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IMPLEMENTING R&D POLICIES: AN ANALYSIS OF SPAIN'S PHARMACEUTICAL RESEARCH PROGRAM *

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Abstract

Using detailed firm-level data, we analyze Spain's Pharmaceutical Research Program, and find differences between the *ex ante* announced evaluation criteria and their *ex post* implementation. By studying the program's implementation, we also uncover that the apparent discrimination against non-European firms is due to the heavy penalty placed on not having local production plants. In this sense the R&D support program works in part as a production support program. Our analysis suggests that the design of public R&D programs cannot be judged exclusively on their results. Analyzing the implementation stage is equally important.

Keywords: innovation policy; pharmaceutical industry; implementation.

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Introduction.

Given its importance, the design of public support programs for innovation has received much attention (Martin and Scott, 2000; Trajtenberg, 2002). To evaluate the effectiveness of such programs, the literature has relied on both case studies and firm-level microeconometric evidence (Klette, Møen and Griliches, 2000; Hall and Van Reenen, 2000). However, between a program's design and its outcome there is an important intermediate step: its implementation. A well designed program may fail if poorly implemented.

To judge the success of a program, one should take into account possible differences between its *ex ante* design and its *ex post* implementation. Moreover, we may only be able to understand a program's design by looking at its implementation. For instance, a program may reward firms on the basis of both research and commercial success, but only its implementation can tell us the relative importance of these criteria. Focusing on Spain's National Pharmaceutical Research Program, we use a unique firm-level data set to explore these issues. Our aim is twofold: on the one hand, highlight the gap between design and implementation, and on the other hand, uncover the priorities of the program by analyzing its implementation.

We look at *Profarma*, the most recent Spanish government support program for pharmaceutical research, which ran from 1998 to 2000. All firms applying to take part in *Profarma* got ranked by a committee of the Ministry of Science and Technology. This ranking translated into financial support and other non-monetary benefits, such as faster approval or beneficial pricing of new drugs. The official call for applications explicitly stated the ranking criteria. Using the application forms as our primary data source, we were able to manually extract all relevant quantifiable criteria on a firm by firm basis. This information then allowed us to determine which of the criteria were effectively used, and their relative importance.

The first important result is that we indeed find significant differences between the *ex ante* announced criteria and the *ex post* applied criteria. A number of variables specifically stated in the call for applications, such as having an R&D center or the ratio of R&D spending to sales, turn out to be statistically unimportant under a variety of different specifications. Such differences may be due to discrepancies between the government's true objectives and its announced policy, or it may reflect a gap between the policy defined by the higher levels of government and its implementation by lower executive levels.

The second important result we uncover is a premium for Spanish and European Union firms. More specifically, on a scale from 1 to 6, the probability of getting a grade of 4 or above increases by 0.61 for Spanish companies, and by 0.45 for European Union firms. However, after dropping the firms without production plants in Spain from the sample, this preferential treatment disappears. Our results therefore suggest that not producing locally is heavily penalized. This raises the question upto which degree this is a program to encourage research rather than an indirect way of subsidizing production and employment. A similar point is made in Trajtenberg (2002), who questions the Israeli policy of making R&D subsidies conditional on future production in the country.

The rest of the paper is organized in the following way. *Section 2* gives some background on the Spanish government support plan to the pharmaceutical industry; *Section 3* analyzes the program *Profarma*; and *Section 4* provides some closing remarks.

1. Spain's National Pharmaceutical Research Program.

2.1. Brief background.

Until recently innovation in the European pharmaceutical industry depended on organic chemistry, the industry's traditional knowledge base. Over the last couple of decades, however, the pharmaceutical industry has been increasingly shifting towards biotechnology. This knowledge shift has also meant a geographical shift: with the possible exception of British firms, the competitive advantage of European companies has eroded, with the U.S. pharmaceutical industry becoming the clear leader (see Gambardella et al., 2000 and Jacobzone, 2000). This has prompted European national governments and the European Union to design plans to counter this trend.[1]

As for the pharmaceutical industry in Spain, in the late seventies it was made up of multinationals and a large number of small family-owned laboratories. These small companies, which accounted for a substantial share of the market, focused on the production of pharmaceutical specialties. They either imported active substances from countries with no patents, or they had license agreements with multinationals. The lack of patent protection opened the door for the more dynamic Spanish companies to copy new drugs, sometimes leading to developments in formulation and dosage.

The 1980s witnessed major restructuring, as multinationals took over many of the smaller Spanish firms, which were unable to survive the breakup of the locally protected market. Spain's entry into the European Union exposed the national industry to greater competition. The common

[1] See *European Commission 93/718* (2 May 1994) for more details on the policy implications of the eroding competitive position of the European pharmaceutical industry.

market meant the removal of both tariff and non-tariff barriers, through, for instance, the harmonization of market regulations. In addition, the 1985 Adhesion Treaty obliged Spain to implement full patent protection, until then largely absent. This prompted the first major initiative to support R&D and innovation in the pharmaceutical industry.

When the National Pharmaceutical Research Program took off in 1986, the local industry lacked the capacity to innovate, R&D was virtually non-existent, and Spain was absent from international markets. Government support to R&D in the pharmaceutical industry has since then gone through four successive plans: *Farma I* (1986-1990), *Farma II* (1991-1993), *Farma III* (1994-1997) and *Profarma* (1998-2000).

