INDUSTRIAL CLUSTERS AND REGIONAL INNOVATION: AN EVALUATION AND IMPLICATIONS FOR ECONOMIC COHESION

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Abstract: *This paper studies the role of industrial clusters in stimulating regional innovation and economic cohesion in Europe. Starting from an overview of industrial clusters in the EU, in which we highlight the strengths and weaknesses of agglomerations of firms, we empirically investigate how cluster and regional characteristics influence R&D investment and innovation output and the role they play in fostering economic cohesion.*
We find that the presence and size of clusters significantly enhance regional innovation in Europe; however, the industry in which regions specialize matters. In particular, specialization in medium-high and high-technology clusters seems to create a better environment for innovation and R&D. Finally, the presence of clusters in a region is positively associated with higher levels of employment.
Keywords: *Clusters / Innovation.*

CLUSTERS INDUSTRIALES E INNOVACIÓN REGIONAL: UNA EVALUACIÓN E IMPLICACIONES PARA LA COHESIÓN ECONÓMICA

Resumen: *Este trabajo estudia el papel de los clusters industriales para fomentar la innovación regional y la cohesión económica en Europa. A partir de una visión de conjunto de los clusters industriales en la UE, en la que se destacan las fortalezas y debilidades de las aglomeraciones de empresas, investigamos empíricamente la forma en que los clusters y las características regionales afectan a la inversión en I+D y al output de innovación y, asimismo, investigamos el papel que desempeñan en el impulso de la cohesión económica.*
Encontramos que la existencia y el tamaño de los clusters regionales fomentan de manera significativa la innovación regional en Europa. Sin embargo, tiene importancia la industria en la que se especializan las distintas regiones. En particular, la especialización en clusters de tecnología media-alta y alta parece crear un entorno más favorable para la innovación y la I+D. Por último, la presencia de clusters en una región se asocia positivamente con mayores niveles de empleo.
Palabras clave: *Clusters / Innovación.*

1. INTRODUCTION AND MOTIVATION

In this paper, we discuss the role of industrial clusters in the European Union, stressing their impact in terms of regional innovation and economic cohesion.

Given the processes of pervasive globalization and market integration, the main engines of growth can be found in knowledge creation and research and development, as emphasized in the Sapir Report (2004). As European countries are moving closer to the technological frontier, it is innovation and new organization structures that will spur competitiveness.

On the other hand, the productive structure of several European countries is characterized by the presence of industrial clusters of small and medium enterprises (SMEs). The relevance and impact of SMEs on economic activity have been studied by industrial economists with particular attention to knowledge and innovation

themes. Considering the role of uncertainty, asymmetry of information and high transaction costs related to knowledge, new theories of industrial evolution investigate entry, growth and survival of enterprises and sector dynamics linking these processes to innovation as a key factor for economic change (Jovanovic, 1982; Ericson and Pakes, 1995; Audretsch, 1995; Hopenhayn, 1992; Lambson, 1991; Klepper, 1996).

These theories suggest that entrepreneurship stimulates and generates growth: the positive impact of entrepreneurial small firms on economic performance mainly stems from the transmission of knowledge spillovers, increase in competition through a higher number of enterprises and increase in the variety of enterprises. Several studies at the country and regional level have focused on the correlation between enterprise size and some indicator of economic performance. A first strand of research has found robust empirical evidence on the role of SMEs in job generation both in the US and in some European countries (Heshmati, 2001; Hohti, 2000; Broesma and Gautier, 1997; Klette and Mathiassen, 1996). Another part of the literature has focused on enterprise growth and survival as a performance measure. A generally shared result is that younger and smaller firms, especially in technology-intensive industries, have higher growth rates and increased likelihood of survival (European Commission, 2003).

A long-standing literature has also speculated on the relative role of SMEs and large-sized enterprises in innovation and technological change. As different typologies of measures evolved over time, an increasing awareness of the role played by SMEs came up among researchers. In fact, there is substantial evidence that R&D indicators are positively related to enterprise size (Acs and Audretsch, 1990). Nevertheless, if we consider not just the input of the innovation process but also an output, such as the number of patents, contributions to patent activity by different size-class enterprises result almost equal (Scherer, 1983; Schwalbach and Zimmermann, 1991). Recent studies have focused on direct measures of innovative output, such as the total innovation rate (the total number of innovations per one thousands employees in each industry); some authors have found that small-firms' innovation rates in manufacturing are actually higher compared to large-firms'. This difference probably depends on structural variables of the specific industry: in highly innovative sectors, where SMEs do not have a high employment share, the relative innovative advantage is held by small enterprises. Therefore, it is possible that the increasing acknowledgement of the role of SMEs in innovation and technological change is due not only to an improvement of measurement activities, but also to some recent changes in economic and social environment that have shifted the innovative advantage towards smaller enterprises (European Commission, 2003).

