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Industry-university interactions in Valencia, a peripheral european region

Interacciones Universidad-Industria en Valencia, una región periférica europea

Adela García-Aracil*, Ignacio Fernández de Lucio**, Antonio Gutiérrez Gracia*** y Elena de Castro Martínez****

Contenido

ABSTRACT
The relationship between I-U collaboration and diverse firm-characteristic related for a peripheral European sample, the Spanish Mediterranean region of Valencia, of manufacturing firms was analyzed by the performance within firms of R&D activities. Discrete choice models were estimated using as explanatory variables managers' educational level, managers opinions about the assessment of several motivations for collaborating with universities and interactive activities most preferred. In general, we have found a strong impact of educational variables, the match between large-sized firms and high technology with I-U collaboration, and the mismatch between R&D with I-U collaboration.

RESUMEN
El objeto de esta investigación es estudiar las relaciones de colaboración Universidad-Industria (U-I) en una muestra conformada por empresas manufactureras de la región mediterranea de Valencia, España. La muestra fue analizadaa partir del desempeño de sus actividades de I&D. Se estimaron modelos discretos de elección utilizando como variables explicativas, el nivel educativo de los gerentes y sus opiniones acerca de las motivaciones para la colaboración con las universidades y cuales son las actividades interactivas de su preferencia. En general, hemos encontrado un fuerte impacto de las variables educativas; relación entre el temaño de las empresas, uso de alta tecnología y colaboración U-I; y una menor relación entre I&D con colaboración U-I.

1. Introduction

Intense global competition, rapid technological change and shorter product life cycles have transformed the current competitive environment (Prahalad, 1998; Ali, 1994). Consequently, there are increased pressures on firms to continually advance knowledge and new technologies in order to ensure long-term prosperity and survival (Ali, 1994; Steele, 1989). While past practices favored

internal initiatives, it is increasingly more difficult for firms to rely exclusively on in-house activities due to limited expertise and resources (Hamel and Prahalad, 1994; Pisano 1990).

Firms can acquire knowledge and technology from many external sources. These sources include competing firms, research organizations, government laboratories, industry research associations, and universities (Mora, 1999; García-Aracil et al., 2003). Universities are unique in terms of their potential. Not only can a firm obtain knowledge and technology, but it can also recruit graduates and faculty to serve as employees and consultants. While much of the inter-organizational literature focuses on the collaboration between two or more industrial firms, we concentrate on industrial firm and university collaboration. Industry-university (I-U) alliances represent an evolving trend for advancing knowledge and new technologies (Okubo and Sjoberg, 2000; Cohen et al, 1998).

1.1. Background

Industry-university relationships have a long history (Bower, 1993). Today, there continue to be compelling reasons for industrial firms and universities to work together. Benefits to a firm include access to highly trained students, facilities, and faculty as well as an enhanced image when collaborating with a prominent academic institution. Universities interact with industry for additional funds, particularly for research (NSB, 2000). Universities also want to expose students and faculty to practical problems, create employment opportunities for their graduates, and gain access to applied technological areas (NSB, 2000). As a result of the complementary nature of I-U relationships, some of these collaborative activities have been instrumental in helping firms advance knowledge and propel new technologies in many areas, e.g, biotechnology (Pisano, 1990), pharmaceuticals (van Rossum and Cabo, 1995) and manufacturing (Frye, 1993).

In recent years, the focus of the most of the studies on industry-university interactions has been based on detailed analysis of industry-science links in narrowly defined fields of research and technology (Meyer-Krahmer and Schmoch, 1998), on the aggregate effect of university research on knowledge production in firms (Varga, 2000; Anselin et al., 1997), or on certain types of knowledge interactions such as citations of university research in firm patents (Jaffe et al., 1993), personnel mobility (Bania et al., 1992; Hicks, 2000), formal an informal personal interactions, cooperative education, curriculum development, recruitment of recent university graduates and employing student interns, cooperative education programs, personnel exchanges (Reams, 1986), joint publications (Hicks, 2000), I-U research consortia, trade associations, the co-authoring of research papers by university and industrial firm members (NSB, 2000) and spin-off formations of new firms by university members (OECD, 2000). Furthermore, industry-university relations have been examined in the context of technology transfer with a strong focus on the use and its effects of new technology from universities (i.e. patents, prototypes) by firms (Bozeman, 2000). All of them are interesting examples of efforts to understand which interactive activities are more popular for addressing immediate industry problems.

