TECHNOLOGY TRANSFER IN PUBLIC UNIVERSITY-INDUSTRY COOPERATION PROGRAMMES. PROPOSAL OF A MODEL BASED ON EMPIRICAL EVIDENCE.

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Abstract: Technology transfer has been defined as goal-orientated intentional interaction between two or more social entities during which the stock of technological knowledge remains stable or is increased through the transfer of one or more components of the technology. One of the recognised problems in the innovation and technology management in Spain is related to the transfer of technology and knowledge between university and industry. The challenges faced by public innovation policies are correlated to an improvement in the transfer of knowledge and technology from universities and research centres to industry; hence the fact that some European authors have emphasised the need to provide this activity with more visibility and prestige, being this one of the new directions of national and European Union technology policies. The objective of this paper is to contribute to the understanding of the underlying factors in the technology transfer process from universities to industry dealing with robotics and production technologies. It aims to provide answers to a number of questions related to success facilitating factors and barriers which hinder the transfer of technology and its ultimate impact on industry. Furthermore, the paper seeks to construct a model which will explain the differences between both transfer processes: those taking place in either an industry or a university context.

The methodology for this research is based on a survey carried out on a sample of public research organisations (universities and R&D centres) and firms participating in two types of projects. The first group corresponds to R&D projects funded by the Inter-ministerial Science and Technology Commission of Spain. These projects were coordinated by universities, with the participation of firms and R&D centres. Second group was composed of projects funded by the Centre for Industrial Technology Development (CDTI). These projects were coordinated by firms, with the participation of universities and R&D centres. The survey, which was completed by 250 organisations, covered a number of aspects related to the attitudes of the participant, questions related to the technology, the barriers encountered, the technology transfer mechanisms and the final impact of the programme.

As conclusions, differences between both groups are highlighted. For universities and R&D centres, the relevant variables are therefore the initial exploitation objectives, legal barriers, access to new knowledge, relevance of knowledge acquisition and fulfilment of these objectives. In other words, the aspects relating to knowledge are clear determinants in the project. For firms, the relevant variables are therefore the

initial industrial exploitation objectives, the relevance of knowledge acquisition objectives and the fulfilment of objectives related to innovation, the commercial exportation of results, the transfer of technology into patents and licences, engineering activities and risk sharing. In firms group, those aspects related to innovation and the exploitation and transfer of results are shown as determinants in the project. Finally, when considering the barriers or obstacles to fulfilling project objectives, it can be concluded that only the technological aspects are shown to be important and that there is no significant difference between the opinion of firms and universities.

1. INTRODUCTION

One of the recognised problems in the innovation and technology management of in Spain is related to the transfer of technology and knowledge between university and industry (Fundación Cotec, 2003). The challenges faced by public innovation policies are correlated to an improvement in the transfer of knowledge and technology from universities and research centres to industry; hence the fact that some European authors have emphasised the need to provide this activity with more visibility and prestige (Schmiemann and Durvy, 2003), being this one of the new directions of national and European Union technology policies (European Commission, 2002).

The objective of this paper is to contribute to the understanding of the underlying factors in the technology transfer process from universities to industry. It aims to provide answers to a number of questions related to success facilitating factors and barriers which hinder the transfer of technology and its ultimate impact on industry. Furthermore, the paper seeks to construct a model which will explain the differences between both transfer processes: those taking place in either an industry or a university context.

This paper has been presented in accordance with the following structure: firstly, it provides an analysis of the academic literature related to the transfer of technology from universities to firms, its current importance, the transfer process models which have been proposed and the factors which determine them. Next, the objectives and hypotheses of the paper are analysed in more detail, taking into account the variables to be analysed in the considered model. The methodology followed in the field work is described and following a discussion of the obtained results. The paper concludes with an explanation of the conclusions and recommendations related to public technology transfer support policies.

