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Coexistence of university–industry relations and academic research: Barrier to or incentive for scientific productivity

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In this article we analyse whether university-industry relations (UIR) are penalising research activity and inhibiting university researchers' scientific productivity and, if so, to what extent. The analysis is based on a case study of two Spanish universities. We find that UIR exercise a positive effect on university scientific productivity only when they are based on the development of R&D contracts, and when the funds obtained through these activities do not exceed 15% of the researcher's total budget. We also find that researchers who combine research and UIR activities obtain higher funding from competitive public sources than that engage only in research. In addition, their average scientific productivity is higher and they achieve higher status within their institutions than those members of faculty who concentrate only on research.

Introduction

Several authors have highlighted that since the mid 1980s radical changes have been taking place in the production of knowledge and in university institutions themselves. ETZKOWITZ [1990] equates these transformations with the emergence of a "second academic revolution", which, like the first, has resulted in the adoption by universities of a new mission, complementing the traditional activities of teaching and research.

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This third mission embraces all those activities related to the generation, use, application and exploitation outside academic environments, of the knowledge and other capabilities available to universities [MOLAS-GALLART & AL., 2002].

The third mission seeks to develop new ways for universities to contribute to economic and social development through a closer linking with the different agents in their environment. As a result, previously isolated institutional spheres have become intertwined, giving rise to entirely new types of science and universities that bring academic, economic and wider social purposes together in a way that is compatible [ETZKOWITZ, 2003; LEYDESDORFF & MEYER, 2003; NOWOTNY & AL., 2001]. As a result of this dynamic, new structures are appearing within universities (technology transfer offices – TTOs) and hybrid structures are being created with other agents (science and technology – S&T-parks, joint institutes), which transcend the institutional frontiers of the university and promote the economic exploitation of its knowledge [TUUNAINEN, 2005]. Thus, a new type of university is emerging, for which there is no agreement in the literature on a common name; they have been referred to variously as "services universities" [ENROS & FARLEY, 1986], and "entrepreneurial universities" [CLARK, 1996; SMILOR & AL., 1993].

The transformations described above presuppose a change in the traditional values of the university. In this sense, LEE [1996] and AZAGRA & AL. [2006], pointed to a change in the attitudes of faculty members toward the recognition of UIR as a valid university activity. However, some authors have highlighted the negative effects of this new external orientation of the university on the traditional missions of teaching and research. Teaching, for example, can be affected by an over-emphasis on short-term specific skill needs at the expense of a broader education [MARTIN & ETZKOWITZ, 2000]. In research, the development of the third mission can work to penalise the autonomy of the university and to direct the lecturer's research agenda toward activities with potential economic utility. Thus, one major question that emerges is whether the university is the appropriate institution to transfer and to commercialise knowledge, not because this function is incompatible with that of creating knowledge, but because it involves a cost, that can be excessive, in terms of its other missions [AZAGRA, 2004].

There is a variety of positions adopted in the literature in relation to this last point. Pessimists see these changes and transformations as a threat to high quality scientific production and the autonomy of researchers [FLORIDA & COHEN, 1999]. ROSENBERG & NELSON [1994], in their study on the US case, conclude that in spite of effective combinations in certain types of research, it is necessary to maintain the division between university and industry. Similarly, some authors have criticized UIR, maintaining that they produce a constant friction between the desire of researchers to publish, and the aim of private sponsors to delay publication in the interests of protecting intellectual property (IP) [DASGUPTA & DAVID, 1994]. The more optimistic approaches, however, generally point out that UIR can contribute to scientific productivity, and some researchers have found a significant relationship between industry financing and scientific performance of professors [GULBRANDSEN & SMEBY, 2005; LANDRY & AL., 1996]. Finally, there is an intermediate position which suggests that university collaboration with industry can improve professors' scientific productivity, but only up to certain level. BLUMENTHAL & AL. [1996], based on a survey of 2,052 faculty members in the life sciences, across 50 US universities, show that those faculty members that receive more than two-thirds of their research support from industry sources have lower academic productivity than those receiving less support from industry. BONACCORSI & AL. [2006] found similar patterns for the Italian university system and provide empirical evidence of the existence of an inverted-U shape curvilinear relationship between UIR and publication.