2.2. The most recent government support plan: *Profarma*.

This paper focuses on *Profarma*, the most recent public program fomenting R&D in the pharmaceutical industry. It ran from 1998 to 2000, with the aim of "establishing a procedure to support research and the introduction of new production technologies for pharmaceuticals and raw materials." In the official call for applications this objective was translated into four quantifiable goals:[1] one, R&D expenses as a proportion of sales of ethical drugs should reach 8%; two, R&D expenses and investments should rise to 312 million €; three, there should be at least 3000 employees in research activities; and, four, the worsening trade balance should be improved.

Participating firms got evaluated and ordered into different categories. This ranking had different ramifications. On the one hand, it translated into financial aid for specific research projects. This financial aid came in the form of direct subsidies or zero interest loans. On the other hand, receiving a good grade had a reputation effect, helpful when it came to price setting or speeding up the approval of new products. Arguably, firms were mostly interested in this non-monetary aspect, as the magnitude of subsidies was limited: it represented a mere 2.20% of R&D investment by participating firms in 1998; this already low figure dropped further to a dismal 0.65% by 2000.[1] The importance of non-monetary benefits is also reflected by the fact that certain firms applied to participate in *Profarma* without asking for research funding.

Apart from rewarding – and thus fomenting – R&D, the public administration was also interested in covering the market as well as possible, since ranking firms provided it with useful

[1] The full text of the call for applications is available at http://www.mcyt.es/idlap/objetivos.htm

information. In that sense *Profarma* can be called a success: in its last year the program included 56 firms, making up 85% of the market in terms of sales.[2]

3. Empirical analysis of *Profarma* (1998-2000).

The objective of our empirical analysis is twofold. On the one hand, using data on all companies that participated in *Profarma*, we want to contrast the *ex ante* announced criteria with their *ex post* implementation by the Spanish Ministry of Science and Technology. On the other hand, we want see what the implementation tells us about the program's priorities. Special attention will be given to trying to understand the apparent premium firms receive for being Spanish or European.

3.1. Data and evaluation procedure

As shown in **Figure 1**, the procedure to rank firms is based on both scientific and economic criteria. The scientific evaluation is responsibility of the *Scientific Assessment Committee*. The committee's members are government officials from the Ministry of Science and Technology and the Ministry of Health. With the help of outside consultants they assign a scientific grade to each company after evaluating their scientific capacity. The economic evaluation is responsibility of the Ministry of Science and Technology, and is based on a number of quantifiable criteria that firms provide on their application form. The final grade is a combination of the scientific grade and the economic evaluation.

(Insert Figure 1 here)

The data were collected manually, using the application forms of all firms as our primary data source. The Ministry of Science and Technology also provided us with the scientific grades. Our data set therefore covers the entire population of participating firms. In 1998 the Ministry of Science and Technology received 51 applications; in 1999 that number remained stable at 50; and in 2000 there was a slight increase to 56 applications. Taking into account missing values for some companies, we were eventually left with around 150 observations.

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[1] It should be mentioned, however, that in the year 2000 the Ministry of Science and Technology started providing zero interest loans, in addition to direct financial support. Unfortunately, we do not have data on their magnitude.

[2] Total sales of participating firms amounted to 7716 million €, whereas total sales of the sector were 9049 million € (according to data of the *Instituto Nacional de Estadistica*).

We now give a list of all the variables we will use in our empirical analysis. This information is summarized in **Figure 2**.

(Insert Figure 2 here)

1. The scientific grade classifies companies into 5 different groups. Since this classification presents a mere ordering, we do not assign number grades to the different groups. Instead, we rely on dummy variables to tell us the numerical distance between grades. (The names of the dummies used in the subsequent econometric analysis are given in brackets.)

    a. Companies of Group A (companies with research activity and production plants in Spain) and Group C (with research activity and no production plants) are classified into the following categories:

        - Excellent (SCIENTIFIC DUMMY GRADE 5)
        - Very good (SCIENTIFIC DUMMY GRADE 4)
        - Good (SCIENTIFIC DUMMY GRADE 3)
        - Acceptable (SCIENTIFIC DUMMY GRADE 2)

    b. Companies of Group B with development activities and production plants, but no research (SCIENTIFIC DUMMY GRADE 1).[1]

2. For the economic criteria, we use all available information from the application forms. Roughly speaking, these correspond to the indicators announced in the call for applications by the Ministry of Science and Technology. (Again, the names of variables appear in brackets.)

    - The existence of an R&D center in the company. (R&D CENTER; if center exist R&D CENTER = 1; if not, R&D CENTER = 0).
    - R&D spending as a fraction of sales. (R&D/SALES).
    - Outside cooperation. (COOPERATION=1 if company cooperates with outside firms or institutions; COOPERATION = 0 if it does not).
    - Patent expenses, in millions of €. (PATENT SPENDING).
    - R&D investment, in millions of €. (R&D INVESTMENT).

[1] To be precise, firms in Group B are divided into “Positive” and “Negative” ones. However, none of the firms got classified into the “Negative” group.

- Total investment, in millions of €. (TOTAL INVESTMENT).
- Sales of pharmaceuticals, in millions of €. (SALES PHARMACEUTICALS).
- Sales of raw materials, in millions of €. (SALES RAW MATERIALS)
- Trade balance, in millions of €. (TRADE BALANCE).
- Net profits, in millions of € (NET ACCOUNTING PROFIT).