2. CONCEPTUAL FRAMEWORK

Technology transfer has been defined as "goal-orientated intentional interaction between two or more social entities during which the stock of technological knowledge remains stable or is increased through the transfer of one or more components of the technology" (Autio and Laamanen, 1995). Academic literature has dealt extensively with technology transfer in all concerned aspects. Bozeman (2000) suggested a contingent model of technology transfer efficiency which takes five aspects into account: the object to be transferred, the means of transfer, the recipient of the transfer, the transfer agent, the aspects related to the context and those factors related to market demand. Reisman (2005) proposed a holistic view of the transfer and suggested a taxonomy for his study in which four dimensions were highlighted: the actors, the type of transaction, the motivation and the disciplines involved.

Recently, the role of technology and knowledge transfer in regional competitiveness in the area of geographical influence of universities has been highlighted (Ronde and Hussler, 2005; Etzkowitz and Klofsten, 2005; Gunasekara, 2006; Mowery and Sampat, 2005; Mazzoleni, 2006; Cooke and Leydesdorff, 2006); in addition, its impact on a number of industries has also been reviewed (Matkin, 1990) as well as on technology innovation (Branscomb, 1993). The impact of technology transfer on the educational process itself was pointed out by Stephan (2001), the role of university culture in the transfer process through firms or entrepreneurship and the relevance of communication in the transfer process has also been emphasised, as well as factors related to relationships, trust, geographical proximity (Santoro and Gopalakrishnan, 2001), networks and informal relationships (Harmon et al, 1997). The issue of university entrepreneurialism, as a means of technology transfer, has also been analysed, becoming the subject of a new school of thought (Etzkowitz et al, 2001; Mowery and Shane 2002; Etzkowitz, 2004; Bercovitz and Feldmann, 2006), and it has become a measure of university efficiency in advanced countries thus giving rise to a new concept: the entrepreneurial university (Siegel et al, 2004).

With regard to cooperation between agents, Gorschek et al (2006) proposed a university/firm technology transfer model based on a research schedule made up of several phases: identifying potential areas of improvement based on the demands of the firm through a process of observation and evaluation; formulating problems to be solved by studying the theoretical framework; proposing solutions in collaboration with the firm; developing validation in the laboratory; carrying out dynamic validation at semi-industrial level; and setting up solutions gradually, thereby leaving the door open to additional changes and proposals. According to these authors, the work of the researcher is not simply carrying out research, but also attempting to make technology transfer happen. Along these lines, Lane (1999) suggested a conceptual model for the process defining the components and their relationships, and discussed how agents facilitate the process of transforming a technology into a new product.

The objectives of industries and universities in the process are an important aspect, such as the failure to establish reasonable objectives (Geisler and Rubenstain, 1989). Caloghirou et al (2001) analysed the support given to university/industry relations in the R&D Framework Programmes of the European Union and also noted the fact that the primary objective of firms is increasing their applied knowledge base, achieving synergies in research, making significant technological progress and sharing R&D costs. In general, it was noted that the main collaboration advantage for firms consists in increasing their applied knowledge base and achieving improvements in their production processes.

Two basic factors have also been noted in the United States in the current discussion on university/industry technology transfer (Lee, 1996). One is the perception of the decline in federal aid for R&D, which threatens the dynamism of research activity. The other is the alternative impact of university/industry cooperation, which may interfere with academic freedom to select their long-term research field. However, other authors have emphasised that it is not only the legal aspects which have helped to increase university/industry technological relations, but above all the fact that universities have begun to develop more attractive research which is closer to firm´s interests (Colyvas et al, 2002).

The importance of organisational aspects in technology transfer has also been emphasised by authors such as Siegel et al (2003), who drew attention to the systems of

compensation for professors, the practices of the TTOs (Technology Transfer Offices) and the cultural barriers between universities and industry, or by Bercovitz et al (2001), who dealt with organisational structure. Other authors have focused on the quality of research teams, leadership, planning and their motivation (Rogers et al, 2001; Meseri and Maital, 2001).

