

# USING PUBLIC AID PROGRAMS TO FINANCE INNOVATION IN MULTI-LEVEL GOVERNANCE SYSTEMS

Manuel GUISSADO-GONZÁLEZ  
Manuel GUISSADO-TATO  
Mercedes VILA-ALONSO

## Abstract

This paper explores how different public administrations (regional, national, European and Framework Program) allocate public resources to promote innovation among innovative companies in the Spanish manufacturing industry. We incorporate variables that have never been treated in this line of research before, such as export-oriented and Pavitt's taxonomy among others. In order to know the preferences of each public program aimed at promoting innovation we use two econometric estimation techniques: first, a binary logistic regression and, second, another binary logistic regression corrected for selection bias derived from the lack of consideration of certain relevant characteristics of manufacturing firms that do not innovate. We check if the importance and statistical significance of certain explanatory variables depend on the estimation method used. We found that the four public administrations preferably assign public resources to Spanish companies that cooperate with other domestic companies. We also found that European programs (EU and Framework Program) show their allocation preferences towards innovative firms that export outside EU. The public aid from the Spanish central administration seeks to promote the creation of large 'national champions'.

**Keywords:** R&D subsidies, technology policy, innovation, European Union, Spain.

## Manuel GUISSADO-GONZÁLEZ

Assistant Professor, Department of Business Administration,  
Faculty of Economics and Business Administration, Vigo  
University, Vigo, Spain  
Tel.: 0034-986-818.756  
E-mail: manuelguisado@uvigo.es

## Manuel GUISSADO-TATO (corresponding author)

Professor, Department of Business Administration, Faculty of  
Economics and Business Administration, Vigo University, Vigo,  
Spain  
Tel.: 0034-986-812.487  
E-mail: mguisado@uvigo.es

## Mercedes VILA-ALONSO

Professor, Department of Business Administration, Faculty of  
Economics and Business Administration, Vigo University, Vigo,  
Spain  
Tel.: 0034-986-812.482  
E-mail: mvila@uvigo.es



## 1. Introduction

The topic of public intervention in the resources allocation literature is a recurrent theme. Classical economists, under the formula of 'laissez faire, laissez passer', argued that public authorities should not intervene, allowing an efficient allocation of resources through the free play of market forces (invisible hand). However, alongside the development of the neoclassical paradigm, market imperfections increased in validity. These imperfections can be economies of scale, externalities or barriers to entry and exit that allow those who exploit them first to gain an advantage (Lieberman and Montgomery, 1988; Chandler, 1990). From the early and intensive exploitation of these imperfections, the concept of competitive advantage was born and this has since spread to encompass country and territory advantages. As a result of both advantages, the intervention of national and regional authorities has become a 'logical' way to create environments that encourage the location of efficient production units within their own boundaries, with the aim of increasing the wealth and welfare of residents (Porter, 1990). By contrast, increasing and rapid technological development led to huge economies of scale that have pushed countries with reduced domestic demand towards the formation of economic blocks of enough size to ensure the survival and progress of their more efficient production units. In other words, minor or moderately sized countries tend to participate in political and economic integration processes with neighboring countries in order to help companies with greater economies of scale find similar market conditions to those that companies in large countries have. Therefore, supranational public authorities burst into the scene in order to intervene in the allocation of resources, creating a more suitable environment for the location and development of the productive units that interest them most (Guisado-Tato, Sandoval-Pérez and Guisado-González, 2009).

Consistent with the foregoing, it should be noted that Spain is a country where the three policy spheres outlined above coexist. As an EU member country, it is regulated by European laws and directives; by contrast, within its own territory, decisions and laws coexist that emanate from the national government, and that govern the whole country. Finally, laws are also issued by different regional governments with regulatory capacities in their respective territories.

Moreover, restricting our attention to the field of innovation, the results of this activity are often subject to so-called 'market failures' (Arrow, 1962). As a result of these market failures, parts of these results are ultimately enjoyed by other economic agents who have not taken the risks and costs involved in the original innovation (Klette, Moen and Griliches, 2000). That is why private agents tend to make fewer investments in innovative activities insofar as the expected returns may be lower than it is the market return for the level of risk assumed. In order to decrease the costs of investment of private agents and to increase their profitability rates, the different areas of political decisions (supranational, national and regional) devote a major part of their public funds to promoting innovation (Acosta and Modrego, 2001; Abramovsky, Harrinson and Simpson, 2004; Bönnte, 2004). This is true insofar as innovation constitutes the main source of economic growth and the generation of competitive advantages.

In other words, the main objective of the interventions of public authorities in the field of innovation is to promote and stimulate private agents' investments. Therefore, most studies that have analyzed the relationships between innovation and public aid have sought to determine whether such aid has reached that aim, i.e. determine the extent to which public aid is a substitute for or complementary to private investment in R&D. Thus, works (Griliches, 1986; Lichtenberg, 1987; Kaiser, 2004) have concluded that innovative firms that have received public aid have not increased their spending on innovation; therefore, we can only classify this public aid as a substitute of private investment. Moreover, the studies conducted by Busom (2000), Lach (2002), Almus and Czarnitzky (2003), and Lööf and Heshmati (2005) have found that private agents undertake innovative projects as a result of public aid received, which infers a certain degree of complementarity between public aid and private investments in innovation projects.

However, it should be noted that only few studies have focused on the analysis of preferences of the different administrations in the allocation of the public resources devoted to promote innovation (Bacaria *et al.*, 2002; Kaiser, 2003; Van der Horst *et al.*, 2006). Nevertheless, this kind of analysis can show ex-post the real targets that public administrations have pursued by granting such aid. For instance, have they favored large or small companies, radical or incremental innovation, product or process innovation, or national or foreign companies? Have they promoted industrial development in a region or in a country, or in a whole economic block that they belong to, or have they favored companies with domestic or exporter vocations?

In addition, these studies have detected the existence of any differences between the rules and the selection mechanisms applied by the different administrative levels that grant the aid. The studies also assessed whether the aid package for innovation granted by different administrations constitutes an integrated 'whole' or if each one clearly pursues different objectives. In other words, they allow us to examine whether the probability of getting subsidies depends on the agency where the request is made.