Some authors have stressed the importance of the mutual relationship and linkages between large and small firms in regional or local dimensions. Recent works have also drawn attention to the empirical relationship between entrepreneurship and economic performance at the national level. OECD countries with higher increases in entrepreneurship have experienced greater rates of growth and lower le-

vels of unemployment; a similar relationship has been found when including non-OECD countries in the analysis (Florio, 1996).

We add to this literature by focusing on agglomerations of firms, mainly SMEs, at the regional level in the EU, and evaluate and empirically assess their contribution to R&D spending, innovation and economic cohesion.

Our main research questions aim at evaluating clusters in terms of regional innovative performance and in encouraging economic cohesion through impacts on employment levels. In the empirical analysis we focus on two research questions.

First, we investigate the specific role that clusters may have in influencing a region's innovative activity rate, measured in terms of expenditures in R&D by the private sector and by innovation output. We also control for regional and cluster characteristics.

Second, we explicitly consider the role industrial clusters have with respect to regional economic cohesion by estimating the relation between cluster size and regional employment.

The rest of the paper is structured as follows. In the section 2, we provide an overview of the importance of clusters in Europe and highlight their characteristics. section 3 describes the data used in the empirical analysis, carried out in section 4. Section 5 provides a critical analysis of cluster policies, while the final section summarizes and concludes and derives policy implications.

2. INDUSTRIAL CLUSTERS IN THE UE

While a precise and widely accepted definition of cluster is difficult to provide, several elements highlighted in the business and economic literature studying industrial relations provide a framework for analysing clusters. The concept was made popular in Michael Porter's 1990 book *Competitive Advantage of Nations,* and has spurred a burgeoning literature on the subject. A survey of this literature is beyond the scope of this paper,[1] but the key dimensions that identify and define clusters will be provided. Jacobs and de Man (1996) and Rosenfeld (1997) provide a list of criteria that are useful in identifying a cluster, including the geographical or spatial dimension of economic activities; vertical and horizontal relations between industry sectors; the use of common technology and inputs; the quality of the network or cooperation with "active channels for business transactions, communication and dialogue, that share specialized infrastructure, labour market and services" (Rosenfeld, 1997, p. 10); the size of the cluster; the strategic importance and the range of products produced. Another aspect characterizing firms that belong to a cluster is the fact that they are faced with common opportunities and threats.

Therefore, we can say that a cluster is "*a group of interconnected and spatially linked companies and associated institutions in a common or related industrial*

[1] For a review see Karaev *et al.* (2007).

sector, characterized by commonalities and complementarities, enjoying positive location-specific externalities". Such externalities include reaping the benefits of inter-firm cooperation and social interaction, specialised human resources and suppliers, knowledge spillovers, and learning from the close interaction with specialised customers and suppliers. The recent literature on clusters and industrial districts stresses both the geographic dimension of the firms' relationships, but also takes into account the role of the social infrastructure and the larger industrial system, going beyond mere spatial and sectoral proximity (Maskell, 2005; Belleflamme *et al.*, 2000; Soubeyran and Thisse, 1999).

According to the OECD (2007), the phenomenon of clustering is a major characteristic of industrial organisation in the OECD countries that have attempted to measure it, and an EU mapping exercise shows how this holds true for many European countries as well. The statistical importance of cluster activity in many OECD economies varies greatly, but nonetheless can be viewed as significant. For instance, France has 144 local productive systems (plus 82 "emerging") and 67 *pôles de compétitivité*, while Italy has 199 industrial districts which account for over 40% of manufacturing employment. The Netherlands classify 12 large-scale clusters which however account for around 30% of industry GDP, and Norway has 62 clusters (55 of which are manufacturing), and these absorb around 22% of manufacturing employment. Finally, the United Kingdom counts 154 (potential) regional clusters which have a major importance in terms of employment, ranging from 40% of regional employment (London) to 15% in the North West region.

By analysing clusters in 32 European countries (including EU-27 Member States, Iceland, Israel, Norway, Switzerland and Turkey), according to a unified statistical methodology, the European Cluster Observatory estimates that approximately 38% of all European employees are working in enterprises that are part of the cluster sector. In some regions, this share goes up to over 50% while in others it drops to 25% (Europe Innova, 2006).