The technology itself has been studied from a contingent perspective of its transfer. The most well-known school is that led by Stock and Tatikonda (2000, 2003) who considered a model of interrelationship between the aspects relating technology and organisation. The complexity of technology (Singh, 1997) and its radical or incremental nature will have an influence on the organisational capacities required for its transfer (Hannan and Freeman, 1984). Along these lines, Shane (2001a, 2001b) found four critical dimensions in the process: observability, the tacit aspects of associated knowledge, the age of the existing technology and the effectiveness of patents.

This technology transfer contingent approach has also been considered by Kremic (2003) when comparing technology transfer by government agencies versus corporate firms. For this author, in a contextual approach, actor's motivation, commitment and transference methods are contingent with a successful technology transfer. International contexts have been also considered by other authors such as Teece (1981) bearing in mind the role of multinational corporations, and other, such as Buckley (1997), that of SMEs. Reddy and Zao (1990) reviewed international technology transfer literature and propose a contingent model in line with key elements such as transferring countries and transaction components. Glass and Saggi (1998) insist on the idea of technology transfer by multinationals and technology spillover through absorbed technology.

The barriers and difficulties in the process have been extensively dealt with. Hall et al (2001) thus noted those inherent in the management of industrial property and those relating the sometimes divergent objectives of both. Greiner and Franza (2003) emphasised the fact that some barriers and facilitators are specific to the technology being considered, whilst many of them, such as the difficulty in defining the end user and the need to demonstrate the technologies to the end users, lie in the transfer of other technologies. For their part, Walker and Ellis (2000) pointed to the cultural and organisational divergence between the transferring entities, as well as the complexity of the technology and the management of the project, as fundamental barriers. These same authors suggested the following technology transfer facilitators: the relationships between the organisations, the early involvement of users, a mutual understanding of the objectives, the technological capacity of the end users, the existence of leadership and the impact of tacit knowledge.

The problems associated with the technology transfer offices and their policies have also been dealt with by various authors. Siegel et al (2004) and Chapple et al (2005) analysed the results in the United States. Anderson (2007) has studied and proposed measurements of their efficiency. Mixed research centres as links between firms and universities have also earned the attention of researchers (Adams et al, 2001).

Finally, public policies have been developed for the promotion of technology transfer. In this field, Bozeman (2000) proposed three paradigms: the policy of innovation promotion aimed at compensating for market deficiencies, the paradigms of the mission of technology and those of technological cooperation. Other authors (Lee, 2002) have dealt with the importance of these public policies in relation to infrastructure, financing, legislation and promotion of university/company alliances. The new "social

contract" between government and research universities has also been considered, as well as its relationship with education (Branscomb, 1993).

3. RESEARCH OBJECTIVES. ISSUES AND PROBLEMS TO BE RESOLVED

According to the report of the Knowledge and Development Foundation (CYD, 2006), only 7.5% of the R&D undertaken in Spanish universities is financed by means of private business capital, compared to 13% in Germany and 9% in the United Kingdom. The situation is different in the United States as direct industry financing represents 5.1%, financing from non-profit organisations (charities) 7,3% and that received from the universities themselves 19.3 % (National Science Foundation, 2007). The same CYD report (2006) pointed out that in 2004 only 3.5% of Spanish innovative firms (representing 31.4% of all Spanish firms) cooperated in innovation with universities. The data related to R+D contracts developed by the Network of University/ Industry Non Profit Organizations (3.519 contracts with a value of 73.3 million Euros, of which only 44% were related to pure R&D), as well as that reported by the network of TTOs is also not very promising. Considering the deficiencies shown by the above data, this paper will address the analysis of variables which are critical in the technology transfer process from university to industry, and identifying the process barriers and facilitators within the framework of the projects offering public support for cooperative research.

