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"WHO PARTICIPATES IN R&D SUBSIDY PROGRAMS?

The case of Spanish Manufacturing Firms"

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ABSTRACT

Empirical evidence on the effectiveness of R&D subsidies to firms has produced mixed results so far. One possible explanation is that firms and project selection rules may be quite heterogeneous both across agencies and across industries, leading to different outcomes in terms of the induced additional private effort. Here we focus on the participation stage. Using a sample of Spanish firms, we test for differences across agencies and industries. Our results suggest that firms in the same industry face different hurdles to participate in different agencies' programs, that participation patterns may reflect a combination of agency goals, and that patterns differ across high-tech and low-tech industries.

KEYWORDS: R&D, subsidies, technology policy, program participation, innovation.
JEL Classification: L52, O31, O38

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1. Introduction.*

Substantial empirical evidence backs the claim that social returns to R&D activities are greater than private returns, giving support to the well-known hypothesis that the market allocation of resources to innovation can be sub-optimal.[1] Identification and measurement of the specific sources of market failures, analysis and design of proper policies to address them, and empirical evaluation of the effects that these policies have in practice are important issues on the research agenda.

An extensive literature identifies several factors that condition a firm's decisions, such as limited appropriability of returns to R&D activities, market competition regime and financial constraints derived from imperfect capital markets. Theoretical models of R&D policy have been developed as well, showing that R&D subsidies could restore incentives to reach the efficient allocation when knowledge spillovers are the main reason for under-investment. Implementation of a subsidy based R&D policy, however, may be difficult in practice given the information requirements.[2] In particular, the public agency must be able to identify those R&D projects where the gap between private and social returns is high, and which would not be carried out without some type of subsidy.

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[1] Zvi Griliches has been a key contributor to this literature. See Griliches (1992, 1995) for overviews on R&D and productivity, and a discussion on measurement problems, and Jones and Williams (1998) on measuring the social returns to R&D.

[2] See Socorro (2003) and references therein.

In addition, each subsidy should be project specific, since the source and magnitude of underinvestment is likely to differ across firms and projects.[3] A first question to investigate is how subsidies are allocated among firms and projects in practice in order to identify patterns, and analyze whether the resulting allocation outcomes are consistent with particular agency goals.

Furthermore, we observe that a variety of public agencies are involved in allocating R&D subsidies. Within European Union countries, national, regional and EU-level R&D subsidy programs are in place. In the US there are federal and state R&D programs as well. We could ask whether all agencies use similar rules in awarding subsidies. For example, in the hypothetical case that the purpose of all agencies was to address market failures, and if there were no explicit ex ante differences in eligibility requirements or in application costs, a firm presenting a proposal for an R&D project should have the same probability of obtaining a subsidy from any agency.[4] Evidence of the contrary would mean that agencies might target or reach in fact different types of firms or projects.

Existing empirical research has addressed the effects that R&D subsidies have on a firm's R&D effort, growth or patenting activity, although results are not conclusive. To

[3] Other commonly used policy tools do not involve the choice of projects by the public agency. R&D tax credits reduce the cost of R&D to all firms, independently of the type of R&D project they undertake. For a review on R&D tax credits, see Hall and Van Reenen (2000).

[4] Programs at the European Union level do have a specific requirement: eligible proposals must involve cooperation among firms and/or institutions from several EU countries. However, international or national cooperation is not required in many national or regional government programs, although it may be encouraged.

the best of our knowledge, there has been very little research on the subsidy allocation process, variation across agencies or industries, and its implications for subsidy effectiveness. Our aim is to take a small, rather exploratory step in that direction, testing some hypotheses about factors that affect a firm's participation status in different R&D subsidy programs, and testing for inter-agency and inter-industry differences. We use data from a firm level survey in Spain to explore how program participation is related to some observed firm characteristics, and how industry and firm characteristics interact in explaining participation in different R&D programs.

Our results show that having previous experience in R&D affects participation status in almost all industries and for both national and regional level programs, suggesting that during the period studied R&D programs had only very limited success at reaching firms that were not already doing R&D. We observe that firm characteristics such as firm size have different weights across agencies and industries, implying that these programs reach in practice different populations of firms. This outcome hints that agencies might either have different goals or face different difficulties in reaching the desired population of firms. Data limitations, however, prevent us from distinguishing between these two hypotheses. The main implication is that when attempting to estimate the additionality effects of public funding, differences across agencies and industries should be expected, partly because of allocation heterogeneity.

In section 2 we briefly summarize some issues raised in current research on R&D subsidy programs. In section 3 we present the most relevant features of our data. In section 4 we discuss the empirical framework, and section 5 describes estimation results. Finally, we draw some conclusions and implications for further research.

2. Some previous evidence.

Systematic evaluation of the performance of government policies is becoming increasingly important both on economic and political grounds. In some policy areas, such as training programs, evaluation research has been developing for quite some time.[5] Extension to innovation policies is more recent, but expanding. Most empirical research on R&D subsidies to firms has focused on the effects they have on privately funded R&D or on performance indicators. Klette, Moen and Griliches (2000) and David, Hall and Toole (2000) provide thorough reviews of econometric studies addressing this issue.[6] Both surveys discuss methodological aspects that may account to some extent for the absence of clear and unambiguous results, and conclude with two recommendations. First, that empirical methods that control for selection and endogeneity bias in the samples, arising from the fact that participation in an R&D program is not random, should be used. And second, that structural models of both public agency and firm decisions should be developed in order to improve our understanding of R&D subsidy effects.[7]

By focusing on how R&D program participation is determined we hope to make a step in that direction. Studying the determinants of participation can shed light on the existence of unexpected barriers to a firm's participation and on the agencies' explicit or implicit screening rules. Programs may fail to reach their goals if many potentially

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[5] See Ashenfelter (1978), and Heckman and Vytlacil (2001).

[6] Some examples of work appearing just after these surveys were submitted are Lerner (1999), Wallsten (2000) and Lach (2002).

[7] The need for developing a good understanding of the microeconomics of firm behavior in order to interpret correctly observed impacts was also pointed out by Feller, Glasmeier and Mark (1996).

eligible firms do not to apply. Subsidies might be allocated with different criteria in different industries by different agencies, leading to differences in effects. Identification of agencies' ex post selection rule is important to detect unintended effects and correctly interpret observed differences in outcomes. In addition, current statistical methods used in program evaluation, such as matching methods and selection models, rely on having a good estimate of the probability of program participation.[8] Focusing on the participation stage is therefore an important part of a broader policy evaluation exercise.

