Complementarity or substitution between University-Industry Relationships and academic research.

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Abstract

This paper analyses whether academic research and university-industry relationships (UIR) activities have complementary effects on the scientific production of university lecturers. The analysis is based on a case study of two Spanish universities. We find that the positive effect of UIR on researchers' scientific production comes mainly from the capacity to provide complementary cognitive resources for research activities. The access to these resources depends on the type of linkage activity and the characteristics of the partner.

Key Words: scientific production; traditional research activities; university – industry relationships; patterns of technological change; complementarity.

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1. Introduction and objectives

In recent decades a new "mission" for universities has been promoted by various social spheres related to the application and exploitation of knowledge and other university capabilities outside of the academic environment (Molas-Gallart et al. 2002). This new mission has increased the relations between university and industry and has generated several concerns related to the adverse effects that this linkage can have on academic research. In relation to this last point, it has been shown, for example, that very close relations with industry can work to penalise the autonomy of the university and to direct the agendas of researchers toward activities with potential economic utility (Martin and Etzkowitz 2000). It has also been shown that the dissemination of research results can be affected because a constant tension between the desire of researchers to publish, and the aim of private sponsors to delay publication in the interests of protecting intellectual property (Dasgupta and David 1994). Nevertheless, despite these concerns, most studies on the subject find a positive relationship between the scientific performance of lecturers and UIR. The literature in this field falls into two categories: those that indicate a positive effect on lecturers' scientific productivity of UIR (Landry et al. 1996; Gulbrandsen and Smeby 2005; Stephan et al. 2004; Calderini and Franzoni 2004; Azoulay et al. 2005; Breschi et al. 2005, 2006; Van Looy et al. 2004-2006; Meyer 2006; Godin and Gingras 2000), and those that indicate that this effect is determined by the degree of UIR (Blumenthal et al. 1996; Bonacorsi et al. 2006) or the type of interaction activity (Manjarrés-Henríquez et al. 2008). The basic argument behind these results is that interactions with industry provide lecturers with access to additional financial resources and relevant knowledge, both of which impact positively on their scientific performance ('resources effect').

The implications of the above are that linkages between industry and academic research, in some case, can be complementary activities to the extent that the development of one increases the effectiveness of the other (Milgrom and Roberts 1990). Complementarity, in this context, goes far beyond the joint development of the two types of activities and assumes the generation of synergistic effects on scientific performance: the greater the linkages with industry, the greater the effectiveness of the lecturer's academic research, and vice versa. However, this aspect has not been explored in detail and the existing studies focus on analysing the individual effects of UIR, ignoring possible complementarities between UIR and traditional research activities.

This article examines these complementarities and evaluates whether the effects of UIR and academic research on the scientific production of university lecturers are complementary, at the same time controlling for the effects of a set of individual attributes. The contribution of our research is threefold. The first is that in this work we study a wide set of channels of linkages with industry. This latter aspect has been one of the weak points of many of the existing studies, which have tended to concentrate on analysis of patents as the main channel of interaction between universities and the socioeconomic environment. This, as some authors have suggested, leads to a partial view of the phenomenon, in which an over emphasis on patenting can hide the presence of other linkage activities that are equally as or even more important in the technology transfer process (D'Este and Patel 2005; Cohen et al. 2002). The second is that we analyze the effect of type of partner on scientific output. The third and more important contribution is that not only do we analyse the individual effects of UIR, we also explore the possible complementarity between UIR activities and traditional academic research with respect to scientific production.

2. Data and Methodology

The study is carried out by means of a database of more than two thousand faculty members from two Spanish public universities, the University of Valencia (UV) and the Polytechnic University of Valencia (UPV), who have conducted research projects and/or have been involved in formal UIR activities during 1999-2004 period. The data are analysed at lecturer level and focusing on three aspects: UIR activities, academic research activities, and scientific production. UIR are analysed based on only those formal activities developed through contractual agreements during 1999-2004 period. These activities have been classified into two groups according to their scientific technological level (Manjarrés-Henríquez et al. 2008). In the first group, those of higher level, we include only those linkage activities based on the development of R&D contracts (R&D), whereas in the second group we include technological support, consultancy contracts and contracts for the provision of services (ATS) and contracts for specific training (ST). These activities are all carried out for the benefit of external agents. However, whereas R&D contracts involve activities aimed at the generation of knowledge, the activities in the second group are directed towards the resolution of specific problems.