Considering a framework of technology development cooperation projects, the hypotheses to be tested are the influence of a number of process variables which in the final achievement for utilisation of project results. These will have to be validated as to whether the initial hypothesis where all variables have a relevant weight for both of the context groups analysed (universities and firms) and whether there are any divergences, in a transfer model, between the influences of these variables for both groups. Table 1 thus considers the variables to be analysed and the aforementioned academic references.

Table 1 – Description of variables

Variable	References
Cooperation aspects	Adams et al, 2001.
Activities	Gorschek et al 2002.
Technology	Stock y Tatikonda, 2000, 2003; Singh, 1997; Hannan y Freeman, 1984; Shane, 2001;.
Organization	O´Shea et al, 2005; Santoro, 2001, Harmon et al, 1998; Harmon et al, 1998; Gorschek et al 2002; Lane 1999; Siegel et al, 2003; Bercovitz et al, 2001.
Objectives & Relevance Objectives Completion	Gisler y Rubenstain, 1989; Caloghirou et al, 2001; Anderson, 2007; Meseri and Maital, 2001; Rahm, 1995.
Markets, Export	Glass and Saggi, 1998; Stock and Tatikonda, 2000; Reddy and Zhao, 1990; Teece, 1981; Buckley, 1997.
TT mechanisms	Morgan et al, 2001; Link y Scott, 2001; Shane, 2002; Thursby et al, 2001; Meyer, 2006.
Reasons to participate, motivation	Lee, 1996; Colyvas et al, 2002; Rogers et al, 2003; Meseri y Maital, 2001.
Barriers	Hall et al, 2001; Greiner, 2003; Walker y Ellis, 2000; Chapple et al, 2005; Anderson, 2007; Adams et al, 2001; Link and Scott, 2001.
Context	Kremic, 2003; Multinational contexts: SME context: Buckley, 1997; Stock and Tatikonda, 2000, etc.

4. FIELDWORK METHODOLOGY

4.1. Introduction

The methodology for this research is based on a survey carried out on a sample of public research organisations (universities and research centres) and firms participating in two types of projects dealing with robotics and production technologies. The first group corresponds to R&D projects funded by the Interministerial Science and Technology Commission (CICYT) of Spain, the executive body for the planning, coordination and monitoring of the National Plan for Scientific Research, Development and Technological Innovation (R&D). These projects were coordinated by universities, though with the participation of firms and technology research centres The second group was composed of projects funded by the Centre for Industrial Technology Development (CDTI), an organization of the Spanish Ministry of Industry and whose objective is to promote innovation and the technology development in Spanish firms. These projects were coordinated by firms, though with the participation of universities and technology research centres.

The public support was different for each group of projects. In the first case it consisted of funding, which completely or partially covered the research activity. In the second case it consisted of a free interest and long term loan. In addition most had subsidies covering the contracts of the participating public research centre.

The survey, which was completed by 250 organisations, covered a number of aspects related to the attitudes of the participant, questions related to the technology, the barriers encountered, the technology transfer mechanisms and the final impact of the programme.

4.2. Population and sample

The database used was that of the CICYT and CDTI projects developed during the period 1996-2004. The composition of the population and sample was as follows:

- Universities (CICYT projects): number of projects: 880; responses obtained: 87 (9.9%); sampling error: 1.96% with a confidence interval of 95%.

- Firms (CDTI projects): number of projects: 1303; responses obtained: 142 (10.9%); sampling error: 1.73% with confidence interval of 95%.

4.3. Procedure and survey

The survey was sent to the project coordinators from September - October 2006. Simultaneously, a telephone follow-up of the survey was carried out. Interviews were also held with various firms and university teams in order to obtain complement the survey results. The questions used in the survey have been summarized below.

- Question 1 - *Participation, number of participants and evaluation*. In this section the purpose was classifying the projects according to the category and relevance of the cooperation level, as well as quantifying the level of cooperation according to the number of participants.

