THE DISTRIBUTION OF R&D SUBSIDIES AND ITS EFFECT ON THE FINAL OUTCOME OF INNOVATION POLICY

JOOST HEIJS AND LILIANA HERRERA

Documento de trabajo Nº 46. Mayo 2004

Edita: Instituto de Análisis Industrial y Financiero. Universidad Complutense de Madrid
Facultad de Ciencias Económicas y Empresariales. Campus de Somosaguas. 28223 Madrid.
Fax: 3942456
Tel: 3942456
e-mail: joost@ccee.ucm.es
Imprime: Servicio de Reprografía de la Facultad de Ciencias Económicas y Empresariales. UCM.

THE DISTRIBUTION OF R&D SUBSIDIES AND ITS EFFECT ON THE FINAL OUTCOME OF INNOVATION POLICY

JOOST HEIJS
Faculty of Economics and Business Administration
University Complutense of Madrid

LILIANA HERRERA
Faculty of Economics and Business Administration,
University of León

RESUMEN

En este trabajo se evalúa el efecto de la política española de subsidios a la innovación sobre la intensidad en I+D de las empresas, teniendo en cuenta, subsidios procedentes de la Administración Central, de las Comunidades Autonómicas y de otros organismos. La metodología empleada permite llegar a una solución próxima a la eliminación de dos grandes problemas metodológicos en la tarea de evaluación de la política: la no estimación del estado contrafactual (lo que hubiese ocurrido en ausencia de políticas) y el problema de endogeneidad derivado del proceso de distribución de las ayudas. Este proceso no es aleatorio y sigue criterios de selección que podrían afectar la efectividad de los programas. Nosotros usamos un enfoque no paramétrico denominado Propensity Score Matching con el fin de superar estos problemas. Los resultados rechazan un efecto de crowding out de los fondos públicos sobre los privados.

Palabras clave: Política de innovación, Adicionalidad, Evaluación de la política de innovación, freerider.

The aim of this article is to analyse the impact of the subventions granted by the Spanish government to innovation activities on the R&D intensity of firms. Our analysis attempts to deal with two of the methodological problems encountered during the evaluation of policy impacts: namely, the non estimation of the "counterfactual" state (what would have happened without the public support); and the problem stemming from the aid distribution process. Subsidy distribution is non-random, and could generate problems at the moment of evaluating innovation policies. The results conclude that firms with a clear capacity to guarantee the successful outcome of projects have higher chances of obtaining subsidies. On the other hand, firms in need of financial help for innovation have lower probabilities of obtaining aid. In relation to the causal effects of innovation policy, subsidies induced a scarce additionality effect, inferior to the amount of the aid awarded. The results reveal that the innovation policy has a greater effect on firms with fewer possibilities of obtaining a subsidy.

KEYWORDS: R&D, R&D Subsidies, Innovation Policy, Propensity Score Matching
JEL Classification: L52, O31, O38, C14)

ACKNOWLEDGEMENTS: We are grateful to the "Fundación SEPI" for kindly providing the data and to Richard Fratini for revising the manuscript. For any question or suggestion Joost@ccee.ucm.es or ddelhe@unileon.es

1 INTRODUCTION

Theoretically, it could be argued that the evaluation of innovation policies should be based on an examination of the extent to which the principal objective, that is, social welfare, has been achieved. However, it is difficult to determine how far R&D policies fulfil this objective. One of the reasons is the lack of a comprehensive theory of technological change and economic development which includes the role of the State [Nelson and Winter, (1982); Nelson, (1984)], or of a macroeconomic model which incorporates the contribution of innovation policies [Capron, (1992)]. Thus the majority of evaluations have been undertaken at a microeconomic level, studying the effects of subsidies on firms in receipt of them, without taking into account their impact on other firms, or on the production system in general, or on social welfare [Meyer-Krahmer, (1989); Heijs (2001)].

In this context, the concept of "additionality", defined by Buiseret et al. (1995) as something which is obtained through public intervention, which wouldn't exist without such intervention, and which is the effect of a public policy of incentives, is a central factor to be considered when undertaking an evaluation. However, a number of aspects interact on cause and effect relationships between public support and innovation activity in firms. Generally, evaluation studies implicitly apply the following arguments [Heijs, (2003)]:

1.- Expenditures in R&D generate a positive effect on economic growth and social welfare.
2.- Public support for technological advancement generates "additional" private R&D investments.
3.- As a result, public support has a positive effect on economic growth and social welfare.

In fact the first assumption has been proved in a multitude of studies which have demonstrated the importance of R&D and technological progress for both the development and profits of firms [Mansfield, (1968); Griliches and Lichtenberg, (1984)]; and for economic growth in general [Soete et al., (1983); Fagerberg, (1994)]. With regard to the second assumption, results from empirical studies have not been conclusive[1] [David et al. (2000)]. Many of these studies have analysed additionality, but only a few have tried to quantify the increase in R&D expenditure. For this second premise to be true, an increase in R&D expenditure would have to be additional, in the sense that the innovative activities thus generated would not have taken place without public support.

The third assumption is the most difficult to prove, because it would involve an extremely complex methodological background. It would only be possible to show that

[1] The studies of Carmichael (1981); Griliches (1986); Lichtenberg (1987); Toivanen and Niinen (1988) and Wallsten (2000) indicate that public investment does not induce greater R&D expenditure. On the other hand, a positive effect of public R&D expenditure on private R&D investment was found in the studies by Griliches (1979); Levy and Terleckyj (1983); Mansfield (1984); Scott (1984); Switzer (1984); Antonelli (1989); Diamond (1998); Klette and Moen (1998); Busom (2000); Czarnitzki and Fier (2002); and Almus and Czarnitszky (2003).

the third premise were correct if the total of all costs and benefits were quantified, and even then, the results could be misleading. Thus, even supposing that the first two premises are correct, the effects of State support on economic growth and social welfare depends on the exact costs and benefits of the policy.

Bearing in mind the limitations arising from this problem, this study is restricted to an estimation of additionality, this being defined as the increase in R&D intensity in firms, generated by R&D subsidies. The methodology employed goes some way to resolving the problem of dealing with two important aspects of policy evaluation: control over the subsidy distribution process, and estimating the counterfactual state. The importance given to these two aspects is a reaction to recent concerns expressed in the literature about the problems of "endogeneity" and "sample selection bias" that evaluation needs to face. Lichtenberg (1987) showed the necessity of controlling government decisions regarding the firms it subsidies. The level of firms' participation in aid programmes is determined by the government's decision to award help, and, implicitly, by the firms' decision to participate. This situation converts public funding into an endogenous variable which needs to be explained. Thus, its inclusion in a regression model could give rise to inconsistent estimations [Busom, (2000)][2]. To this should be added the possibility of distortions in the selection process arising from government pressure to select successful firms, or from the skill developed among some firms for attracting a significant number of subsidies [Lerner, (1999); Wallsten, (2000); Heijs, (2003)].