Regarding the Spanish economy, three recent studies on this subject have been published in international journals (Blanes and Busom, 2004; Fernandez-Ribas, 2009; Altuzarra, 2010). Going beyond the last cited work, our research provides the following contributions:

1. We incorporate into the analysis a set of variables that the traditional literature on innovation considers to be relevant, namely the classification of enterprises by Pavitt's (1984) taxonomy, and the export or domestic nature of each company. The first allows us to visualize whether the beneficiaries of the aid work in traditional or advanced technology fields, while the second allows us to visualize whether the granting of public aid depended on the competitive environment in which the company works.
2. We conducted two different kinds of estimations. First, we used logistic regression, in line with Altuzarra (2010). In the second estimation, we conducted another binary logistic regression corrected for selection bias derived from the lack of consideration over certain relevant characteristics of manufacturing companies

that do not innovate. Many studies in the field of innovation emphasized that this method of estimation is more accurate and that the statistical significance of certain explanatory variables is affected by the selection bias previously noted (Cassiman and Veugelers, 2006).

The structure of the remainder of this paper is as follows: section 2 establishes the framework and defines the objectives of this work; section 3 describes the sample, variables and methodology; section 4 samples the results and the discussion; and section 5 delivers the main conclusions.

## **2. Theoretical Framework**

In order to optimize and coordinate the three policy decision levels in the EU, the Treaty of Maastricht (1992) established as common rule among its members, namely the 'subsidiarity principle', whereby higher administrative levels act when regional or national levels are insufficient. Therefore, we delineate the theoretical foundations that underlie the intervention of any administrative level to determine innovation policies and the objectives of their different programs (Oates, 1998; Laranja, Uyerra and Flanagan, 2008; Fernández-Ribas, 2009).

Thus, it is often noted that lower levels of government (regional and national) have a greater ability to understand and correct the dysfunctions that may exist in their corresponding systems of innovation, particularly in regard to non-tradable innovation inputs that require a certain degree of geographical proximity for a proper setting in motion (Feldman and Kelley, 2002), as occurs in the promotion of partnership agreements between companies that perform complementary activities (Fernández-Ribas and Shapira, 2009). In addition, the intervention of national and regional authorities is justified by the dissimilar and heterogeneous allocation of resources by the countries and regions of the EU. The needs and degree of technological development of these regions are very different; this difference is extended to the objectives of national and regional programs to support innovation. Each country or region understands better their own needs and wants, supporting more decidedly certain strategic sectors (Fernández-Ribas, 2009). The differences between business profitability and social returns justify the existence of innovation subsidies; moreover, these differences are specific to each project (Blanes and Busom, 2004) and even specific for each country on the same project, which justifies public intervention in innovation at the regional and national levels.

By contrast, the existence of externalities is often noted as a justification for the intervention of public authorities in the EU in resource allocation:

1. Regarding externalities, as in the whole EU, profitability is higher than that achieved in any region or country that finances innovation-generating externalities; the EU should fund these kinds of innovation activities. In this case, national or regional aid would not make sense, because it does not only benefit their respective areas.
2. It should be emphasized that the existence of increasing returns is one of the main market failures associated with the generation of technology. In these cases, tech-

nological activities may require specific major investments. Therefore, if national or regional agencies fund these projects, they would not fund low-cost projects that are strategic to their territories.

In addition, if the EU does not support these kinds of projects, companies would be forced to make strenuous efforts and administrative management to find financing from different innovation support agencies. This way of acting would be inefficient compared with the centralization of EU funds for projects of high costs.

Therefore, innovative Spanish manufacturing companies can apply for innovation subsidies from three institutional levels: regional, national and European. In Europe, two different types of programs exist: the Structural Funds and Framework Programs. In this work, we are interested in broadening our understanding of the policy priorities at each institutional level.

In the field of public aid for innovation business, size is an ambiguous variable. On one hand, it seems logical to expect that large firms are more likely to seek public aid for their innovative projects because they have more resources and administrative capacity to, first, know and then confront and resolve the bureaucratic complexities involved in any requests for public aid (Czarnitzki and Hussinger, 2004). On the other hand, for the sake of the so-called 'philosophy of generating national champions' or 'picking winners' it is also expected that public administrations subsidize big businesses by allowing them to appear as defenders of national employment. In this regard, North, Smallbone and Vickers (2001) highlighted that public aid is usually focused on companies that are going well, that is, companies that show high growth rates.

By contrast, it is expected that small businesses are the prime target of public aid. This intervention is justified by market failures, to which small businesses are more exposed. Furthermore, Feldman and Kelley (2006) pointed out that public administrations are interested in promoting innovative projects that have a high capacity to generate spillovers. Therefore, it is expected that small companies receive more public support in view of their propensity to explore radical technologies.

As previously noted, the empirical evidence about the relationship between firm size and the public administration propensity to grant public aid for innovation is ambiguous. For example, Busom (2000), and Lööf and Heshmati (2005) noted the existence of a negative relationship between firm size and the probability of receiving public aid targeted towards innovation. Arvanitis, Hollenstein and Lenz (2002) did not indicate the statistical significance of the size variable. However, the great majority of empirical studies have shown a positive relationship between the public administration propensity to grant public aid for innovation and business size (Wallsten, 2000; Czarnitzki and Fier, 2002; Almus and Czarnitzki, 2003; González and Pazó, 2008; Hussinger, 2008).

Moreover, taking into account the multiple criteria of different innovation agencies, we expect that European funds tend to finance, from the perspective of economies of scale, large firms. From the same perspective, national agency acts thereafter. By contrast, we expect that size is a non-significant variable at the regional level because in the territorial area the budget for the promotion of innovative activities is lower and

the number of companies receiving aid is relatively superior compared with that in other territories.

The ability of companies to generate and commercially exploit new ideas depends on their cumulative experiences in R&D (Cohen and Levinthal, 1989, 1990). Consequently, we expect that the more technologically intensive are the sectors, the more the probability that they participate in innovative projects and, that is, the chances of receiving public aid from the administration are increased. The same thing happens to companies that show the highest levels of intensity in R&D at the individual level. However, projects of complex technology sectors and individual companies with the highest intensity in R&D typically require larger amounts of investment, and thus we expect that companies that comply with these variables are involved in European funding programs and no other administrations programs.