Firms have a variety of motivations for collaboration with university research center. For example, large firms often pursue risky initiatives outside their current technological domain simply because they have financial strength to do so (NSB, 2000; Rosner, 1968). Large firms work with universities on industry-wide, pre-competitive issues related to a broad range of leading-edge technologies, many of which are unrelated to the firm's core business (Rea et al., 1997). Relationships with universities are used by these firms to strengthen skills, knowledge, and gain access to university facilities in order to advance a broad range of knowledge bases useful in non-core technological areas. Since knowledge transfer and research relationship are more suited for working on wide-ranging knowledge in a variety of technological areas, it follows that large industrial firms interested in non-core areas would concentrate their efforts in knowledge transfer and research support relationships. Since large firms use I-U relationships to bolster their work on technologies not central to their core business, these firms are less likely to engage in cooperative research and technology transfer activities since these relationships are better suited for pursuing core technological initiatives.

The channels used for transferring knowledge and technology depend on the characteristics of knowledge, such as the degree of codification, the tacitness or the embeddedness in technological artifacts. The potential economic value of knowledge affects the way, knowledge is exchanged between actors, too, demanding for knowledge interactions, which ensure secrecy, increase trust between actors and allow for exclusive appropriation of knowledge (Saviotti, 1998). Certain I-U relationship activities incorporate and demand specific technical knowledge from the technical cores of both organizations. For example, technology transfer happens through a dense network of individual ties between university scientists and engineers and industrial firm R&D personnel (Oliver and Liebeskind, 1998). Much research in organization theory has demonstrated that organization structure is closely linked to firm size and plays a role in a firm's ability to adapt to the environment, create and assimilate knowledge, and be innovative (Burns and Stalker, 1961). Organizational structure is also a consequential factor that directly impacts dynamic firm capabilities (Teece et al., 1997). As such, an organization's structure affects both knowledge and technology transfer since knowledge and/or technology transfer involves identifying the appropriate sources, interacting with those source, acquiring the knowledge and/or technology, and integrating them into existing organizational systems and procedures (Zmud, 1982). Thus, a critical success factor in interactive activities depends on the firm's ability to accurately understand, interpret, evaluate, and absorb specific knowledge and technologies (Cohen and Levinthal, 1990).

1.2. Research questions

All the mentioned studies have dealt with data from industry-university linkage in the United States, Canada and Europe marked with intense interaction between high-technology industries and university research centers. However, in this paper, data was taken from a representative survey from a peripheral Spanish region: Valencia. The analysis of I-U on a regional level has received growing attention in the last few years (Varga, 1998). The analysis of the I-U interaction was based on data from 700 manufacturing firms surveyed in 2001. The data was obtained through a standardized survey named 'Encuesta a la Comunidad Empresarial Valenciana sobre las relaciones universidad-empresa' carried out by Valencian government institutions.

The survey addressed the industry-university relationship considering the different I-U linkages, the motives for collaboration, a variety of interactive activities as well as the formality and difficult on the agreements covered by firms and universities, and the role of the government in those commitments. Questions on general characteristics of the firm such as size, organization structure, technological characteristics, as well as the performance of R&D activities and industrial innovation processes in terms of new products or cost reduction were raised in order to determine the extent to which these factors might explain varying R&D performance and differing collaboration paths of firms.

Briefly, this research tries to answer the following questions:

- Which factors contribute significantly to the industry-university interaction?
- Which firms' motivations for collaborating with university constitute the most obvious explanation for the I-U interactions?
- Are there other variables such as managers' level of education, technological characteristics or interactive activities that have major effects on I-U interactions?

The paper is organized as follows: section 2 presents a descriptive analysis; section 3 covers empirical model and presents the empirical findings. Finally section 4 provides a summary and conclusions.

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2. Descriptive Analysis

2.1. The context

Valencia the third largest city in Spain, on the Mediterranean, is an active industrial and commercial center producing textiles, metal products, chemicals, automobiles, furniture, toys, and colored tiles. Within the Spanish context, it belongs to the country's main industrial centers, among which can be found regions like Madrid, Catalonia or the Bask Country. In socioeconomic terms, it could be considered as a peripheral region in the context of the European Union. Despite this, its position in terms of participation in national and European research programs is relatively low, especially when compared to the regions of Madrid and Catalonia.