Generally, empirical studies measuring the effects of subsidies on innovation activity in firms use regression models. According to Wallsten (2000), although a positive correlation between subsidy and private R&D can be established using these models, it is not possible to determine if the subsidies boost private R&D spending, or if those firms which spend most on R&D are those which receive subsidies. This would indicate that it is not sufficient to control the problem of endogeneity, but that it is also necessary to isolate the policy effect of other possible causes, which could explain an autonomous evolution of R&D expenditure [Arvanitis, (2002)]. Independently of the method used, researchers agree that in estimating the causal effect of innovation subsidies, it is fundamental to compare the effect of the policy with a situation where there is no such policy operating [Papaconstinantinou and Polt, (1997)]. This situation, the counterfactual state, must therefore be appraised.

A method of non-parametric matching, called Propensity Score Matching (PSM) was used in this study, in order to produce a situation as close as possible to solving these problems. PSM has been used recently to evaluate innovation policy in Germany and France [Czarnitzki and Fier, (2002); Almus and Czarnatzki, (2003); Duguet, (2003)]. In contrast to these studies, this study has included aspects not previously considered in the literature on innovation policy. These aspects are related to the strategic activity of firms, their investment potential, the difficulty of accessing innovation resources, and the state of the market in which they are operating. The wide range of variables helps to

[2] Recent studies addressing these problems have incorporated control groups into their models, and equations which explain firms' participation in aid programmes [Lerner, (1999); Busom, (2000); Wallsten, (2000); Acosta and Modrego, (2001); Arvanitis et al., (2002); Czarnitski and Fier, (2002); Almus and Czarnitski, (2003); Duguet, (2003)].

provide a better understanding of the factors influencing aid distribution, and its possible relation to the final result of the policy. The study also includes a general analysis of the additionality effect resulting from aid granted to innovation. Unlike other studies applying the same methodology, this study widens the analysis by repeating the estimates with different subgroups of firms based on their size. This latter process was carried out with the intention of analysing whether the distribution and effect of innovation policy change according to the size of the firm.

The study is structured as follows; Section two describes the methodology employed. In the third section, data and variables are presented. The results of an empirical analysis are discussed in section four, and finally, the conclusions are presented in section five.

2. METHODOLOGY[3]

Since the work of Rosenbaum and Rubin (1983), PSM has been widely used for the evaluation of political intervention, particularly for policies aimed at the labour market [Dehejia and Wahbaum, (1999); Lechner, (1999); Heckman et al. (1999)]. PSM allows to estimate the Average Effect of Treatment on the Treated τ (ATT), by observing the potential outcome of the exposure to treatment (Y_1) or factual state, compared to the non-exposure (Y_0) or counterfactual state. In the case of policy evaluation, this method is used to estimate causal effect of innovation subsidies on R&D intensity at the firm level (Y). Thus, if P represents the participation status of firms in the aid programme, and is given the value of 1 when the firm receives the subsidy, and 0 when it does not, ATT can be expressed as:

$$E(\tau) = E(Y_1 | P = 1) - E(Y_0 | P = 1) \qquad [1]$$

Because Y cannot be observed simultaneously in both states during the same period of time, it is not possible to observe the counterfactual state $E(Y_0|P=1)$, and this must therefore be estimated [Czarnitzki and Fier, (2002)]. The estimation is carried out using a control group comprising firms which have not received the subsidy and can facilitate information relevant to this state.

Given that the distribution of subsidies is non-random, the potential outcome of a lack of policy – counterfactual state – cannot be estimated simply as simple average of its value in the firms that do not receive subsidies. The method begins by establishing a propensity to obtain grants as a criteria for matching firms in receipt or not, of aid. Given the wide range of variables which influence on propensity to obtain support, it is necessary to reduce them to a single scalar p(X) or Propensity Score – PS to improve the matching. PS is defined as the conditional probability of receiving aid given a set of individual characteristics (X). A probability model is used to estimate PS. In this study, a logit model has been applied:

$$\Pr\{P_i = 1 \mid X_i\} = F(h(X_i)) \qquad [2]$$

[3] Broader information about the methods used in this paper can be consulted in Herrera/Heijs, 2003

where $F(.)$ is the function of the normal distribution, or logistical cumulative, and $h(X_i)$ is a function of co-variants with lineal terms of highest order.

Given the difficulty of finding two firms with the same PS value, several methods of estimation can be used. For this study, it was decided to use the Nearest Neighbour Matching – NMM)[4]. The matching process consists in taking for each treated unit a unit of the control group with the closest PS value. Becker and Ichino (2002) offer a mathematical description of this method.

However, estimating the effect requires that the observable differences between the two groups of firms be controlled, in order to ensure that the potential outcome resulting from a lack of policy Y_0 would be the same in both cases. To achieve this, Rosenbaum and Rubin (1983) discuss a series of assumptions. The first states that the set of individual characteristics (X) should be balanced. In this way, firms with the same PS value would have the same distribution of individual characteristics regardless of programme participation status. Thus their exposure to aid would be random [Becker and Ichino, (2002)].

$$P \perp X \mid p(X) \qquad [3]$$

In addition, a Conditional Independence Assumption introduced by Rubin (1977) should be fulfilled, where it is assumed that the differences are captured in X and the potential outcomes $\{Y_0, Y_1\}$ are independent of programme participation status.

$$Y_1, Y_0 \perp P \mid X \qquad [4]$$

given a propensity score,

$$Y_1, Y_0 \perp P \mid p(X) \qquad [5]$$

Thus, the potential outcome of the non-participants Y_0 conditioned by p(X), has the same distribution function as the potential outcome Y_0 of the subsidised firms, in the case no subsidy has been received. In other words, the counterfactual state estimated for firms in receipt of aid is the closest to that experienced in the case no aid has been received. It should be stressed that it is necessary to know all the variables that influence on Y_0 or Y_1, and on programme participation status. The availability of data makes it impossible to achieve this situation, it is necessary for the researcher to include a wide range of variables in order to arrive at a reasonable approximation of this assumption [Almus et al. (1999); Almus and Czarnitzki, (2003)].[5]

Finally, the estimation of the effect will depend on the fulfilment of the Stable Unit Treatment Value Assumption – SUTVA, where the impact on the firm of the subsidy does not depend on the participation status of other firms in the programme. In other words, under this assumption, the result observed for a firm in receipt of subsidies is

[4] Becker and Ichino (2000), review these methods of estimation. The authors stress that in relation to differences between quality and quantity of matchings, no one method is better than another.
[5] The authors argue that it is not possible to formally test the feasibility of the assumption; therefore PSM is a technique which requires a wide range of variables.

dependent entirely on that firm [Rubin, (1978); Rosenbaum and Rubin, (1983); Angrist et al., (1996)].

This condition is probably fulfilled in this study, given that the innovation effort of a firm depends largely on its individual effort. In the case of Spain, subsidies are low compared with private investment. It was found that the mean size of aid of the firms of the sample was 7.1% of its total R&D expenditures[6]. Furthermore, the use made by firms of the subsidies they received differs according to individual needs, and its final effect depend on its appropriate use and management. Nevertheless, this study includes all subsidy schemes currently in operation in Spain, which should reduce possible interference arising from firm participation in more than one programme. A review of the fulfilment of this condition in the case of innovation policy in Germany can be consulted in Almus and Czarnitzki (2003).

