R&D Cooperation Determinants, Evidence from Chilean Firms

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In this paper we study the determinants of R&D cooperation among innovative firms using data from the 4^{th} Chilean Innovation Survey. We follow the empirical model developed by Cassiman and Veugelers (2002) in which cooperation is allowed to be a function of the technology of the information flows. From our main results we find that incoming spillovers, cost-risk sharing and legal protection affect positively and significantly the probability of cooperating among Chilean firms, while lack of information and firm size have a negative impact on the same variable. In our empirical approach information flows seem to have a larger impact over cooperation with universities and consulting agents. Endogeneity problems present in the model have been properly addressed using a two-stage conditional maximum likelihood test (2SCML) due to Rivers and Vuong (1988) and using an instrumental variable for the first stage estimates of incoming spillovers.

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1 Introduction

R&D activities have a very important impact on the development of new products and productive processes as shown on Crepon, Duguet and Mairesse (1995). When we study the innovative process of firms it turns out to be very important to analyze not only the incentives that take a firm to allocate financial resources on R&D but also how these innovative firms cooperate in the use of their resources with the intention of developing together some research activities that will later traduce on a process or product innovation.

We claim that cooperation in an innovative process is an efficient manner of developing innovative products and processes mainly for two reasons. First because it avoids the same innovative process to be developed two or more times instead of one, causing an important cost reduction for all firms participating on the cooperative process. Secondly because of the possibility that complementing the knowledge available in two firms may turn into the development of a new process or product that would have not been possible with the information or knowledge available only for one of the firms.

If there are some specific conditions that promote R&D cooperation among Chilean firms, it will be useful to analyze them empirically in order to have a useful tool at the time of innovative policy making.

Following Cassiman and Veugelers (2002), we use a model that addreses the possible endogeneity of some variables. The estimation procedure we used has the characteristic of firstly testing the presence of endogeneity problems on a set of variables using a Two Stages Conditional Maximum Likelihood method. After this, we have applied a Probit Conditional Maximum Likelihood Method with Instrumental Variables, in order to correct for the specification problem of the model caused by the endogenous variable detected in the first stage of our work.

Within our results we find that incoming spillovers affect positively and very significantly the probability of innovating. This result has been robust in all our estimation procedures. An indicator of whether cost and risk sharing is perceived as a benefit, and the existence of legal protection affect positively the probability of cooperating. On the other side, lack of information affects negatively the probability of cooperating for innovative purposes being this impact very significant in all our estimations. Finally we conclude that larger firms cooperate significantly less than small firms in Chile suggesting that organizational problems may be representing a cooperation restraint in large firms from our sample.

The rest of this document is structured as follows. On section 2 we briefly comment on some conceptual antecedents and previous empirical findings. Section 3 explains our model. Section 4 refers to the data of the 4^{th} Chilean Innovation Survey. Section 5 shows our main results and section 6 concludes.

2 R&D cooperation determinants

One of the most important inputs for a firm's innovative activities is knowledge. A firm that is capable of successfully incorporating information flows is probably more capable and willing of having a cooperative behavior for its innovative activities.

On the other side, firms that can't appropriate the results of their innovative activities will tend not only to practice less cooperation but also to engage less on R&D activities.

The literature on R&D cooperation determinants focuses mainly on the importance of information flows to stimulate the firms to engage or not in cooperative R&D activities. Recent empirical strategies have approached a distinction between incoming information flows and outgoing information flows. They show how firms are more propensive to cooperate both, when they have enough absorptive capacity to receive and use external public knowledge, and when they can appropriate of the knowledge generated by their own innovative activities.

Cassiman and Veugelers (2002) developed a model in which they study separately the effects of incoming spillovers and appropiability over the probability of participating in cooperative R&D agreements. They used data from the Belgian Community Innovation Survey (CIS). They concluded that incoming spillovers and apropriability have important and separately identifiable effects on R&D Cooperation among Belgian firms. Furthermore, they found differences in the effect of these variables over the cooperation with different types of partners.