In relation to capital ownership, we expect that the different public administrations would have a higher propensity to finance innovative projects of companies with Spanish capital. This is because these programs seek to promote the technological development of domestic firms. However, we expect that this propensity decreases in the case of aid from European agencies to the extent that it tends to favor companies that work in Spain and other EU countries.

The codified knowledge variable refers to the defense of R&D results through patent protection mechanisms, the registration of utility models and the use of trademarks and copyright. The theoretical literature indicates that these protective mechanisms are related to innovative activities (Teece, 1986; Cassiman and Veugelers, 2006). Certain studies proved that if legal protection mechanisms are effective, the size of companies is less decisive in stimulating and protecting the related innovation processes (Cohen and Kepler, 1996). In these cases, the innovation disadvantages of small firms are less obvious. Therefore, an inter-industry variation is expected, and thus the influence of this variable on the allocation of public funds assigned to promote innovation of the different administrations is not clear *a priori*.

In this work, we also explore the propensity of the public administrations to allocate different resources depending on whether the company performs product or process innovations, or radical or incremental innovation. *A priori*, this propensity can differ greatly from industry to industry, so we make no assumptions.

In addition, we are also interested in the influence of business cooperation in the allocation of public funds to finance innovative projects. This is because cooperative activities can influence the innovative activities of a company. By contrast, there is evidence that innovative firms are the most frequent users of public sources for financing their projects (González, Jaumandreu and Pazó, 2005).

However, cooperation agreements not only affect companies and their competitive positioning, but also concern the processes of the generation and diffusion of new technologies. This affects the welfare generation and prosperity in societies of which these companies are part. All this stems from the interest of the government in promoting, through grants from public funds, the satisfaction of social interest through cooperative arrangements.

In the specific field of public aid for innovation through the promotion of cooperation agreements between companies and between companies and different government agencies focused on our research. Kleinknecht and Reijnen (1992), and Reger and Kuhlmann (1995) concluded that support for innovation increased the number of materialized cooperation agreements, thereby contributing to the spread of technology. In this sense, Gemünden, Heydebreck and Herden (1992) noted that the public aid for innovation provided by the different public administrations can explain the increase in cooperation agreements between companies. Furthermore, Georghiou and Roessner (2000) and Luukkonen (1998, 2000) analyzed the allocation of public aid programs for innovation in cooperative contexts, finding a positive effect on the innovation capacity of enterprises that cooperate. In addition, Fernandez-Ribas (2009) and Altuzarra (2010) also tested the positive relationship between the establishment of cooperation agreements and the propensity of governments to grant public aid for innovation. In this case, we also expect a similar relationship, mainly when cooperation agreements are established between Spanish companies and between Spanish and European companies. The influence of cooperation agreements with foreign companies, if any, may be because of the pursuit of specific and temporary objectives in the search of capabilities that national or European companies do not have.

In general, innovation requires increasing levels of investment, involves high levels of uncertainty, which are intensified still further by the remarkable increase in competition that globalization creates, shortens the life cycles of products, displays similar characteristics to public goods, presents serious problems of appropriability and requires specific and unique management and technical skills (Cusumano, 1985; Grupp, 1995; Ma and Lee, 2008). In addition, innovation generates a cost structure that produces a significant increase in fixed costs and a decrease in the recovery time of investments (Bower and Hout, 1988; Yip, 1992). Also, by contrast, it is usually noted that companies that perform R&D have more difficulties finding foreign financing (Blanes and Busom, 2004), and such funding is often more expensive than that applied to fixed asset investments (Hall, 2002). Therefore, as the interest of public administrations is promoting innovation, it is expected that innovative companies with problems derived from the lack of internal resources, difficulties in obtaining external funding or high costs of innovative projects seek public support to implement these projects. Thus, we expect that the higher the barriers for companies to innovate, the greater the propensity of the public administrations to take part in the financing of their innovation projects.

Moreover, the literature suggests that the competitive environment in which companies operate influences the codified knowledge that they generate for themselves (Veugeleers and Cassiman, 1999). Therefore, it is expected that companies with higher export intensity (under a demanding competitive atmosphere) receive greater public support than non-exporters do. In this sense, we hope that firms that export outside the EU receive more support than those that direct their exports to EU countries.

Depending on different technology generation sources and the nature and impact of the innovations produced, Pavitt (1984) established four categories of companies:

specialized suppliers, scale-intensive, dominated by providers and based on science. *A priori*, the last two categories present the most differentiated innovation patterns and for those categories, the innovation strategies employed by firms can be distinguished more clearly. Moreover, scale-intensive firms compete based on economies of scale, while specialist suppliers firms provide equipment to science-based and scale-intensive firms. We believe that it is extremely interesting to understand whether the different institutional levels that exist within the EU show identical support patterns for each of the categories proposed by Pavitt, and if not, to determine what kinds of categories are preferential to each institutional level. *A priori*, we do not make any assumptions on this matter.

### 3. Sample, variables and methodology

The data used for the analysis come from the database Technological Innovation Panel in 2008 (PITEC, 2008), developed by the National Statistics Institute of Spain under the guidelines of the Oslo Manual. The sample consists of 12,813 companies. Of these, 5,801 operate in the manufacturing sector, out of which 3,872 are in innovative manufacturing<sup>1</sup>.

Table 1 shows the names and definitions of the variables used in the analysis and the averages and standard deviations of each of them, which exempts us from making a tidy explanation of them. But then, we perform some precision that we consider essential. Thus, we point out that the dependent variable FRFUND refers to whether Sixth Framework Program (2002–2006) and/or Seventh EU Framework Program<sup>2</sup> (2007–2013) allocate public resources to innovative companies. Codified knowledge (CODKN) is captured by four items in the survey: patents, utility models, trademarks and copyrights. If the company used one or more of these methods, the CODKN variable takes the value 1. If the company does not use any of these protection methods its value is 0. Moreover, we distinguish between radical and incremental innovation. The first occurs when the company has introduced a good or service into market, while innovation is incremental if the good or service introduced is new for the firm but not for the market. Regarding the variable that measures barriers to innovation, this expresses the average value obtained from three items (lack of internal funds, lack of external financing and excessive innovation costs), each valued at four levels of importance: 1 – not relevant; 2 – low; 3 – medium; 4 – high. Therefore, the innovation barriers are a continuous variable from 1 to 4.