3. The <u>scientific grade</u> and the <u>economic criteria</u> give rise to a <u>final grade</u>, which orders companies into different categories. To facilitate our analysis, we assign corresponding number grades to these different groups. However, since the final grades should not be viewed as a cardinal ranking, we will use an ordered probit as our estimation technique.
    a. Group A: Companies with research activity and production plants.
        - Excellent (number grade 6)
        - Very good (number grade 5)
        - Good (number grade 4)
        - Acceptable (number grade 3)
    b. Group B: Companies with development activities and production plants (number grade 2)
    c. Group C: Companies with research activity and no production plants (number grade 1).

In the subsequent econometric analysis the final grade will be the dependent variable, with the economic criteria and the scientific grade as the regressors.

3.2. *Ex ante* criteria vs. *ex post* implementation by the Ministry of Science and Technology.

Although the official call for applications by the Ministry of Science and Technology specified the evaluation criteria, it did not reveal the relative importance of each one of them. To see how the *ex post* implementation may have differed from the *ex ante* announcement, we look at what the data tell us about the actual evaluation process.

This gives us the following basic estimating equation, where the dependent variable is the final grade and the regressors are the economic criteria and the scientific dummy grades:

$$\text{FINAL GRADE}_i = \sum_j \alpha_j \text{ECONOMIC CRITERION}_{ij} + \sum_k \beta_k \text{SCIENTIFIC DUMMY GRADE}_{ik} + \varepsilon_i \qquad (1)$$

The basic observation *i* is a firm-year. Since the final grade reflects an ordinal – rather than a cardinal – ranking, we use an *ordered probit* to estimate equation (1). Indeed, our ranking says that a final grade of 6 is better than a final grade of 5, and that a final grade of 5 is better than a final grade of 4, without implying that the difference between 6 and 5 is the same as the difference between 5 and 4.

(Insert Table 1 here)

The results are reported in **Table 1.** Column (1) regresses the final grade on all economic criteria and on the scientific dummy grades. The numbers in brackets give the P-values. To facilitate reading, the coefficients in bold are statistically significant at the 5% level. Apart from the scientific grades, four variables fall into that category: patent spending, R&D investment, the sales of pharmaceuticals and the trade balance. The coefficients on all of these four variables are positive, so that an increase in any one of them has a positive effect on the final grade. As can be seen in column (1), the effect of the scientific dummy grade is measured relative to "scientific dummy grade 3", which has been dropped from the regression. Not surprisingly, grades higher than 3 have a positive effect on the final grade, whereas grades lower than 3 have a negative effect.

With a data set of 150 observations using four dummy variables for the different scientific grades is potentially costly in terms of loss in degrees of freedom. To remedy this issue, we would like to reduce these different dummies to just one variable. Our results in column (1) suggest that the difference in coefficients between any two adjacent scientific dummy grades is not too different from 1. It therefore seems acceptable to interpret the ordinal ranking of the five scientific dummy grades as a cardinal ranking. As can be seen in column (2), this approximation is reasonable. The variables which are statistically significant at the 5% level are the same as those in column (1); the values of their coefficients change very little; and more importantly, the estimation is more precise, as reflected by their generally lower P-values.

Another question of interest is whether the evaluation process changed over the three years of the plan. To explore this possibility, in column (3) we introduce time dummies for 1999 and for 2000. Neither show up to be significant. We also investigated whether the coefficients of the different independent variables changed from year to year. This is not the case, so we refrain from reporting the results here.

Our results in column (1) through (3) suggest that some of the variables we would think measure R&D effort turn out to be statistically insignificant. This is the case of, for instance, having an R&D center or collaborating with outside firms and institutions. These variables were supposedly important in the *ex ante* call for applications, but do not seem to have mattered for the *ex post* implementation of the plan. One possible reason could of course be that the scientific grade picks up the effect of these variables. To see whether this is the case, column (4) drops the scientific grade from the regression. As can be seen, this does not change the variables which are statistically significant at the 5% level. Given the possible concern about multicollinearity, we further experimented with dropping certain variables, based on the correlogram in **Table 2**. None of the results changed significantly. This is not surprising: as shown in Table 2, correlations between variables are not excessively high.

(Insert Table 2 here)

We now turn to the quantitative interpretation of our results. To do so, we focus on column (2) of **Table 1**, which includes all economic criteria and the scientific grade as regressors. Given that we are using an ordered probit, the coefficients in **Table 1** do not have a direct interpretation. For instance, the coefficient 0.745 on the “scientific grade” does not mean that an increase in the scientific grade by 1 point leads to an increase in the final grade of 0.745. This is because we are interpreting the final grade as a mere ordinal ranking, so that an increase in the final grade of 0.75 does not have a precise meaning. Instead, with an *ordered probit* the relevant question to ask is how the probability of getting one grade, rather than another, changes in function of the explanatory variables. **Table 3** gives us this information. Consider, for instance, the line with the scientific grade. An increase in the scientific grade by 1 point decreases the probability of getting a final grade of 1, 2 and 3 by, respectively, 0.13, 0.13 and 0.04; and it increases the probability of getting a final grade of 4, 5 and 6 by, respectively, 0.05, 0.09 and 0.16.

To interpret the other four variables which are statistically significant – patent spending, R&D investment, sales of pharmaceuticals and the trade balance – we look at how the probability of getting a high grade (above 3) changes when we increase each of these variables by one standard deviation. For patent spending this raises the probability of getting a high grade by 0.13; for R&D investment the probability goes up by 0.14; for sales of pharmaceuticals we get a figure of 0.21; and for the trade balance we find 0.18.