With the exception of a report by Feldman and Kelley (2001) on winners of awards from the Advanced Technology Program (ATP) in the US, we have not found empirical work where the main focus is explaining participation status at the firm level as the outcome of agency allocation criteria. Two studies discussed below use semi-aggregate data as observation unit. Feldman and Kelley had access to information from a specific survey of 1998 ATP applicants, including the ratings reviewers gave to the projects. They find that indicators of spillover potential such as the number of business and university linkages significantly affected the probability of winning an award, jointly with reviewers' ratings. In most cases, and in ours in particular, this type of information is not available to the researcher, who tries to infer public agencies' implicit selection rules from the relationship between observed variables and outcomes.

Two empirical papers have previously focused on how public funds are allocated to different types of R&D projects or to industries, from an aggregate or semi-aggregate perspective. Lichtenberg (1999) studies the allocation of public grants for biomedical R&D, and asks whether decisions are consistent with an allocation rule based on disease

[8] See, for example, recent work by Almus and Czarnitzki (2003) and Duguet (2004).

characteristics. The unit of observation in this case is the disease, not the research group. He estimates the size and number of research grants awarded by the NIH as a function of disease burden, prevalence and incidence, and finds all three factors to be significant. Svensson (1998) uses a sample of 13 OECD countries and 24 industries to investigate the weight of political relative to economic factors in explaining the relative magnitude of R&D subsidies received by each industry. He finds that both types of variables affect an industry's share of R&D subsidies.[9]

We use firm-level data to study the effects that some variables have on the outcome of firms' and agencies' decisions, and test for possible differences in patterns of firm participation across agencies. Our data include participants and non participants in R&D subsidy programs. An important limitation we face is that we do not know which firms applied but did not obtain public funding, or what were the characteristics of the R&D projects presented by firms. Consequently, we will not be able to unambiguously identify the agencies' screening rule, but we still will be able to make some inferences based on the estimation of program participation equations.

3. A brief overview of the data.

[9] In a similar spirit, two studies attempt to make inferences about agency rules relative to the allocation of patent rights. Van Dijk and Duysters (1998) estimate a firm's success at being granted patents from the European Patent Office as a function of firm characteristics. Their sample consists of patent applicants in the data processing industry. Cockburn, Kortum and Stern (2002) focus on the patent examination process at the USPTO; in particular on the role that some patent examiners' characteristics may have on patent litigation outcomes.

Our data consists of a large sample of manufacturing firms, some of which have obtained public funding to finance their R&D activities. The source is a firm-level survey[10] sponsored by the Ministry of Industry in Spain and conducted yearly since 1990. The sample is designed so as to include all firms with more than 200 employees, and a stratified random sample of those with less than 200 employees and more than 10.[11] More than 2000 manufacturing firms are surveyed each year. The survey covers a wide range of questions. In particular, firms were asked whether they had obtained public funding for R&D activities, from which funding institutions and the amount of funding received from each source.

In Tables 1 and 2 we highlight the most relevant features concerning R&D and R&D subsidies for firms in the sample over the period 1990-1996. Table 1 shows that about one third of manufacturing firms carried out formal R&D activities, and that this share was quite stable over the sample period. It also shows the extent of R&D program participation. Of those firms doing R&D about one fourth received some form of subsidy, which on average represented 14 to 24 % of R&D spending by each firm. Each year more than 150 firms in the sample were receiving some subsidy. Overall, 463 different firms received public funding for some time during the sample period, in most cases (43 %) for one year, 21 % for two years, and the remaining for three or more years.

[Insert Table 1 about here]

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[10] The survey, "Encuesta Sobre Estrategias Empresariales" is conducted by the Fundación Empresa Pública. See http://www.funep.es/ for further information.

[11] A detailed description of the survey and the sample is provided in Fariñas and Jaumandreu (1999).

There are three sources of public funds for firms' R&D activities in Spain: the central or national administration, regional administrations, and other institutions[12]. Some central administration programs have been in place for more than 20 years, while most regional administrations' programs were set up during the nineties. Both administrations use a variety of tools to encourage innovation, ranging from the provision of infrastructures to direct support of individual firms' R&D. Eligibility rules are not very restrictive: all agencies emphasize that reaching small and medium sized firms is an important policy goal, but there are many programs that are addressed to all firms in most fields.[13] The main observable difference between these two administrations is that, from 1990 to 1996, the volume of funds obtained by firms in the sample from the central administration is much larger than the volume of regional funds.

Table 2 shows that most firms in the sample (at least 70 %) received funding from only one source. The distribution of private R&D expenditure and of subsidies across industries is highly correlated. In 1996, firms in four industries (chemicals, electrical and electronic goods, vehicles and other transportation) accounted for over 80 % of all R&D in manufacturing. Public funding of firms in the sample was even more concentrated that year, mostly benefiting Motor Vehicles and Other transportation equipment.

[Insert Table 2 about here]

[12] Other institutions includes European Union funds and non-profit private foundations.

[13] Innovation and Science policy in Spain became increasingly significant from the mid eighties, when a National Plan for Scientific policy and Technological Development was implemented. Within the National Plan there are different types of programs (by field, some focusing on research, others on development). We do not have information on which type of program firms in our sample obtained funds from.

4. Participation in R&D programs: hypotheses, variables and empirical setting.

Since program participation status is the outcome both of the application decision made by a firm and of the approval or rejection decision made by the public agency, we need to discuss some hypotheses about the relationship between firm characteristics and each agent’s decisions as well as the final outcome.

4.1. Explaining firm's decisions: who will apply?

When facing the decision of whether or not to carry out an R&D project, a firm is likely to compare the expected present value of private profits associated with the project to the expected present value of profits if it does not do it and just runs its standard production operations. Public funding, whether it consists of a grant or of a subsidized loan, reduces the costs of doing R&D. Assuming that a firm is aware of the existence of these programs, its decision to do R&D will take into account the likelihood of obtaining public funding. If costs of applying are small enough, and eligibility rules are not too restrictive, in principle we may assume that all firms that would find R&D profitable even without any subsidy will be willing to apply for one. In addition, a subsidy could make R&D activities profitable for some firms that otherwise would not do any R&D, and they will apply too. Finally, for some firms the expected subsidy might be to low to make R&D privately profitable, so they will not apply. Hence on the firm side we have to postulate some hypotheses about variables that may affect private returns of R&D projects. To do this we turn to previous studies and focus on a limited number of factors that have been found relevant on empirical or theoretical grounds.

Human capital.

We assume that the ability to envision, design and implement an R&D project strongly depends on the level of formal and informal skills of the firm's employees and managers, the stock of human capital. These skills affect the ability to both generate ideas and take advantage of and use the existing common pool of technological or scientific knowledge. This is known in the literature as absorptive capacity (Cohen and Levinthal (1989); Cockburn and Henderson (1998)). We will consider a simple measure of human capital in our empirical work: the number (or the percentage) of employees in the firm that have an engineering or college degree.[14] We expect a positive association between human capital and both the profitability of R&D and the probability of applying for a subsidy because the higher the level of human capital, the greater the ability to produce ideas for new projects.