The Valencia economy is based on a number of small and medium-sized firm structures, 67 percent of the industrial companies have less than 6 employees and 22 percent between 6 and 19 employees (INE, 2002). The Valencia level of R&D spending is even lower than the already low Spanish level, 0.6 and 0.9 percent of GNP, respectively (INE, 2002). At the same time, the Valencia economy is based on a number of traditional industrial sector, but lacks of science-based industries (for example, telecommunications) where their owners lacking modern business education or research traditions.

To analyze the impact of these region's characteristics on industry-university interactions and R&D activities, data, for that purpose, were collected from 700 manufacturing firms surveyed in 2001, broken down between those belonging in sector activity from 15 to 36 NACE code and 64.2 sector activity (telecommunications). The response rate to the questionnaire was 38 percent. This may be taken as an indicator of the weak interest taking in the questions addressed by the Valencia firms. As we can observe in Table 1, 11.00 percent of the responding firms collaborated with one or more university and 22.71 percent performed R&D. However, 510 firms both did not cooperate with universities and did not perform R&D.

Table 1
Participation rate

I-U Collaboration	Perform R & D		
	No	Yes	Total
No	510	113	623
	81.86	18.14	100.00
	94.27	71.07	89.00
Yes	31	46	77
	40.26	59.74	100.00
	5.73	28.93	11.00
Total	541	159	700
	77.29	22.71	100.00
	100.00	100.00	100.00

Source: Encuesta a la Comunidad Empresarial Valenciana sobre las relaciones universidad-empresa.

2.2. Descriptive analysis by technological linkages

For our analysis, based on the Pavitt's (1984) taxonomy and theory about technological linkages among different categories of firm, we aggregated the firms into five different groups: supplier dominated firms, scale-intensive firms, specialized equipment suppliers, science-based firms and information-intensive firms. Table 2 shows the percentage of firms in our sample by industrial sectors. Altogether, this percentage was the highest for firms considered as supplier dominated firms 51.57 percent. Specialized equipment suppliers accounted for the next largest group of 21.71 percent. Scale-intensive firms came next with 15.00 percent of firms and science-based firms with 9.29 percent. In contrast, the proportion of informative-intensive firms was relatively low, 2.43 percent.

Differentiation according to the performance of I-U collaboration is also shown in Table 2. Higher proportion of firms classified as supplier dominated firms and specialized equipment suppliers did not collaborate with any university, 54.25 and 22.95 percent, respectively. The opposite occurred in those classified as information-intensive firms, science-based firms and scale-intensive firms. The same pattern was found in those that engaged in R&D activities.
Based on the assumption about the importance of the firm capabilities, in particular, how managers coordinate and integrate activities within the firm to best utilize and enhance the knowledge and technology, information about the managers' level of education is also presented on an ordered scale ranking from 1 (primary level) to 5 (higher education degree): main manager, product manager, R&D manager, administrative manager and other chief executive. Table 2 shows a positive relationship between managers' level of education and R&D activities. The higher managers' level of education, the more likely to engage R&D activities.

Table 2
Percentages of firms by industrial sectors

Industrial sectors	% Distribution	Perform I-U Collaboration		Perform R&D		Average managers level of education	
		Yes	No	Yes	No	Yes R& D	No R& D
Supplier dominated firms	51.57	29.87	54.25	42.03	55.58	3.60	3.23
Scale-intensive firms	15.00	32.47	12.84	19.32	13.18	4.03	3.61
Specialized equipment suppliers	21.71	11.69	22.95	15.94	24.14	4.13	3.36
Science-based firms	9.29	20.78	7.87	19.81	4.87	4.39	3.71
Information-intensive firms	2.43	5.19	2.09	2.90	2.23	4.83	3.45
Total	100.00	100.00	100.00	100.00	100.00	3.96	3.33

Source: Encuesta a la Comunidad Empresarial Valenciana sobre las relaciones universidad-empresa.

2.3. Descriptive analysis by firm size

The same indicators as above were analyzed according to firm size (Table 3). This variable was measured by the number of employees within the firm. Micro firms were those having 10 employees; small firms those having from 11 to 50 employees; medium from 51 to 250 employees, and large those having more than 250 employees. Table 3 shows 70.43 percent of the Valencian firms were small and medium firms accounted for the next largest group of 18.00 percent. It is also observed a positive relationship between firm size and the performance of I-U collaboration, R&D activities and managers' level of education, for example, the higher-sized firm, the more likely to involve in I-U collaboration.