- Question 2 - *Nature of the activities*. This question refers to the type of activities which were developed in the project: basic research, technology development, engineering, end user, etc (dichotomous responses from 0 to 1).

- Question 3 - *Technological aspects of the project.* Here the intention was obtaining information on the technology and its characteristics in relation to technology and organisational complexity and risk (scale of responses from 1 to 5).

- Question 4a - *Relevance of project objectives.* This question refers to aspects of the various project objectives and their relevance for the interviewee: new product developments, existing product improvement, new process development, improvement of existing processes, demonstrators, pilot plants, knowledge acquisition, work management improvement, access to new markets, new industrial plants and commercial cooperation agreements.

- Question 4b - *Accomplishment of project objectives.* The interviewee was questioned about the degree of accomplishment of the objectives analysed above.

- Question 5a - *Objectives related to final industrial utilisation of results.* The final objectives considered by the R&D project, in relation to the developed technology, represent a relevant variable. The intention was to investigate the ultimate objectives of the project, such as industrial exploitation, internal or external utilisation or joint commercialisation.

- Question 5b - *Final industrial utilisation of the results.* Here the interviewee was questioned about the degree of accomplishment of these objectives (rated from 1 to 5).

- Question 6 - *Markets where the results were exploited.* The interviewees were asked where the results were commercialised, national, European, Latin America, North America or other markets. Responses are dichotomous as well as in percentage terms.

- Question 7 - *Technology transfer mechanisms.* This question sought to identify the technology transfer mechanisms through patents, technology transfer agreements, new firm's creation, technological alliances, production licences or commercialisation agreements (dichotomous variable).

- Question 8 - *Reasons for participation.* Irrespective of the project objectives, interviewees were asked to identify the reasons for participating in a project supported by a public R&D programme: access to financing, to new markets, to new knowledge, sharing costs, reducing risks, prestige or image (scale of responses from 1 to 5).

- Question 9 - *Obstacles.* The aim was to identify the obstacles encountered by the participants in the development of the project: technical, market changes, partner withdrawal, divergence between partners, communication problems, consortium management, lack of external financing and lack of synchronisation in financing (scale of responses from 1 to 5).

5. RESULTS OBTAINED

5.1. Cooperative aspects

In the case of the university and research centres group, 52.7% of the projects were cooperative, whilst in the case of firms this figure was only 13.1% (Table 2). However, universities essentially cooperate with other universities (65) and research centres (19), with very little cooperation with firms (9). In relation to firms, these

essentially cooperated with other firms (21), with very little cooperation with universities (9) and research centres (7) (Table 3).

Table 2 - Type of participation

	Individual	%	Cooperative	%
	Participation				
Universities	42	48.3	45	52.7
Firms	119	86.9	18	13.1

Table 3 - Level of cooperation

	Firms					Universities				
	0	1	2	3	4	0	1	2	3	4
Universities	79	7	1	0	0	48	33	14	5	2
Firms	121	13	2	0	1	128	16	0	0	0

Note: 0 indicates a lack of response.

5.2. Descriptive analysis

The analysis of the means differences between both groups has shown the following results:

- *Evaluation of the project.* Universities fundamentally evaluate the project as research ($\bar{x} = 0.954$) and to a lesser extend as technological development ($\bar{x} = 0.552$). Firms award research a lower rating ($\bar{x} = 0.387$), jointly with engineering ($\bar{x} = 0.307$), whilst they define the activity as technology development with a higher rating ($\bar{x} = 0.883$).

- *Technology evaluation.* The evaluation of technology is also diverse. For firms, both novelty ($\bar{x} = 4.044$) and the organisational effort of the project ($\bar{x} = 4.073$) are high, whilst the level of risk ($\bar{x} = 3.445$) is medium. For universities, novelty ($\bar{x} = 4.322$) is more important, unlike the level of risk ($\bar{x} = 3.092$) and the organisational effort ($\bar{x} = 3.360$).