Once the previous assumptions have been fulfilled, the ATT can be estimated as follows [Becker and Ichino, (2002)]:

$$\tau = E\{E\{Y_{1i} \mid P_i = 1, \mathrm{p}(\mathrm{X}_i)\} - E\{Y_{0i} \mid P_i = 0, \mathrm{p}(\mathrm{X}_i)\} \mid P_i = 1\} \qquad [6]$$

Through controlling the observable differences between the two groups, the only difference left can be attributed to the effect of the policy. The difference between the outcome of units treated (subsidised firms – Y_1) and the outcome of the control group (non-subsidised firms – Y_0) is calculated. ATT is arrived at by taking an average of these differences.

3. DATA AND VARIABLES

3.1 Data

The data examined in this study comes from the 'Business Strategy Survey' (Encuesta sobre Estrategias Empresariales – ESEE), produced by the SEPI Foundation. We have used data relating to innovating firms for the period 1998 – 2000. The sample contains 681 firms, 243 of which received innovation subsidies from the Central Administration, the Autonomic Communities, and Other Organisms[7] not specified in the survey. In contrast to other studies, we analyse all innovation subsidy policies currently operating in Spain simultaneously.

3.2 Variables

The potential outcome, from which the innovation policy effect is estimated, is the R&D intensity of firms, defined as the average R&D expenditure over sales during the period, multiplied by one hundred. Firm participation status in innovation support

[6] A figure which is very close to the Spanish mean of 7.2%, according to calculations made from data published by INE in "Estadísticas sobre Actividades de Investigación y Desarrollo Tecnológico 2001". Size of subsidy = (quantity of subsidy/R&D expenditure).

[7] We have been able to confirm that the majority of subsidies under the classification Other Organisms in fact come from the European Union.

programmes funded by the Central Administration, the Autonomic Communities or Other Organisms is reflected in a dichotomous variable which has the value of 1 if the firm received a subsidy from one of these sources, and 0 if not.

Variables for estimating the propensity to receive R&D subsidies were selected following the related empirical evidence [Fernández et al., (1996); Lerner, (1999); Heijs, (1999, 2000); Busom, (2000); Wallsten, (2000); Heijs, Acosta and Modrego, (2001); Arvanitis et al., (2002); Czarnitzki and Fier, (2002); Almus and Czarnitzki, (2003); Duguet, (2003)].[8] A description of these variables is given in Table 1. Three groups of variables were identified: variables associated with the characteristics of the firm and financial capabilities, its market and its innovative behaviour.

1) Variables associated with the characteristics of the firm:

Size and *age* were included as indicators reflecting management capacity, obtainment of resources, and experience [Heijs, (1999); Arvantis et al., (2002); Czarnitzki and Fier, (2002); Almus and Czarnitzki, (2003)]. In fact almost all studies indicate that this is an important variable to explain the propensity to participate. Five *industries* were considered in order to control sectorial differences[9]. An indicator of *region* was introduced in order to verify whether proximity to a large concentration of infrastructures supporting innovation influenced on the propensity to obtain grants. Following the work of Buesa et al. (2002), we differentiated between firms located in central regions and firms located in peripheral regions of the national innovation system.

The *firms ownership* was incorporated to confirm whether participation of public capital, foreign capital, or capital from other societies influenced on the propensity [Busom, (2000); Arvanitis et al., (2002); Almus and Czarnitzki, (2003)][10]. *Product diversification* was included as a variable representing firm strategy. Cohen (1995) and Hitt et al. (1997) present evidence that diversification is positively related with R&D intensity. It could be concluded that firms showing diversity rely on innovation in order to be able to offer a wide yet specialized range of products, and thus would be interested in subsidies.

Finally, two variables were included to detect possible deviations in aid distribution: *Investment capacity of firms* and *innovation funding difficulty.* Firms with a high capacity for investment could, presumably, carry out significant R&D investment without an evident need for being subsidised. On the contrary, it would be supposed that tools such as subsidies are directed towards firms where funding is a barrier to innovation [Arvanitis et al., (2002)]. Firms which can develop their activities regardless, that is, without subsidies, should not be the recipients of aid.

[8] All these studies have included equations in their models which explain the participation of firms in support programmes.
[9] In the case of Spain [Heijs, (1999, 2001); Busom, (2000)], the low participation of traditional sectors, and the high participation of firms in the mass production assemblers and R&D sectors stands out.
[10] The tendency in these studies is to select more firms with public capital participation, and fewer firms with foreign capital participation.

2) Variables related to the market.

The choice of this group of variables responds to the necessity to consider, in innovation policy evaluation models, the competitive environment in which the firms operate [Papaconstantinou and Polt, (1997)]. Three aspects are analysed: evolution of the main market of the firm, evolution of their market share, and the export propensity as an indicator of the external pressure and competitivity level. Three states have been defined for *evolution of the main market* of the firm: growing, steady, and shrinking markets. The variable is included in order to verify whether the State supports firms in dynamic sectors (strategic policy), or if, on the contrary, it supports firms in more traditional sectors (defensive policy). *Evolution of market share* has been modelled in the same way: growing, steady, and shrinking market share. This variable shows whether the pressure of demand has any influence on the propensity of obtaining public support for innovation due to the fact that public agents do pick-up the winners.

As with other studies, *export propensity* as a measurement of foreign competitivity [Fernández et al., (1996); Busom, (2000); Almus and Czarnitzki, (2003)] and *import propensity*[11] were considered as a variable which would reflect the competitive pressure of foreign firms on the market [Almus and Czarnitzki, (2003)].

3) Technological indicators

Indicators have been introduced in order to verify whether those firms with an articulated and formal innovation activity are also those which are the principal recipients of subsidies. Two dichotomous variables indicate the level of *formality of innovative activity* and *cooperative attitude.* In relation to the first variable, it is to be expected that those firms which systematically plan their activities, and detail them in a plan, will find subsidy applications easier. To some extent, this variable is also representative of the absorptive capacity or their capability to present a well defined and formalised project which could be related to the propensity of getting subsidies. The technological cooperation indicator was included in order to examine whether firms of a certain potential for technological transfer have a greater probability of participation in support programmes. For the same reason, a firm's capacity for *technological export* was included.

Unlike other studies, it seemed important to include *technological import* as an indicator of technological dependence. One of the aims of innovation policy could be to reduce such dependence and promote internal innovation production.

4. Empirical results

In the presentation of our empirical results we distinguish between two types of analysis. First, the identification of the variables that influence the probability of getting public support. And second, we analyse the causal effect of these support schemes on

[11] With the aim of fitting the variables age, investment capacity, and import-export propensity to a normal distribution, a square root transformation was performed.

the R&D intensity of firms. The algorithms applied in this paper to estimate the PS, PSM and the ATT were developed by Becker and Ichino (2002).

Table 1. Description of the variables of the study.