In order to contrast the hypotheses formulated we use the sample of 3,872 innovative manufacturing firms and binary logistic regressions. We perform four logistic regressions, one for each dependent variable (REFUND, NAFUND, EUFUND and FRFUND). The remaining variables act as independent variables.

However, because we restricted our analysis to the world of innovative manufacturing firms, the extent to which these kinds of companies can receive public support for innovation can raise problems of selection bias. This kind of bias can occur when the selection variable used (in this case, or may not be an innovator) is observed rather

than estimated. The result can be that in the model to be estimated, the effects of non-innovative companies that could influence the probability that the different public administrations allocate, or not, public resources to the innovative companies. To correct this bias the so-called Heckman correction method is often used, which was applied to all manufacturing firms (5,801 firms). However, when the dependent variable is binary, and therefore not continuous, some authors recommend a similar but different correction method (Greene, 1993; Hass and Hansen, 2005). The method proposed by Manning, Duan and Rogers (1987) involves a regression to the selection variable (innovate or not innovate) upon a group of explanatory variables about the probability to innovate<sup>3</sup> in order to determine such probability and use it as an explanatory variable in the model that estimates the probability that the administration provides public support for innovation. Thus, the obtained coefficients in this second phase have been corrected for any selection bias.

**Table 1:** Description and definition of the variables

<b>Dependent variables</b>	<b>Values</b>	<b>Names</b>	<b>Mean / Standard deviation</b>
Regional public funds	0 No 1 Yes	REFUND	.299/.458
National public funds	0 No 1 Yes	NAFUND	.274/.446
EU structural public funds	0 No 1 Yes	EUFUND	.036/.187
EU framework program for research	0 No 1 Yes	FRFUND	.026/.158
<b>Independent variables</b>			
Size	1 Fewer than 50 employees 2 Between 50 and 249 employees 3 Greater than 249 employees	SIZESM SIZEME SIZEBIG	1.732/.743
Technological intensity of the sector*	1 Low 2 Medium-low 3 Medium-high 4 High	TILOW TIML TIMH TIHIG	2.335/1.011
Foreign capital**	0 No 1 Yes	FGNCAP	.149/.357
Product innovation	0 No 1 Yes	PRODIN	.766/.423
Process innovation	0 No 1 Yes	PROCIN	.747/.435
R&D intensity firm	Expenditures on innovation / Turnover	RDI	.127/1.825
Codified knowledge	0 No 1 Yes	CODKN	.342/.474
Cooperation with Spanish firms	0 No 1 Yes	COOPSP	.350/.477
Cooperation with European firms	0 No 1 Yes	COOPEU	.133/.340
Cooperation with US firms	0 No 1 Yes	COOPUS	.031/.174
Cooperation with firms from other countries	0 No 1 Yes	COOPOT	.027/.162

Dependent variables	Values	Names	Mean / Standard deviation
Barriers to innovation	Continuous values from 1 to 4	BARIN	2.897/ .866
Radical innovation	0 Not new to the market 1 New to the market	RADIN	.466/ .499
Incremental innovation	0 Not new to the firm 1 New to the firm	INCRIN	.600/ .490
Exports to EU countries	Percentage of turnover	EXPUE	19.818/26.992
Exports to other countries	Percentage of turnover	EXPOTH	9.607/16.462
Pavitt' s sectoral taxonomy	1 Specialized suppliers 2 Scale-intensive 3 Supplier-dominated 4 Science based	SPSUP SCINT SUPDOM SCBAS	2.331/1.048

\* OECD (2003)

\*\* Is used as a proxy variable belonging to a group of companies with headquarters abroad

#### 4. Results and discussion

Table 2 shows the number of companies in relation to some of the most relevant variables involved in the analysis. Thus, we found that 45.5% of innovative manufacturing firms have received public funds for innovation derived from a combination of the four administrative levels under study. Furthermore, 16.6% are financed exclusively by regional administrations and 13.9% by national administrations. In all the administrative levels considered, we found that the percentage of companies that perform incremental innovations is slightly higher than is the percentage of companies that perform radical innovations. In relation to the Pavitt taxonomy, scale-intensive companies are the most abundant of any administrative levels.

**Table 2:** Summary of the characteristics of public support programs for innovation

	Public support				
	Only Regional funds	Only National funds	Only European funds	Only Program Marco	Mixed funds
Size: Fewer than 50 employees	321 (8.3)	173 (4.5)	19 (0.5)		687 (17.7)
Size: Between 50 and 249 employees	244 (6.3)	212 (5.5)	11 (0.3)		685 (17.7)
Size: Greater than 249 employees	76 (2.0)	155 (4.0)	8 (0.2)		389 (10.0)
Firms that receive public funds	641 (16.6)	540 (13.9)	38 (1.0)		1761 (45.5)
Firms that cooperate	315 (8.1)	257 (6.6)	20 (0.5)		957 (24.7)
Firms with radical innovations	307 (7.9)	284 (7.3)	17 (0.4)		931 (24.0)
Firms with incremental innovations	372 (9.6)	345 (8.9)	22 (0.6)		1097 (28.3)
Pavitt: Specialized suppliers	170 (4.4)	96 (2.5)	11 (0.3)		444 (11.5)
Pavitt: Scale-intensive	251 (6.5)	224 (5.8)	17 (0.4)		669 (17.3)
Pavitt: Supplier-dominated	134 (3.5)	93 (2.4)	5 (0.1)		308 (8.0)
Pavitt: Science-based	86 (2.2)	127 (3.3)	5 (0.1)		340 (8.8)

Note: In parentheses are the percentages of the total number of innovative manufacturing firms.