Table 3
Percentages of firms by firm size

Industrial sectors	% Distribution	Perform I-U Collaboration		Perform R&D		Average managers level of education	
		Yes	No	Yes	No	Yes R& D	No R& D
Micro	8.43	0.00	9.47	1.45	11.36	n.a.	3.05
Small	70.43	41.56	74.00	58.94	75.25	3.70	3.25
Medium	18.00	45.45	14.61	31.88	12.17	4.35	4.05
Large	3.14	12.99	1.93	7.73	1.22	4.38	4.00
Total	100.00	100.00	100.00	100.00	100.00	3.96	3.33

Source: Encuesta a la Comunidad Empresarial Valenciana sobre las relaciones universidad-empresa.

2.4. Employers' opinion about Industry-University interactions

On the other hand, managers were asked to what extent several motivations for collaborating were the most important, ranking from 0 (not at all important) to 3 (most important). Table 4 shows that the level of importance was quite similar across motives. This latter finding is not surprising if we take into account that Valencian firms did not typically use university relationships that provide solutions to critical issues affecting central business areas and core technologies.

Table 4
Industry-University motivations for collaborating

	Average score (scale 0-3)
Obtain innovative ideas	2.34
Staff training	2.33
Discern technology trend	2.20
Change of technology management	2.06
Register process innovations	1.99
Register product innovations	1.96
Perform joint R&D	1.93

Source: Encuesta a la Comunidad Empresarial Valenciana sobre las relaciones universidad-empresa.

Finally, managers were asked to what extent several interactive activities were preferred to involve in I-U collaboration. In Table 5, we can observe according to the evaluation of the total sample that the advising and technical support was the most important interaction types between firms and universities. The low technological level that the Valencia industries have, could explain this finding. Education of personnel, students training and informal contacts were the next important I-U interaction types. Therefore, contract research was not the most activity preferred linking mechanism between industry and universities. A further interesting result was that managers rank collaborative research higher than contract research. An explanation would be that collaborative research would

imply a bi-directional exchange of knowledge, whereas contract research was primarily a one-directional knowledge export from firms. The high ranking of informal contacts would support this high relevance of mutual knowledge exchange, too. On the same note, the low ranking of exchange researchers would support the weak relationship between industries and universities.

Table 5
Industry-University activities preferred

	Percentage
Advising and technical support	76.23
Education of personnel	69.25
Training students	66.45
Informal contacts	60.97
Joint R&D	58.55
Contract R&D	50.16
Develop R&D joint-centers	43.13
Register patents	36.76
Exchange researchers	30.84

Source: Encuesta a la Comunidad Empresarial Valenciana sobre las relaciones universidad-empresa.

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3. Empirical Model and Results

To clarify the effects of industrial sectors, firm size and the performance of R&D activities on the industry-university interaction, we estimated an econometric model. Our dependent variable took two outcomes: (1) if the firms collaborated with universities, (0) otherwise. To reflect our discrete dependent variable, if the firm collaborated with universities or not, we used probit models under divers specifications. Thus, maximum-likelihood estimation of the models was carried out (Green, 1997). The explanatory variables were classified into four categories represented diverse elements that could influence I-U collaboration scores: educational variables from managers, industrial sector according to technological linkages, motivations for collaborating and interactive activities. To refine the effects of each explanatory variable on I-U collaboration scores, we estimated four different specifications of the probit model. The estimation results are presented in Table 6. Descriptive statistics for all these variables are reported in Appendix A.

Table 6. Probit model of industry-university collaboration (t-values in parentheses)[a]