Our research focuses on the Spanish context and aims at assessing whether UIR are penalising research activity and inhibiting university researchers' scientific productivity. The study is carried out on 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 been involved in UIR activities during the 1999–2004 period. The data are analysed at lecturer level and we study the effect that the participation of these researchers in UIR activities exercises on both the development of research activities and on their individual scientific productivity.

It should be noted that the two universities in this study are two of the most important universities in Spain. Also, these universities stand out in the Spanish context in terms of their outputs in both academic research and technology transfer. Finally, these universities are representative of the two models of higher education institutions in Spain: "General Universities" and "Technical Universities".[1]

The UV and UPV are located in the Valencian Community, a region designated as being of low absorptive capacity, based on research and development (R&D) and innovation indicators [AZAGRA & AL., 2006; GARCIA-ARACIL & AL., 2006].

The data and methodology

We use data on the research activity and the UIR activity of two Spanish universities: UV and the UPV. These two universities account for 64% of the lecturers and nearly 57% of the university students in the Valencian Higher Education (HE)

[1] General Universities are those universities that develop their teaching in most fields of knowledge, while Technical Universities restrict their teaching mainly to technical fields, such as engineering and technology.

system.[2] There are some differences between these two universities in terms of age, size and subject specialisation. UV is one of the oldest universities in Spain (500 years) and also the largest university in the region; its teaching activity, although covering almost all disciplines, is mainly oriented towards the social sciences and humanities. UPV, on the other hand, was created only some 40 years ago and its teaching activities are mainly oriented towards engineering and technology.

The C&D Foundation 2005 report ranks UV and UPV 4th and 7th respectively among Spanish universities in terms of public funding received (Fundación CyD 2005). However, only UPV figures in the top ten universities for the amount of private funding per lecturer, and this university has the highest reputation for active involvement in UIR. On the other hand, the C&D Foundation report ranks UV 5th among Spanish universities in terms of number of scientific publications per lecturer, which demonstrates its strong tradition in basic research. Both universities have Technology Transfer Offices (TTOs), which started activities in 1989, integrated into their organisational structures to facilitate UIR.

Our study focuses on three aspects: UIR, academic research, and scientific productivity. UIR is analysed in terms of external agents' (firms, public administrations, non-profit organisations, etc.) exploitation of university activities. This extends the traditional definition of UIR, which is usually limited to the development of joint activities with the productive sector, and comes closer to the concept of the "third mission". Their academic research is analysed taking account of the research projects carried out by lecturers through competitive public grants.[3] Finally, scientific productivity is assessed as the number of articles published by each researcher in journals indexed in the Thomson Institute for Scientific Information (ISI) database during the 2003–2004 period.

The data are analysed at lecturer level. Bearing in mind the key aspects above mentioned, we consider only faculty members who have been in charge of research projects supported by competitive public grants, or activities contracted by external

[2] The Valencian HE system includes more than 10% of the students and professors in Spain, and its budget represents 1.2% of regional GDP, in contrast to the 0.9% of GDP of the national public university budget. Five public and two private universities, with more than 10,000 professors/lecturers, and approximately 142,000 enrolled students in 2004, make up the Valencian HE system. 40% of these professors were involved in social sciences, 34% in engineering and technology, 11% in humanities and the remaining 15% in exact, natural and health sciences [HERNÁNDEZ-ARMENTEROS, 2004].

[3] In our analysis we classify these projects according to the geographical origin of the grants:

a) Regional projects (RP). Research projects financed by regional public agencies (e.g. Regional government).

b) National projects (NP). Research projects financed by national public agencies (e.g. National research councils).

c) European projects (EP). Research projects financed by European public agencies (basically the framework programmes).

agents, during the 1999–2004[4] period. The final sample includes 2,135 professors/ /lecturers,[5] (in the following we refer to researchers to mean either of these categories).

In order to assess whether involvement in UIR penalises research activities, we split the sample into three groups:

1. Researchers involved in both research projects and activities contracted by external agents.
2. Researchers who participated only in activities contracted by external agents.
3. Researchers who participated only in research projects.