Structural characteristics of the firms	
Size	Log of number of employees
Region	(0) Peripheral region versus (1) central region
Age	Average age of the firm in the period 1998-2000
Producers of traditional consumer goods*	1 indicates that the firm belongs to this sector
Suppliers of traditional intermediate goods	1 indicates that the firm belongs to this sector
Specialised suppliers of intermediate goods and equipment	1 indicates that the firm belongs to this sector
Mass production assemblers	1 indicates that the firm belongs to this sector
R&D based sectors	1 indicates that the firm belongs to this sector
% of foreign capital	Percentage of participation of foreign capital
% of public capital	Percentage of participation of public capital
% of the others firms capital	Percentage of participation of other firms capital
Market characteristics	
Growing markets	1 if the firm considered its main market as growing
Steady markets*	1 if the firm considered its main market as steady
Shrinking markets	1 if the firm considered its main market as increasing
Growing market share	1 if the firm considered its market share as growing
Steady market share*	1 if the firm considered its market share as steady
Shrinking market share	1 if the firm considered its market share as increasing
Diversification	Average number of goods produced by the firm in the analysed period
Export propensity	Rate between the average exports and the average sales in the analysed period
Import propensity	Rate between the average imports and the average sales in the analysed period
Innovative behaviour	
Degree of formalisation of R&D activities	1 if the firms fulfill at least one of the following conditions; having a department or commission for R&D; have an R&D plan; elaborated R&D indicators of the results
Co-operation in innovation	1 if the firm had agreements of co-operation in R&D with at least one of the following agents: clients, providers, competitors, or technological centres
Export of technologies	1 if the firm exported technologies
Import of technologies	1 if the firm imported technologies
Financial capabilities	
Investment Capacity	Rate between the average amount of investment and the average sales in the analysed period
Difficulties to finance R&D	1 indicates that the firms had problems finding finance for its R&D activities

*** Used in the models as reference variables**

4.1 Determinant factors that influence on the propensity to participate in public support programmes.

We applied a Logit model to estimate the propensity to obtain public subsidies for each of the firms in the sample. The results of the estimation allowed us to draw conclusions about the public aid distribution. The Logit model was applied to the whole sample as well as for three sub-samples of firms classified by size (Tables 2 and 3, respectively).

Moreover, we have estimated the marginal effects to enable a more accurate interpretation of the results[12].

Table 2 reflects the general outcome of our study. The results indicate (Model 1) that the firms who participate most frequently in public support schemes for innovative activities are: large firms, mass production assemblers, enterprises with a high presence of public capital, those operating in growing markets, those with a high import propensity, those with a good capacity to invest and the most innovative ones[13]. On the other hand, those firms with a higher presence of foreign capital and domestic individual firms, those operating in shrinking markets and those experiencing difficulties in financing their R&D activities, all participate less often in public support programmes.[14]

To ensure the reliability of our results we controlled their robustness by elaborating additional models (2 to 4). Here we can observe that the removal of some variables did not change our general results. The only real change was the inclusion of the R&D based sector in model two, which can be explained by the absence of the indicators of innovative behaviour. Moreover, the global evaluation of the model can be considered satisfactory. The values of the pseudo R^2 are acceptable and the general model classifies over 76% of the firms in the correct group. Repeating the analysis for different sub-samples of firms based on size (see Table 3), we were able to appreciate an improvement in the overall statistics which evaluated the robustness of the model.

[12] The marginal effects reflect the relative importance of the variables that explain the level of participation of the firms in public support programmes. These effects indicate the marginal change on the probability of receiving subsidies owing to a change in one of the independent variables.

[13] The most innovative firms are defined as those which fulfil one or more of the following conditions: having formalised R&D activities; co-operation in R&D or export technologies.

[14] We also estimated a model lagged on R&D expenditures. Both general models –with or without a lag- offer very similar results. We decided to use the model without lagged data for three reasons. First, the main conclusions are similar in both estimations. Second, the model without lagged data classifies somewhat better the cases, while when using the lagged data we lost a certain number of firms or observations. This fact was not so problematic when we used the whole sample, however, when working with smaller sub-samples it is preferable not to lose any observations. Moreover, the lag is based on the R&D expenditure of only one year instead of an average R&D effort of two or three years. This would be an important problem due to the fact that the data showed high fluctuations in yearly R&D expenditures. Therefore, we have used –to analyse the additionality- the average of a three-year period from 1998-2000. The data of R&D expenditures for the period 1995-1997 are not complete and using those data we lost over 200 firms. The model with lagged R&D expenditures showed two differences in relation to the significant explanatory variables. On one hand, this model indicates that enterprises in central regions participate less often. However, in the model without the lag this variable was not considered a statistically significant variable (11,2%). The estimation of several models to confirm the robustness of our results –excluding for each model one of the variables or including the lag for R&D expenditures by sales- proved that the only instability of the model was the region. This variable was statistically significant in some models while not in others. On the other hand, in the model with lags the "growing market" was not a significant variable (15%), while the other model which included this variable had a significance level of 6,9%. Taking into account the foregoing discussion, we decided not to use the model that included the lagged R&D expenditures.

Table 2: Identification of Spanish firms supported in the whole sample using different models (LOGIT estimations).

	1 Main model		2. Structural attributes	3. Structural attributes and market features	4. Structural attributes and innovation
Structural characteristics of the firms	Beta	M. E.	Beta	Beta	Beta
Size (employment)	0.32 ***	0.068***	0.46 ***	0,43 ***	0,32 ***
Region	-0.31		-0.15	-0,21	-0,28
Age	0.02		-0.02	0,00	-0,04
Producers of traditional consumer goods	Reference variable				
Suppliers of traditional intermediate goods	0.23		0.19	0,17	0,22
Specialised suppliers of intermediate goods and equipment	-0.14		0.02	-0,01	-0,15
Mass production assemblers	0.77 ***	0.177***	0.80 ***	0,77 ***	0,77
R&D based sectors	0.43		0.92 ***	0,93 ***	0,44
% of foreign capital	-0.01 ***	-0.002***	-0.01 ***	-0,01 ***	-0,01 **
% public capital	0.02 *	0.003**	0.15 *	0,02 **	0,02 ***
% of other firms capital	-0.001		0.00	-0,00	0,00
Market characteristics					
Growing markets	0.38 *	0.081		0,37 *	
Steady markets	Reference variable				
Shrinking markets	-0.23			-0,30	
Growing market share	0.02			0,13	
Steady market share	Reference variable				
Shrinking market share	-0.64 *	-0.122		-0,55 *	
Diversification	-0.48			-0,26	
Export propensity	0.02			0,05	
Import propensity	0.13 **	0.026**		0,12 *	
Innovative behaviour					
Degree of formalisation of R&D activities	0.83 ***	0.169***			0,79 ***
Co-operation in innovation	1.08 ***	0.209***			1,20 ***
Export of technologies	1.78 ***	0.419***			1,65 ***
Import of technologies	-0.02				-0,03
Financial capabilities					
Investment Capacity	0.35 ***	0.075***		0,32 ***	
Difficulties to finance R&D	-0.54 *	-0.105*			-0,42
Specification of the models					
Number of firms	681		684	681	684
Number of supported firms	244		244	244	244
Pseudo R^2	0.23		0.10	0.15	0.19
Log likelihood (improvement of LL)	-343.21 (100)		-400.87 (45)	-379.46 (64)	-360.18 (85)
Correctly classified firms (%) Total	76		67.1	74.1	72.2
Supported firms	70		58.3	71.1	64.3
Not supported firms	79		69.5	75.0	75.2

** = p ≤10%; ** = p ≤5%; *** = p≤1%* M.E.= Marginal Effects

The highest marginal effects were observed for the variables which indicate the innovative behaviour of the firms, followed by the sector of mass production

assemblers. The next variables in order of importance were the shrinking market share, the difficulties in financing R&D and the capacity for investment.