Path dependency.

Previous experience in doing R&D contributes to the stock of knowledge embodied in human capital. Firms that have experience in R&D may be more likely to keep doing R&D and to apply for funding. Previous experience makes it easier for them to expand their portfolio of R&D projects without incurring high set up costs.

Technological opportunity.

The shape and parameters of innovation production functions are likely to be quite different across industries. Technological opportunity, defined in the literature as advances in scientific and technological understanding originating in own or other industries (Klevorick et al. (1995)), might be constant across firms within a given

[14] CEO characteristics, such as age and type of education and experience may also be relevant, as found in Barker and Mueller(2002). Unfortunately, we do not have data on these issues.

industry, but is likely to differ across industries, as many empirical studies have documented (Cohen (1995)). Lim (2003) provides evidence on differences in the innovation and research processes in the semiconductor and pharmaceutical industries, where in the latter innovation is more closely related to basic research than in the former.[15] These differences may translate into different parameters for economies of scale and scope, as well in different set-up costs of R&D across industries. A frequent way of dealing with this heterogeneity empirically has been the inclusion of industry dummies in empirical specifications of R&D models. We will instead perform separate estimations by industry, as this allows for interaction effects between opportunity and other relevant variables for R&D decisions such as firm size or financing constraints.

Firm Size.

Two arguments can be made to predict a positive relationship between firm size and the likelihood of doing R&D. First, the development of innovations may involve fixed set-up costs, part of which may be sunk. This will determine a minimum volume of revenues or sales for profitability to be positive. Firm size helps overcome the fixed cost barrier, and hence becomes an important factor in explaining the probability of doing R&D. In some industries fixed costs will be lower than in others.[16]

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[15] Qualitative information from R&D managers gives additional support to that view. In an international workshop on business R&D strategies, managers of firms in the information and communication field described the research process as consisting more in combining available technologies than in basic research. In the pharmaceutical industry, managers characterized innovation in their field for its long product development time (10 years) and for the high cost of producing a new chemical entity (OECD 2001a).

[16] González and Jaumandreu (1998) estimate, using basically the same data set used here, that minimum R&D intensities under which firms tend not to invest in R&D are high in industries such as chemical

In addition, expected revenues generated by the new process or product will be a function of the price and the size of demand for the product. These depend on appropriability conditions, which in turn are affected by the strength of property rights, availability of alternative means of appropriation, and extent of market power. The interaction between appropriability conditions and competition effects is complex,[17] and we do not have firm level indicators for these factors. However, the extent of appropriability may be correlated with firm size, once other possible correlates are taken into account (Cohen and Klepper (1996)). We can again expect inter-industry variation: in those industries where the patent system is an efficient protection mechanism, such as in pharmaceuticals,[18] firm size might be less constraining for doing R&D than in other industries, everything else constant.

Financing constraints.

The effective cost of doing R&D may vary across firms as a result of differences in the availability and cost of financing resources. The well known argument is that R&D investment usually involves higher risk than investment in tangible physical assets, and that asymmetric information between borrowers and lenders has particularly severe

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products, vehicles and leather industries, and relatively low in the food and beverage industries, suggesting higher set up costs in the former.

[17] Some models predict an inverted U relationship between R&D intensity and competition; empirical studies do find evidence in favor of this hypothesis.

[18] Cohen et al. (2000) report that in the US, firms in the Pharmaceutical and Medical Equipment industries find patents to be a relatively effective mechanism for appropriability, although secrecy and lead time were declared to be equally effective. In contrast, firms in the Communications equipment industry considered lead-time to be the most effective mechanism, while patents less than half as much.

effects in this case. Imperfect capital markets are more likely to result in under-financing, and firms may have to rely mostly on own resources to fund R&D projects. Empirical evidence supports the hypothesis that the cost of external funds to finance R&D is higher than the cost for alternative investments, although differences may vary across countries (Hall (2002)). Bond et al. (1999) suggest that financial constraints may affect mostly the decision to engage in R&D, rather than the level of R&D. Cincera (2003) finds stronger effects of cash flow constraints for young firms.

Overall, evidence supports the inclusion of *cash flow* as an indicator of possible funding constraints faced by firms.[19] We expect a positive correlation between cash-flow level and the probability of doing R&D, and hence of applying for a subsidy. However, financing constraints might make a firm more likely to apply for public funding, leading to a negative correlation. Hence, the final correlation between cash-flow and application for public funding is undetermined. We expect to observe industry variation as well: in industries where the potential for profitable R&D projects is higher, venture capital may provide external funding. As an indicator of the ease of access to capital markets we will include a binary variable for publicly traded firms.

Domestic ownership.

The last factor we will take into account in explaining a firm's R&D decisions is foreign ownership. Affiliates of foreign owned companies may benefit from R&D developed in the home country of the mother company, and may have no incentive to carry out

[19] A study by Suárez (2000) on the choice of funding sources by Spanish firms, finds that firms that have high cash-flow tend to be less likely to use funds from financial intermediaries. Firm size and age are positively related to using funds from external sources.

additional R&D in the host country nor to apply for public funding.[20] We expect on average a negative relationship between foreign ownership and R&D or R&D subsidy application in the case of Spain.

To summarize, two types of firms are likely to apply for an R&D subsidy: those that would do R&D anyway because it is privately profitable, and those that would not without a sufficiently large expected subsidy. We expect a positive relationship between the level of human capital, firm size, or cash flow and the likelihood of doing R&D, and hence a positive relationship among these variables and the likelihood of applying for public support. The impact of firm size or cash flow on participation will be weak only to the extent that the second type of firms apply and obtain public funding. The intensity of these relationships would vary across industries. In industries where fixed R&D set up costs are low, we would expect a higher proportion of small firms both doing R&D and applying for subsidies, predicting a low correlation between size and participation status. In industries with large fixed costs, and to the extent that subsidy programs often set a cap on the total amount of public funding provided, we would instead expect a positive correlation between firm size and participation.

4.2. Funding Agencies' choices: some hypotheses.

Public agencies might have a variety of objectives when designing R&D subsidy programs. These objectives will determine the total budget allocated to these programs,

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[20] See Veugelers (1997), Veugelers and Cassiman (2000) and, for empirical evidence on Spanish firms, González (1999). We do not think that in most cases the main reason for a foreign firm to locate in Spain is conducting R&D, at least during the sample period.

its distribution across industries, the ranking criteria or screening rule to be used for choosing projects and firms, and the amount of subsidy awarded to each individual firm.