López (2004) uses a similar approach to that developed by Cassiman and Veugelers (2002) and studies the determinants for R&D cooperation in the Spanish manufacturing firms. Results show a positive effect of the importance of external information sources and the ability of the firm to appropriate the returns from innovations on the probability of R&D cooperation.

Mark and Graversen (2004) discuss the rationale for firms' choices of cooperative R&D partners which can be public research institutions or private firms. They use micro data from the Danish Centre for Studies in Research and Research Policy collected for year 2001. The determinants for R&D cooperation include R&D competence stocks, absorption capacity and R&D time horizon. They find heterogeneity in the cooperation determinants for different kinds of partners.

Atallah (2005) considers an R&D cooperation model with asymmetric firms; it focuses on cooperation among firms with different levels of efficiency. The results suggest that firms' preferences over whom to cooperate depend on spillovers and on cost differences among firms. With low (high) spillovers, a firm prefers to cooperate with the most (least) efficient among the remaining firms. As the cost differential between firms increases efficient (inefficient) firms prefer to cooperate with the most (least) efficient firm more often.

Schmidt (2005) analyzes the determinants of R&D cooperation among German manufacturing firms. Using data from the Third Community Innovation Survey (CIS3), the paper focuses on the effect of information flows over cooperation for R&D activities. He found a positive relation between knowledge flows and cooperative activities. Moreover evidence showed that firms with high intramural R&D budgets are more likely to cooperate with universities and research institutions than with suppliers and customers.

Vencatachellum and Vesaevel (2006) studied the effects of spillovers on R&D

cooperation using French data. They found among their results that a firm which benefits from higher spillovers from its rivals is more likely to cooperate horizontally in R&D. Furthermore, the impact of incoming spillovers over R&D cooperation is positive and significant only when they are above a certain threshold, it is to say, the value and the precision of the estimates increased with the information flows that firms report receiving from their competitors.

3 The Model

The model is based on the idea that information flows are one of the most important aspects determining R&D cooperation. Cassimann and Veugelers (2002) separate information flows between those that come from outside and to increase firm's knowledge, and those that come from the firm and allow other agents to benefit from the firm's experience and knowledge. They developed a very simple and intuitive empirical model and tested it using a sample of 411 firms. This study relies largely on their work and therefore the reader should refer to their paper in order to find detailed explanations of the model and estimation strategies that we only summarize in this paper for simplicity.

Cooperation in the knowledge production process is depends on the opportunities and risks associated with the cooperative strategy.

It is expected that the more important are incoming knowledge flows or spillovers, more likely it is that the firm will be able to benefit from R&D agreements. When public information sources are important on the firm's knowledge developement, it is expected that the return to cooperating will be greater because partners are will be more capable of transmitting useful information.

When expect to find that the level of appropriability of the knowledge that has been generated into the firm or within a cooperation agreement has a positive impact in the level of cooperation. Therefore in our empirical model we consider a variable that measures legal protection of knowledge as perceived by the firm to capture this effect. When a firm is capable protecting its knowledge by legal means, it is to say, when a firm has patents or know-how agreements, it may be more likely that it will cooperate.

We also include other variables in the model that are supposed to affect R&D cooperation agreements. Lack of Information as a constraint for innovating is a variable that takes value 1 if lack of information is declared by the firm as an important restraint for innovating. Lack of information being important for innovative firms could mean that they do not have yet information of what is being done by competitors in their associated research topic, so they are not in good position for cooperating with other firms or institutions. Thus, we expect this variable to affect the probability of cooperating in a negative way.

We consider the possibility of sharing the risks and the costs that innovative activities may have when this are high and expensive as declared by the firms. When the costs and risks of innovative activities are considered high by the firms, it is more likely that they will tend to cooperate in order to produce process and product innovations in a less expensive way. For this study we have constructed a cost risk sharing variable based on the following firm level information: difficulty for finding sources of finance; high cost of innovating; high risk perceived; too long payback period of innovating activities.