For each of the activities outlined above, the database provides information on the contracting partner, distinguishing between public bodies and industry. Furthermore, in order to control for the potential variations related to the industrial characteristics of the partner, we adopt Pavitt's (1984) taxonomy of patterns of technological change, which classifies firms as supplier-dominated (SD), scale intensive (SI), specialized supplier (SS) and science-based (SB). Although this can lead to some simplification, its applicability as a criterion for classifying firms has been demonstrated in several studies (Arundel et al., 1995; Cesaratto and Mangano, 1992).

The academic research activities (*AR*) are analyzed taking into account the research projects developed by researchers funded by public grants, at regional, national and/or European level, during 1999-2004. In contrast to activities contracted by external agents, the activities included in this group are directed basically to the creation of new knowledge and are largely defined by the researcher's particular interests.

Finallly, scientific production is measured as the number of articles published by a researcher in journals indexed in the Thomson ISI database, during 2003-2004. Although analysis of international journals articles presents some limitations (e.g., relative quality of work and journal, multiple authorship, types of publication, etc.), it is used as an indicator of scientific production because this is the primary means of diffusing academic research, and publications are central to good performance in the scientific community. Each of the econometrics models in this paper are estimated using scientific production as dependent variable. Keeping the characteristics of this variable in mind (non-negative integers, highly-skewed distribution, with significant overdispersion and a large number of zeros), the estimation of the model was carried out using the regression binomial negative model. For more information about the variables used, please see table 1.

3. Main Results

To achieve the proposed objectives, we applied three different econometric models. In the first model, we included the academic research activities (AR), university-industry relationship activities, and some general characteristics of the lecturer (position and work experience) as the explanatory variables. This first model can be considered the baseline model and shows the main effects of the explanatory variables analysed. The results of model 1 indicate that the effects of UIR on scientific production depend on the tools used to establish the relationship. When UIR are based on low technological scientific level activities (ATS and ST) can inhibit a researcher's scientific production. Thus, too much emphasis on the development of routine activities for industry can render the institution simply a "consulting university" with poor scientific indicators. In contrast, when the linkages are based on activities with a high scientific-technological content (R&D contracts), UIR have a positive and significant effect on scientific production.

Model 2 studies in depth the analysis of the effect of R&D contracts taking into account the type of contracting partner. Specifically, we include 5 new variables to distinguish between R&D contracted by public bodies and the four sector categories considered in this work. The results show that only R&D contracts established with firms in the category of specialized suppliers and science-based firms have a significant and positive impact on researcher's scientific output. R&D contracts developed with firms belonging to other categories (supplier-dominated and scale intensive) have no significant effect and in the case of public bodies the estimated coefficient is even negative. This result is novel and demonstrates that the effect of UIR on scientific production of researcher not only depends on the linkage activity, but also the partner's characteristics.

Finally, analysis of complementarities is included in model 3 through the interaction between the variables for SB_SS (specialized supplier and science-based) and academic research (SB_SS*AR*). The interactive term is significant and has positive sign. This result indicates that an increase in the value of one of the variables increases the effect on scientific production of the other, which suggests the existence of complementarity between them.

Conclusion

Several studies show that traditional academic research activities and interaction with external agents is becoming the norm for universities. This paper looked at the relations between UIR and traditional academic research activities, focusing on the complementary or substitutive nature of these activities on the scientific production of university lecturers.

In line with earlier findings, the results of this study suggest that UIR can have a positive effect on scientific production, depending on the type of the linkage activity. Specifically, only when the linkage is based on activities with high scientific technological content (R&D contracts) there are significant and positive effects on scientific production of researchers. However, beyond this result, our analysis highlights that the effect of UIR depends also on the partner characteristics. In this way, only the R&D contracts established with firms in high R&D-intensity sectors have a positive effect on scientific production of the lecturer. This type of linkage provides, further, synergic effects with the traditional research.