The main economic rationale for R&D subsidies is the negative incentive effect caused by lack of appropriability generated by knowledge spillovers or by failures in capital markets. In practice public agencies may have additional goals. They might wish, through R&D subsidies, to attract firms into a particular location (country or region), or to encourage technological upgrading of firms of particular importance (in terms of employment, for instance) for the country or region. An agency's supply of funds and choice of R&D projects and firms will reflect these goals. Furthermore, if all agencies at different administration levels within a country share the same goals, they will give a very similar weight to given firm characteristics, and R&D subsidies would reach the same type of firms. Provided that application costs were similar across agencies, estimation of firm participation equations for any type of agency would produce similar results. In what follows we discuss the expected association between each of potential agency objectives and some firm characteristics.

If the main purpose of an agency is to fund R&D projects that would not be otherwise carried out because of market failures, we would expect it to rank applications according to some measure of the spillover gap. It is hard to have such a measure, but if evidence indicates that market failures affect more severely small or young firms, and the agency knows and uses this evidence, we should then observe firm size, cash flow and firm age to be negatively related to the probability of obtaining a subsidy for R&D. We will call this the market failure hypothesis.

Differences across agencies might arise when knowledge spillovers have limited geographical scope. Then agencies might coordinate their policies and specialize according to the geographical scope of those spillovers, each targeting a different type of projects or of firms. For example, if only large firms, and not small firms, had the capability to carry out R&D projects generating international spillovers, then it would make sense to expect a positive association between firm size and probability of obtaining supranational R&D subsidies. At the same time we would expect a negative association between firm size and the probability of obtaining regional R&D funds.

A second potential goal of public agencies might be to foster national champions, funding those R&D projects that are more likely to have commercial success, independently of the gap between social and private benefits. Larger, experienced firms are likely to enjoy an advantage in that case, as well as domestic firms. We will call this the success hypothesis, and expect a positive correlation between firm size, cash flow or domestic ownership and the probability of obtaining public support.

A third possible goal of the agencies might be to encourage technological upgrading of firms in declining or traditional industries in order to increase the chances of firm survival. In that case we would expect firm size again to be positively associated with the probability of participation, because policy makers are likely to be more concerned about potentially large employment losses. R&D experience, the number of highly qualified employees or domestic ownership would not be expected to have a significant weight, while cash flow might have a negative effect on the probability of granting. We will call this the survival hypothesis.

Table 3 below summarizes these conjectures about the patterns of correlation between some firm characteristics and the probability of being offered a subsidy under different policy goals.[21] It is difficult to sign a priori the association between policy goal and some of the firm characteristics, and we indicate this through a question mark. But the signs of firm size and cash flow could be quite informative about which is the dominant goal of an agency. We should also consider the possibility that the agencies' goals, or combination of goals, vary across industries.

[Insert Table 3 about here]

4.3. Empirical specification.

The probability that a firm participates in an R&D program can be written as the joint probability of two variables, the outcome of the firm's decision process –whether to apply or not- and the outcome of the agency's decision process –awarding or denying the subsidy, conditional on the firm having applied.[22]

$$\begin{aligned}\text{Prob}(\text{Participating} = 1|X) &= \text{Prob}(\text{Apply} = 1 , \text{Grant} = 1 ; X) \\ &= \text{Prob}(\text{Grant}=1|\text{Apply}=1, X)\text{Prob}(\text{Apply}=1|X) \quad [1]\end{aligned}$$

[21] As a matter of fact, in Spain one of the main national agencies requests from applicants information both about firm characteristics and about the R&D project to be developed if subsidized. This includes: number of employees, share owned by foreign stockholders, past R&D expenditures, exports, debt, cash flow, possible patentability of research output, and whether the project has a pre-competitive nature. We presume that all these variables enter the agency's decision rule.

[22] We assume that all firms, including those without previous R&D experience, are aware of R&D programs in place.

Ideally we would like to estimate separately the two probabilities involved in participating. Testing hypotheses concerning a firm's willingness to apply for R&D subsidies and public agencies' selection rules requires having data on applicants, both successful and unsuccessful, and on non-applicants. This would enable identification and estimation of the effects that explanatory variables have on each side of decision process. In our sample, however, we only observe whether or not firms had subsidized funding, but not whether they had unsuccessfully applied. In addition, we do not have specific variables that would clearly affect one decision but not the other. This implies that we can not identify a structural model and distinguish between the effects that firm size or other included explanatory variables have on the application decision from the effects on the granting decision. Instead, we just estimate the net effect, that is, reduced form parameters. In our empirical analysis we proceed in two steps, the first being of a descriptive nature, and the second involving the estimation of a set of participation models.

Step 1: A descriptive Multinomial Logit model. Ignoring the decision processes of firms and agencies, we can simply classify each firm into one of three mutually exclusive categories: not doing R&D, doing R&D but not participating in a given agency's R&D program, and doing R&D and participating. Firms in the first category do not find R&D profitable in any case; those in the second category find R&D to be profitable even without a subsidy, and firms in the third category have R&D projects determined to be socially profitable by the public agency. We could ask what distinguishes firms that participate from those that do not but do R&D, and from those that do not do R&D. To investigate this is we define a categorical variable, STATUS, taking three possible values: 0 for firms that do not do R&D nor participate, 1 for firms that do R&D but do not participate, and 2 for firms that do R&D and participate. We estimate a multinomial logit model as a purely descriptive device, and compute the marginal effects that each explanatory variable has on the probability of a firm falling into a particular category. This procedure may allow us to distinguish between the roles that for instance firm size has as an obstacle to doing R&D from its role as an obstacle to participation. We will later test whether these associations are similar across industries and sources of public funds.

Step 2: An explanatory model for participation status and R&D effort. Alternatively, R&D status and participation status can be modeled as the outcomes of two related processes. For a given firm, a possible specification is:

$$P_{jt}^{*} = \alpha_j RD_{t-1} + \beta_j X_t + e_{jt} \qquad [2]$$

$$RD_t^{*} = \Sigma_j \gamma_j P_{jt} + \delta Z_t + u_t \qquad [3]$$

where P_{jt}^{*} is an unobserved index of a firm's participation propensity in agency j's R&D program, and parameters α_j and β_j may differ across agencies. Error terms e_{jt} may be correlated. RD_t^{*} can be either the observed R&D expenditure or the binary indicator for doing R&D, and γ_j captures the effect of participation in different programs on R&D effort. As discussed above, we focus on [2], distinguishing between two types of agencies (national and regional) and six types of manufacturing industries.[23] Vector X contains the exogenous explanatory variables discussed above and defined in table 4. Year dummies are also included to control for possible variation in the agency's budget

[23] We do not consider the third type of funding source, "Other", because of its heterogeneity.

allocated to each industry during that time period, as well as in macroeconomic environment.[24]

[Insert Table 4 about here]

Using data on the amount of public funding received by each firm from each agency would allow us to obtain more information on the agencies' preferences. Although the survey contained information in that respect, we decided not to use it for several reasons. First, almost half of the firms that report having received public funding do not report the amount received. Second, while the qualitative decision to grant some funding might reasonably be related to characteristics of firms, the size of the subsidy might instead be mostly related to characteristics of the project, which we do not observe. Finally, when we specify a subsidy size equation for participants, controlling for selection, we do not find clear economic arguments to impose exclusion restrictions to identify the model, given the variables we can use.