The results indicated a statistically significant relationship between **size** and the degree of participation. The smaller the firm, the lower the propensity to participate. In fact, a change of size implied an increase of 6.8% in their probability to participate. Empirical studies have pointed out this effect, even in support programmes specifically targeted at small and medium sized firms. In these programmes, the smaller firms participate less frequently than the medium sized ones [Becher, (1990); Heijs, (1999)].

One reason that the smaller firms participate less frequently in the support schemes, is their human resources limitations, for example their time necessary for preparation of application forms or for gathering information about various kinds of financial aid from the public administration is limited [Heijs, (2000, 2001); Almus and Czarnitzki, (2003)][15]. A second reason for the exclusion of the SME´s from technology policies could be the implicit requirements of the programmes. A broad range of public financial support schemes for innovation –theoretically accessible to all firms- are focused on clearly designed R&D projects, which hinders the entrance of small firms with other types of innovative activities[16]. Large firms more often have R&D departments and laboratories reaching a critical mass of R&D activities and staff. Therefore, those firms more often meet the explicit and implicit requirements of public support programmes. At the same time, the limited capacity of innovation management in smaller firms could hinder the conversion of their innovation activities into well-organised projects with clear objectives[17]. This problem generates the auto-exclusion of smaller firms due to the very strict concept of the R&D activities which are the object of the majority of support schemes.

The variable **region** discriminated between central and peripheral regions of the innovation system. As mentioned before, in the model for the whole sample the variable region was not statistically significant (see footnote 14). However, for the sample of small firms the variable "region" was a significant explanatory variable. Within the group of small firms those established in central regions have less possibilities for obtaining public support than those located in peripheral regions. Moreover, it can be stated that for most of the estimations -where the "region" was not considered a significant explanatory variable-, the level of significance for this variable was just above the ten percent limit.

In relation to the **firms ownership,** the results shows a negative discrimination in relation to the overall support of Spanish and international public agencies with regard

[15] Moreover, the study of Heijs (1998, 1999) –about the low interest loans for R&D offered by the Spanish government- points out that small firms, if they present themselves for support, have a higher chance that their applications will be financed by the Spanish government than in the case of the larger firms. This could indicate that it is not that the government who overlooks the SME's, but that they apply less frequently for support. In fact, almost all the large firms who applied for help sent three or more projects while the small ones sent only one.

[16] Exceptions are tax measurements and German support for costs of R&D personnel.

[17] The analysis of firms in two Spanish regions –Navarra and Basque Country- reflect that in particular those smaller innovative firms who indicated that their R&D activities were normally incremental and not formalised, did not even apply to the central government for support (Heijs, 1999).

to firms with foreign capital. In fact, the higher the percentage of foreign capital, the lower the propensity for getting support. This result -also found by Busom, (2000) and Almus and Czarnitzki, (2003)- is especially important within the framework of European integration, in which it is strictly forbidden to discriminate against European firms. Moreover, the model indicates – as in the study of Heijs, (2000, 2001)- positive discrimination, independent of their size, towards enterprises with a higher percentage of public capital.

Analysing the **sectorial differences**, the results revealed only for the mass production assemblers a statistically higher probability to participate than for the average firm, a result also confirmed by the estimations of the sub-samples of firms by size. This means that, except for this sector, distribution of the general R&D support did not seem to be concentrated in specific sectors[18].

In relation to the **market characteristics** of the firms subsidised, the statistical results suggested that the most dynamic firms operating in growing markets had more possibilities of obtaining support than those in stable or shrinking markets or those which were losing position in their main markets. This could probably be interpreted as a policy of "picking the winners". Public schemes support the most competitive firms or sectors.

Regarding the **financial capabilities of the firms,** our model showed that those firms in a better financial position participated more frequently, whilst firms that found it difficult to finance their R&D were discriminated against by public agencies, although several support schemes are, at least theoretically or politically, focussed on this group.

The import propensity – which indicates, to a certain extent the competitive pressure of foreign firms on the market [Almus and Czarnitzki, (2003)]- was significantly related to the level of participation in public support programmes, although this relationship was only found for the sub-sample of medium-sized firms. We did not find any evidence indicating a significant influence of this variable for the smallest or largest firms.

The **innovative behaviour** or level seemed to be one of the most important aspects for explaining access to public support measures. The results obtained from our models have pointed out that the more innovative firms had a higher probability of participating in public support programmes and that these variables showed the highest marginal effects. In fact, in our sample comprising only innovative firms, the probability, ceteris paribus, of firms that export technologies of participing in public support programmes was 42% higher than those which are not capable of commercialising their technological results in the international market. Moreover, for firms that have formalised R&D activities or co-operate with other agents in the innovation system this percentage was respectively 17% and 21% higher in comparison with other firms.

[18] On one hand, we found similar results in an earlier work [See Herrera and Heijs, (2003)] founded on the same model but with 12 sectors based on their productive activities. In this paper we did not find a statistically significant difference between sectors. On the other hand, we are aware that we have used only a few aggregated sectors and that there could exist differences using more detailed data.

The existing evaluation studies indicate that the firms reached by the instruments of technology policy are firms who already carry out innovative activities [Siegert et al, (1985); Becher, (1989); Meyer-Krahmer, (1989, 1995); Buesa and Molero, (1995); Molero and Buesa, (1996); Heijs, (2000, 2001); Almus and Czarnitzki, (2003); Fier and Czarnitzki, (2003); Duguet, (2003)][19]. Most studies showed that only a very small number of the supported firms undertook R&D in an irregular way and hardly any of them started R&D activities for the first time due to public aid [Meyer-Krahmer, (1989); Becher, (1989); Molero and Buesa, (1995, 1996); Kulicke et al, (1997); Heijs, (2000, 2001)]. However, it should be stressed that it is probably not the public agencies that discriminate against the less innovative firms, but that these enterprises claim support less often [See Heijs, (1999)].

In the former analysis we indicated the differences between the global model and the findings of **the models for sub-samples by size** for some specific variables. Taking into account those additional models, we have concluded, in general terms, that they have confirmed the basic findings of the overall model. Firms with the highest probability of participating in public support programmes were the most innovative ones, those with a high degree of nationally owned capital, the mass production assemblers and those with a high degree of financial capability. Moreover, the estimation of the sub-sample of smaller firms (with less than 200 employees) indicated that size was still a statistically significant variable.

It can be highlighted, that in all the models the most important variables –with the highest marginal effects- were those related to the innovative behaviour.

Some variables, not considered as statistically significant in the general model, were statistically significant for some of the sub-samples. In the case of the smallest firms, firms in the peripheral regions had a higher probability of obtaining public support than firms in central regions. One of the explanations for this fact could be the existence of particular support instruments designed specifically for undefined innovation activities (not R&D) carried out in peripheral regions and not existing in the central regions. These instruments specifically increase the participation of small firms, although not in an obvious way for the global model.

The models for medium and large sized firms confirmed the idea of "picking the winner". In both cases, firms with growing market shares had a higher probability of participation. For the sub-sample of smaller firms we did not detect this type of policy.

[19] Some additional models -not included in this paper- have shown that even within the group of highly innovative firms it is possible to detect "more" innovative firms with a clearly greater possibility of obtaining support for R&D than other firms. These extra LOGIT models were estimated for three sub-samples of firms controlled by their relative R&D effort, and identify as explanatory variables those related to the innovative behaviour of the firms, indicating that the more innovative firms participate more often.