Variables	Model I	Model II	Model III	Model IV
Main manager's higher education	0.606 (3.180)***	0.522 (2.601)**	0.482 (2.364)***	0.445 (2.103)**
Product manager's higher education	0.839 (3.113)***	0.778 (2.717)***	0.725 (2.490)***	0.679 (2.226)**
R&D manager's higher education	1.078 (2.924)***	0.801 (1.967)**	0.749 (1.812)*	0.663 (1.554)
Administrative manager's higher education	0.547 (3.127)***	0.456 (2.438)***	0.456 (2.402)***	0.438 (2.240)**
Other chief executive	1.212 (5.368)***	1.025 (4.362)***	1.022 (4.194)***	0.936 (3.671)***
Scale-intensive firms		0.722 (4.073)***	0.716 (3.957)***	0.690 (3.699)***
Specialized equipment suppliers		-0.024 (-0.116)	0.016 (0.078)	-0.063 (-0.289)
Science-based firms		0.708 (3.433)***	0.719 (3.400)***	0.677 (3.051)***
Information-intensive firms		0.799 (2.154)**	0.772 (2.018)**	0.708 (1.828)*
Medium and large size (sales revenues)		0.284 (1.940)*	0.250 (1.679)*	0.193 (1.248)
Perform joint R&D			0.212 (2.315)**	0.201 (2.051)**
Obtain innovative ideas			-0.035 (-0.294)	-0.085 (-0.696)
Discern technology trend			0.098 (0.896)	0.105 (0.942)
Staff training			-0.115 (-1.165)	-0.121 (-1.160)
Change of technology management			-0.071 (-0.624)	-0.102 (-0.859)
Register product innovations			0.045 (0.324)	0.123 (0.849)
Register process innovations			-0.016 (-0.114)	0.002 (0.014)
Informal contacts				-0.262 (-1.721)*
Advising and technical support				0.178 (0.836)
Training students				0.473 (2.452)***
Education of personnel				-0.283 (-1.510)
Contract R&D				0.332 (1.936)*
Joint R&D				-0.164 (-0.821)
Register patents				-0.278 (-1.569)
Scientist exchange				0.025 (0.130)
Develop R&D joint-centers				-0.236 (-1.303)
Intercept	-1.701 (-13.750)	-2.065 (-12.244)	-2.252 (-7.733)	-2.183 (-6.948)
Observations	700	700	700	700
Lr χ^2 (5; 10; 17; 26)	37.85	72.31	81.37	100.38
Log likelihood	-223.634	-206.404	-201.874	-192.373

a * Significant al 10% level; ** significant at 5% level; *** significant at 1% level.

Source: Encuesta a la Comunidad Empresarial Valenciana sobre las relaciones universidad-empresa.

Under the first specification (Model I), we found that the manager's level of education had a strong influence on the performance of I-U collaboration. We split the managers according to their position in the firm, that is, main manager, product manager, R&D manager, administrative manager and other chief executive and we defined dummy variables coded 1 if managers completed higher education against those who did not complete that level of education (coded 0). Our empirical results show that managers with higher education were more likely to enhance I-U collaboration. Thus, the level of education of the managers appeared to be part of a firm's decision in order to collaborate or not with a university. This finding was similar to observe in an academic survey ("Encuesta de la Comunidad Académica de la Comunidad Valenciana y las Relaciones Universidad-Empresa") also

carried out in Valencia region in the same period, where a vast majority of the academic researchers basically collaborated with those employers holding a higher education degree (García-Aracil et al., 2003).

The second specification (Model II) shows, as it was expected, that those firms, which were classified as science-based and information-intensive, were more likely to involve in I-U collaboration activities with respect supplier dominated firms (the omitted category). In addition, scale-intensive firms also presented a high likelihood of participating in I-U activities. This result can be explained by the strong weight of the ceramic sector in this category, one of the most relevant sectors in the Valencia economy, especially in innovation activities. On the other hand, the causal links running from I-U collaboration to firm technical change and to firm size were observed in our finding as Nelson and Winter (1982) also suggested. However, specialized equipment suppliers did not show effects on the decision of collaboration with universities. Again, personal executive education characteristics have the strongest impact.
Under the third specification (Model III), several motivations for collaborating were added as regressors. Only perfom joint R&D activities had a strong impact. Neither obtain innovative ideas, discern technology trend, staff training, change of technology management, register product innovations nor register process innovations showed significant effects on I-U collaboration. Again, managers' level of education, industrial sector and firm size had relevant significance on a firm's decision.

When industry-university interactive activities were included in the equation (Model IV), similar results were found for most of the previous key variables. About interactive activities, it was found that in contrast as we showed in Table 5, contract R&D activities and training students were the strongest activities among firms in order to make the decision of collaborating or not with a university, and informal contacts was not such as preferred as we expected. It could be said that employers did not considered any informal contact as an industry-university interaction, and due to the low absorptive capacity that characterized the Valencia industries, employers were interested in training students.

4. Conclusions

In this paper we have analyzed the relationship between industry-university collaboration and diverse firm-characteristic related variables for a peripheral European sample, the Spanish Mediterranean region of Valencia, of manufacturing firms according to the performance within firms of R&D activities. Discrete choice models were estimated using managers' educational level, managers opinions about the assessment of several motivations for collaborating with universities and interactive activities most preferred as explanatory variables.