When focusing our attention to the EU-10, the situation regarding clusters is a bit different (Ketels and Solvell, 2006). Overall, the cluster sector accounts for approximately 32% of all employment in the New Member States (NMS), with a uniform regional distribution, ranging from as low as 23.5 % in the Lublin (Poland) region, up to the 47.6% share in Slovenia. The sectoral composition is a distinctive feature of these countries, setting them apart from the general EU trends. The cluster sector in the NMS is mainly manufacturing-driven, with most of the manufacturing industries organized in clusters. Specifically, NMS are specialized in labour-intensive cluster categories. Considering the time period between 2000 and 2004, the cluster sector in the NMS registered significant increases in employment, with traditionally non important categories (such as business services) displaying the highest gains, providing opportunities for new businesses.

An indirect measure of cluster strength and their economic impact is export performance. It has been calculated that, for all of the EU-10 countries, more than

60% of their exports relate to activities in sectors where clusters are present and have a comparative advantage. In Latvia, for example, 75% of the country's exports in 2003 came from the 15 cluster categories where it has an important world market share. Interestingly, despite the relative importance of the cluster organizational form, and its importance in terms of exports, not all of the EU-10 countries have specific policies in place. Specifically, Estonia, Lithuania, Slovakia, Cyprus and Malta lack a comprehensive cluster policy, focusing on more traditional economic development strategies. Latvia and Poland have some cluster initiatives, which are however part of an overall strategy of increasing the economy's competitiveness. Only three countries, namely the Czech Republic, Hungary and Slovenia have well established cluster policies.

Policy-makers' interest in clusters and policies aimed at providing support to this organizational form also stem from the high innovative yield that firms belonging to a cluster-like environment provide. A recent survey conducted by the DG Enterprise and Industry on a sample of 3528 companies in the EU-25, four (at the time) candidate countries –Bulgaria, Croatia, Romania and Turkey–, and Norway, Switzerland and Iceland, highlights the innovative contribution of clusters (Innobarometer, 2006). The main results show that 78% of the innovative companies that belong to a cluster introduced new or improved products compared to the 74% of the general sample of innovative firms interviewed in the 2004 Innobarometer. When considering process innovations, 63% of the innovative cluster firms introduced innovative production technology, compared to the 56% found in the 2004 survey of the general innovative sample. Also, innovative firms in clusters are more likely to patent and trademark new products, processes and services: 26% of innovative firms in clusters applied for a patent, against the 12 % of general 2004 sample. Similarly, 29 % of innovative companies in clusters have registered at least one trademark in the previous 2 years, compared to only 14% of innovative firms surveyed in 2004.

On a similar note, the Regional Innovation Scoreboard (RIS) 2006, compares regions with a strong cluster presence with the most innovative regions in Europe, and finds that 7 out of 19 regions having a strong cluster portfolio are among the top third most innovative regions (Europe Innova, 2006). This evidence suggests that there might be a positive correlation between a region's cluster portfolio and its innovative capability, providing support for policies aimed at the promotion of clusters of small-medium enterprises (SME), especially in high tech and high value added sectors.

3. DATA

Regional EU data on industrial clusters is derived from the European Cluster Observatory (ECO), which provides performance and evaluation measures of regional agglomerations of employment, defined as statistical regional clusters. Our main variables of interest are *size*, *focus* and *specialization*: the amount and quality

of knowledge circulating and spilling over between firms located in a cluster is dependent upon the cluster's size, the degree to which it is specialized and the extent to which the region is focused upon production in the relevant industry. *Size* is measured as the share of cluster's employment on total European employment in clusters in the relevant industry. The larger the size, the more likely it is that the presence of clusters in a region has economic effects. *Focus* is defined as the ratio between cluster's employment and regional employment. This variable measures the extent to which the regional economy is focused upon the industry in which the cluster is present. Finally, the s*pecialization* variable compares the proportion of employment in a cluster industry in a region over the total employment in the same region, to the proportion of total European employment in that cluster category over total European employment. Thus, the index of specialization is:

$$\frac{(\text{Employment in a region in an industry})/(\text{Total employment in a region})}{(\text{Employment in an industry in Europe})/(\text{Total employment in Europe})}$$

Our sample consists of 1763 clusters in different sectors or industries for the year 2005. Regional innovation data for 2006 are derived from the Regional Innovation Scoreboard (RIS, 2009). We consider business R&D expenditure as a percentage of GDP, patent applications to the European Patent Office (EPO) per million population, the regional composite innovation index (*RII*) based on cluster analysis, employment in high-tech manufacturing as a percentage of workforce and population with tertiary education per 100 population aged 25-64. Finally, we use Eurostat data for regional GDP in PPS and total regional employment while the average compensation in million € is from the Cambridge Econometric (CE) database.