5. Estimation results.

The sample is divided in several groups of industries according to the degree of technological intensity.[25] We discuss first in some detail the results obtained for the

[24] We have to make two further remarks about the data. First, cash flow is missing for some observations. We construct an independent variable, cash flow times a dummy for missing status and include it in the estimated model instead of the original, jointly with the missing indicator (*Miss Cash*). This allows for unbiased estimation of the coefficients of interest and keeps sample size at a reasonable level. Second, all variables are annual, except for the human capital indicator, which is available every 4 years.

Chemical and Drug Industry, and then summarize and compare results with those of remaining industries.

5.1. Results for the Chemical Industry.

Step 1. Table 5 presents the results obtained from the estimation of two multinomial logit models with three outcomes each. In the first the alternatives are “not doing R&D” (Status=0), “doing R&D but not participating in national R&D programs” (Status=1) and “doing R&D and participating in national R&D programs” (Status=2). In the second model, the alternatives are “not doing R&D”, “doing R&D but not participating in regional R&D programs” and “doing R&D and participating in regional R&D programs".[26] To simplify table presentation, only estimates corresponding to the third alternative are shown for the second model. Coefficients shown are the marginal effect that a change in each explanatory variable has on the probability that a firm falls in each of the three possible states.

The first column shows that the probability of not doing R&D decreases with firm size and human capital intensity. Firm size has the highest effect, followed by being fully domestic. The second column shows that the probability that a firm will do R&D even

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[25]We follow a modified version of the standard OECD classification in four groups of technology intensity, defined as R&D expenditures divided by value added or by production (see OECD (2001)). Greater disaggregation is not possible because the number of observations would be too small in terms of participation in regional level programs.

[26] Alternatively, we could have classified firms in five mutually exclusive categories: no R&D, do R&D without participation, do R&D and participate in national programs only, do R&D and participate in regional programs only, and do R&D and participate in both. The number of observations would be too small, however, in some of these categories.

without national level funding is positively related to firm size and to cash flow.[27] The third column shows that several variables affect the probability that a firm will both do R&D and receive funding from the national level programs. Comparison of marginal effects in column 2 to those in column 3 suggests the possible influence of the agency's preferences. First, the most important effect is being a pharmaceutical firm, which increases the probability of participating by 0.17 points. Second, the effect of size, although positive and significant, is smaller than the effect size had on the probability of doing R&D. This suggests that the agency indeed may be choosing medium or small firms among those applying, therefore moderating the importance of size as a barrier, although its influence remains positive. It also seems to favor domestic firms and those with higher intensity of human capital, while cash flow is not significant. The age of the firm is not found to have any effect on the likelihood of being in any category in that industry.[28]

We then estimate the multinomial logit model for the case where firms participate in regional level R&D programs. For "No R&D" status, results are almost identical to those obtained in the previous model, as expected. Differences arise in the "Doing R&D and participating" status, as shown in the last column on Table 5. Firm size, human capital and being domestic are again significant, but the magnitude of the effect is

[27] When we run a probit model on a sub-sample of R&D doers and non-doers, excluding participants, we obtain practically the same results: firm size, human capital intensity and cash flow are, in that order, the variables affecting the probability of doing R&D.

[28] We find that including previous experience in R&D in the model, increases the probability of doing R&D increases by 0.55 points, and the probability of doing R&D and participating by 0.05 points. This variable cannot be used to estimate the regional multinomial logit because it is a perfect predictor, however, so for comparability it is excluded from the first multinomial model as well.

smaller. In addition, firms with lower cash flow are somewhat more likely to participate. Finally, pharmaceutical firms are not more likely to participate in these programs. We will discuss further testing of differences between the two types of agency below. Overall, these descriptive results suggest that firm size is an important obstacle to R&D in this industry, and that national and regional agencies programs mitigate this effect. They also suggest that these programs reach somewhat different types of firms, the national agency showing a preference for pharmaceutical firms, and regional agencies for firms with lower cash flow.[29]

[Insert Table 5 about here]

Step 2. There were only seven cases of firms not doing R&D in year t and obtaining a subsidy from the national programs the following year. All participants in regional programs were doing R&D the previous year. Though previous experience in R&D is not explicitly required to participate, the data suggest that those firms that were doing R&D are possibly more likely to apply for funding, or make better R&D proposals and obtain a higher acceptance rate, or both. For estimation purposes, this means that R&D experience becomes a perfect predictor, making the estimated coefficient close to infinity, so the model cannot be estimated. Consequently, we estimate three alternative participation models for national and regional programs, shown in Table 6. First, a simple probit using the whole sample (column 1); second, a probit restricting the sample to those firms that were doing R&D the previous year (column 2), and third, since that

[29] The Small-Hsiao test of independence of irrelevant alternatives suggests that the null hypothesis cannot be rejected. When we estimate a simple logit model with two alternatives, participating or not, excluding from the sample those firms that fall in category “no R&D”, results are in fact very similar, confirming the independence hypothesis.

may introduce selection bias, we estimate a probit model for participation controlling for selection on having previous R&D experience (columns 3 and 4). The same procedure is performed for participation in regional programs, and results are shown on columns 5 to 8.

Overall the results are in line with those obtained with the multinomial logit model, and most are robust to specification changes.[30] They confirm that the probability of doing R&D in this industry is related to firm size and human capital. Conditioning on previous R&D experience, national and regional R&D programs seem to reach different types of firms. National programs reach mostly pharmaceutical, domestic firms, with high intensity in human capital. We do not find evidence that the age of the firm or financial variables affect the likelihood of participating in national programs, indicating that those programs did not succeed, on average, in reaching young firms or those facing funding constraints. In contrast, regional government programs do not favor pharmaceutical firms. The association with firm size and other remaining observed characteristics is smaller, and cash flow has a negative effect.

