing considerably the number of observations we can handle. The model has been transformed to first differences to eliminate non-observable individual effects and biases in the estimations. This transformation induces first order serial correlation.

Using the model introduced in section 2.2 we consider that technology growth is determined not only by the distribution in the base year but by the industrial composition of the territories in previous years. Consequently we would observe a growth process that is determined by the value of the externality indexes in previous years. Therefore equation (13) includes lagged externality indexes. In this way we try to shed light on the dynamic process of externalities or, in other words, the persistence of knowledge external effects.

3.3. Results

Table 3 contains the estimated coefficients of equation (13) using alternatively, as the dependent variable, inter-annual productivity and value added growth. All the regressors are measured in the base year for each observation of the dependent variable or in growth terms. We present both levels and first differenced equations that we believe to be more adequate. This transformation of the model allows us to eliminate the individual fixed effects on growth.

Table 3
Inter-annual growth in Spanish province-industries. 1979-1992

	Productivity		Value added	
	Levels	1st differences	Levels	1st differences
Intercept	0.03 (1.99)	0.00 (0.06)	0.03 (1.99)	0.00 (0.06)
Employment growth	-0.10 (6.40)	-0.18 (8.77)	0.90 (60.92)	0.82 (40.38)
Wage growth	0.50 (17.79)	0.46 (17.84)	0.50 (17.79)	0.46 (17.84)
Productivity growth	0.11 (3.72)	0.10 (3.10)	0.11 (3.72)	0.10 (3.10)
Ind. Esp.	-0.08 (1.57)	-4.72 (4.27)	-0.08 (-1.57)	-4.72 (-4.27)
Ind. Esp.^{2}	-1.04 (0.35)	36.60 (2.33)	-1.04 (-0.35)	36.60 (2.33)
Reg. Esp.	-0.29 (4.77)	-5.71 (9.04)	-0.29 (-4.77)	-5.71 (-9.04)
Reg. Esp.^{2}	3.88 (2.81)	40.06 (4.39)	3.88 (2.81)	40.06 (4.39)
Diversity	-0.50 (1.92)	-3.47 (1.83)	-0.50 (-1.92)	-3.47 (-1.83)
Competition	0.90 (0.95)	-5.59 (0.62)	0.90 (0.95)	-5.59 (-0.62)
Wald joint signific.	415.01	549.64	4160.58	3466.90
Wald time dummies	29.60	24.88	29.60	24.88
Wald externalities	29.13	129.36	29.13	129.36
Res. Square Sum	531.11	1201.14	531.11	1201.14
Total Square Sum	658.89	1793.76	1529.18	4049.41
Standard Error	0.06	0.07	0.06	0.07
Robust test f.o.corr	-7.30	-10.15	-7.30	-10.15
Robust test s.o.corr	-1.86	2.38	-1.86	2.38

Note, first of all, that the estimations for value added and productivity growth only differ in the employment growth coefficient and, as expected, the value of this parameter in the second case is the estimated coefficient in the first case minus one. The value for this coefficient seems to indicate the existence of slightly decreasing returns to scale.

Moving on to the coefficients of the externalities variables, we observe that all of them have the expected signs described in the previous section and thus the interpretation given there applies. Diversity effects play a positive role towards productivity and value added growth. The competition coefficient has a positive sign, as expected, although it seems not to affect growth significantly. Finally, the effects of specialization deserve an extended explanation. If the variable is introduced in levels, it has a negative effect on growth. On the contrary the squared term has a positive effect. Our interpretation for these results is that while low levels of specialization have a negative influence on growth, when specialization reaches a certain level it has a positive and significant effect on growth. Besides, we observe a different intensity between the industrial and the regional specialization effects the second being more significant.

In order to test the persistence of the different effects just described and according to the previous section, we have introduced a set of lagged specialization, diversity and competition indexes in the equation to study the dynamic effects of these variables on inter-annual growth rates of the dependent variable. We consider that a period between one and eight years keeps the structure of the panel and clarifies on the dynamic process of the external effects. As the number of observations per unit diminishes, a larger number of lags would damage the panel, but on the contrary a reduced number of lags would not include enough years to capture the effects like those identified for example by Henderson (1994), and de Lucio, et al. (1997). Performing these estimations, we can infer the persistence of the effects we are interested in.

The estimations of an extended equation (13) are shown in Table 4 where only the external effects coefficients are presented. These are the same when the dependent variable is productivity growth or value added. Table 4 shows that, looking at the most significant estimated coefficients, all signs are kept, both with respect to those shown in Table 3 and across time. Bold characters are used to signal out those coefficients significant at the 10% level. The interpretation of these coefficients is thus the same as before, however, the different lags introduced allow for additional interpretations related to the maturity of the external effects considered.

Table 4
Dependent variable: productivity or value added growth in province-industries.
External effects' lagged responses.