In Table 1 we have selected regions according to the Regional Innovation Scoreboard aggregate index (*RII*), reporting regions with high, medium and low levels of innovation, in order to illustrate how clusters' characteristics and the underlying regional production structure relate to knowledge creation. We report, for each region, the first three clusters in terms of size, measured as the share of employment in the cluster in the selected region with respect to employment in clusters of the same industry all over Europe.

In the top panel of Table 1 we consider the German Oberbayern region, with a high level of innovation. In this region, 18 clusters are reported. The first three clusters are in the Instruments, Aerospace, and Power sectors. As reported in Table 1, this region has a high level of specialization in these industries. For example, the share of regional employment in the Aerospace industry is more than four times the share of European employment in the same sector.

Despite the strong specialization in the Aerospace cluster, the share of regional employment is quite low with respect to other clusters in the region. Note that the most important clusters in this innovative region are in high-tech and R&D intensive industries.

In the middle panel of Table 1 we report the same data for the French region Centre, characterized by an intermediate level of innovation.

The biggest clusters in this region are in the Biopharma, Finance and Food industries, with mixed characteristics in terms of innovation and R&D intensity and output. This region is remarkably specialized in Biopharma, while in the other two sectors considered the difference with the rest of Europe is negligible. Moreover, the region is mainly focused on Finance and Food, despite the fact that Biopharma is the most important cluster. Despite Finance and Food account for a negligible share of total European employment in these types of clusters, they represent a relevant share of regional occupation.

Finally, in the bottom panel of Table 1 we report data for the Portuguese region of Alentejo, reporting low levels of innovation. The most important clusters in this region are in the Lighting, Construction and Agricultural industries, which can be considered low and medium-low knowledge intensive. In this case it is remarkable the importance of the Construction clusters in terms of focalization.

Table 1.- Clusters and innovation in selected regions

Oberbayern (DE)	Clusters	18			
	RII percentile	0.99			
SECTOR	SIZE	SPECIALIZATION		FOCUS	EMPLOYEES
Instruments	3.99	4.65		1.35	21,339
Aerospace	3.85	4.49		0.88	13,957
Power	3.6	4.2		1.21	19,159
Centre (FR)	Clusters	5			
	RII percentile	0.5			
SECTOR	SIZE	SPECIALIZATION		FOCUS	EMPLOYEES
Biopharma	1.7	4.36		1.95	13,960
Finance	0.52	1.33		5.14	36,858
Food	0.45	1.16		3.14	22,531
Alentejo (PT)	Clusters	6			
	RII percentile	0.01			
SECTOR	SIZE	SPECIALIZATION		FOCUS	EMPLOYEES
Lighting	0.34	3.75		1.05	1,769
Construction	0.31	3.44		12.27	20,627
Agricultural	0.29	3.16		1.43	2,413

SOURCE: Authors' elaboration of ECO and RIS data.

4. EMPIRICAL ANALYSIS

Our main research questions aim at evaluating clusters in terms of regional innovative performance and in encouraging economic cohesion through impacts on employment levels. Specifically, our empirical investigation seeks an answer to the following research questions: *RQ1: Is the presence of industrial clusters related to*

regional innovative activities, and how do specific cluster characteristics affect this relationship? RQ2: What is the role of industrial clusters with respect to regional economic cohesion and employment?

4.1. CLUSTERS AND INNOVATION

With respect to the first question, we will consider three indicators to evaluate regional innovative activities and outcomes: private sector R&D expenditures, the number of patent applications to the EPO per million inhabitants and the composite indicator *RII*. We control for country fixed effects and the log of GDP per capita in PPS in all specifications.

Our main specification, estimated with robust OLS, is the following:

$$Innovation_r = \alpha + \beta\ Cluster_{rc} + \gamma\ Region_r + \varepsilon_{rc} \quad (1)$$

where *r* indicates the regional level and *c* the cluster level.

In Table 2, we analyze the role of regional and cluster-specific characteristics on private sector's expenditure in R&D. The region's economic size, measured in terms of per capita GDP, is, as expected, positively related to business expenditure in innovation: richer regions tend to have higher levels of spending by private firms. Moreover, we control for human capital, proxied by the share of population with tertiary education. The higher the share of higher educated workers in the region, the higher business expenditure in R&D is. Finally, at the regional level, we also control for the share of workers employed in high-tech manufacturing sectors. The estimated coefficient is positive and highly significant in all the specifications (columns 2, 3, 5, 6).