(Insert Table 3 here)

From this section we can conclude that certain criteria which were *ex ante* announced to be important turned out not to matter *ex post*: this is the case of, for instance, having an R&D center, the ratio of R&D spending to sales, and cooperating with other firms and institutions. Of the four variables that do matter, in addition to the scientific grade, only two seem justifiable from the point of view of rewarding firms that excel in R&D: patent spending and investment in R&D. A third variable, sales of pharmaceuticals, may make sense if we think that it measures translating R&D into commercial success. The fourth variable, the trade balance, has more to do with industrial policy than with encouraging R&D. Rewarding companies that export a lot and import little is reminiscent of the mercantilist idea that "exports are good and imports are bad". It may also reflect a preference for domestic production as a way of creating employment.

3.3. Uncovering the premium to Spanish and European Union firms.

In this section we address the question whether Spanish (or European Union) companies received favorable treatment. Over the three years considered, Spanish firms obtained an average final grade of 3.75 on a scale from 1 to 6, compared to 3.65 for European Union firms and 3.15 for firms from the rest of the world.

These higher grades could of course simply reflect better R&D performance by Spanish firms. At first sight, the data lend support to this explanation. **Figure 3** shows R&D expenditure as a ratio of sales of ethical drugs, distinguishing between firms from Spain, the European Union, and the rest of the world. As can be seen, Spanish firms performed clearly better than the rest. However, not all R&D indicators point in the same direction. For instance, the average scientific grade for Spanish firms stood at 3.7, substantially lower than the 4.1 for non-European Union firms.

(Insert Figure 3 here)

Regardless of what these indicators tell us, our goal is to check whether there is any residual preferential treatment after controlling for all the economic criteria and the scientific grade. We therefore regress the final grade on the same list of indicators as before, with the only difference that we now include two dummy variables to control for the origin of firms: the dummy SPANISH FIRM takes on value 1 if more than 50% of the firm's capital is Spanish and 0 if not; similarly, the variable EUROPEAN UNION FIRM takes on value 1 if more than 50% of its capital is from the European Union and value 0 if not.

Table 4 reports the results for our ordered probit estimation. Column (1) suggests that Spanish and European Union firms received preferential treatment: after controlling for all economic criteria and the scientific grade, the coefficients on SPANISH FIRM and EUROPEAN UNION firm are positive and statistically significant. As for the other explanatory variables, there are two changes compared to our previous results. First, patent spending ceases to be significant. Second, the trade balance becomes insignificant in favor of the sales of raw materials. Note that this latter change does not affect our previous conclusions, since the trade balance and the sales of raw materials reflect the same concern of the public administration: the reduction of imports (and possibly domestic job creation). Indeed, firms that produce their own raw materials (and sell them) tend to be vertically integrated, and need not rely on imports for their production.

(Insert Table 4 here)

As before, certain variables could be statistically insignificant, because their effect is picked up by the scientific grade. In column (2) we therefore leave out the scientific grade, and find that patent spending and the trade balance now show up to be significant. Another interesting observation: the preferential treatment of Spanish and European Union firms is bigger when we include the scientific grade than when we do not. In addition, the relative advantage of being from Spain rather than from the European Union is also greater. This reflects a simple fact: Spanish firms got on average a scientific grade of 3.7, compared to 3.9 for European Union firms, and 4.1 for firms from the rest of the world.

To interpret the payoff for being from Spain or from the EU, we focus on column (1), and calculate what the coefficients imply about the probabilities of getting a high final grade. The results are reported in **Table 5**. Being Spanish increases the probability of getting a high final grade (above 3 on a scale from 1 to 6) by 0.61. In the case of European Union firms, the effect is 0.45. To put these magnitudes into perspective, the effect of being Spanish is equivalent to an increase in the scientific grade by 1.65 points (on a scale from 1 to 5). It is also equivalent to increasing pharmaceutical sales by 3 standard deviations, and raising R&D investment by more than 4 standard deviations.

(Insert Table 5 here)

This leaves us with the question of what the underlying reason is for the premium received by Spanish and European Union firms. One possible explanation is that R&D by Spanish firms is more likely going to lead to production in Spain. To test this hypothesis, in column (3) we re-run our standard regression on the subgroup of firms that have production plants in Spain. This amounts to leaving out 15 observations. When doing so, the preferential treatment disappears. Though striking, this result is not entirely surprising. As mentioned before, when the Ministry of Science and Technology assigns the final grade, firms with R&D activities but no production plants get relegated to Group C, corresponding to the lowest grade.

This means that firms get heavily penalized for not having production plants. Since these firms are by and large from outside the European Union, this shows up as favorable treatment to local firms. This explains some of our previous findings. Whereas Spanish firms get on average a low scientific grade of 3.7, compared to a higher 4.1 for non-European firms, they end up with a high final grade of 3.75, compared to a lower 3.15 for non-European firms. Such a policy of fomenting local production is not uncommon. For instance, Israel, a basket case for successful public support to R&D, makes subsidies conditional on future production in the country. However, if that is the case, part of the subsidies to R&D should be counted as production or employment subsidies (Trajtenberg, 2002).