Although firm size contributes positively to the likelihood of participating in any of the two types of programs, its influence is much smaller than on the probability of doing R&D, indicating that both agencies receive applications from smaller firms and that they are successful at obtaining some funding. This suggests that both programs reduce the weight of firm size as a barrier to R&D, but since the effect of size is still positive

[30] Coefficients and significance do not change much if a univariate probit or logit model for participation for the sub-sample that does R&D is estimated, without controlling for selection. The only coefficient that seems unstable corresponds to Cash Flow when estimating the probability of doing R&D, depending on whether firm age is included or dropped from the regression.

and not negative, we may conclude that agencies are not reaching a large proportion of small firms. This might be either because smaller firms do not apply or because, if they do, their projects are more likely to be rejected. In terms of the association patterns between firm characteristics and possible agency goals, these results suggest that participation in national programs would be compatible, ex post, with a policy of subsidizing success, whether or not this is the intended goal. Participation patterns in regional programs could be attributed to a combination of goals.[31]

[Insert Table 6 about here]

5.2. Heterogeneity across agencies and industries.

We summarize first the results obtained from estimating the descriptive multinomial logit model for different industries. Table 7 reports the significant marginal effects of the main variables obtained from the multinomial logit estimation for each group of industries. We observe that the independent variables have a different effect on status depending on the industry. Not doing R&D (category 0) is mostly related to firm size in all industries, but it appears to be a more important obstacle in medium or high tech industries. Domestic firms are more likely to fall into the category of R&D doers in most except the food, tobacco and textile industries. Differences in human capital intensity also matter, but relatively more in some traditional industries. Financial variables (cash flow or being publicly traded) are not found to be significant in most cases. The age of the firm is not found to have much effect, except in some advanced

[31] Some firms in the sample had access to funds from both sources. Using sub-samples of firms that had funds from only one source could possibly lead to more clear cut results in terms of differences across agencies, but this would reduce further the number of observations, especially for regional programs.

technology industries, where younger firms are more likely to do R&D, while the opposite is found in more mature industries. As for participation in national R&D programs, we observe that being a domestic firm increases the probability in technologically intensive industries. Participation in regional level programs seems to be somewhat related to financial variables.

[Insert Table 7 about here]

These results suggest that R&D programs reach different types of firms in each industry, possibly reflecting differences in agency goals. As discussed above, we are unable to test directly for intended agency allocation rules with our data, but still we can reasonably test the following *null hypothesis: the likelihood that a firm in a given industry will be a participant in each agency's subsidy program is driven by the same factors in a similar way.* To do this we estimate a bivariate probit model where the dependent variables are participation status in the two agencies, and test for equality of coefficients of both equations (H_0: $b_1 = b_2$). We define two unobserved index variables, Y_{NG} and Y_{RG}, measuring participation potential in each possible agency (national or regional), and the respective observed participation status, D_{CG}, and D_{GR}:

$$Y_{CG} = b_1' X + e_1 \quad ; \qquad \text{with } D_{CG} = 1 \text{ if } Y_{CG} > 0$$

$$Y_{RG} = b_2' X + e_2 \quad ; \qquad \text{with } D_{RG} = 1 \text{ if } Y_{RG} > 0$$

Disturbances are likely to be correlated because of the presence of unobserved firm characteristics that affect participation status in both sources, such as R&D project characteristics. As before, we use the sub-sample of firms that did R&D the previous period. Tables 8 and 9 summarize the results. Table 8 shows the marginal effect of a change in an independent variable on the probability of participating in each agency's program, conditional on the firm doing R&D the year previous to participating. It seems that, in general, larger and domestic firms have a higher probability of participating in national level programs in high or medium-high technological intensity industries, but not in low technological intensity industries. Lagged cash flow and being publicly traded are not found significant for participation in national programs. In the case of regional level programs, firm size and being domestic have a smaller effect on the probability of participation, and financial variables are sometimes significant. Results are similar to those obtained in the multinomial logit estimation. In terms of goodness of fit measures, estimates of national level participation equations are generally better than regional level participation equations.

[Insert Table 8 about here]

Table 9 gives the results of test statistics for the hypothesis of equality of coefficients in both equations. Column (1) provides the chi-square statistic for the null hypothesis of equality of all coefficients; column (2) gives the outcome of testing equality of individual coefficients. For all but one group of industries we reject the hypothesis that national and regional R&D subsidies reach, on average, firms with the same observed characteristics within a given industry, conditional on previous R&D experience.

[Insert Table 9 about here]

How to interpret overall these results in terms of the possible correspondence between firm characteristics and the hypothetical goals of the agencies? As the data show, both national and regional programs in the period 1990-1996 reached mostly firms that had previous experience in R&D. These firms might have been more likely to apply, or, if inexperienced firms also did, their projects might have been more likely to be rejected. Firm size is never found to have a negative effect on participation, suggesting that it is very difficult to attract an important share of small firms into R&D activities, especially in industries of high technological intensity. Nevertheless, the effect that firm size has on participation is smaller than the effect it has on the decision to do R&D, suggesting that both public agencies give size a different weight than the market. To the extent that size is associated with market failures, it would seem that both agencies do take them into account to some extent. However, since firm age is not found to have a negative effect on participation, nor cash flow for national level programs, these results suggest that these programs, during the sample period, were not appropriate to address the type of market failures that affect young and start-up firms.

The higher importance of size and human capital in explaining participation in national level R&D programs suggests that the agency might be selecting those firms with better projects, in the sense of their chances of having commercial success, in industries of high or medium-high technological intensity. The agency could be playing in part the role of certifying the quality of, and providing funds to, R&D projects that perhaps could have been financed by private investors had they had the ability to evaluate them.[32] The public agency may be acting as if addressing an information failure in the private sector, which is different from the standard failures associated with R&D. On the other hand, the agency could be funding R&D projects which involve higher risk than private investors are willing to take. To test this though we would need data on the nature of the projects, and on the evolution and sources of private funding for R&D after participating.

Regional level programs instead seem to reach on average smaller firms. Financial variables also have some effect in some cases, suggesting that the observed outcomes at the regional level may be compatible with both the market failure and the survival hypotheses.

Finally we have tested for industry heterogeneity in participation in national level programs.[33] We estimate a separate participation probit model for some industry groups, and then a series of pooled models. Results show that for each of the high and medium-high tech industries equality of coefficients is rejected, but not for those classified as medium-low or low tech. The main difference across industries is that national agency funds reach mostly domestic firms in industries such as pharmaceuticals, computers, communications equipment. This is not so in the remaining industries.

6. Summary of findings and concluding remarks.

[32] Lerner (1999) suggests this possible certifying effect of public agencies in his evaluation of the SBIR program in the US.

[33] We do not report the estimates here, and just summarize the results.