Turning to cluster characteristics, we introduce, as a measure of the importance of clusters for innovation, the number of clusters in the region (*number)*: regions with a higher number of clusters in different sectors tend to have a higher R&D expenditure by businesses (columns 1-3).

The size of clusters (columns 4- 6), in terms of employment, positively and significantly affects private innovation spending, suggesting that clusters' dimension at the sectoral level plays a role in pushing innovation and R&D expenditure.

On the other hand, the variable *focus*, defined in the previous section, has a statistically significant negative estimated coefficient. In general, when a cluster accounts for a larger share of a region's overall employment, spillover effects may be stronger; however, this does not appear to foster R&D expenditure by firms. On the contrary, the effect seems to be negative and statistically significant: focalization in a particular cluster is associated, in our data, with a reduction of firms' expenditure in innovation. A possible interpretation of this result is that what matters more for regional innovation are the characteristics of the industries in which the region has a stronger agglomeration of workers and firms. If a region is focalized in a low-

tech cluster or in a labor-intensive one, which are less knowledge-intensive and less likely to invest in R&D activities, then focalization has a negative effect on regional indicators of innovation.

Table 2.- Business R&D

	(1)	(2)	(3)	(4)	(5)	(6)
PRIVATE R&D						
GDP per capita	0.074***	0,043***	0,042***	0,097***	0,044***	0,043***
	[0.000]	[0,000]	[0,000]	[0,012]	[0,000]	[0,000]
Tertiary education	0.269***	0,380***	0,378***	0,227***	0,360***	0,358***
	[0.000]	[0,000]	[0,000]	[0,030]	[0,000]	[0,000]
Emp_Hightech		0,455***	0,448***		0,476***	0,472***
		[0,000]	[0,000]		[0,000]	[0,000]
Number	0.005***	0,002***	0,002***			
	[0.000]	[0,000]	[0,000]			
Size				2,464***	1,919***	1,882***
				[0,340]	[0,000]	[0,000]
Focus	-0.168	-0,233*	-0,227*	-0,480***	-0,296**	-0,294**
	[0.315]	[0,087]	[0,093]	[0,171]	[0,025]	[0,025]
Specialization	-0.000	-0,001	-0,002*	-0,009***	-0,007***	-0,007***
	[0.944]	[0,459]	[0,053]	[0,001]	[0,000]	[0,000]
Spec * High			0,004**			0,003**
			[0,012]			[0,049]
Constant	-0.370***	-0,271***	-0,256***	-0,526***	-0,260***	-0,251***
	[0.003]	[0,000]	[0,003]	[0,117]	[0,002]	[0,003]
Observations	1,763	1,763	1,763	1,763	1,763	1,763
R-squared	0.653	0,744	0,746	0,638	0,749	0,749

NOTES: *p*-values associated with robust estimation in brackets. ***p<0.01, **p<0.05, *p<0.1.

SOURCE: Authors' elaboration of ECO, RIS and Eurostat data.

Finally, we control for the degree of regional specialization (*specialization*) in clusters. In the first two specifications (columns 1 and 2), where we control for the number of clusters in the region and the degree of focalization, specialization in a particular industry has no significant relationship with private R&D expenditure. However, when we control for specialization in industries classified as intensive in technology, the estimated coefficient of specialization per se turns to be significantly negative, while specialization in medium-high and high-technology clusters fosters private spending in innovation. When we control for the size of the cluster (columns 4-6), specialization per se has a negative relationship with expenditure, while specialization in high-technology industries has a positive and significant effect (column 6).

Table 3 reports the results of the estimation of the relationship between regional and cluster characteristics and innovation, considering the composite index of innovation as a dependent variable (*RII*).

The level of regional per capita GDP is positively and significantly related to innovation, as well as the percentage of population with tertiary education and the share of employment in medium-high and high-tech manufacturing.

The number of clusters observed in each region has a positive effect on innovation (columns 1-3) as well as clusters' size in terms of employment: the presence and the dimension of clusters are positively related to aggregate innovation at the regional level.

On the contrary, *focus*, i.e. the cluster's share of region's overall employment, has a negative relationship with innovation.

Finally, results on regional specialization are confirmed: while specialization per se has a negative effect on innovation activity, regional specialization in medium-high and high-technology clusters stimulates it.