4. Concluding remarks.

This paper has studied how the Spanish Ministry of Science and Technology ranked pharmaceutical companies in the framework of *Profarma*, a government plan aimed at fomenting R&D. The focus has been on the implementation of the plan, rather than on its design. By using detailed firm-level data, we have shown remarkable differences between the *ex ante* announced selection criteria and the *ex post* criteria the Ministry applied. By uncovering differences between design and implementation, our paper suggests that when evaluating government R&D plans, too much attention may be given to analyzing the optimality of the design or to studying the achievement of the objectives, and too little to its actual implementation. Even if selection criteria are optimal, the plan may fail if its implementation falls short.

Moreover, we have shown that the premium for being Spanish or European can be explained by the large penalty placed on firms that do not produce locally. This suggests that encouraging production and employment – and not just R&D – is also one of the program's main priorities.

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FIGURE 1

EVALUATION PROCEDURE AND DETERMINANTS OF THE FINAL GRADE.

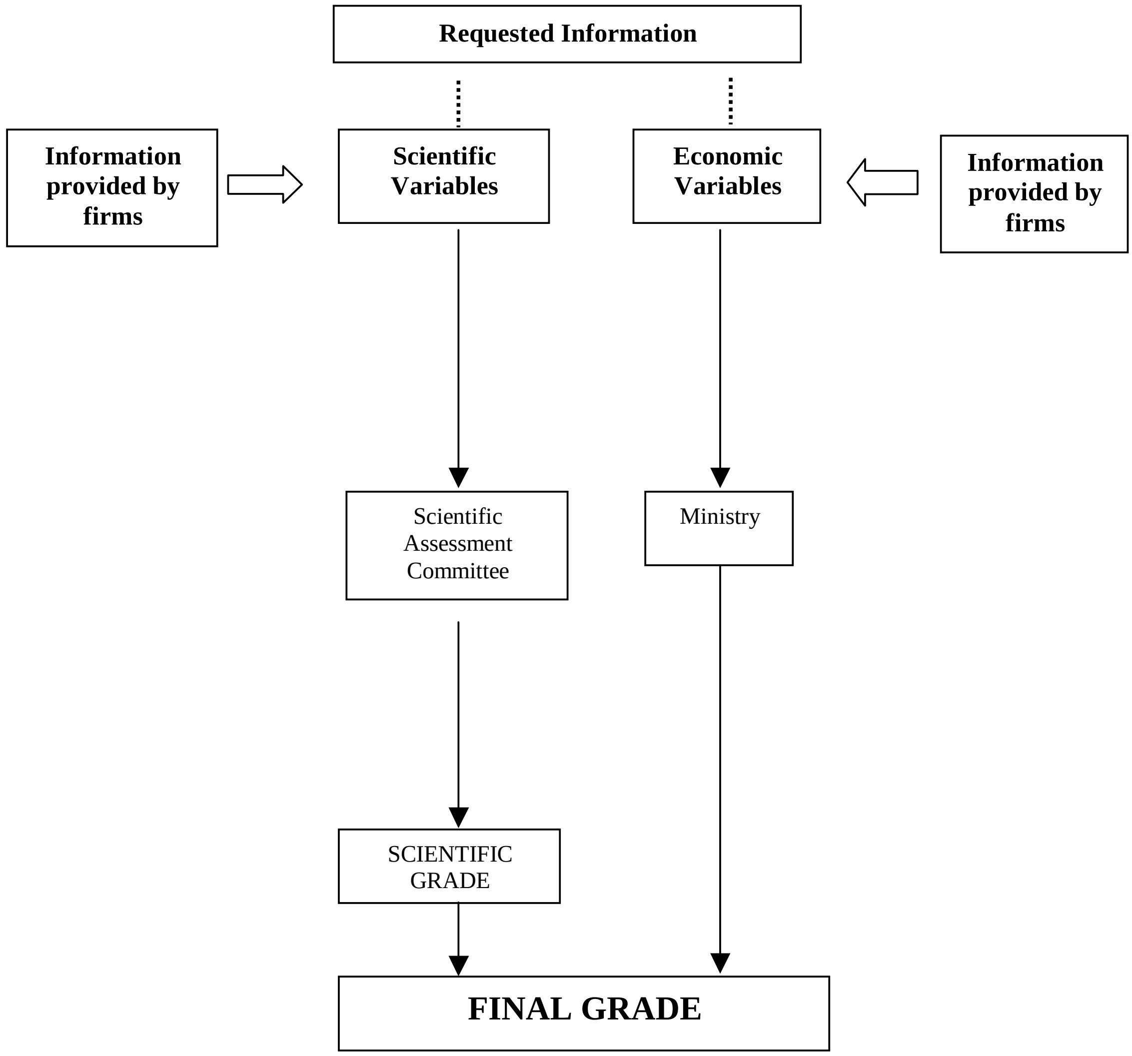
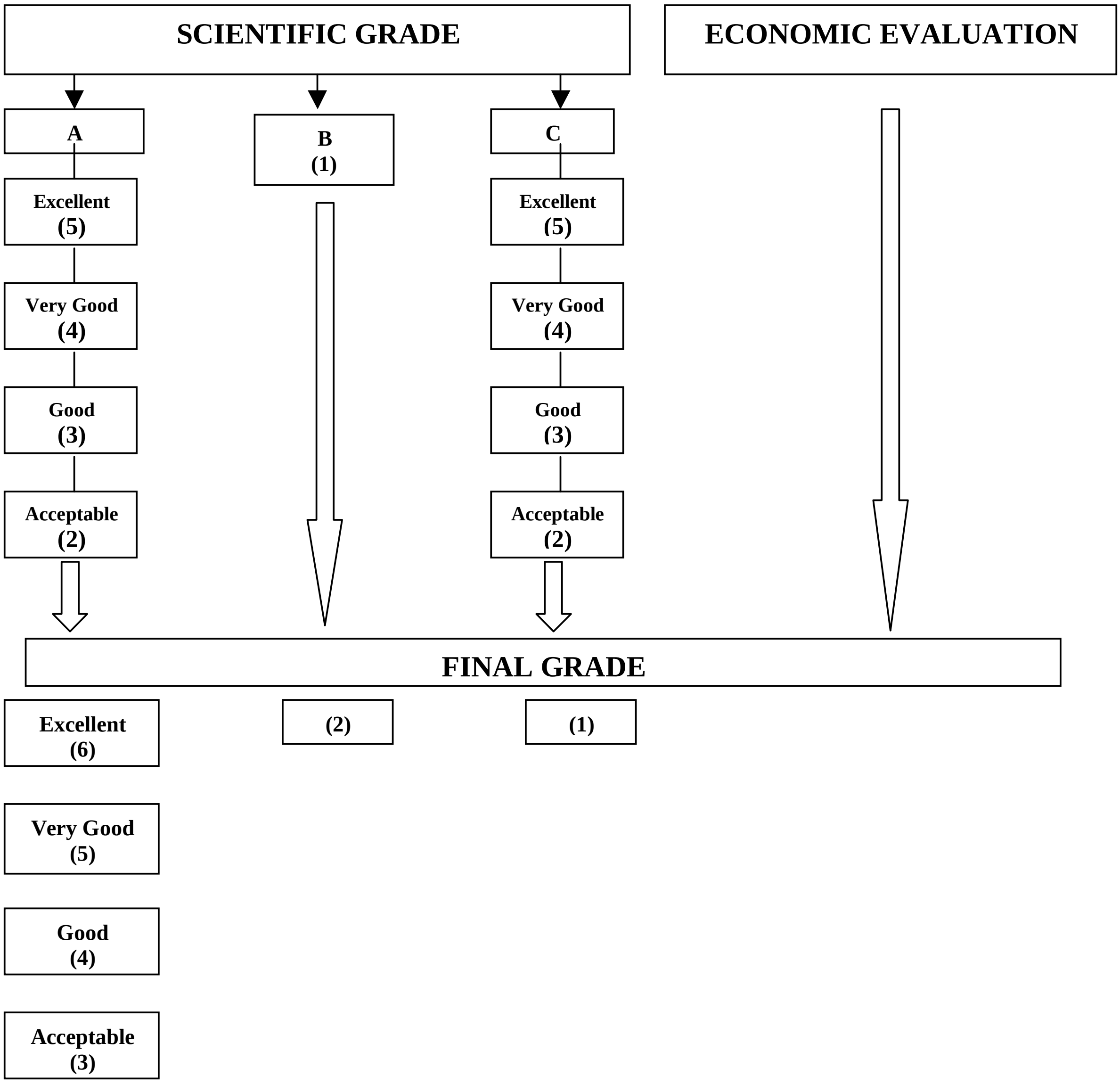