Subsidized R&D loans and grants to firms together with tax incentives for R&D activities are currently widely used as tools to encourage private innovation effort in many OECD countries. Asking to what extent these tools of technology policy are working effectively, and what factors might limit their effectiveness, become important policy issues. One possible reason for limited effectiveness of direct subsidies or grants might be found at the level of the determination of participation status: programs might fail to reach the targeted population, or the agency selection rule might not be accurate enough. This issue has not been previously investigated, as far as we know.

We have focused on the participation stage and investigated whether there are systematic differences in the likelihood of participation of firms in national and regional level R&D programs in Spain, and how some firm characteristics affect participation. Our main results are the following:

1. Holding the industry constant, *we reject the hypothesis that participation in regional and national R&D programs is driven by the same variables in all but one group of low technological intensity industries.*

2. There are some *common patterns* of incidence of some firm characteristics on program participation. Previous experience in R&D is always positively associated with participation. Subsidy policies seem to have been more effective in attracting firms that already do R&D (especially in the high tech industries) during the period examined, than in inducing non-R&D doers to change their behavior. Firm size is found to have either positive or no statistically significant effects, but never

negative. This suggests that firm size is an important barrier, and that agencies only partially succeed in attracting relatively smaller firms. Success in attracting young firms seems limited as well. Other complementary policies, such as providing venture or seed capital, might be more effective in some cases.

3. Most *differences* across agencies and industries concern the magnitude of the size effect, incidence of human capital intensity, cash flow and domestic ownership, suggesting that the observed allocation would be consistent with different combinations of goals in each agency. The participation patterns observed for national level programs seem to be consistent with the success hypothesis in industries of high or medium high technological intensity. The participation pattern observed for regional level programs would be consistent with the market failure or survival enhancing hypotheses.

4. Holding funding source constant, *we reject the null hypothesis of industry homogeneity in participation in national level R&D programs* in the case of high and medium high technology industries.

We interpret our results as providing evidence that national and regional programs end up supporting different types of firms, and that each agency may be using R&D subsidies with somewhat different policy goals in each industry. Accordingly, R&D subsidies can be expected to have different effects on private R&D effort or on productivity in different industries and for different agencies.

An important limitation our research faces is that we do not know which firms applied for but did not obtain public funding, or what were the characteristics of the firms' R&D proposals. Consequently, we have not been able to unambiguously identify the agencies' screening rule from the effects of other factors hindering firm participation. Better data are needed in order to improve our understanding of firms' decisions to apply for public funding, of agency allocation rules and their compatibility with potential goals, and of the effects of R&D subsidies. First, we need to know which firms applied for but did not receive R&D funding in order to be able to separate agency decision rules from application obstacles. Second, it would be desirable to have information about the nature of R&D projects, not only on firm characteristics. Although these might be correlated, this correlation need not always be strong, and after all agencies evaluate projects. Third, better measures of the firms' human capital are needed, especially at the management level. We think that progress in evaluation research relies to a good extent on improvements in data quality, and hope that public institutions involved in survey design will take into account these needs in the near future.

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Table 1. R&D activities and R&D subsidies
Spanish Manufacturing Firms, 1990-1996

Year	Number of Firms in the sample	Firms doing R&D		Firms receiving R&D subsidies		Private R&D/Sales % (only R&D doers)	Average Subsidy ratio of firms receiving subsidy
		Number	Percent	Number	Percent		
1990	2154	714	33.1	183	25.6	2.28	13.6
1991	2051	745	36.3	176	23.6	2.23	14.6
1992	1968	683	34.7	175	25.6	2.13	14.8
1993	1864	628	33.7	152	24.2	2.06	15.5
1994	1872	654	34.9	171	25.1	2.05	21.8
1995	1701	590	34.7	154	26.1	2.03	23.3
1996	1712	593	34.6	161	27.1	2.01	16.4

Table 2. Number of firms receiving R&D subsidies by funding source.

Source	1990	1991	1992	1993	1994	1995	1996
Central Admin. only	72	76	71	69	64	68	57
Regional Admin. only	52	37	37	24	41	34	26
Other only	22	16	17	17	17	14	30
Central & Regional	19	28	18	14	19	15	21
Central & Other	11	10	16	13	14	9	12
Regional & Other	2	2	5	4	5	3	4
Central, Regional & Other	5	7	11	11	11	11	11
Total	183	176	175	152	171	154	161

Table 3. Firm characteristics and agency objectives.

Variables	Expected signs according to policy goal		
	Market failure	Success	Survival
Experience in R&D	?	+	?
Firm age	-	?	+
Cash-Flow	-	+	-
Human capital	+	+	?
Firm Size	-	+	+
Domestic ownership	?	+	?

Table 4. Variable definition.

Variables	Description
Dependent variables	
STATUS	Categorical variable with 3 values: 0 if firm does no R&D; 1 if it does R&D but does not participate; 2 if it does R&D and participates
Participation in Central Admin. Programs	=1 if firm participates; 0 otherwise
Participation in Regional Adm. Programs	=1 if firm participates, 0 otherwise
Explanatory variables	
EXPERIENCE	Binary; =1 if firm was doing R&D, previous year
AGE	Age of the firm in years
HUMAN CAPITAL	Number (or percentage) of university graduates and engineers in the firm
SIZE	Firm size measured by the number of employees
CASH FLOW	Firm's cash flow; lagged one period.
DOMESTIC	Binary: =1 if fully domestic
TRADED	Binary: =1 if publicly traded

Table 5. R&D and Participation Status. Chemical Industry.
Multinomial Logit Estimation.
Marginal effects on the probability of being in each category

	National Programs 0= No R&D; 1= R&D, no participation; 2= R&D and participation			Regional Programs
	STATUS=0	STATUS=1	STATUS=2	STATUS=2
(Log)AGE	.025 (0.53)	-.009 (0.21)	-.016 (1.52)	.002 (.26)
HUMAN CAPITAL	**-.012**** (1.95)	.007 (1.27)	**.005***** (2.94)	**.001**** (1.95)
FIRM SIZE	**-.208***** (6.16)	**.143***** (4.55)	**.064***** (4.94)	**.016***** (3.11)
DOMESTIC	**-.145*** (1.64)	.071 (.84)	**.074***** (2.85)	**.048**** (2.39) .
CASH FLOW	-.024 (1.55)	**.026*** (1.69)	-.001 (.20)	**-.013**** (1.89)
DMSCASH	.028 (0.48)	-.026 (0.47)	-.002 (.11)	-.005 (.49)
DNOPHARMA	.071 (.92)	.09 (1.28)	**-.169***** (3.74)	.004 (.25)
Observations in each category Number of firms	263 68	394 109	129 47	34 16
Log Likelihood Total number of Observations Number of firms Pseudo R^2	-561.93 786 159 0.30			-460.07 786 159 0.27

Notes common to all tables henceforth:
1. Observations are firm-years. For most firms we have several observations, and these will not be independent. This is taken into account in estimation, and the robust Huber/White estimator of variance is used.
2. Robust z statistic shown in parentheses in absolute value. Significant marginal effects, in bold, are shown: *** indicates significance at the 1 % level; ** at the 5 %, and * at the 10 %.