Finally, as it has been allowed in the previous empirical literature, firm size and R&D intensity may be R&D cooperation determinants. We have included size and size squared as well as R&D intensity and industry level of cooperation in order to control for unobservable industry level characteristics that may affect firms' decision to cooperate with other firms or institutions.

As de dependant variable is binary taking only values 1 or 0, we need our econometric specification to be defined as follows:

$$E(y_i) = P_r(y_i = 1) \to 1 \quad when \quad \alpha + \beta x_i \to \infty$$

and

$$E(y_i) = P_r(y_i = 1) \to 0 \quad when \quad \alpha + \beta x_i \to -\infty$$

This way we can define our main equation which under the assumption of no endogeneity problems may be properly estimated by a simple Probit Model as follows:

$$y = F(\alpha + X\beta)$$

Where:

y = 1 if the firm cooperates and 0 in other case.

β_1 : effect of incoming spillovers over the probability of cooperating.

β_2 : effect of Easy Imitation over the probability of cooperating.

β_3 : effect of Lack of Information over the probability of cooperating.

β_4 : effect of Cost and Risk sharing over the probability of cooperating.

β_5 : effect of Legal Protection over the probability of cooperating.

β_6 : Industry Level Cooperation effect over the probability of cooperating.

β_7 : Industry Level of Legal Protection effect over the probability of cooperating.

β_8 : effect of R&D intensity over the probability of cooperating.

β_9 : effect of size of firm (log of employees) over the probability of cooperating.

β_{10} : nonlinear effect of size of firm over the probability of cooperating.

As it has been shown in previous literature, some of the variables included in this model may be endogenous. According to Cassiman and Veugelers (2002), incoming and outgoing information flows may be endogenous variables. Since firms that cooperate may also try to control information flows with their R&D agreements, the fact of cooperating may also be a determinant of the incoming information flows or spillovers. Moreover, an R&D agreement may also be used by firms to control both the outgoing information flows to partner firms an to non-partner firms.

Other works like Veugelers (1997) and Colombo and Gerrone (1996) have found reasons to believe that R&D intensity may also be endogenous regressors in this empirical model. We also consider their experience on this paper. Cost-risk has also been treated as an endogenous variable in Lopez (2004) because the effects of cooperating are also possible to affect how much the variables used to build this regressor are considered by firms as obstacles to innovation.

In order to approach our model in a more consistent way we test for the presence of endogeneity. We perform a test on the four variables that have been referred to as endogenous in previous works that consider the determinants of R&D agreements. We firstly estimate the model using a two stages conditional maximum likelihood method which has been recently reviewed by Wooldrige (2002). This model, that was previously considered in Heckman and MaCurdy (1985) and Rivers and Voung (1988) and has been followed by a series of empirical works, has the characteristic of providing a simple way to test for the endogeneity of some of the variables in the model. In the first step of this

procedure all the variables that are possibly endogenous are regressed one by one on all the variables that are assumed to be exogenous. The test is performed on the second step of this procedure where we consider the resids of each of the first step equations as independent variables of our main equation which has R&D cooperation as dependant variable.

We can now define a model that considers the presence of endogenous explanatory variables. We assume that the endogenous explanatory variables (y_2) are a function of the other exogenous explanatory variables described in our previous equation (X) and that they also depend on a set of instruments (Z).

So we can write the model as follows:

$$y_1 = F(\alpha_0 + \beta_1 x_i + \beta_2 y_2)$$

$$y_2 = F(\alpha_1 + \beta_3 x_i + \beta_4 z_i)$$

Where x_i, z_i are $k \times n$ and $p \times n$ matrices respectively while y_2 is a $n \times j$ matrix. Then β_1 and β_3 are both $1 \times k$, β_4 is $1 \times p$ and β_2 is a $1 \times j$ vector.

4 Description of the Data

The data used in this paper has been obtained from the Fourth Chilean Innovation Survey, collected by the National Institute of Statistics during the year 2005.