FIGURE 2

FIRMS' TYPOLOGY



A: Firms with R&D and production plants in Spain

B: Firms with development activities and production plants in Spain

C: Firms with R&D. No plant

FIGURE 3

R&D EXPENDITURE / SALES OF ETHICAL DRUGS

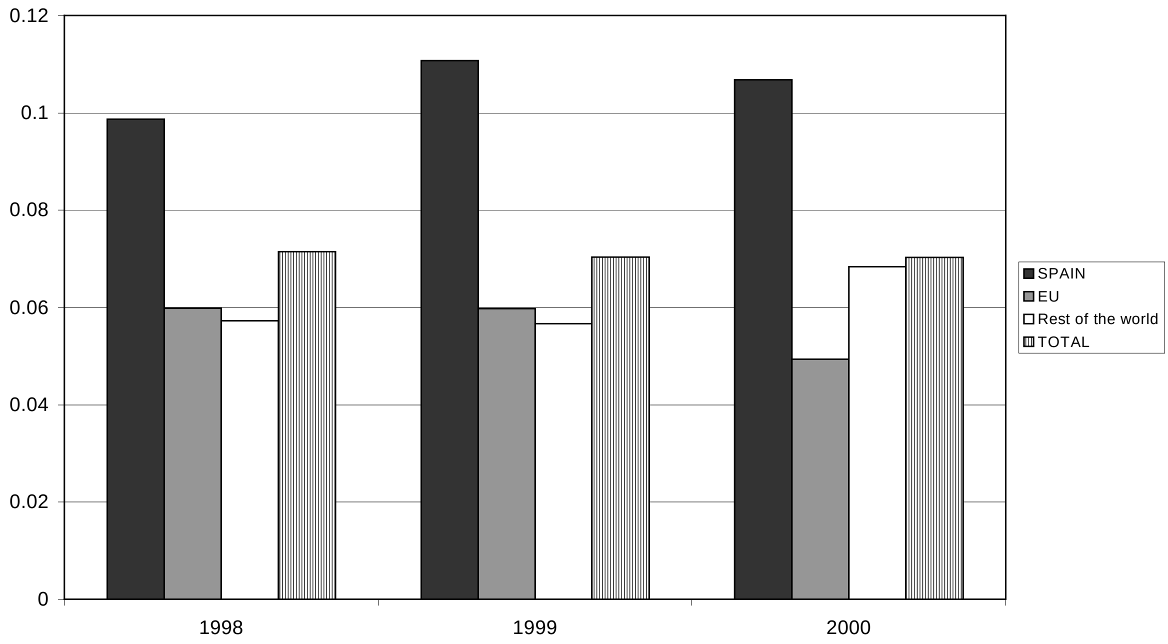


TABLE 1

DETERMINANTS OF THE FINAL GRADE (ORDERED PROBIT)