Table 3 shows the corresponding results of the logistic regressions performed. In this table, we distinguish between the uncorrected coefficients for selection bias by the

inclusion of omitted variables from the duly corrected coefficients for selection bias. Our analysis is based on the estimation of corrected coefficients. We include the estimation without bias correction to show the importance of the estimation method employed. Apart from changes in coefficients, at the regional and national levels is where the estimation method is more prevalent. Locally, we find that the ‘barriers to innovation’ variable loses a degree of significance according to the bias correction method, while the ‘exports to countries outside the EU’ variable becomes no longer significant. Nationwide changes in the levels of significance affect a substantial number of variables. However, the estimation method does not affect the degree of significance of variables in regard to the Structural Funds and Framework Programs.

**Table 3:** Estimates of each public support program for innovation

	Uncorrected estimate selection bias				Corrected estimate selection bias			
	REFUND	NAFUND	EUFUND	FRFUND	REFUND	NAFUND	EUFUND	FRFUND
SIZEME	.124	.585***	-.066	.004	.062	.409***	-.031	.011
SIZEBIG	.067	1.194***	.152	.335	-.031	.911***	.204	.346
TIML	.159	.207*	.268	.397	.122	.101	.290	.401
TIMH	.048	.227	-.691	.042	-.017	.035	-.652	.050
TIHIG	.143	.724**	-.179	.699	.056	.456*	-.128	.709
FGNCAP	-.359**	-.522***	-.202	-.279	-.363**	-.526***	-.200	-.278
PRODIN	-.201	.061	-.011	.324	-.214	.024	-.002	.326
PROCIN	.048	-.022	-.134	-.325	.045	-.031	-.133	-.325
RDI	-.014	.230***	.009	.018	-.013	.266**	.009	.018
CODKN	.092	.191**	.144	.132	.082	.163**	.147	.132
COOPSP	1.160***	.859***	.851***	1.332***	1.156***	.850***	.855***	1.332***
COOPEU	.066	.303**	1.149***	1.141***	.060	.283**	1.153***	1.142***
COOPUS	.215	.064	.350	.442	.221	.075	.347	.442
COOPOT	-.020	.069	.105	.255	-.026	.050	.112	.257
BARIN	.113**	.087*	-.059	-.060	.089*	.021	-.047	-.058
RADIN	.286**	.308**	-.080	-.021	.285**	.304**	-.078	-.020
INCRIN	.053	.078	.104	.020	.049	.068	.106	.021
EXPUE	.002	.004**	.001	-.001	.001	.002	.001	-.001
EXPOTH	.004*	.004*	.009*	.014**	.003	.001	.009*	.014**
SCINT	-.272	.146	-.740	-.278	-.262	.172	-.744	-.279
SUPDOM	-.255	.038	-1.045*	-.028	-.244	.066	-1.050*	-.029
SCBAS	-.477***	.161	-.236	-.232	-.473***	.170	-.240	-.233
R <sup>2</sup>								
Nagelkerke	.122	.171	.121	.177	.123	.178	.121	.177
Correctly classified	71.8%	74.7%	96.4%	97.4%	71.6%	74.8%	96.4%	97.4%

Note: Statistical significance of the coefficients at 1%\*\*\*, 5%\*\* and 10%\*

Regionally, five variables show a significant influence on the probability that the public administration grants aid for innovation. Thus, this probability decreases when companies have foreign capital included in its social capital and when it comes to science-based companies according to Pavitt’s typology. Our results are consistent with those of Altuzarra (2010) regarding foreign capital in terms of significance and sign. This result shows that foreign companies can face legal and administrative bar-

riers that prevent them from receiving public aid and that, because of their particular strengths in the innovation area, they do not have to resort to such funding sources. The negative influence of foreign capital is stressed at all administrative levels studied, although both at the European level and in the Framework Programs this influence is not statistically significant. Regarding science-based companies, our result differs from Fernandez-Ribas's research (2009), which showed that this variable is not statistically significant. However, the aforementioned difference may come from the author who did not use the typology of Pavitt. On the contrary, Fernandez-Ribas used another typology developed by the OECD (2003) regarding knowledge content where science-based companies are limited exclusively to the services sector.

Moreover, the variable that shows the greater positive influence is cooperation with domestic companies, while cooperation with companies from other countries shows no statistically significant influence, in line with Altuzarra's research (2010). In addition, the higher the barriers to innovation are the greater is the probability of receiving public support from the regional government, again in line with Fernandez-Ribas (2009). Altuzarra (2010) did not use this variable in his analysis. Finally, we find that firms that innovate with the aim of introducing new products to the market (radical innovation) are more likely to receive public support from the regional government. In our case, the influence of incremental product and process innovations is not statistically significant. Altuzarra (2010) did not use variables that refer to incremental and radical innovations, but found that process innovations have a positive and significant influence on the probability of receiving regional aid.

The probability that the state administration grants public aid for innovation is influenced by nine statistically significant variables. Medium-sized and large companies have a significant and positive influence. This agrees with the results of Altuzarra's research (2010), except at the regional funding level. Furthermore, in our case, technology-intensive sectors have a significant and positive influence on the probability of receiving aid from national sources. However, in Altuzarra's investigation (2010) the technological intensity of sectors did not show a significant influence. In our work, a firm's R&D intensity has a positive and significant influence on the probability of receiving public funds from the national innovation support programs, corroborating Fernandez-Ribas's findings (2009) in the Catalonian economy<sup>4</sup>. However, in Altuzarra's work (2010) this variable was not significant for the entire Spanish economy. In any case, our variable is more sensitive and accurate because it measures R&D internal capacity gradually, while the two studies mentioned above have binary natures. Consequently, knowledge absorptive capacity (Cohen and Levinthal, 1990) is better represented by the variable that we use.