Table 1 shows some basic description of the database that has been used for this work. The sample is composed by 3,122 firms of which 1,494 firms (48%) have declared to have carried out innovations in the two-year period before the survey. The survey has considered firms from the manufacturing, mining, energy and services sectors. The most innovative enterprises in Chile are those from the mining sector with a 58% of innovative firms. The sector in which the smallest proportion of firms carries out some type of innovation is the Services sector with a 43% of innovative firms.

From all innovating firms included in the sample only a 12.4% has cooperated with other innovative firms in order to perform R&D activities. Firms that cooperate with Universities are 106 representing a 7.1%, while firms that cooperate with Competitors are 96 and represent a 6.2% of the total innovative firms. Firms that cooperate with consulting professionals are 93 and represent a 6.2% of the innovative firms. Finally, the 166 firms that cooperate with Customers represent an 11% of the innovating firms.

Table 2 presents the mean values of the most important variables of our model. Incoming Spillovers has a sample mean of 0.655 and is significantly higher for firms that cooperate with Consulting professionals. Easy Imitation has a sample mean of 0.727 and presents no significant mean difference between cooperating and non-cooperating firms. Lack of Information has a sample mean of 0.283 and has a significantly lower mean value for firms that cooperate with any kind of partner. Cost-Risk has a sample mean of 0.223. This variable has a mean that is not significantly different between cooperating and non-cooperating firms. Legal Protection has a sample mean of 0.198 and has a significantly higher mean values for firms that cooperate with any kind of partner. There is on average 461.5 employees per firm. The number of employees is significantly higher for firms that cooperate with any kind of partner. R&D Intensity has a mean of 0.012 for innovative firms and is significantly higher for firms that cooperate with at least one kind of partner and for firms that cooperate with universities.

5 Results

5.1 Preliminary Probit Regressions

Results exposed on table 3 suggest that there is evidence to believe that incoming information flows determine a grater likelihood of performing R&D cooperation within our sample. This result is robust on all regressions no matter which kind of partner is being considered. The highest impact of incoming spillovers is over the cooperation agreements with consulters and competitors. Cooperation with suppliers and customers and cooperation with universities seem to be affected in a smaller magnitude by the existence of incoming spillovers.

Legal Protection affects positively and significantly the probability of engaging in R&D agreements. This is consistent with the empirical model previously specified. We have found that, for Chilean firms, the grater impact of this variable is on cooperation with universities.

Lack of Information affects negatively and significantly the probability of having R&D cooperation agreements inside of the Chilean firms. This parameter takes a higher absolute value when the dependant variable is cooperation with universities and cooperation with consulters. This result may be because firms that declare having lack of information do not know what is being done by others in their research topic. This way they are not prepared for cooperating with other firms or institutions on innovating activities.

Cost-Risk variable seems to affect cooperation agreements in a positive way. This result is consistent in all our specific-partner estimations but appears with a low significance in the regression that considers all kinds of cooperation together. The value of the parameter is higher when the dependant variable is cooperation with competitors and cooperation with consulters.

This specification also controls by Industry Level of Cooperation, Industry Level of Legal Protection, R&D Intensity during the period, Size and Size Squared. All controls are always significant except by R&D Intensity which is only significant for cooperation with all partners and for cooperation with universities.

5.2 Two-Step Endogeneity Test Results

We have used for our estimations a two-step endogeneity test that can be found in Heckman and MaCurdy (1985) and Rivers and Voung (1988). This allows us to state the direction of the causality relations for all the variables that we believe may be endogenously determined. In this case we have tested the endogeneity of four of the independent variables included in our model. This variables are; incoming spillovers, legal protection, R&D intensity and cost-risk.

In the first step of our test we regress each of the allegedly endogenous regressors with all the assumed independent variables of the model. Then we use the predicted value of the latent variable in the second step of the estimation procedure. The second equation has R&D cooperation as dependant variable. It includes the resids of each of the first step equations as regressors. We check the significance of these regressors in order to see if there are endogeneity problems.