DEPENDENT VARIABLE: FINAL GRADE	(1)	(2)	(3)	(4)
R&D CENTER	-0.010	0.074	0.169	0.054
	(0.972)	(0.793)	(0.543)	(0.854)
R&D/SALES	-4.951	-3.772	-0.584	-3.805
	(0.068)	(0.149)	(0.813)	(0.146)
COOPERATION	-0.668	-0.606	-0.828	-0.606
	(0.185)	(0.213)	(0.083)	(0.213)
PATENT SPENDING	**3.189**	**3.256**	**5.111**	**3.307**
	(0.022)	(0.013)	(0.000)	(0.012)
R&D INVESTMENT	**0.424**	**0.454**	**0.665**	**0.464**
	(0.044)	(0.018)	(0.001)	(0.018)
TOTAL INVESTMENT	-0.026	-0.032	-0.023	-0.031
	(0.296)	(0.198)	(0.332)	(0.213)
SALES PHARMACEUTICALS	**0.005**	**0.005**	**0.007**	**0.005**
	(0.018)	(0.014)	(0.000)	(0.016)
SALES RAW MATERIALS	0.007	0.008	0.007	0.008
	(0.247)	(0.179)	(0.241)	(0.182)
TRADE BALANCE	**0.011**	**0.010**	**0.008**	**0.009**
	(0.001)	(0.002)	(0.009)	(0.002)
NET ACCOUNTING PROFIT	-0.002	-0.001	0.003	-0.001
	(0.848)	(0.921)	(0.772)	(0.965)
SCIENTIFIC GRADE		**0.745**		**0.741**
		(0.000)		(0.000)
SCIENTIFIC GRADE 1	**-1.204**			
	(0.000)			
SCIENTIFIC GRADE 2	-0.281			
	(0.294)			
SCIENTIFIC GRADE 4	**1.170**			
	(0.002)			
SCIENTIFIC GRADE 5	**2.191**			
	(0.000)			
YEAR 2000				-0.028
				(0.900)
YEAR 1999				-0.071
				(0.763)
Pseudo R2	0.294	0.284	0.19	0.284

P-values given in brackets. Coefficients in bold are statistically significant at the 5% level.

TABLE 2

CORRELOGRAM OF REGRESSORS

	R&D CENTER	R&D/SALES	COOPERATION	PATENT SPENDING	R&D INVESTMENT	TOTAL INVESTMENT	SALES RAW MATERIALS	TRADE BALANCE	NET ACCOUNTING PROFIT	SPANISH FIRM	EUROPEAN UNION FIRM	SALES PHARMACEUTICALS	SCIENTIFIC GRADE
R&D CENTER	1												
R&D/SALES	-0.1233	1											
COOPERATION	-0.1045	-0.2014	1										
PATENT SPENDING	0.1823	0.1532	-0.2415	1									
R&D INVESTMENT	0.1703	0.0151	0.0310	0.0394	1								
TOTAL INVESTMENT	0.1784	-0.2162	0.0501	0.0592	0.5061	1							
SALES RAW MATERIALS	0.1263	-0.0335	0.0079	0.2515	0.1740	0.3864	1						
TRADE BALANCE	0.3302	0.2602	-0.1142	0.2012	-0.2111	-0.1570	0.1958	1					
NET ACCOUNTING PROFIT	0.1116	-0.1272	0.0569	0.0970	0.2962	0.4071	0.3404	-0.2017	1				
SPANISH FIRM	0.2374	0.1708	-0.0112	0.3689	0.0318	-0.1401	0.0512	0.4736	-0.0352	1			
EUROPEAN UNION FIRM	0.1733	-0.1712	-0.1159	-0.1779	-0.0472	0.0464	-0.1566	-0.1539	0.0829	-0.5763	1		
SALES PHARMACEUTICALS	-0.1411	-0.2870	0.1157	-0.0314	0.4876	0.5774	0.2972	-0.6231	0.6141	-0.2955	0.0797	1	
SCIENTIFIC GRADE	0.1015	0.0980	-0.1212	0.3493	0.4986	0.4002	0.2716	-0.1863	0.3989	-0.0949	0.0175	0.4990	1