Table 3: Identification of the Spanish firms supported using different sizes (LOGIT estimations).

	1. Small firms (0-200 employees)		2. Medium firms (200-500 employees)		3. Large firms (Over 500 employees)	
Structural characteristics of the firms	Beta	M.E.	Beta	M.E.	Beta	M.E.
Size (employment)	0.58 *	0.068**	0.49		0.33	
Region	-0.99 **	-0.123**	0.13		-0.15	
Age	0.00		0.10		-0.01	
Producers of traditional consumer goods (reference)						
Suppliers of traditional intermediate goods	-0.21		0.23		0.67	
Specialised suppliers of intermediate goods and equipment	-0.16		-0.48		0.01	
Mass production assemblers	1.03 **	0.152*	1.07 *	0.228*	0.56	
R&D based sectors	0.22		0.85		0.43	
% of foreign capital	-0.02 **	-0.003**	-0.01 **	-0.003**	-0.01 ***	-0.003***
% public capital	Exc.		0.00		0.03 **	0.008**
% private capital	-0.00		-0.01	-0.001	0.01 *	0.002*
100% individual firm						
Market characteristics						
Growing markets	-0.07		0.12		0.64 *	0.160*
Steady markets (reference)						
Shrinking markets	-1.04		-0.33		0.09	
Growing market share	0.39		1.24 *	0.259*	-0.67 *	-0.167*
Steady markets (reference)						
Shrinking market share	-1.66		-0.04		-0.96	-0.231*
Export propensity	0.08		0.03		0.04	
Import propensity	0.11		0.32 **	0,060**	0.14	
Innovative behaviour						
Diversification	0.04		-1.26		-0.61	
Degree of formalisation of R&D activities	0.86 *	0.107*	0.87 *	0,152**	0.84 *	0.204**
Co-operation in innovation	0.89 *	0.102*	1.63 **	0,259***	1.82 ***	0.406***
Export of technologies	2.73 **	0.567**	1.19		2.65 ***	0.469***
Import of technologies	0,06		-0,16		-0.01	
Financial capability						
Investment Capacity	0,33 **	0.039**	0,64 **	0,120**	0.07 *	0.018
Difficulties to finance R&D	-0,65		-1,66 **	-0,212***	-0.41	
Specification of the models						
Number of firms	255		184		234	
Number of supported firms	56		61		116	
Pseudo R^2	0,26		0,30		0.25	
Log likelihood (improvement of LL)	-99,83(35)		-81,85 (45)		-120.75	
Correctly classified firms (%) Total	84		79		75	
Supported firm	89		73		76	
Not supported firms	86		81		74	

*= $p \leq 10\%$; ** = $p \leq 5\%$; *** = $p \leq 1\%$; Exc. = Excluded from the model for statistical procedure. M.E.= Marginal Effects

4.2 Impact of subsidies on R&D intensity

Once observable differences between the two groups of firms had been analysed and controlled, the average effect of subsidies on R&D intensity (R&D expenditure/sales) of firms was established, the results are summarized in Table 4. In order to estimate the average effect, an area of common support was used which allowed to eliminate the firms showing poor matching levels. The total number of firms included in each analysis is shown in the table. The average innovation policy effect was significantly different to zero in all cases.

Table 4: Impact of the support on the level of relative R&D efforts.

	Average effect ATT .- percentage	Supported firms	Not supported firms	Statistical test (T-value)	(Bootstrap T Value)
Whole sample	1,599	243	123	4,955***	4,280
Small firms (0-200 employees	2,090	56	32	4,043***	4,139
Medium firms (200-500 employees)	2,029	61	34	3,581***	3,930
Large Firms (Over 500 employees)	1,627	115	55	3,343***	3,325

**= p ≤ 10%; ** = p ≤ 5%; *** = p≤ 1%*

The intensity of R&D in those firms in receipt of subsidies was on average 1.59% higher than for those firms which have not received aid. We repeated the analysis for several sub-samples of firms by size. Comparison of these analyses indicated that the highest level of impact was detected in small and medium sized firms (almost 2.1%) while for the largest firms the impact was considerably lower (1.6%). This allows us to conclude that the smaller the firm, the greater the effect.

Although on average support did not considerably increase the innovation effort, it is important to stress that public funding did not have a 'crowding-out' effect on private investment. In other words, firms are not substituting, in a generalised fashion, private effort for public effort. Nevertheless, it should also be stressed that the additionality effect did not rise above 7.1% according to the size of the aid, in any of the sub-samples.

5. Final remarks and conclusions

All innovation subsidy schemes currently in operation in Spain have been evaluated simultaneously in this paper. We have estimated the causal effect of subsidies on R&D intensity of firms belonging to the manufacturing sector. The study includes a general analysis of all the firms in the sample, and three analyses according to firm size (large, medium and small firms). We have used a non-parametric method called Propensity Score Matching (PSM). The method allowed us to address two aspects of importance in the evaluation of policy: namely, the process of aid distribution, and an estimation of the counterfactual state.

The first part of the analysis, aimed at studying and controlling the aid distribution process, leads to the conclusion that, taking all models into consideration, firms with a

high capability of guaranteeing the success of a project receive more subsidies. The results are conclusive:

- Subsidies are aimed mainly at large firms, whether national or individual.
- Agencies prefer firms with a high investment capability. Firms which experience difficulty in funding innovation have a lesser likelihood of obtaining subsidies. This is an important conclusion, given that one of the aims of financial aid is to support firms for whom funding is a barrier to innovation.
- Public support measurements were focussed on firms in growing sectors or markets. Such an inclination towards the most dynamic industries can be considered as a policy of "picking the winners". Enterprises which are operating in shrinking markets or are losing their market shares, received less frequently public support in the general framework of innovation policies. Only in relation to small firms did we not find such results.
- Innovative behaviour indicators were conclusive in explaining the participation of firms in aid programmes. The results showed that the most innovative firms in the sample have a higher level of participation than the less innovative ones. Firms which maintain technological cooperation agreements, export technology, or have a formal articulated innovation policy, obtain a greater percentage of subsidies.

Regardless of size, aid distribution policy is clearly focused on results (picking the winners). Such technology policy initiatives favour some of the most dynamic and fast growing innovative firms, widening or accelerating their innovative activities, but do not generate an improved industrial dynamic by increasing the number of innovative firms. A modern technology policy should not only stimulate R&D activities of already innovative firms, but also raise the number of innovative firms.

In our opinion, the distribution process has an influence on the final outcome of innovation policy. Firms which do not display an evident necessity for aid could more likely substitute private investment for public investment. As a result, we found that the final outcome of policy did not exceed size of aid in any of the sub-samples of firms analized. We also found that the R&D intensity of the supported firms is 1,6 percent higher than the non-supported firms. Although our analysis allows us to rule out a crowding-out effect of public funding over private funding, in comparison with other studies using the same methodology, [Czarnitzki and Fier (2002); Almus and Czarnitzki, (2003); Duguet, (2003)], the effect in the case of Spain is minimal.

Controlling the estimation by size of firms we showed that small and medium sized firms have a higher level of additionality than large firms. These results reveal that the innovation policy has a greater effect on firms with fewer possibilities of obtaining a subsidy, as indicated by the general model. Therefore, governments should design aid distribution policies. The effect of these policies should be evaluated not only on groups of firms, but also in terms of effect on industrial dynamics and the economy in general. Evaluation studies of innovation policy should include an analysis of the context in which subsidies are conceded, and a causal analysis between the distribution and the end result of the policy.