In sum, these results go beyond the results from previous studies in the sense that they emphasize that the positive effects of UIR on researchers' scientific production are based mainly on the access to the resources, especially cognitive, that complement research activities. The access to these resources depends on the type of linkage activity and the characteristics of the partner.

The above results have important implications for the design of university policies. Although they show that UIR does not penalize per se a researchers' scientific productivity, they underline that the indiscriminate promotion of these types of activities could result in lower scientific performance. Therefore, some policies promoting UIR as a substitute of the public funds for research, raise concerns regarding the negative impact those policies could have on scientific contribution.

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TABLES

Table 1. Description of the variables

Variable	Description	Scale	Mean	S.D
Depend variable				
SP	Scientific Production	Nº of articles published by each researcher in journals ISI 2003-2004 period	1.46	2.82
University-Industry Relationships				
TSP	Technological support, consultancy and provision of services. Low scientific technological level.	Logarithm of the value in Euros (€) of the financing obtained from TSP contracts 1999-2004.	2.18	2.17
ST	Specific training. Low scientific technological level	Logarithm of the value in Euros (€) of the financing obtained from training	0.15	0.76
R&D	R&D Contracts. High scientific technological level.	Logarithm of the value in Euros (€) of the financing obtained through R&D contracts 1999-2004.	1.47	2.13
Academic Research				
AR	Academic Research: public grants from regional, nationals and/or European bodies	Logarithm of the value in Euros (€) of the financing obtained through public grant at regional, national and/or European level during 1999- 2004.	2.72	2.34
Researcher characteristics				
EXP	Work experience	Number of "quinquenios" obtained by the professor during their life work: 1"quinquenio" is equal to 5 years of experience	3.08	1.95
POS	Position inside of the university	Scale ordinal of 0-4, where 4 is the highest scale and corresponds to university professor	2.40	1.44
Characteristics of the university				
UNIV	University to which the lecturer belongs	Dummy Variable 0-1 1, if the lecturer belongs to UV 0, if the lecturer belongs to UPV	0.52	0.50
Partner type				
PB	Public body	Logarithm of the value in Euros (€) of the financing obtained through R&D contracts from PB 1999-2004	1.02	1.89
Pavitt's taxonomy				
SD	Supplier-dominated	Logarithm of the value in Euros (€) of the financing obtained through R&D contracts from SD 1999-2004	0.04	0.42
SI	Scale Intensive	Logarithm of the value in Euros (€) of the financing obtained through R&D contracts from SI 1999-2004	0.13	0.75
SS	Specialized Supplier	Logarithm of the value in Euros (€) of the financing obtained through R&D contracts from SS 1999-2004	0.07	0.57
SB	Science-Based	Logarithm of the value in Euros (€) of the financing obtained through R&D contracts from SB 1999-2004	0.14	0.75

Table 2. Negative Binomial Regression for the models 1 and 2

Independent variables	*Scientific Production* Model 1		*Scientific Production* Model 2		*Scientific Production* Model 3	
	B	***S.E.***	***B***	***S.E.***	***B***	***S.E.***
Researcher's characteristics						
POS	0,303***	0,0238	0,307***	0,0239	0,491***	0,0233
EXP	-0,024	0,0144	-0,026	0,0145	-0,035	0,0143
Characteristics of the university						
UNIV	-0,054	0,0413	-0,068	0,0420	-0,029	0,0418
Academic research						
AR	0,323***	0,0129	0,314***	0,0131		
University - Industry Relationships						
TSP	-0,046***	0,0098	-0,047***	0,0101	-0,121***	0,0096
ST	-0,065	0,0273	-0,055	0,0277	-0,049	0,0272
R&D	0,041***	0,0087				
Partner type						
PB			-0,013	0,0101		
SD			0,038	0,0395		
SI			0,014	0,0198		
SS			0,070***	0,0232		
SB			0,142***	0,0162		
Complementarity analysis						
SS_SB*AR					0,040***	0,0026
log likelihood		-4053,510		-4021,757		-4384,847
* **P < 0.01	**P < 0.05					