We find that only Incoming Spillovers is endogenous on table 4. So we can proceed now to our final estimation procedure which will use instruments for incoming spillovers.

5.3 CML with Instrumental Variables Results

Table 5 contains the Conditional Maximum Likelihood results with the use of instrumental variables for incoming spillovers. The instruments that we used are industry level of incoming spillovers[1], and basicness of R&D[2].

Results show that incoming spillovers determine a greater probability of R&D cooperation. This result is seen on all regressions independently of which kind of partner is being considered. A negative bias of the incoming spillovers parameter related to endogeneity problems has been reduced. The highest impact of incoming spillovers is over cooperation agreements with universities and consulters. Cooperation with suppliers and customers and cooperation with competitors seem to be affected in a smaller magnitude by the existence of incoming spillovers.

Legal Protection affects positively and significantly the probability of engaging in R&D agreements. In accordance with the preliminary probit regressions, we have found that for Chilean firms the grater impact of this variable is on the cooperation with universities. We conclude that legal protection has a higher impact over cooperation with universities, consulters and vertically related firms compared to the impact it has over cooperation with competitors.

Lack of information affects negatively and significantly the probability of having R&D cooperation agreements among Chilean firms. As in the previous probit regressions from table 3, this parameter takes a relatively higher absolute value when the dependant variable is cooperation with consulters.

Cost-Risk variable affects cooperation agreements in a positive way. This result is significant in all cases with the exception of the regression where the dependant variable is cooperation with all kinds of partner. Cost-Risk shows a more intensive impact over cooperation with competitors and cooperation with consulters.

In general after controlling for the presence of endogeneity we find that our results are robust and that the differences in the parameters with respect to the simple probit regressions are in accordance with the presence of a bias that has been successfully addressed on the regressions from table 5. This model also controls by industry level of cooperation, industry level of legal protection, R&D intensity during the period, size and size squared.

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[1] The correlation between Incoming Spillovers and Industry Level of Incoming Spillovers is 0.15

[2] The correlation between Incoming Spillovers and Basicness of R&D is 0.58

5 Concluding Remarks

This paper contributes to the literature by studying the R&D cooperation determinants with data obtained from the fourth Chilean Innovation Survey. We have used Instrumental Variables and Conditional Maximum Likelihood Methods in order to estimate properly the empirical due to the existence of endogeneity problems in our preliminary probit regressions. Moreover, following the previous literature we have tested for the presence of endogeneity in several regressors of the model finding that incoming spillovers is the only endogenous variable in the model.

Following Cassiman and Veugelers (2002) and also considering other applications of this model and previous literature on R&D cooperation determinants, we have tested endogeneity of incoming and outgoing information flows and also of R&D intensity and cost-risk variables. Results show that incoming spillovers determine a greater probability of R&D cooperation. This result is seen on all regressions independently of which kind of partner is being considered. Using instrumental variables increased the value of the incoming spillover parameter. We found that cooperation with universities and consulters are the most affected by information flows by having the highest values of incoming spillovers and legal protection parameters.

Lack of Information impacts negatively and significantly the probability of having R&D cooperation agreements for the Chilean firms, while cost-risk seems to affect cooperation agreements in a positive way, this result is significant in most of our regressions. In this paper the results of evaluating R&D cooperation determinants in Chilean firms are exposed.

Our results add to the literature by confirming the main findings of Cassiman and Veugelers (2002) and the literature that follows. Furthermore we use a larger sample of 1463 firms from a developing country in which overall R&D performance is lower than in the developed world where similar empirical evidence was previously found. Additionally we used an instrument that has high correlation with the instrumented variable obtaining a considerable reduction in the bias of the parameters produced by endogeneity problems.

From our empirical findings we conclude that incoming spillovers affect positively in larger scale cooperation with universities and with consulting agents than cooperation with competitors, suppliers and customers. On the other side legal protection has a higher effect on cooperation with universities and consulters but also on cooperation within the vertical chain that connects the firm to the market.