The strong relationship between managers' qualifications and I-U collaboration is one of the most outstanding results. For instance, I-U collaboration was strongly and positively related in all cases where managers had a higher education level with respect those who did not.

The relationship between industry-university collaboration and industrial sector by technological linkages is other of the most interesting results of our study. We have found that those firms classified as informative-intensive firms were more likely to involve in I-U collaboration activities with respect supplier dominated firms. In the same direction, the match between large-sized firm and I-U collaboration was also found significant.

Variables related to firms' motivation for collaborating with universities show a more diverse pattern. It seems that only the performance of joint R&D activities was important. Neither obtain innovation ideas, discern technology trend, staff training, change of technology management, register product innovations nor register process innovation showed significant effects on I-U collaboration.

Finally, variables related to managers opinion about most interactive-activity preferred, we have found that those firms that collaborated with universities preferred contract R&D instead of informal contacts (some level of mistrust among actors could explain this fact). On the other hand, a highly trained student was also lighted as a benefit to a firm.

Thus, Valencia region characterized as a small and open economy with predominantly small and medium-sized firm structure where their owners lacking modern business education or research traditions, based on a number of traditional industrial sector, like toys, plastics, textile, metal, furniture, ceramics and so on, but lacks telecommunications, biotechnology or other similar industries science-based, these region's characteristics have an important influence on the performance of industry-university collaboration and R&D activities as well.

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References

- Ali, A. (1994): "Pioneering versus incremental innovation: review and research propositions", Journal of Product Innovation Management, 11, 46-61.
- Anselin, L., Varga, A., Acs, Z. (1997): "Local geographic spillovers between university research and high technology innovations", Journal of Urban Economics, 42, 422-448.
- Bania, N., Calkins, L., Dalenberg, R. (1992): "The effects of regional science and technology policy on the geographic distribution of industrial R&D laboratories", Journal of Regional Science, 32, 209-228.
- Bower, D.J. (1993): "Successful joint ventures in science parks", Long Range Planning, 26(6), 114-120.
- Bozeman, B. (2000): "Technology transfer and public policy: a review of research and theory", Research Policy, 29, 627-655.
- Burns, T., Stalker, G.M. (1961): The Management of Innovation, Tavistock, London.
- Cohen, W., Florida, R., Randazzese, L., Walsh, J. (1998): "Industry and the academy: uneasy partners in the cause of technological advance", in Noll, R. (ed.), Challenges to Research Universities, The Brookings Institute Washington, DC, 171-200.
- Cohen, W., Levinthal, D. (1990): "Absorptive capacity: a new perspective on learning and innovation", Administrative Science Quarterly, 35, 128-152.
- Frye, J. (1993): "University-industry cooperative research yields dividends", International Journal of Technology Management, 8, 577-586.
- García-Aracil, A., Fernández, I., Gutiérrez, A. (2003): "Análisis de las actividades de investigación y desarrollo y de cooperación entre las comunidades académica y empresarial de la Comunidad Valencia", Revista d'Estudis Autonòmics, Valencia.
- Geisler, E. (1995): "Industry-university technology cooperation: a theory of inter-organizational relationships, technology analysis", Technology Analysis and Strategic Management, 7, 217-229.
- Green, W.H. (1997): Econometric Analysis, third edition, Prentice-Hall, New Jersey.
- Hamel, G., Prahalad, C.K (1994): Competing for the Future, Harvard Business School Press, Boston.
- Heckman, J.J. (1979): "Sample selection bias as a specification error", Econometrica, 47, 153-161.
- Hicks, D. (2000): "Using innovation indicators for assessing the efficiency of industry-science relationships", in Proceedings of the presentation of the paper at the joint German-OECD conference, Berlin.
- INE (2002): Estadística sobre las actividades en investigación científica y desarrollo tecnológico (I+D), Madrid.
- Jaffe, A., Trajtenberg, M., Henderson, R. (1993): "Geographic localization of knowledge spillovers as evidence by patent citations", Quaterly Journal of Economics, 108, 577-598.
- Mora, E.M. (1999): "La cooperación universidad-empresa: un análisis de las dimensiones y tipología de los acuerdos de colaboración", Revista de Ciencias Sociales y Jurídicas, Studia Carande, 2(4), 267-286.