In each of these groups, we analyse the intensity of the research and the linking activities. Also, using comparison of means methods,[6] we analyse whether there are significant differences among these groups with regard to scientific productivity and researchers.

The basic specification used to evaluate the effects of UIR on scientific productivity is:

$$SP = \alpha_0 + (\alpha_1 R\&D + \alpha_2 TSC + \alpha_3 ST + \alpha_4 (R\&D)^2) + (\alpha_5 EP + \alpha_6 NP + \alpha_7 RP) + (\alpha_9 EXP + \alpha_{10} POS)$$

Table 1 presents the variables used in the analysis.

Scientific productivity (*SP*) is the dependent variable and is measured on an ordinal scale representing the annual average number of articles published by each researcher in journals indexed in the ISI during the 2003–2004 period.

UIR are evaluated by considering three types of activities: R&D contracts (*R&D*); technological support and consultancy contracts (*TSC*); and contracts for specific training (*ST*). The database provides information on the number of contracted actions and their value. However, here we consider only the latter. Thus, the variables are measured as values (in Euros) in terms of the funds obtained by the researcher for the 1999–2004 period, derived from the three types of activities described above. We applied logarithmic transformation in order to normalise these variables [MCLEAY & TRIGUEIROS, 1998].

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[4] Note that our unit of analysis refers to lecturers who were in charge of research projects or activities contracted by external agents, i.e. the main researcher responsible for the development of these activities, although the university retains legal responsibility for these activities. Thus, the sample in this study (2,135 lecturers) is smaller than the total population of lecturers involved in these activities.

[5] The data were provided by the Vice Rector of Research, through the UV and UPV TTOs. These data are derived from a study funded by the High Consultant Council of R&D of the Generalitat Valenciana.

[6] We use two comparison of means methods: analysis of variance (ANOVA) and the non parametric Kurskall Wallis test. The first method is applied in cases were the dependent variable is continuous, and the second is applied when the variable is discrete. The non parametric Kurskall Wallis test is similar to the ANOVA test, and the contrast is applicable in the absence of normality and homocedasticity conditions [DICKINSON, 1971; SÁNCHEZ, 1999].

Table 1. Description of the variables

Variable	Description	Scale	Mean	S.D.
Dependent variable				
SP	Scientific Productivity	Scale ordinal of 0–3 0, if the researcher has not published in any journals in the ISI database in 2003–2004 1, if the average number of articles for 2003–2004 is in the range 1–2.5 2, if the average number of articles for 2003–2004 is in the range 2.5–5 3, if the average number of articles for 2003–2004 is more than 5	0.91	2.21
University-industry relations activities				
R&D	R&D Contracts	Logarithm of the value in Euros (€) of the financing obtained through R&D contracts 1999–2004	1.43	2.11
TSC	Technological support and consultancy	Logarithm of the value in Euros (€) of the financing obtained from TSC contracts 1999–2004	1.77	2.15
ST	Specific Training	Logarithm of the value in Euros (€) of the financing obtained from training contracts 1999–2004	0.14	0.74
$(R\&D)^2$	R&D contract to square	Logarithm of the value in Euros (€) to square of the financing obtained from R&D contracts 1999–2004	6.51	10.15
Research projects financed by competitive public grants				
EP	European Projects	Logarithm of value in Euros (€) of research projects financed by european public bodies 1999–2004	0.35	1.28
NP	National Projects	Logarithm of value in Euros (€) of research projects financed by national public bodies 1999–2004	1.90	2.35
RP	Regional Projects	Logarithm of value in Euros (€) of research projects financed by regional public bodies 1999–2004	1.59	2.09
Researcher characteristics				
EXP	Works Experience	Number of "quinquenios" obtained by the professor during their life work: 1"quinquenio" is equal to 5 years of experience	3.02	1.98
POS	lecturer's position within the university	Scale ordinal of 0–4, where 4 is the highest scale and corresponds to university professor	2.48	1.40

Both technological support and consultancy, and specific training are activities directed towards the solving of specific problems, whereas R&D contracts involve activities aimed at the generation of knowledge and, generally, are correlated with higher levels of funding. However, what all these activities have in common is that they are carried out for the benefit of external agents.