Our results have important policy implications because from them we can easily conclude that improvements on knowledge legal protection system should have a positive impact over the level of cooperation among firms. Similarly, facilitating public information flows will also have a positive effect over R&D cooperation, especially stimulating cooperation with universities and consulting agencies.

Variable Definitions

• Incoming Spillovers: Variable which takes the value 0 if innovation ideas are not originated by Professional conferences, exhibitions, meetings and journals, and takes values between 1 (low) and 4 (high) when this sources are declared to be sources for innovating ideas. Rescaled between 1 (high) and 0 (not relevant).

• Basicness of R&D: Variable which takes the value 0 if innovation ideas are not originated by institutional sources and takes values between 1 (low) and 4 (high) when institutional sources are declared to be sources for innovating ideas. Rescaled between 1 (high) and 0 (not relevant).

• Lack of Information: Variable which take the value 0 if lack of information is not an obstacle, as declared by the firm, for the innovative process, and takes vales between 1 (low importance) and 4 (high importance) when the lack of information is an obstacle for innovating. Rescaled between 0 (not relevant) and 1 (high).

• Legal Protection: Variable that takes value 0 if the firm has no patents or know-how agreements and 1 in other case.

• Cooperation: Variable which takes value 0 if the firm does not declare to have cooperated for innovative activities with any other agent (suppliers, clients, competitors, consultors, universities, research institutes) and takes the value 1 if the firm has declared to cooperate with at least one of them.

• Cooperation with competitors: Variable which takes the value 1 when the firm has declared to cooperate for innovating with its competitors, and takes value 0 in other case.

• Cooperation with Consulters: Variable which takes the value 1 when the firm has declared to cooperate for innovating with private consulters or R&D laboratories, and takes value 0 in other case.

• Cooperation with Suppliers or Customers: Variable which takes the value 1 when the firm has declared to cooperate for innovating with its suppliers or customers, and takes value 0 in other case.

• Cooperation with Universities: Variable which takes the value 1 when the firm has declared to cooperate for innovating with universities or public research institutes, and takes value 0 in other case.

• Cost-Risk: Sum of the scores of importance of the following declared obstacles for innovating (values between 0 (not relevant) and 4 (very important obstacle): Difficulty for finding sources of finance; High cost of innovating; High risk perceived; Payback period too long. Rescaled between 0 (not relevant) and 1 (high).

• Industry Level Imitation: Mean of Imitation at each industry. The industry has

been defined with a 2-digit classification.

• Industry Level of Incoming Spillovers: Mean of Incoming Spillovers at each industry. The industry has been defined with a 2-digit classification.

• Industry Level of Legal Protection: Mean of Legal Protection at each industry. The industry has been defined with a 2-digit classification.

• Industry Level of Cooperation: Mean of Cooperation at each industry. The industry has been defined with a 2-digit classification.

• Industry Level of Cooperation with Competitors: Mean of Cooperation with Competitors at each industry. The industry has been defined with a 2-digit classification.

• Industry Level of Cooperation with Consulters: Mean of Cooperation with Consulters at each industry. The industry has been defined with a 2-digit classification.

• Industry Level of Cooperation with Suppliers or Customers: Mean of Cooperation with Suppliers or Customers at each industry. The industry has been defined with a 2-digit classification.

• Industry Level of Cooperation with Universities: Mean of Cooperation with Universities at each industry. The industry has been defined with a 2-digit classification.

• R&D Intensity 2004: Ration between intramural R&D expenditures and turnover.

• Size: Log of number of employees of the firm.

• Size squared: square of log of number of employees.