Table 6. Participation in national and regional R&D programs. Chemical Industry.

	Participation in National Programs				Participation in Regional Programs				Probability Doing R&D	
	Probit Whole sample Marginal Ef (1)	Probit Subsample $DRD_{t-1}=1$ Marginal Ef. (2)	Probit with selection. Estimated Coefficients (3)	Marginal Effects on Prob(DFN| DRD=1) (4)	Probit Whole Sample Marginal Ef. (5)	Probit Subsample Marginal Ef. (6)	Probit with selection (7)	Marginal Effects on Prob(DFR|D RD=1) (8)	From Probit with selection (9)	Marginal Effects on Prob(DRD) (10)
HUMAN CAPITAL	**0.01** (3.34)	**0.01** (3.81)	0.042 (2.80)	**0.01**	**0.002** (2.15)		0.001 (0.06)	**0.002**	0.040 (2.71)	**0.01**
FIRM SIZE	**0.07** (5.56)	**0.10** (4.47)	0.376 (2.29)	**0.09**	**0.01** (3.75)		-0.092 (0.15)	**0.02**	0.564 (6.79)	**0.19**
DOMESTIC	**0.08** (2.37)	**0.12** (2.33)	0.520 (1.98)	**0.09**	**0.04** (2.92)	**0.06** (2.5)	0.493 (1.43)	**0.05**	0.365 (1.45)	
CASH FLOW			-0.001 (0.08)		**-0.01** (2.37)	**-0.01** (2.63)	-0.01 (2.36)	**-0.01**		
DMSCASHL			-0.039 (0.23)				-0.101 (0.17)			
DTRADED			0.008 (0.02)				0.499 (1.07)			
DNOPHARMA	**-0.19** (4.60)	**-0.30** (4.97)	-1.045 (4.04)	**-0.21**			0.128 (0.25)			
Constant			-2.622 (2.14)				-0.784 (6.09)		-2.847 (5.92)	
Year dummies	included	included	included		included	included	included	included	included	
Log Likelihood Wald rho=0 Pseudo R^2	-247.37 0.30	-150.11 0.32	-561.46 Do not reject		-114.41 0.18	-87.26 0.16	-460.86 Reject			
Observations	775	426	781		775	426	781		781	

Notes:
1. In this table marginal effects are reported in bold. For selection models, both estimated coefficients and marginal effects are reported.
2. DRD=1 if a firm does R&D at t; $DRD_{t-1}=1$ if a firm does R&D at t-1; DFN=1 if firm obtains national funds; DFR=1 if it obtains regional funds.
3. Goodness of fit of DFN (DFR): The model correctly predicts 78 % (74 %) of non participants, and 77 % (74 %) of participants, conditional on DRD=1.
The model correctly predicts 65 % of observations with DRD=0, and 87% of observations with DRD=1.

Table 7. Multinomial Logit Status Estimates. By industry type.
Significant marginal effects only

	STATUS	Chem & Drugs	New Tech	High-Med Tech	Med-Low Tech	Low FWT	Low NMM
Age	No R&D		.01	-.01	-.01		
	R&D		-.02		.01		
	National						
	Regional						
Human Capital	No R&D	-.01	-.01	-.02	-.02	-.04	-.02
	R&D			.02	.01	.04	.02
	National	.005			.01		.002
	Regional	.001					.002
Firm Size	No R&D	-.21	-.06	-.18	-.20	-.09	-.15
	R&D	.15	-.08	.14	.18	.09	.13
	National	.07	.14	.05	.02	.01	.01
	Regional	.02		.03	.01	.004	.02
Domestic	No R&D	-.15	-.11	-.20		.08	
	R&D			.13		-.08	
	National	.08	.16	.08	.01		.01
	Regional	.05		.06			.01
Cash Flow	No R&D						
	R&D	.02					
	National						-.001
	Regional	-.013	-.001				-.001
Publicly traded	No R&D		-.23				
	R&D						
	National						
	Regional			-.04			

Notes:

1. STATUS has three possible values: 0 if a firm does not do R&D nor participate. 1 if it does R&D but does not participate; 2 if it participates. Two sets of multinomial logit models are estimated, one for participation in national level programs, and one for participation in regional level programs. Row "National" shows results for doing R&D and participating in national level programs. Row "Regional" shows results for doing R&D and participating in regional level programs. Results for the other two categories in the estimated multinomial logit are not reported for brevity.
2. Industry groups are as follows: Chemical and Drugs; New Tech (Office equipment and electronics); High-Med (Office equipment, electrical products and car industry); Med-Low (Metals, Machinery, Other transportation, Rubber and Plastics); Low FWT (Food, Meat, Wood, Textiles, Leather, Paper), and Low NMM (Non metallic minerals and Metal products).

Table 8. Participation in national and regional level programs.
Marginal effects on the probability of participating in R&D programs
Bivariate probit estimates

	Chemical		Medium-High		Medium-Low		Low FWT		Low NMM	
	National	Region	National	Region	National	Region	National	Region	National	Region
Age							0.04			
Human Capital	0.01		.007		0.01				0.006	
Size	0.09		0.07	0.03	0.06	0.02	0.03		0.04	0.04
Domestic	0.12	0.05	0.14	0.09	0.07			0.03	0.09	0.09
Cash Flow		-0.09		0.01			0.01			
Traded				-0.08		0.20		-0.02		

Note: Estimated correlations of disturbances in both equations are always positive and significant in all types of industries, ranging from 0.48 to 0.73.

Table 9. Testing Hypothesis of equality across agencies.
Sample: only firms that did R&D the previous period.
(based on bivariate probit estimation)

Industry	(1) Chi-2 test of equality of all coefficents (df)	(2) Outcome of tests for individual coefficients
Chemical & Drugs	70.03 (13): Reject	Reject equality of human capital, firm size, cash flow and pharma dummy
Medium-high	42.84 (12): Reject	Reject equality of human capital, size, traded.
Medium-low	38.95 (15): Reject	Reject equality of size, traded.
Low FWT	47.31 (14): Reject	Reject equality of human capital, size, cash flow and traded.
Low NMM	13.80 (12): Do not reject	Do not reject equality of all coefficients.

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