Table 3.- Regional Innovation Indicator

	(1)	(2)	(3)	(4)	(5)	(6)
RII						
GDP per capita	0.133***	0.104***	0.102***	0.160***	0.112***	0.111***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Tertiary education	0.529***	0.613***	0.610***	0.483***	0.589***	0.588***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Emp_Hightech		0.283***	0.275***		0.319***	0.313***
		[0.000]	[0.000]		[0.000]	[0.000]
Number	0.005***	0.003***	0.003***			
	[0.000]	[0.000]	[0.000]			
Size				2.308***	2.014***	1.958***
				[0.000]	[0.000]	[0.000]
Focus	-0.151	-0.189*	-0.181*	-0.457***	-0.345***	-0.342***
	[0.243]	[0.082]	[0.090]	[0.001]	[0.002]	[0.002]
Specialization	-0.001	-0.001	-0.003***	-0.009***	-0.008***	-0.009***
	[0.238]	[0.101]	[0.001]	[0.000]	[0.000]	[0.000]
Spec * High			0.005***			0.004***
			[0.000]			[0.005]
Constant	-1.135***	-0.979***	-0.957***	-1.326***	-1.032***	-1.019***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Observations	1,622	1,622	1,622	1,622	1,622	1,622
R-squared	0.760	0.803	0.805	0.743	0.801	0.802

NOTES: *p*-values associated with robust estimation in brackets. ***$p<0.01$, **$p<0.05$, *$p<0.1$.

SOURCE: Authors' elaboration of ECO, RIS and Eurostat data.

Considering the output of innovative activities, in Table 4 we show results for equation 1 with patent applications as a dependent variable. The main differences with respect to Tables 2 and 3 seem to be associated with the role of regional economic activity (log of GDP per capita in PPS) which is associated to a higher coefficient when patent applications are considered. On the other hand, human capital has a lower coefficient in general: what seem to matter more for patent application is not higher education per se, but the level of employment in innovative sectors.

Table 4.- Patent Applications

	(1)	(2)	(3)	(4)	(5)	(6)
PATENTS						
GDP per capita	0.166***	0.132***	0.131***	0.205***	0.147***	0.147***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Tertiary education	-0.000	0.107***	0.106***	-0.050**	0.086***	0.086***
	[0.998]	[0.000]	[0.000]	[0.044]	[0.001]	[0.001]
Emp_Hightech		0. 360***	0.358***		0.412***	0.411***
		[0.000]	[0.000]		[0.000]	[0.000]
Number	0.007***	0.004***	0.004***			
	[0.000]	[0.000]	[0.000]			
Size				2.359***	1.913***	1.908***
				[0.000]	[0.000]	[0.000]
Focus	-0.040	-0.092	-0.090	-0.480***	-0.335***	-0.335***
	[0.712]	[0.314]	[0.332]	[0.000]	[0.000]	[0.000]
Specialization	0.001	0.001	0.001	-0.007***	-0.006***	-0.006***
	[0.323]	[0.253]	[0.485]	[0.000]	[0.000]	[0.000]
Spec * High			0.001			0.001
			[0.260]			[0.777]
Constant	-1.277***	-1.105***	-1.099***	-1.561***	-1.218***	-1.217***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Observations	1,680	1,680	1,680	1,680	1,680	1,680
R-squared	0.852	0.893	0.893	0.827	0.886	0.886

NOTES: *p*-values associated with robust estimation in brackets. ****p*<0.01, ***p*<0.05, **p*<0.1.

SOURCE: Authors' elaboration of ECO, RIS and Eurostat data.

Considering clusters' characteristics, once again the number of clusters and their size seem to be related with a larger number of patents per million of inhabitants.

The proxies for focalization and specialization are still negative and significant, but only after controlling for cluster's size.

Interestingly, there is no effect on the number of patents normalized by the population of specialization in medium-high and high-technology industries.

4.2. CLUSTERS AND ECONOMIC COHESION

Table 5 shows results for the estimation of a labour equation where regional employment (in logs) is dependent on GDP, the average wage level, the working age population with tertiary education, employment in high-tech manufacturing sectors and the presence of industrial clusters and their focus, as defined in Section 3. The baseline specification (column 1) shows that regional employment is negatively related to the average compensation level and positively to economic activity, measured by the log of GDP per capita in PPS. Cluster size is also associated to a positive and significant estimated coefficient, indicating that the presence of well-developed clusters is related to higher regional employment and thus contributes to economic cohesion.

In the second column, we control for highly skilled labour force, which displays a positive and significant coefficient, with other results unchanged. Adding the percentage of employees in high tech manufacturing sectors (column 3) shows that the skill structure of the labour force is important for the overall regional employment level. Being specialized in high tech and innovative sectors seems to be, on average, associated with a higher level of employment. Finally, when controlling for the focus of the clusters present in the region (column 4), we can conclude that higher concentration of employment in the cluster is associated with a lower level of regional employment.