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Table 1: Sample Statistics

All Sample Firms	3,122
Innovating Firms	1,494
Percentage of All Firms	47.85%
Manufacturing Firms	1,269
Innovating Manufacturing Firms	640
Innovating Manufacturing Firms	50.43 %
Energy Firms	150
Innovating Energy Firms	72
Innovating Energy Firms	48%
Mining Firms	64
Innovating Mining Firms	37
Innovating Mining Firms	57.81%
Services Firms	1,412
Innovating Services Firms	613
Innovating Services Firms	43.41%
Non-cooperating Firms	1,309
Percentage of Innovating Firms	87.62%
Cooperating Firms	185
Percentage of Innovating Firms	12.38%
Firms Cooperating with Universities	106
Percentage of Innovating Firms	7.1%
Firms Cooperating with Competitors	93
Percentage of Innovating Firms	6.22%
Firms Cooperating with Consulters	93
(percentage of innovating firms)	6.22%
Firms Cooperating with Customers	166
(percentage of innovating firms)	11.11%

Table 2: Descriptive Statistics

	Sample Mean	Mean non-cooperating Firms	Mean Cooperating Firms	Mean Cooperation with Universities	Mean Cooperation with Competitors	Mean Cooperation with Consulters	Mean Cooperation with Customers
	(N=3,122)	(N=1,309)	(N=185)	(N=106)	(N=93)	(N=93)	(N=166)
Incoming Spillovers	0.655	0.653	0.686	0.707	0.741	0.752**	0.698
Lack of Info	0.283	0.289	0.183**	0.160*	0.182**	0.150**	0.174**
Cost-Risk	0.223	0.224	0.2	0.235	0.236	0.225	0.198
Legal Protection	0.198	0.189	0.340**	0.405**	0.333**	0.408**	0.349**
Employees	461.5	240.1	3704.2*	507.8*	627.9*	7028.2*	4099.3*
R&D Intensity	0.012	0.011	0.021**	0.032**	0.020	0.020	0.158

** Difference in means between cooperating and non-cooperating firms significant at 5%.

Table 3: Results of Probit Preliminary Regressions

	(a)	(b)	(c)	(d)	(e)
Single Equation	Cooperation with	Cooperation with	Cooperation with	Cooperation with	Cooperation with
Probit Estimates	any organization	Universities	Competitors	Consulters	Suppliers or Customers
Incoming Spillovers	0.238**	0.258**	0.376***	0.408***	0.321***
	(0.094)	(0.117)	(0.124)	(0.127)	(0.105)
Legal Protection	0.409***	0.518***	0.335**	0.452***	0.457***
	(0.105)	(0.123)	(0.132)	(0.129)	(0.112)
Lack of Info	-0.308***	-0.406***	-0.277*	-0.452***	-0.292**
	(0.114)	(0.148)	(0.147)	(0.158)	(0.126)
Cost-Risk	0.175	0.294**	0.351**	0.328**	0.212*
	(0.118)	(0.137)	(0.141)	(0.143)	(0.127)
Industry Cooperation	7.875***				
	(1.472)				
Ind. Cooperation Univ.		11.569***			
		(2.210)			
Ind. Cooperation Comp.			13.530***		
			(2.386)		
Ind. Cooperation Cons.				13.197***	
				(2.395)	
Ind. Cooperation Vertical					10.494***
					(2.141)
Ind. Legal Protection	-1.409**	-1.479*	-1.904**	-1.501*	-1.269*
	(0.714)	(0.823)	(0.925)	(0.816)	(0.731)
R&D Intensity	1.267*	2.175***	1.114	1.171	1.225
	(0.728)	(0.739)	(0.944)	(0.908)	(0.771)
Size	-0.241**	-0.158	-0.238**	-0.316***	-0.213**
	(0.103)	(0.116)	(0.115)	(0.115)	(0.105)
Size squared	0.027***	0.017	0.028**	0.037***	0.023**
	(0.010)	(0.011)	(0.011)	(0.011)	(0.010)
Constant	-1.396***	-1.909***	-1.951***	-1.889***	-1.678***
	(0.310)	(0.323)	(0.329)	(0.330)	(0.297)
LL	-489.014	-314.526	-290.654	-288.947	-398.258
χ^2	85.35	90.07	72.96	87.42	71.61
N	1463	1463	1463	1463	1463