- *Relevance of the project objectives.* There is a major difference between both groups in relation to the development of new products: firms ($\bar{x} = 3.832$) and universities ($\bar{x} = 3.172$); though the mean difference does not appear to be significant from a statistical point of view. Firms have objectives related to improvement whereas the universities' objectives relate to demonstrators (enabling them to publish), within the low values observed.

  The low points awarded to processes' improvement are particularly significant. The points awarded to search for agreements are, in general low, particularly for firms. This would be surprising unless we consider the fact that universities look forward to form alliances for new projects[1].

  If we analyse the project objectives in two groups of composite variables, for both objectives related to improvement of knowledge assets (RELOBJCONOC; α=0.670), and those related to innovation (RELOBJINNOV; α=0.690), the

[1] As it was pointed out in the interviews.

means of the firms are higher. However, it should be emphasised that the single variable RCONOC (knowledge acquisition) a much higher means difference can be observed in universities ($\bar{x} = 4.287$) in comparison with firms ($\bar{x} = 3.883$); and it is statistically significant (p<0.001).

- *Accomplishment of project objectives.* If the accomplishment of general objectives is analysed, the replies show, in general, low levels, with a mean rating of approximately 3 with high standard deviation measurements. In general, universities score lower than firms, except in relation to demonstrators where they score above firms ($\bar{x} = 3.253$ compared to $\bar{x} = 2.781$) and in knowledge acquisition, where they score above firms ($\bar{x} = 4.299$ compared to $\bar{x} = 3.650$). The differences are significant in all the variables except for the development of new products and the improvement of processes.

  If we consider the objectives in two groups of composite variables, in both, the objectives related to improvement of practical knowledge (CUMPLOBJCONOC; α=0.720), and those related to innovation (CUMPLOBJINNOV; α=0.715), the means of firm's scores are higher, pointing out a greater commitment to the achievement of these objectives.

- *Initial objectives for industrial exploitation of the project results.* If the initial industrial utilisation or commercialisation objectives are analysed, in a way which is congruent with the above, the firms always score higher than the universities. The only exception is foreign exploitation, which is low for all the groups and there are no significantly mean differences. The composite variable OBJEXPLOT shows higher values for firms as compared to universities, and the mean differences are also significant.

  When the accomplishment of exploitation objectives is analysed, the three variables (internal, external and joint exploitation) have higher values in the case of firms, although the means differences in the external case is not significant. The mean of the composite variable for total exploitation (CUMPLEXPLOT; α=0.695) is 6.781 for firms and 5.034 for universities, and statistically significant (p<0.001).

- *Markets for exploitation of project results.* The national exploitation variable is clearly higher in the case of firms, with p<0.001. The composite variable exploitation with export is also higher in the case of firms ($\bar{x} = 0.978$ compared to $\bar{x} = 0.115$), with p<0.05. Nevertheless, the percentages are low in both cases. For their part, the technology from university projects was exported to foreign markets in less than 10% of cases. For the firms this percentage is 50%.

- *Project technology transfer mechanisms.* The results obtained are rather scarce, as only 51 of the total number of projects (23%) have resulted in patents (11% in the case of universities and 12% for firms), with no significant difference between both groups. In the other categories there are significant differences between both groups, with technology alliances being the most relevant, in 25% of the cases for universities. The figure for the firms was only 8.75% (Table 4).