- National Science Board (2000): Science and Engineering Indicators, National Science Foundation, US Government Printing Office, Washington, DC.
- Nelson, R., Winter, S. (1982): An Evolutionary Theory of Economic Change, Harvard University Press, Cambridge, M.A.
- OECD (2000): Analytical Report on High Tech Spin-offs, DSTI/STP/TIP, Paris.
- Okubo, Y., Sjoberg, C. (2000): "The changing pattern of industrial scientific research collaboration in Sweden", Research Policy, 29(1), 81-98.
- Oliver, A.L., Liebeskind, J.P. (1998): "Three levels of networking for sourcing intellectual capital in biotechnology: implication for studying interorganizational networks, international studies of management", International Studies of Management and Organization, 27(4), 76-103.
- Pavitt, K. (1984): "Sectoral patterns of technical change: towards a taxonomy and a theory", Research Policy, 13(6), 343-373.
- Pisano, G. (1990): "The R&D boundaries of the firm: an empirical analysis", Administrative Science Quartely, 35, 153-176.
- Prahalad, C.K. (1998): "Managing discontinuities: the emerging challenges", Research Technology Management, 14-22.
- Rea, D., Brooks, H., Burger, R., LaScala, R. (1997): "The semiconductor industry-model for industry university government cooperation", Research Technology Management, 46-54.
- Reams, R. (1986): University-Industry Research Partnerships, Quorum Books, Westport, Conn.
- Rosner, M (1968): "Economic determinants of organizational innovation", Administrative Science Quarterly, 12, 614-625.
- Saviotti, P. (1998): "On the dynamics of appropriability of tacit and codified knowledge", Research Policy, 26, 834-5-856.
- Schartinger, D., Rammer, C., Fischer, M.M, Fröhlich, J. (2002): "Knowledge interactions between university and industry in Austria: sectoral patterns and determinants", Research Policy, 31, 303-328.
- Steele, L. (1989): Managing Technology, McGraw-Hill, New York.
- Teece, D.J., Pisano, G., Shuen, A. (1997): "Dynamic capabilities and strategic management", Strategic Management Journal, 18, 509-533.
- Van Rossum, W., Cabo, P. (1995): "The contribution of research institutes in EUREKA projects", International Journal of Technology Management, 10, 853-866.
- Varga, A. (2000): "Regional economic effects of university research: a survey", Working Paper, Department for Economic Geography and Geoinformatics, University of Economics and Business Administration, Vienna.
- Varga, A. (1998): University Research and Regional Innovation, a Spatial Econometric Analysis of Academic Technology Transfers, Kluwer Academic Publishers, London.
- Zmud, R.W. (1982): "Diffusion of modern software practices: influence of centralization and formalization", Management Science, 28, 1421-1431.

Appendix A

Table A1
Descriptive Statistics

	Mean	Std. Dev.	Min.	Max.
Main manager's higher education	0.17	0.37	0	1
Product manager's higher education	0.05	0.22	0	1
R&D manager's higher education	0.02	0.15	0	1
Administrative manager's higher education	0.24	0.43	0	1
Other chief executive	0.07	0.25	0	1
Supplier dominated firms	0.52	0.50	0	1
Scale-intensive firms	0.15	0.36	0	1
Specialized equipment suppliers	0.22	0.41	0	1
Science-based firms	0.09	0.29	0	1
Information-intensive firms	0.02	0.15	0	1
Medium and large size (sales revenues)	0.50	0.50	0	1
Perform joint R&D	1.93	0.99	0	3
Obtain innovative ideas	2.34	0.90	0	3
Discern technology trend	2.20	0.95	0	3
Staff training	2.33	0.92	0	3
Change of technology management	2.06	0.91	0	3
Register product innovations	1.95	1.02	0	3
Register process innovations	1.99	1.02	0	3
Informal contacts	0.61	0.48	0	1
Advising and technical support	0.76	0.42	0	1
Training students	0.66	0.47	0	1
Education of personnel	0.69	0.46	0	1
Contract R&D	0.50	0.49	0	1
Joint R&D	0.58	0.49	0	1
Register patents	0.37	0.47	0	1
Scientist exchange	0.31	0.46	0	1
Develop R&D joint-centers	0.43	0.49	0	1

Source: Encuesta a la Comunidad Empresarial Valenciana sobre las relaciones universidad-empresa.

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