	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Lag 6	Lag 7	Lag 8
Industrial Specialization	**-10.86** (-7.77)	0.32 (0.52)	0.70 (1.38)	**0.88** (1.67)	0.03 (0.10)	**0.59** (1.67)	-0.15 (-0.48)	0.22 (0.76)
Squared Industrial Specialization	**184.82** (6.76)	**38.97** (1.80)	-27.24 (-1.24)	**-33.67** (-2.06)	-4.04 (-0.20)	**-40.14** (-1.92)	**54.40** (2.39)	17.58 (0.88)
Regional Specialization	**-5.28** (-9.66)	**-0.93** (-3.08)	**-0.84** (-3.60)	**-0.48** (-2.08)	**-0.71** (-3.16)	-0.34 (-1.25)	**-0.57** (-2.47)	**-0.61** (-2.12)
Squared Regional Specialization	**24.53** (3.79)	-1.37 (-0.23)	1.07 (0.13)	-12.33 (-0.96)	**11.17** (1.71)	-1.63 (-0.19)	-5.90 (-0.61)	-1.01 (-0.08)
Diversity	-1.68 (-0.65)	-1.97 (-0.95)	0.50 (0.33)	0.69 (0.33)	-1.89 (-1.13)	-1.24 (-0.77)	0.66 (0.33)	**-4.88** (-1.98)
Competition	-8.91 (-1.00)	-11.52 (-1.14)	6.07 (0.62)	**-22.52** (-1.94)	1.58 (0.30)	6.37 (0.96)	-10.13 (-1.43)	3.94 (0.53)

Diversity and competition effects, in particular, seem to positively influence industry growth. The competition externality seems to have its maximum effect on growth four years later, while diversity has its maximum effect eight years later.

Although specialization effects have the same sign as the ones presented in Table 3 for the first year, the results of Table 4 offer further insight into the dynamic effects of specialization. First of all, we observe a decreasing effect of this externality as time passes by. Secondly, the coefficients for industrial specialization and squared industrial specialization have opposite signs that reverse around the 4th to 6th lags. This evidence confirms that specialization has different net effects depending on its level.

Together with the sign reversal in the lagged industrial specialization variables, we observe an increase in the size of the base year coefficient in Table 4 as compared to the one presented in Table 3. We interpret the coefficient in Table 3 as a (weighted) sum of the lagged coefficients in Table 4. As for the regional specialization coefficient in the base year, we observe it decreases when more lags are introduced. The same interpretation applies to squared regional and industrial specialization coefficients. Finally we observe that the regional specialization effects span over a longer time period than industrial specialization effects.

4. Concluding comments

In this paper we have attempted to test for the presence and persistence of a variety of externalities that may influence the growth of economic activity in the territory, more precisely industrial value added and productivity growth. Our methodology has followed closely that of Glaeser et al. (1992) and Henderson (1994) although we present here some significant improvements. Primarily we have carried out panel data estimations that eliminate the regional-industrial individual effects. Secondly, we have tried to overcome the limitations that arise when using employment to analyse industrial growth. Instead we have used value added and productivity growth. This is particularly relevant when industrial employment has been falling while value added has been increasing. Thirdly, we present a model where the measures that proxy external effects are derived endogenously.

The empirical analysis has been done using data from the Spanish Industry Survey from 1978 to 1992 for 26 manufacturing branches across the fifty Spanish provinces. The evidence presented in the paper suggests that there are dynamic externalities favouring the growth of economic activity as measured by industrial value added and productivity. We confirm the presence of diversity (Jacobs) and competition (Porter) external economies. We also find evidence of dynamic economies of specialization (MAR) when a certain level of specialization is reached.

According to these results technological spillovers take place through cross fertilization between diverse industries and between firms belonging to the same industry when there is a high level of specialization. Competition is also favourable for growth. These findings coincide with those obtained by, amongst others, Glaeser et al. (1992) and de Lucio, Herce and Goicolea (1996), particularly for the diversity result. Under high levels of specialization, we also observe the likelihood of positive specialization and competition externalities (Porter) in line with Henderson (1994). Finally the results presented here are robust to whichever variable is used to proxy industry growth: employment, as in previous contributions, or value added or productivity, as it is done in this paper.

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Annex 1

Manufacturing sectors used in the empirical analysis and mean Gini coefficients[4] calculated using value-added.

Manufacturing sector	GINI
Plastics and synthetic fibres	0.98
Office equipment	0.98
Pharmaceutical products	0.96
Petrochemistry, org. and non-organic chemistry	0.92
Electronic materials, precision and optics	0.84
Production and 1st transf. of metals	0.78
Vegetables and fish preserves	0.71
Other final consumption chemical prod.	0.70
Other industrial chemical products	0.69
Textiles	0.68
Leather and shoes	0.62
Fertilizers and paintings	0.58
Glass products and ceramics	0.57
Food products and tobacco	0.51
Printing	0.50
Alcohol and drinks	0.42
Agricultural and industrial machinery & eq.	0.41
Electric machinery and materials	0.41
Plastic derivatives	0.36
Paper and derivatives	0.35
Wood, cork and derivatives	0.33
Furniture	0.33
Flour mills, bread and pastry	0.24
Apparel	0.24
Mat. for building and const. & non-metallic minerals	0.24
Metal mills	0.18

4 The Gini coefficients are based on industry value-added. We calculate the amount of value added in an industry-province and divide it by the national value-added for the industry (q_i). This ratio is normalized by the province's share of total manufacturing (p_i). Then we sort out the provinces ascendingly. Lastly we calculate the Gini coefficient as follows: $G_i = \sum_{i=1}^{N-1} (p_i - q_i) / \sum_{i=1}^{N-1} p_i$. This index ranges from 0 to 1. The higher the index, the greatest the geographic concentration of the industry.

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