Table 5.- Regional employment (cluster size)

	(1)	(2)	(3)	(4)
LABOR				
Wage	-0.972***	-0.966***	-0.965***	-0.960***
	[0.000]	[0.000]	[0.000]	[0.000]
GDP per capita	0.420***	0.343***	0.320***	0.322***
	[0.000]	[0.000]	[0.000]	[0.000]
Tertiary education		0.536***	0.588***	0.584***
		[0.000]	[0.000]	[0.000]
Emp_Hightech			0.196***	0.189***
			[0.000]	[0.000]
Size	1.967***	1.697***	1.697***	1.717***
	[0.000]	[0.000]	[0.000]	[0.000]
Focus				-0.743***
				[0.000]
Constant	5.056***	5.640***	5.760***	5.793***
	[0.000]	[0.000]	[0.000]	[0.000]
Observations	1,773	1,763	1,763	1,763
R-squared	0.952	0.956	0.957	0.957

NOTES: *p*-values associated with robust estimation in brackets. ***$p<0.01$, **$p<0.05$, *$p<0.1$.

SOURCE: Authors' elaboration of ECO, RIS and Eurostat data.

In Table 6 we consider simply the presence of clusters at the regional level. The *number* variable is positive and statistically significant across all specifications, indicating that the agglomeration of firms in general is conducive to higher employment values.

In column 2 we add human capital, which, as expected, is positively associated with the regional labor force. Employment in high-tech industries (column 3), contrary to results in Table 5, is not statistically significant. Finally, in column 4, we show that *focus* has no statistically significant impact on regional employment levels.

Table 6.- Regional employment (cluster presence)

	(1)	(2)	(3)	(4)
LABOR				
Wage	-0.914***	-0.898***	-0.898***	-0.898***
	[0.000]	[0.000]	[0.000]	[0.000]
GDP per capita	0.358***	0.260***	0.259***	0.261***
	[0.000]	[0.000]	[0.000]	[0.000]
Tertiary education		0.612***	0.614***	0.612***
		[0.000]	[0.000]	[0.000]
Emp_Hightech			0.007	0.007
			[0.864]	[0.863]
Size	0.048***	0.049***	0.049***	0.045***
	[0.000]	[0.000]	[0.000]	[0.000]
Focus				-0.241
				[0.230]
Constant	5.815***	6.612***	6.611***	6.610***
	[0.000]	[0.000]	[0.000]	[0.000]
Observations	1,773	1,763	1,763	1,763
R-squared	0.956	0.961	0.961	0.961

NOTES: *p*-values associated with robust estimation in brackets. ***$p<0.01$, **$p<0.05$, *$p<0.1$.

SOURCE: Authors' elaboration of ECO, RIS and Eurostat data.

5. CLUSTERS POLICIES

The previous section has shown that industrial clusters play an important role in the European economy, in terms of innovative potential and as poles of regional employment. It is thus interesting to understand if there is scope for specific policy interventions and to verify to what extent existing measures may help promoting innovation and social cohesion through cluster support.

When analysing existing policy measures, cluster policies can be related to three main categories: regional policy, science and technology policies and industrial and enterprise policies. From a regional policy perspective, cluster policy actions may specifically target lagging regions and focus on SMEs, while from a technology policy standpoint, the objective is to provide an incentive for clusters in the high-tech sectors, promote collaborative R&D initiatives and include both small and large firms. Finally, when considering cluster policy support in terms of more general industrial policy, the instruments try to target the main determinants and drivers of growth, supporting industries undergoing significant structural change and creating competitive advantages to attract inward investment and promote exports (OECD, 2007).

The main instruments used in OECD countries by programmes focusing on clusters fall into three main categories. The first set of instruments is used to engage relevant actors, the second to provide collective services, and finally to promote collaborative research among cluster participants.

Instruments used to engage actors are essential to identify the common goals and key issues of the cluster, and to bring relevant actors together. Among the main tools are accurate mapping studies of clusters, use of facilitators or brokers and promoting events that help support the network. Collective services include instruments that help improve capacity, scale and skills of SMEs participating in the cluster initiative, increase external linkages in terms of attracting FDI and fostering international activities, especially exports, and finally concentrate on attracting and training of skilled labour force. The final set of tools are those aimed at promoting collaborative research and commercialization of results, through support of joint programs and links with universities and research centres, technology transfer support and access to finance for spin-offs.

Several critical considerations can be proposed to evaluate the existing policy measures and their effectiveness in terms of cluster promotion. We will briefly present some common instruments actually used, and highlight potential problems, based on the work by Bekar and Lipsey (2001).