Property rights protection (codified knowledge) affects positively and significantly the probability that the national public assistance programs allocate resources to companies which need them but have no significant influence on other public assistance programs. In Altuzarra's investigation (2010), this variable was not used. This influence can be interpreted as a derivative of an attempt by a national government that seeks to

strengthen R&D-intensive firms (so IRD is significant) and hence with a high relation to legal protection mechanisms. Obviously, as other agencies do not try to strengthen high IRD business, we do not show a significant relationship with the 'coded knowledge' variable. Cooperation with national and other EU companies also has a significant and positive influence. However, cooperation with companies in different countries is not significant. The results are completely consistent with those obtained in Altuzarra's study (2010). In this case, only the radical nature of innovation influences positively and significantly with national agencies, exactly what happens with regional agencies. We find that national and regional agencies tend to support companies engaged in radical innovation, while the remaining types of innovations (product, process and incremental) are not an objective of any innovation aid agency. Instead, Altuzarra (2010) did not use radical and incremental innovation variables. However, in that study, process innovation was significant at all institutional levels.

In relation to EU Structural Funds, we find that cooperation with other national and EU firms has a positive and significant influence, mainly cooperation within the EU. We find that EU funds strongly promote cooperation with other EU companies, which infers that Structural Funds generate spillovers within the EU's territorial scope. This result is similar with that obtained by Altuzarra (2010). However, we also explore the influence of aid on exports inside or outside the EU. In this case, we note that the Structural Funds are positively and significantly related to exports outside the EU. We also note that one of the clear objectives pursued by the EU is to promote innovative export-oriented companies. The data do not support that Spanish national and regional agencies have the promotion of innovative exporting companies among their objectives. This constitutes, in our opinion, an unfocused action, given the chronic structural deficit on the Spanish trade balance. In relation to Pavitt's typology, we observe that supplier-dominated companies have a significant and negative influence on the probability of receiving aid from Structural Funds. In that case, the benchmark is provided by companies known as specialist suppliers.

Finally, European aid from the Marco program seems to pursue the same objectives as those of the Structural Funds inasmuch as the significant variables are the same in both programs, except Pavitt's typology has no significant influence on the Marco program.

To summarize, from the results obtained, we can characterize each aid program. The results suggest that regional aid does not discriminate according to access to coded methods, size, sectoral technological intensity, R&D intensity, export orientation or the level of product, process or incremental innovation. However, having foreign capital and being a science-based company decreases the probability of receiving regional aid for innovation. On the contrary, companies that cooperate with other domestic companies that are involved in radical innovations and perceive cost, financial and risk barriers (concerning innovation activities) receive preferential regional public funding. In short, the main objective of regional aid is to assist distressed companies in their innovation activities and to promote R&D cooperation.

Innovation aid at a domestic level does not discriminate based on product, process or incremental innovation, nor in terms of innovation barriers perceived, export capacity, or belonging to a group according to Pavitt’s typology. By contrast, this aid tends to penalize foreign capital companies and favor larger companies belonging to high technological intensity sectors that show a high R&D intensity and are active in radical innovation. These companies display a tendency to protect their innovations through coded methods and to cooperate with other companies and institutions, both Spanish and European. It seems clear that national administrations have clearer objectives than do regional agencies to the extent that they support larger companies belonging to technologically complex sectors that are prone to defending their radical innovations through coded methods.

European funds, both the Structural Funds and Framework Programs, are characterized by promoting cooperation at a national and a European level and supporting companies that have shown an export capacity outside the EU. In addition, the European Structural Funds tend to discriminate against supplier-dominated firms (in relation to specialist providers). It seems obvious that European aid aims to promote cooperative agreements in order to help knowledge dissemination and innovation throughout the European territory. Such aid also aims to strengthen European companies competing in international markets with companies outside the EU. To summarize, Table 4 reflects the degree of fulfillment of our expectations regarding the behavior of some of the variables used in our estimates.

**Table 4:** Summary of hypotheses

Variable	Hypothesis supported?
Size	Partially
Sectoral technological intensity and R&D intensity	Partially
Foreign capital	Yes
Codified knowledge	Partially
Cooperation	Yes
Barriers to innovation	Partially
Exports	Partially

## 5. Conclusions

Of the 17 explanatory variables analyzed, we found that six did not have a statistically significant influence on any of the administrative levels considered. These variables are as follows: product innovation, process innovation, cooperation with US companies or organizations, cooperation with companies or agencies from other countries, and incremental innovation and exports to other EU countries. Furthermore, we found that cooperation with other Spanish firms or agencies is a common objective of the four administrative levels that grant public aid for innovation. The other variables analyzed show a statistically significant influence on one or more government layers, emphasizing, above all, cooperation with companies or organizations from other countries in the EU. This variable is a prime target of all administrative levels except the regional one.

We checked that firm size has only significant influence on the aid program of the Spanish national agency. The aid programs of other agencies do not discriminate against companies by size. Consequently, it seems that, in the field of innovation, the Spanish government supports the creation of national champions in the context of the EU. In addition, we found that the Spanish state agency is the only one that discriminates positively and significantly companies belonging to higher technological intensity sectors.

Our results indicate that foreign capital companies are negatively discriminated against by Spanish aid agencies (regional and national), and that this incidence is not significant in relation to European programs.

We found that the influence of the technological intensity of each company is significant only on the aid granted by the Spanish state agency. This result reinforces previous findings about the size and membership of high technology-intensive sectors. The same can be said about codified knowledge and radical innovation, although in the latter, this kind of innovation is also a target of Spanish regional agencies. It seems obvious that one of the major objectives of the Spanish government is to support large firms from technologically complex sectors that are inclined to have large budgets for innovation and are concerned about creating radical innovations. Therefore, the national administration tries to correct some of the more notable shortcomings on the innovation of the Spanish production system. By contrast, only regional public aid programs for innovation aim to help companies overcome innovation obstacles regardless of whether they are large or small businesses.

Export-oriented companies to other countries outside the EU are the main target of the two European agencies, while this vocation has no influence on the two Spanish aid programs. Finally, in relation to Pavitt's taxonomy, note that domestic agencies support science-based companies, while European Structural Funds support supplier-dominated firms.

## Notes

1. Being an innovative company involves not only being active in one or more innovation activities (product, process, ongoing or unsuccessful), but also showing positive innovation expenditures. Consequently, we eliminated 972 companies that defined themselves as innovative despite having zero innovation expenditures.

2. The Framework Programs are an EU initiative to promote and support R&D that aim to improve competitiveness. The announcements are open once or twice a year. Participants often receive grants that reach 50% of actual costs. For researchers, SMEs and technology centers, the subsidy may reach 75%.