Table 4 - Technology transfer mechanisms

	PATENT		ACESION		CNEMP		TECH. ALLIANCES		LICENCE		ACOM	
	0	1	0	1	0	1	0	1	0	1	0	1
Universities	75	12	80	7	87		65	22	84	3	84	3
Firms	98	39	129	8	126	11	125	12	132	5	116	21
Total	173	51	209	15	213	11	190	34	216	8	200	24

- *Reasons for project participation.* For universities, the reasons for project participation are basically access to financing ($\bar{x} = 4.161$ compared to $\bar{x} = 3.489$ in firms) and access to new knowledge ($\bar{x} = 4.506$ compared to $\bar{x} = 3.723$ in firms). For firms, the reasons are access to new markets ($\bar{x} = 3.453$ compared to $\bar{x} = 1.322$ in universities), prestige and image ($\bar{x} = 3.241$ compared to $\bar{x} = 1.770$ in universities) and risk avoidance, with very low ratings in general ($\bar{x} = 2.672$ compared to $\bar{x} = 1.207$ in universities).

- *Barriers or obstacles to accomplish the project objectives.* Only the technology aspects appear as relevant, with an average rating of 3.790, and with no significant difference between the firms and universities. The other factors rated very low scores (below 1), meaning they were not considered relevant. However, there is a significant mean difference in all aspects except for project financing. Unlike universities, firms point out changes in the market as the most relevant topic.

5.3. Multivariate analysis

In order to identify which variables are critical and, subsequently, establishing a model a factor analysis has been carried out on both populations: universities and research centres, and firms.

Universities and research centres

A factor analysis points out to the combination of four components explaining 80.18% of the sample variance. The four basic components are:

C1 = f (CUMPLOBCONOC, RELOBJCONOC, BARRLEGA, BARRFINANC, BARRORG, COMPLORG);

C2 = f (CUMPLOBINNOV, RELOBINNOV);

C3 = f (CUMPLEXPLOT, OBJEXPLOT);

C4 = f (COMPLTEC, COMPLORG)

The first (C1) relates to knowledge and project obstacles; the second (C2) relates to relevance and accomplishment of innovation objectives; the third (C3) relates to relevance and accomplishment of exploitation objectives; and the fourth (C4) relates to technology and organizational complexity (Table 5).

A regression model has been developed to explain accomplishment of exploitation objectives. The resulting function for the group of universities is as follows (Table 6):

CUMPLEXPLOT = f (constant, OBJEXPLOT, BARRLEGA, ACCONOC, RELOBCONOC, CUMPLOBJCONOC);

$$R^2 = 0.881; \quad p < 0.001$$

Table 5 - Factor analysis of universities and research centres

The relevant variables are therefore the initial exploitation objectives, legal barriers, access to new knowledge, relevance of knowledge's acquisition and fulfilment these objectives. In other words, in this group the aspects relating to knowledge are clear determinants in the project.

Table 6 - Significance of the variables

Variable	P <
(Constant)	0,05
OBJEXPLOT	0,001
BARRLEGA	0,001
ACCONOC	0,001
RELOBCONOC	0,001
CUMPLOBJCONOC	0,001

Firms

The factor analysis concludes with four basic components and their combination explains 82.53% of the sample variance. The four basic components are:

C1= f (RELOBJCONOC, CUMPLOBCONOC, CUMPLOBINNOV, RELOBINNOV);

C2 = f (TIPOPART, NEMPCOOP);

C3 = f (BARRLEGA, BARRORG);

C4 = f (CTRISK)

The first (C1) relates to knowledge (relevance of the objectives related to knowledge and its fulfilment, as well as relevance and fulfilment of innovation objectives). The second (C2) relates to the type of participation (individual or collective) and the number of cooperating firms. The third (C3) relates to legal and organisational barriers and the fourth (C4) relates to risk sharing advantages (Table 7).