Standard errors in parenthesis, ***significant at 1%, **significant at 5%, *significant at 10% *

Table 4: Testing for Endogeneity, Results of 2SCML

Two Stages	(a)	(b)	(c)
Conditional ML	Cooperation	Cooperation	Cooperation
Incoming Spillovers	0.163**	0.163*	0.168*
	(0.098)	(0.098)	(0.098)
Lack of Info	-0.447**	-0.444***	-0.399***
	(0.176)	(0.157)	(0.169)
Cost-Risk	-0.023	-0.023	0.059
	(0.194)	(0.194)	(0.177)
Legal Protection	0.304**	0.305**	0.266**
	(0.122)	(0.120)	(0.177)
Industry Cooperation	7.623***	7.627***	6.916
	(1.579)	(1.576)	(1.409)
R&D Intensity	-4.362	-4.370	1.118
	(5.277)	(5.276)	(0.732)
Size	-0.293***	-0.293***	-0.243**
	(0.113)	(0.112)	(0.102)
Size squared	0.030***	0.030***	0.027***
	(0.010)	(0.010)	(0.010)
θ Incoming Spillovers	0.410**	0.410**	0.402**
	(0.192)	(0.192)	(0.192)
θ Appropiability	-0.995	-0.997	-0.590
	(0.807)	(0.806)	(0.711)
θ R&D Intensity	5.666	5.673	
	(5.403)	(5.402)	
θ Cost-Risk	0.026		0.042
	(0.625)		(0.623)
Constant	-0.571	-0.563	-1.125*
	(0.846)	(0.825)	(0.668)
LL	-488.252	-488.253	-488.831
χ^2	86.87	86.87	85.71
N	1463	1463	1463

Standard errors in parenthesis, ***significant at 1%, **significant at 5%, *significant at 10% *

Table 5: Results of CML with Instrumental Variables

	(a)	(b)	(c)	(d)	(e)
Instrumental Variables	Cooperation with	Cooperation with	Cooperation with	Cooperation with	Cooperation with
Probit Estimates	any organization	Universities	Competitors	Consulters	Suppliers or Customers
Incoming Spillovers	0.602**	1.000***	0.813**	1.056***	0.735***
	(0.273)	(0.260)	(0.318)	(0.282)	(0.285)
Legal Protection	0.306***	0.338***	0.197	0.292**	0.338***
	(1.340)	(0.123)	(0.133)	(0.128)	(0.115)
Lack of Info	-0.302***	-0.366***	-0.272*	-0.417***	-0.286**
	(0.114)	(0.142)	(0.145)	(0.154)	(0.125)
Cost-Risk	0.166	0.261**	0.328**	0.299**	0.201
	(0.116)	(0.131)	(0.139)	(0.138)	(0.125)
Industry Cooperation	6.448***				
	(1.340)				
Industry Cooperation Univ.		8.638***			
		(1.964)			
Ind. Cooperation Comp.			11.315***		
			(2.240)		
Ind. Cooperation Cons.				10.753***	
				(2.276)	
Ind. Cooperation Vertical					8.656***
					(2.021)
R&D Intensity	1.111	1.799**	1.061	0.802	1.042
	(0.720)	(0.722)	(0.897)	(0.884)	(0.766)
Size	-0.248**	-0.183*	-0.250**	-0.332***	-0.227**
	(0.100)	(0.110)	(0.112)	(0.111)	(0.104)
Size squared	0.027***	0.017	0.028***	0.037***	0.024**
	(0.010)	(0.011)	(0.011)	(0.011)	(0.010)
Constant	-1.590***	-2.152***	-2.218***	-2.158***	-1.886***
	(0.279)	(0.301)	(0.317)	(0.310)	(0.293)
LL	-1452.901	-1275.436	-1254.715	-1251.228	-1361.570
χ^2	81.51	108.30	71.50	95.85	70.80
N	1463	1463	1463	1463	1463

Standard errors in parenthesis, ***significant at 1%, **significant at 5%, *significant at 10%