3. At this stage, we use the following explanatory variables: size (natural logarithm of the number of employees), percentage of turnover from exports to EU countries, percentage of turnover from exports to other countries, membership areas of low, medium-low, medium-high and high technological intensity and 11 factors that measure the barriers to innovation perceived by business (cost factors, knowledge factors, market factors and reasons for not innovating).

4. The Fernández-Ribas work refers to Catalonia's economy, one of the most prosperous regions of Spain.

## References

1. Abramovsky, L., Harrinson, R. and Simpson, H., 'Increasing Innovative Activity in the UK? Where Now for Government Support for Innovation and Technology Transfer', Institute for Fiscal Studies, Briefing Note no. 53, 2004.
2. Acosta, J. and Modrego, A., 'Public Financing of Cooperative R&D Projects in Spain: The Concerted Projects under the National R&D Plan', 2001, *Research Policy*, vol. 30, no. 4, pp. 625-641.
3. Almus, M. and Czarnitzki, D., 'The Effects of Public R&D Subsidies on Firms' Innovation Activities: The Case of Eastern Germany', 2003, *Journal of Business and Economic Statistics*, vol. 21, no. 2, pp. 226-236.
4. Altuzarra, A., 'Public Funding for Innovation at Different Levels of Government: An Analysis of Spanish Manufacturing', 2010, *European Journal of Economics, Finance and Administrative Sciences*, no. 20, pp. 94-105.
5. Arrow, K.J., 'Economic Welfare and the Allocation of Resources for Inventions', in National Bureau of Economic Research, *The Rate and Direction of Inventive Activity: Economic and Social Factors*, Princeton: Princeton University Press, 1962, pp. 609-626.
6. Arvanitis, S., Hollenstein, H. and Lenz, S., 'The Effectiveness of Government Promotion of Advances Manufacturing Technologies (ATM): An Economic Analysis based on Swiss Micro Data', 2002, *Small Business Economics*, vol. 19, no 4, pp. 321-340.
7. Bacaria, J., Borràs, S. and Fernandez-Ribas, A., 'Public Action and Innovation-Support Institutions in New Technological Agglomerations: The Case of the Vallès Occidental Country', 2002, *European Urban and Regional Studies*, vol. 9, no 4, pp. 283-296.
8. Blanes, J.V. and Busom, I., 'Who Participates in R&D Subsidy Programs? The Case of Spanish Manufacturing Firms', 2004, *Research Policy*, vol. 33, no. 10, pp. 1459-1476.
9. Bönnte, W., 'Spillovers from Publicly Financed Business R&D: Some Empirical Evidence from Germany', 2004, *Research Policy*, vol. 33, no. 10, pp. 1635-1655.
10. Bower, J.L. and Hout, T.M., 'Fast Cycle Capability for Competitive Power', 1988, *Harvard Business Review*, vol. 66, no. 6, pp. 110-118.
11. Busom, I., 'An Empirical Evaluation of the Effects of R&D Subsidies', 2000, *Economics of Innovation and New Technology*, vol. 9, no. 2, pp. 111-148.
12. Cassiman, B. and Veugelers, R., 'In Search of Complementarity in Innovation Strategy: Internal R&D and External Knowledge Acquisition', 2006, *Management Science*, vol. 52, no. 1, pp. 68-82.
13. Chandler, A.D. Jr., *Scale and Scope: The Dynamics of Industrial Capitalism*, Cambridge, MA: Harvard University Press, 1990.
14. Cohen, W.M. and Levinthal, D.A., 'Innovation and Learning: The Two Faces of R&D', 1989, *Economic Journal*, vol. 99, no. 397, pp. 569-596.
15. Cohen, W.M. and Levinthal, D.A., 'Absorptive Capacity: A New Perspective on Learning and Innovation', 1990, *Administrative Science Quarterly*, vol. 35, no. 1, pp. 128-152.
16. Cohen, W.M. and Klepper, S., 'A Reprise of Size and R&D', 1996, *The Economic Journal*, vol. 106, no. 437, pp. 925-951.
17. Cusumano, M., *The Japanese Automobile Industry: Technology & Management at Nissan & Toyota*, Cambridge, MA: Harvard University Press, 1985.
18. Czarnitzki, D. and Fier, A., 'Do Innovation Subsidies Crowd Out Private Investment? Evidence from the German Service Sector', 2002, *Applied Economics Quarterly*, vol. 48, no. 1, pp. 1-25.