A regression model has been developed to explain the accomplishment of the result utilisation objectives. The resulting function in the population of firms is the following (Table 8):

CUMPLEXPLOT = f (cte, OBJEXPLOT, CUMPLOBJINNOV, RELOBINNOV, EXPORT, TTPAT, ACING, CTERISK);

$$R^2 = 0.765; p<0.0001.$$

Table 7 - Factor analysis of firms

Rotated Component Matrix^a

	Component			
	1	2	3	4
TIPOPART		,922		
NEMPCOOP		,954		
RELOBCONOC	,855			
CUMPLOBJINNOV	,817			
CUMPLOBJCONOC	,888			
CTERISK				,989
BARRORG			,874	
BARRLEGA			,920	
RELOBINNOV	,813			

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,530
Bartlett's Test of Sphericity	Approx. Chi-Square	603,903
	df	36
	Sig.	,000

Table 8 - Significance of the variables

Variables	P <
(Constant)	0,08265
OBJEXPLOT	0,00000
CUMPLOBJINNOV	0,00000
RELOBINNOV	0,00000
EXPORT	0,00001
TTPAT	0,00183
ACING	0,00032
CTERISK	0,00342

The relevant variables are therefore the initial industrial exploitation objectives, the relevance of knowledge acquisition objectives and the fulfilment of objectives related to innovation, the commercial exportation of results, the transfer of technology into patents and licences, engineering activities and risk sharing as reasons for participating. It can be observed that, in the firms group, those aspects related to innovation and the exploitation and transfer of results are shown as determinants in the project.

5. CONCLUSIONS

Despite the fact that a significant percentage of the projects (26.16%) are cooperative, the responses indicate that participants do not have a feeling of participation in this sense, except in the case of firms and with minimum ratings. The mutual evaluation of the role of universities and firms is very low; indicating that the distance between both groups is significant, thus, representing a major barrier to technological development. Universities value their collaboration with other universities but not with a particularly high score. Universities and firms interviewed pointed out that, in these programmes, cooperation is not valued as a decisive element in the granting of the financial support.

The universities see the project fundamentally as research activity and, to a lesser degree, as technology development. However, the evaluation of firms is quite opposite,

and is complemented by the significant value given to engineering. The firms value both novelty and organisational effort of the project, whilst the universities value novelty but not organisational effort. From the responses it can be deduced that the risk of the projects undertaken is rather low in both groups.

Other differences between both groups are also highlighted: development of new products is relatively important for firms (from which it can be inferred that they are developing incremental innovation projects) whilst for the universities this aspect is not important. Firms have objectives related to improvement, whereas universities' objectives relate to demonstrators (enabling them to publish), within the low values observed. The level of importance given to the improvement of processes is particularly significant, and is surprising given the low level of innovation in processes shown by the Spanish innovation surveys. The level of objectives related to pursuing agreements is in general low, but particularly for firms, which would be surprising if we did not consider the fact that the universities look to form alliances for new projects. The resistance to cooperation again appears, and was also highlighted in the Spanish innovation surveys.

The self-evaluation of the interviewees points out a low level of accomplishment of project objectives. In general, the universities score at lower levels than firms, except in relation to demonstrators and new knowledge acquisition, where they point above firms. However, the average scores of firms are higher, pointing to a slightly greater commitment to the achievement of these objectives.

If the initial industrial exploitation or commercialisation objectives are analysed, results are congruent with the above, firms always scoring higher than universities, the only exception being foreign exploitation, low for both groups. As surveys and technology innovation data suggest, there is no great inclination to export technology.

The results are low considering the use of technology transfer mechanisms. Only 51 of the projects (23%) have resulted in patents (11% in the case of universities and 12% for firms), with no significant difference between both groups. The other categories do show significant differences between both groups, with technology alliances being the most important and used most extensively by the universities.

In relation to the reasons for participation in the projects, universities value, basically, access to project financing and access to new knowledge acquisition. For their part, the firms place a greater value on access to new markets and prestige and image reasons. Risk avoidance in general has very low scores, which is logical if it is taken into account that the projects are not considered to have a risk aspect.

Finally, when considering the barriers or obstacles to fulfilling project objectives, it can be concluded that only the technological aspects are shown to be important and that there is no significant difference between the opinion of firms and universities. The rest of the factors rated obtain very low scores.

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