REFERENCES

Acosta, J. y Modrego, A. (2001), "Public Financing of Cooperative R&D Projects in Spain: The Concerted Projects under the National R&D Plan". *Research Policy*, Vol. 30, p. 625-641.
Almus, M. y Czarnitzki, D. (2003), "The Effects of Public R&D Subsidies on Firms' Innovation Activities: The Case of Eastern Germany". *Journal of Business & Economic Statistics*, Vol. 21, No.2, p. 226-236.
Angrist, J. Imbens, G. y Rubin, D(1996), "Identification of Causal Effects using Instrumental Variables". *Journal of the American Statistical Association*, Vol. 91, p. 444-455.
Antonelli, C. (1989), "A Failure-Inducement Model of Research and Development Expenditure, Italian Evidence from the Early 1980's". *Journal of Economic Behaviour and Organisation,* Vol. 12, No. 2, p.159-180
Arvanitis, S. (2002), "Microeconometric Approaches to the Evaluation on RTD Policies: A Non-technical summary of the State of the Art". Working Paper: Swiss Institute for Business Cycle Research, No. 55, p. 1-14.
Arvanitis, S.; Hollenstein, H. y Lenz, S. (2002), "The Effectiveness of Government Promotion of Advances Manufacturing Technologies (ATM): An Economic Analysis Based on Swiss Micro Data". *Small Business Economics*, Vol. 19, p. 321-340.
Becker, S. e Ichino, A. (2002), "The Estimation of Average Treatment Effects Base on Propensity Score". *The Stata Journal*, Vol. 2, No. 4, p. 358-377.
Buesa, M.; Pellitero, M.; Heijs, J. y Baumert, T. (2002), "Los Sistemas Regionales de Innovación en España: Una Tipología Basada en Indicadores Económicos e Institucionales". *Revista de Economía Industrial*, Vol. 5, No. 347, p. 15-32.
Busom, I. (2000), "An Empirical Evaluation of the Effects of R&D Subsidies". *Economic Innovation and New Technology*, Vol. 9, p. 111-148.
Buiseret, T.; Cameron, H.; y Georgiou, L. (1995), What Differences Does it Make? Additionality in the Public Support of R&D in Large Firms. *International Journal of Technology Management*, Vol. 10, Nos. 4/5/6, p. 587-600.
Carmicheal, J. (1981), "The Effects of Mission Orientated Public R&D Spending on Private Industry". *Journal of Finance*, Vol. 36, No. 3, p. 617-627
Capron, H. (1992), Economic and Quantitative Methods for the Evaluation of the Impact of R&D Programs: A state of art. EUR 14864 EN, Commission European. Bruselas.
Cohen, W. (1995), "Empirical Studies of Innovative Activity". Handbook of the Economics of Innovation and Technological Change. Oxford, Oxford University Press.
Cochran, W. y Rubin, D. (1973). "Controlling Bias in Observational Studies: A Review". *Sankhya*, Vol. 35, p. 417-446.
Czarnitzki, D. y Fier, A. (2002), "Do Innovation Subsidies Crowd Out Private Investment? Evidence from the German Service Sector". *Applied Economics Quaterly*, Vol. 48, No. 1, p 1-25.
David, P., Hall, B. y Toole, A (2000), "Is Public R&D a Complement or Substitute for Private R&D? A Review of the Econometric Evidence". *Research Policy*, Vol. 29, p. 407-529.
Diamond, A. (1998). "Does Federal Funding Crowd Out Private Funding of Science?". Presentation at the American Economics Association Meetings, Chicago.
Dwhejia, R. y Wahba, S. (1999), "Causal Effects in Nonexperimental Studies: Reevaluating the Evaluation of Training Programs". *Journal of the American Statistical Association*, Vol. 94, p. 1053-1062.
Duguet, E. (2003), "Are R&D Subsidies a Substitute or a Complement to Privately Funded R&D? Evidence from France using Propensity Score Methods for Non-experimental data". Working Paper: Maison des Sciences Économiques, Université de Paris I. ftp://mse.univ-paris1.fr/pub/mse/cahiers2003/V03075.pdf
Fagerberg, J. (1994), "Technology and International Differences in Growth Rates". *Journal of Economic Literature*, Vol. 32, p. 1147-1175.
Fernández, E.; Junquera, B.y Vázquez C (1996), "The Government Support for R&D: The Spanish Case". *Technovation*, Vol. 16, No. 2, p. 59-65.
Griliches, Z. (1979), "Issues in Assesing the Contribution of Research and Development to Productivity Growth". *Bell Journal of Economics*, Vol. 10, No.1, p. 92-116.
Griliches, Z (1986), "Productivity, R&D and Basic Research at Firm Level, Is there still a relationship?. *American Economic Review*, Vol. 76, No. 1, p. 141-154.