19. Czarnitzki, D. and Hussinger, K., 'The Link between R&D Subsidies, R&D Spending and Technological Performance', ZEW Discussion Paper, no. 04-56, 2004.
20. Feldman, M.P. and Kelley, M.R., 'How States Augment the Capabilities of Technology-Pioneering Firms', 2002, *Growth and Change*, vol. 33, no. 2, pp. 173-195.
21. Feldman, M.P. and Kelley, M.R., 'The Ex-ante Assessment of Knowledge Spillovers: Government R&D Policy, Economic Incentives and Private Firm Behavior', 2006, *Research Policy*, vol. 35, no. 10, pp. 1509-1521.
22. Fernández-Ribas, A., 'Public Support to Private Innovation in Multi-Level Governance Systems: An Empirical Investigation', 2009, *Science and Public Policy*, vol. 36, no. 6, pp. 457-467.
23. Fernández-Ribas, A. and Shapira, P., 'The Role of National and Regional Innovation Programmes in Stimulating International Cooperation in Innovation', 2009, *International Journal of Technology Management*, vol. 48, no. 4, pp. 473-498.
24. Gemünden, H.G., Heydebreck, P. and Herden, R., 'Technological Interweavement: A Means of Achieving Innovation Success', 1992, *R&D Management*, vol. 22, no. 4, pp. 359-376.
25. Georghiou, L. and Roessner, D., 'Evaluating Technology Programs: Tools and Methods', 2000, *Research Policy*, vol. 29, no. 4-5, pp. 657-678.
26. González, X., Jaumandreu, J. and Pazó, C., 'Barriers to Innovation and Subsidy Effectiveness', 2005, *Rand Journal of Economics*, vol. 36, no. 4, pp. 930-950.
27. González, X. and Pazó, C., 'Do Public Subsidies Stimulate Private R&D Spending?', 2008, *Research Policy*, vol. 37, no. 3, pp. 371-389.
28. Greene, W.H., *Econometric Analysis*. New York: Macmillan, 1993.
29. Griliches, Z., 'Productivity, R&D, and Basic Research at Firm Level in the 1970's', 1986, *American Economic Review*, vol. 76, no. 1, pp. 141-154.
30. Grupp, H., 'Science, High Technology, and the Competitiveness of EU Countries', 1995, *Cambridge Journal of Economics*, vol. 19, no. 1, pp. 209-223.
31. Guisado-Tato, M., Sandoval-Pérez, A. and Guisado-González, M., 'The Role of Government in Business Location Decisions: Education and Research as Country Advantage', in Oglesby, R.A. and Adams, M.G. (eds.), *Business Research Yearbook. Global Business Perspectives*, vol. 16, no. 1, International Academy of Business Disciplines, 2009, pp. 183-191.
32. Hall, B., 'The Financing of Research and Development', 2002, *Oxford Review of Economic Policy*, vol. 18, no. 1, pp. 35-51.
33. Haas, M. and Hansen, M., 'When Using Knowledge Can Hurt Performance: The Value of Organizational Capabilities in a Management Consulting Company', 2005, *Strategic Management Journal*, vol. 26, no. 1, pp. 1-24.
34. Hussinger, K., 'R&D and Subsidies at the Firm Level: An Application of Parametric and Semi-Parametric Two-Step Selection Models', 2008, *Journal of Applied Econometrics*, vol. 23, no. 6, pp. 729-747.
35. Kaiser, R., 'Multi-Level Science Policy and Regional Innovation: The Case of the Munich Cluster for Pharmaceutical Biotechnology', 2003, *European Planning Studies*, vol. 11, no. 7, pp. 841-857.
36. Kaiser, U., 'Private R&D and Public R&D Subsidies: Microeconomic Evidence from Denmark', Centre for Economic Business Research, 2004-19, 2004.
37. Kleinknecht, A. and Reijnen, J., 'Why Do Firms Cooperate on R&D: An Empirical Study', 1992, *Research Policy*, vol. 21, no. 4, pp. 347-360.

38. Klette, T.J., Møen, J. and Griliches, Z., 'Do Subsidies to Commercial R&D Reduce Market Failures? Microeconomic Evaluation Studies', 2000, *Research Policy*, vol. 29, no. 4-5, pp. 471-495.
39. Lach, S., 'Do R&D Subsidies Stimulate or Displace Private R&D? Evidence from Israel', 2002, *Journal of Industrial Economics*, vol. 50, no. 4, pp. 369-390.
40. Laranja, M., Uyarra, E. and Flanagan, K., 'Policies for Science, Technology and Innovation: Translating Rationales into Regional Policies in a Multi-Level Setting', 2008, *Research Policy*, vol. 37, no. 5, pp. 823-835.
41. Lichtenberg, F., 'The Effect of Government Funding on Private Industrial Research and Development: A Re-Assessment', 1987, *The Journal of Industrial Economics*, vol. 36, no. 1, pp. 97-104.
42. Lieberman, M.B. and Montgomery, D.B., 'First-Mover Advantages', 1988, *Strategic Management Journal*, vol. 9, no. 51, pp. 41-58.
43. Lööf, H. and Heshmati, A., 'The Impact of Public Funds on Private R&D Investment: New Evidence from a Firm Level Innovation Study', MTT Discussion Papers 3-2005, 2005.
44. Luukkonen, T., 'The Difficulties in Assessing the Impact of EU Framework Programmes', 1998, *Research Policy*, vol. 27, no. 6, pp. 599-610.
45. Luukkonen, T., 'Additionality of EU Framework Programmes', 2000, *Research Policy*, vol. 29, no. 6, pp. 711-724.
46. Ma, Z. and Lee, Y., 'Patent Application and Technological Collaboration in Inventive Activities: 1980-2005', 2008, *Technovation*, vol. 28, no. 6, pp. 379-390.
47. Manning, W.G., Duan, N. and Rogers, W.H., 'Monte Carlo Evidence on the Choice between Sample Selection and Two-Part Models', 1987, *Journal of Econometrics*, vol. 35, no. 1, pp. 59-82.
48. North, D., Smallbone, D. and Vickers, I., 'Public Sector Support for Innovating SMEs', 2001, *Small Business Economics*, vol. 16, no. 4, pp. 303-317.
49. Oates, W.E. (ed.), *The Economics of Fiscal Federalism and Local Finance*, Cheltenham, UK: Edward Elgar, 1998.
50. OECD, Science, Technology and Industry Scoreboard, Paris: OECD Publications Service, 2003.
51. Pavitt, K., 'Sectoral Patterns of Technical Change: Towards a Taxonomy and Theory', 1984, *Research Policy*, vol. 13, no. 6, pp. 343-373.
52. Porter, M.E., *The Competitive Advantage of Nations*, New York: Free Press, 1990.
53. Reger, G. and Kuhlmann, S., *European Technology Policy in Germany: The Impact of European Community Policies upon Science and Technology in Germany*, Physica-Verlag GmbH & Co., 1995.
54. Teece, D., 'Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing, and Public Policy', 1986, *Research Policy*, vol. 15, no. 6, pp. 285-305.
55. Van der Horst, A., Lejour, A. and Straathof, B., 'Innovation Policy: Europe or the Member States?', CPB Document N. 132, 2006.
56. Veugelers, R. and Cassiman, B., 'Make and Buy in Innovation Strategies: Evidence from Belgian Manufacturing Firms', 1999, *Research Policy*, vol. 28, no. 1, pp. 63-80.
57. Wallsten, S.J., 'The Effect of Government-Industry R&D Programs on Private R&D: The Case of The Small Business Innovation Research Program', 2000, *The Rand Journal of Economics*, vol. 31, no. 1, pp. 82-100.
58. Yip, G., *Total Global Strategy: Managing for Worldwide Competitive Advantage*, Englewood Cliffs, NJ: Prentice-Hall, 1992.