TABLE 3

EFFECT OF EVALUATION CRITERIA ON THE PROBABILITY OF GETTING DIFFERENT FINAL GRADES

PROBABILITY OF OBTAINING FINAL GRADE	1	2	3	4	5	6
R&D CENTER	-0.0127	-0.0127	-0.0040	0.0046	0.0087	0.0162
R&D/SALES	0.6493	0.6464	0.2059	-0.2336	-0.4436	-0.8244
COOPERATION	0.1043	0.1038	0.0331	-0.0375	-0.0713	-0.1324
PATENT SPENDING	**-0.5604**	**-0.5579**	**-0.1777**	**0.2016**	**0.3829**	**0.7115**
R&D INVESTMENT	**-0.0782**	**-0.0778**	**-0.0248**	**0.0281**	**0.0534**	**0.0993**
TOTAL INVESTMENT	0.0054	0.0054	0.0017	-0.0020	-0.0037	-0.0069
SALES PHARMACEUTICALS	**-0.0009**	**-0.0009**	**-0.0003**	**0.0003**	**0.0006**	**0.0011**
SALES RAW MATERIALS	-0.0014	-0.0014	-0.0004	0.0005	0.0009	0.0017
TRADE BALANCE	**-0.0016**	**-0.0016**	**-0.0005**	**0.0006**	**0.0011**	**0.0021**
NET ACCOUNTING PROFIT	0.0002	0.0002	0.0001	-0.0001	-0.0001	-0.0002
SCIENTIFIC GRADE	**-0.1282**	**-0.1276**	**-0.0407**	**0.0461**	**0.0876**	**0.1628**

These results are based on the regression in column (2) of Table 1. The numbers in bold correspond to criteria which are statistically significant at the 5% level. To interpret this table, focus on the scientific grade (the last line). An increase in the scientific grade by 1 point decreases the probability of getting a final grade of 1 by 0.1282, and it increases the probability of getting a final grade of 6 by 0.1628.

TABLE 4

DETERMINANTS OF THE FINAL GRADE (ORDERED PROBIT), CONTROLLING FOR FIRM ORIGIN

DEPENDENT VARIABLE: FINAL GRADE	(1)	(2)	(3)
R&D CENTER	-0.426	-0.134	0.108
	(0.18)	(0.66)	(0.86)
R&D/SALES	-3.893	-0.158	9.686
	(0.17)	(0.95)	(0.23)
COOPERATION	-0.511	-0.692	1.135
	(0.30)	(0.15)	(0.17)
PATENT SPENDING	1.624	**4.804**	1.553
	(0.26)	(0.00)	(0.51)
R&D INVESTMENT	**0.459**	**0.748**	0.365
	(0.04)	(0.00)	(0.30)
TOTAL INVESTMENT	-0.017	-0.017	-0.050
	(0.49)	(0.49)	(0.27)
SALES PHARMACEUTICALS	**0.005**	**0.007**	0.004
	(0.02)	(0.00)	(0.29)
SALES RAW MATERIALS	**0.018**	**0.012**	**0.024**
	(0.01)	(0.05)	(0.05)
TRADE BALANCE	0.006	**0.006**	0.006
	(0.10)	(0.05)	(0.36)
NET ACCOUNTING PROFIT	-0.011	-0.002	0.012
	(0.36)	(0.88)	(0.58)
SCIENTIFIC GRADE	**0.931**		**3.644**
	(0.00)		(0.00)
SPANISH FIRM	**1.533**	**0.672**	-0.417
	(0.00)	(0.02)	(0.51)
EUROPEAN UNION FIRM	**1.132**	**0.764**	-0.748
	(0.00)	(0.01)	(0.19)
Pseudo R2	0.33	0.21	0.83
Number of observations	149	149	134

P-values given in brackets. Coefficients in bold are statistically significant at the 5% level.

TABLE 5

EFFECT OF EVALUATION CRITERIA ON THE PROBABILITY OF GETTING DIFFERENT FINAL GRADES, CONTROLLING FOR FIRM ORIGIN

PROBABILITY OF OBTAINING FINAL GRADE	1	2	3	4	5	6
R&D CENTER	0.0734	0.0731	0.0233	-0.0264	-0.0501	-0.0932
R&D/SALES	0.6701	0.6671	0.2125	-0.2411	-0.4578	-0.8508
COOPERATION	0.0879	0.0875	0.0279	-0.0316	-0.0601	-0.1116
PATENT SPENDING	-0.2796	-0.2783	-0.0886	0.1006	0.1910	0.3550
R&D INVESTMENT	**-0.0789**	**-0.0786**	**-0.0250**	**0.0284**	**0.0539**	**0.1002**
TOTAL INVESTMENT	0.0030	0.0030	0.0010	-0.0011	-0.0021	-0.0038
SALES PHARMACEUTICALS	**-0.0009**	**-0.0009**	**-0.0003**	**0.0003**	**0.0006**	**0.0011**
SALES RAW MATERIALS	**-0.0031**	**-0.0031**	**-0.0010**	**0.0011**	**0.0021**	**0.0040**
TRADE BALANCE	-0.0010	-0.0010	-0.0003	0.0003	0.0007	0.0012
NET ACCOUNTING PROFIT	0.0019	0.0019	0.0006	-0.0007	-0.0013	-0.0024
SCIENTIFIC GRADE	**-0.1602**	**-0.1595**	**-0.0508**	**0.0576**	**0.1095**	**0.2034**
SPANISH FIRM	**-0.2640**	**-0.2628**	**-0.0837**	**0.0950**	**0.1803**	**0.3351**
EUROPEAN UNION FIRM	**-0.1949**	**-0.1940**	**-0.0618**	**0.0701**	**0.1332**	**0.2475**

These results are based on the regression in column (1) of Table 4. The numbers in bold correspond to criteria which are statistically significant at the 5% level. To interpret this table, focus on the Spanish firm (second to last line). Being Spanish decreases the probability of getting a final grade of 1 by 0.2640, while it increases the probability of getting a final grade of 6 by 0.3351.