Griliches, Z.; y Lichtenberg, F.(1984), "R&D and Productivity Growth at the Industry Level: Is There Still a Relationship?" En: *R&D, Patents and Productivity*, Chicago, University of Chicago Press.
Heckman, J. (1979), "Sample Selection Bias as Specification Error", *Econometrica*, Vol. 47, No. 1, p. 153-161.
Heckman, J., LaLonde, R. y Smith, J. (1999), "The Economics and Econometrics of Active Labour Market Programs". En: Handbook of Labour Economics. Amsterdam, Ashenfel y Card.
Heijs, J. (1999), "La Difusión de los Créditos del CDTI en el País Vasco y Navarra". *Ekonomiaz: Revista Vasca de Economía*, No. 44, p. 287-301
Heijs, J. (2001), Política Tecnológica e Innovación; Evaluación de la Financiación Pública de I+D. Madrid, Consejo Económico Social, Colección de Estudios.
Heijs, J. (2003), "Freerider Behaviour and the Public Finance of R&D Activities in Enterprises: The Case of the Spanish Low Interest Credits for R&D". *Research Policy*, Vol. 32, No. 3, p. 445-461.
Hitt, M., Hoskisson, R y Kim, H(1997), "International Diversification: Effects on Innovation and Firm Performance in Product-Diversified Firms." *Academy of Management Journal*, Vol. 40, No. 4, p. 767-798.
Klette, T.J. y Moen, J.(1998), "R&D Investment responses to R&D subsidies: a theoretical analysis and econometric evidence", Presentation to the NBER Summer Institute, July.
Lechner, M. (1999), "Earnings and Employment Effects of Continuous off The Job Training in East Germany after Unification". *Journal of Business and Economic Statistics*, Vol. 17, p. 74-90.
Lerner, J. (1999), "The Government as Venture Capitalist: The Long-run Impact of the SBIR program". *Journal of Business*, Vol. 72, No.3, p. 285-318.
Levin, R y Reiss, P. (1984), "Test of Schumpeterian Model of R&D and Market Structure. En: *R&D, Patents and Productivity*, Chicago: University of Chicago Press.
Levy, D. y Terlecky. N. (1983), "Effects of Government Funding on Private R&D Investment and Productivity: A Macro Economic Analysis". *Bell Journal of Economics*. Vol. 14, p. 1551 – 1561.
Mansfield, E. (1984), "R&D and Innovation Some Empirical Findings". En: *R&D, Patents and Productivity*, Chicago, University of Chicago Press.
Mansfield, E.(1968), Industrial Research and Technological Innovation: An Econometric Analysis. New York, NY: W.W. Norton & Company.
Meyer-Krahmer, F. (1989) Der Einfluss Staatlicher Tecnologiepolitiek Auf Industrielle Innovationen. Nomos.
Nelson, R. (1984). High-technology Policies: a Five-nation Comparison. Washington, DC: American Enterprise Institute for Public Policy Research.
Nelson, R. y Winter, S. (1982), An Evolutionary Theory of Economic Change, Cambridge, Harvard University Press.
Papaconstantinou, G.; y Polt, W. (1997); Policy Evaluation in Innovation and Technology: An overview. OECD Conference Policy Evaluation in Innovation and Technology: Towards Best Practices.
Rosenbaum, P. y Rubin, D. (1983), "The Central Role of the Propensity Score in Observational Studies for Causal Effects". *Biometrika*, Vol. 70, No. 1, p. 41-55.
Rubin, D. (1977), "Assignment to Treatment Group on the Basis of Covariate". *Journal of Educational Statistics*, Vol. 2, p. 1-26.
Rubin, D. (1978), "Bayesian Inference for Causal Effects: The Role of Randomization". *Annals of Statistics*, Vol. 6, p. 34-58.
Scott, J. (1984), "Firms Versus Industry Variability in R&D Intensity". En: *R&D, Patents and Productivity*, Chicago, University of Chicago Press.
Soete, L. y Turner, R. (1984), "Technology Diffusion and The Rate of Technical Change". *Economic Journal*, Vol. 84, No. 375, p. 612 – 623.
Switzer, L. (1984), "The Determinants of Industrial R&D: A Funds Flow Simultaneous Equation Approach". *Review of Economics and Statistics*, Vol. 66, No. 1, p. 163-168
Toivanen, O. y Niininen, P. (1998). "Investment, R&D, Subsidies, and Credit Constraints. Working Paper, Department of Economics MIT and Helsinki School of Economics.
Wallsten, S. (2000), "The Effects of Government-Industry R&D Programs on Private R&D: The Case of the Small Business Innovation Research program". *RAND Journal of Economics*, Vol. 13, No. 1. p. 82-100.

ÚLTIMOS TÍTULOS PUBLICADOS

19.- *El Control de los intercambios internacionales de armamento y tecnologías de doble uso: el caso de España.* Mikel Buesa. (2000).

20.- *Patrones tecnológicos y competitividad: un análisis de las empresas innovadoras en el País Vasco.* Mikel Buesa y Arantza Zubiaurre. (2000).

21.- *Public finance of the R&D activities in enterprises: Role and impact of the Spanish low interest credits for R&D.* Joost Heijs (2000).

22.- *Intervencionismo estatal durante el franquismo tardío: un análisis del condicionamiento industrial.* Mikel Buesa y Luis E. Pires (2001).

23.- *Nuevas pautas de internacionalización de la I+D de las empresas multinacionales estadounidenses.* Ana Bellver (2001).

24.- *Sistemas nacionales y regionales de innovación y política tecnológica: Una aproximación teórica.* Joost Heijs (2001)

25.- *Justificación de la política de innovación desde un enfoque teórico y metodológico.* Joost Heijs (2001).

26.- *Los sistemas nacionales de innovación: una revisión de la literatura.* Mikel Navarro (2001).

27.- *El análisis y la política de clusters.* Mikel Navarro (2001).

28.- *Los sistemas regionales de innovación del País Vasco y Navarra*. Mikel Buesa (2001).

29.- *Centralisation or dispersion?: a spatial analysis of the impact of the single market programme on the activity of us manufacturing affiliates.* Andrew Mold (2001)

30.- *El sistema regional de innovación de la Comunidad de Madrid*. Mikel Buesa (2002).

31.- *Economía de la secesión: Los costes de la 'No-España' en el País Vasco*. Mikel Buesa (2002).

32.- *The spanish public financial support accesible for small and medium sized firms: organisations, programes, instruments and measures*. Joost Heijs (2002).

33.- *Los determinantes de la capacidad innovadora regional: una aproximación econométrica al caso español. Recopilación de estudios y primeros resultados.* Thomas Baumert y Joost Heijs (2002).

34.- *Recursos y resultados de los sistemas de innovación: elaboración de una tipología de sistemas regionales de innovación en España.* Mónica Martínez Pellitero (2002).

35.- *Medida de la capacidad innovadora de las Comunidades Autónomas: construcción de un índice regional de innovación.* Mónica Martínez Pellitero y Thomas Baumert (2003)

36.- *Innovación tecnológica y competitividad: análisis microeconómico de la conducta exportadora en México.* Salvador Estrada y Joost Heijs (2003).

37.- *Indicadores de la sociedad de la información en España.* Salvador Estrada (2003)

38.-*Los centros tecnológicos y el sistema regional de innovación. El caso del País Vasco.* Mikel Navarro Arancegui y Arantza Zubiaurre Go ena (2003).

39.- *Ciencia y Tecnología en la España democrática: la formación de un sistema nacional de innovación*. Mikel Buesa (2003).

40.- Las empresas del País Vasco ante la secesión Mikel Buesa, Joost Heijs, Thomas Baumert y Mónica Martínez Pellitero (2003)

41.- *Difusión y adicionalidad de las ayudas públicas a la innovación: una estimación basada en "propensity score matching".* Liliana Herrera y Joost Heijs (2004).

42.- *Relaciones e interacción entre los agentes del sistema nacional de innovación de España: resultados de la encuesta-IAIF/FECYT.* Joost Heijs, Andrés Fernández Díaz, Patricia Valadez y Alicia Coronil (2004).

43.- *Evaluación de la efectividad de la política de cooperación en la innovación.* Joost Heijs, Andrés Fernández Díaz, P atricia Valadez y Alicia Coronil (2004).

44.- *Patrones regionales de uso y consumo de TIC´S: hacia un índice regional de la Sociedad de la Información. Salvador Estrada* (2004). (Disponible en íngles)

45.- *Configuración estructural y capacidad de producción de conocimientos en los sistemas regionales de innovación: Un estudio del caso español.* Mikel Buesa, Joost Heijs, Mónica Martínez Pellitero y Thomas Baumert (2004). (Disponible en íngles)

Normas de edición para el envío de trabajos:

Texto: Word para Windows
Tipo de letra del texto: Times New Roman 12 Normal
Espaciado interlineal: Sencillo
Tipo de letra de las notas de pie de página: Times New Roman 10 Normal
Numeración de páginas: Inferior centro
Cuadros y gráficos a gusto del autor indicando programas utilizados
En la página 1, dentro de un recuadro sencillo, debe figurar el título (en negrilla y mayúsculas), autor (en negrilla y mayúsculas) e institución a la que pertenece el autor (en letra normal y minúsculas)
En la primera página del trabajo, se deberá incluir un *Resumen* en español e inglés (15 líneas máximo), acompañado de *palabras clave*

Los trabajos habrán de ser enviados en papel y en soporte magnético a la dirección del Instituto de Análisis Industrial y Financiero.