Several public bodies have fostered cluster formation through the creation of government research parks or by attracting a leading company to a specific region. This can cause problems if the research parks are not true joint ventures involving public and private sector and the local business community. The public sector should facilitate cluster development in accordance with the private sector, not following a top down approach. This concept was introduced by Perroux (1955), which refers to this approach as "*pole de croissance*", back in 1955.

This top down approach has however proven to be useless in absence of proper accounting of local specificities and without a sound input-output mechanisms design.[2] When devising a cluster policy, it should be kept in mind that clusters should build on existing specialties and technical competencies within a region. New clusters should not be artificially created around the development of totally new technologies or with technical knowledge very far form the region's existing frontier. Government support should go to clusters that promote incremental innovation and that build on existing specialties. Also, the boundaries of clusters should be carefully studied and should not be limited to a geographical dimension. Cluster boundaries should reflect economic links and relations, created also by the existence of knowledge spillovers, and government intervention and aid should not be based solely on political and administrative boundaries.

Given the crucial role attributed to SMEs and clusters in innovative activity, a main goal of any cluster policy should be to encourage and help development and dissemination of knowledge among the firms in the cluster. It also should increase firms' awareness to the benefits of cooperation of results and information sharing and active networking. Also, public policy should encourage and facilitate spin-offs from existing clusters, which have proven in the past to be successful. Public

[2] For a more in depth analysis of growth pole strategy application see Parr (1999).

policy should not simply provide direct subsidies, but should encourage support and interaction from universities and national research centres, and foster the attraction of private capital.

Economic policy for clusters may comprise performing cluster studies, setting up facilities and institutions for fostering dialogue, providing direct subsidies for cooperation and establishing networking schemes for private firms (Hospers and Beugelsdijk, 2001). In general, regional cluster policy comprises elements of innovation and industrial policy and can be conducted at regional, national or supranational level.

While most of the existing policy measures aimed at promoting cluster formation and functioning seem to concentrate on organizational and administrative aspects, managers' growing concern relates to financing as well. Data from the Innobarometer (2006) highlight the fact that 68% of managers interviewed agree that public authorities have an important or fundamental role in supporting clusters, and that more financial support to cluster-projects is called for, especially in Belgium, Lithuania, Malta, the UK and Turkey.

From the evidence provided in the previous section, we believe clusters to be important from and economic and innovation perspective for regional growth and performance and that the current globalization trends may pose serious challenges. The socio-economic impact of trade integration in the EU-27, and the effects of world-wide globalization on the European industrial structure and composition will be significant and long-lasting. Given the importance of clusters in the European economy, this will deeply affect SMEs in several traditional industries, especially in the relatively labour-intensive industries, particularly in manufacturing. The current clusters organisation will be faced with a series of shocks and several of them, depending on their stage in the life cycle and the sector they belong to, will need to either restructure in depth, or might eventually fade away.

To conclude, we advocate a systemic approach, aimed directly at industrial clusters, which stresses the importance of innovation and competitiveness, and is based on a mix of financial and non financial instruments. The main underlying principles are a competitiveness scenario analysis, the involvement of stakeholders, fostering of concentration and selectivity, and integrated innovation packages for regional industrial systems.

6. CONCLUSIONS

The objective of the EU is to invest in knowledge creation and research and development, as emphasized in the Sapir Report (2004), in order to enhance the competitiveness of European countries and regions in the global arena. As European countries are moving closer to the technological frontier, innovation and new organization structures will spur competitiveness. Innovation is becoming an open process, in which several actors, including private firms, universities, customers

and other organizations, co-operate in a more complex fashion than before. Traditional regional comparative advantages are transforming, with once thriving production centres losing out to lower-cost locations, and a shift towards highly technological and R&D intensive manufacturing sectors or to higher value added non-manu-facturing industries (OECD, 2007). What is needed is therefore a wide industry restructuring, with less vertically integrated firms and more instruments to help new organizational forms of enterprises and cooperative agreements in sectors with high innovation potential. Public policies should provide firms and workers with an incentive to create links and facilitate knowledge creation and transfer as a way of making European regions and countries more competitive.

Our analysis has shown how agglomerations of firms in different industrial sectors at the regional level are positively related to innovative activities and employment, suggesting a role for economic policies supporting clusters and directed towards increasing R&D spending and employment creation to ultimately enhance social and economic cohesion. The presence of cluster seems to be relevant in fostering innovation activities and employment but it is important to identify in which industries firms agglomerate, given that specific sectoral characteristics are crucial in determining the overall effect on regional innovative performance.

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