As pointed out earlier, the literature provides only preliminary empirical evidence that UIR can have a positive influence on scientific productivity. We consider that the effects of UIR on researchers' productivity depend on the type of interaction involved. We would suggest that it is only when they occur through R&D contracts that UIR have a positive effect; in all other cases, UIR can inhibit a researcher's scientific productivity.

We also included in our model an additional variable, calculated as the logarithm of the squared value of R&D contracts $(R\&D)^2$, to evaluate whether the effect that UIR exercises on scientific productivity is, as some authors have suggested [BONACCORSI & AL., 2006; BLUMENTHAL & AL., 1996], positive up to a certain level.

The econometric model includes three variables related to academic research: regional projects (*RP*); national projects (*NP*); and European projects (*EP*).[7] These variables are measured respectively as the value (in Euros) of the competitive public grants received by the researcher in the 1999–2004 period, from regional, national and European public bodies, to develop research projects. We applied logarithmic transformation once again to assure the normality of the variables.

In contrast to activities contracted by external agents, the projects included in this group are directed basically to the creation of new knowledge and are largely defined by the researcher's particular interests. Thus, we can expect the variables *RP, NP* and *EP* to be positively related to the lecturer's scientific productivity.

In the economic literature, scientific productivity has also been explained by a set of variables related to the researcher's personal attributes, including age, gender and position within the university [LEHMAN, 1958, 1960; LEVIN & STEPHAN, 1991; BONACCORSI & DARAIO, 2003; CARAYOL & MATT, 2006]. We integrate some of these features in our regression analysis. *EXP* is a proxy for work experience and is measured as the number of "quinquenios" obtained by the lecturer.[8] The variable *POS* is related to the lecturer's position and is measured on an ordinal scale that takes account of faculty grading. In Spain, the highest scale corresponds to university professor. As CARAYOL & MATT [2006] suggest, the expected effects of promotion are ambiguous. On the one hand, since publication is a key requirement for promotion to a higher scale, there are important incentives for increased scientific productivity to achieve promotion, which reduce once the promotion is awarded. However, since promotion implies a significant increase in social status within the academic sphere, researchers occupying higher positions in the university hierarchy may show greater productivity based on their better ability to exploit external and internal resources (status effect).

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[7] These variables match those described in Footnote 4.

[8] In Spain, the "quinquenio" (five year period) is a recognition granted to the university professor based on experience in teaching, and affects salary. Quinquenios are granted every five years after an evaluation process. Thus, a professor who has been teaching for 20 years could possess up to 4 quinquenios. Quinquenios can be assumed to be granted in almost all cases; thus, they can be used as a proxy variable for teaching experience.

As we can see from the definition of the variables, scientific outputs relate to the 2003–2004 period, while the variables related to UIR and research activities refer to a longer time period (1999–2004). This distinction was made to take account for the time gap between research activities and publication of results. Similar techniques are used in some of the existing studies [GULBRANDSEN & SMEBY, 2005].

Results

UIR and research

Table 2 presents the sample distribution based on the three groups defined in the methodology. Most researchers (40%) are involved only in UIR activities; 28% combine research activities with UIR; 32% are involved only in research.

Table 2. Sample distribution

	Group	No. researchers	% of sample
1.	Researchers engaged in both research projects and activities contracted by external agents.	598	28%
2.	Researchers that participate only in activities contracted by external agents.	852	40%
3.	Researchers that only engage in research projects.	685	32%
	Total	2135	100%

Figures 1 and 2 show that researchers engaged in both research and UIR activities receive higher average funding than researchers that engage in only one type of activity. The mean value of the R&D contracts, for example, is six times higher for group 1 than group 2. Also, the mean value of European projects is almost five times higher for group 1 than group 3 and more than twice as high in the case of the national and regional projects.

Also, the F-ratios in the ANOVA test and the Sheffé test for multiple comparisons, show statistical significant differences among the three groups of researchers related to scientific productivity. Specifically, group 1 researchers tend to publish more than their colleagues (Table 3). Thus, researchers that engage in both research and UIR activities not only receive higher external funding, but also demonstrate higher scientific output.

This first set of results seems to indicate that faculty members are able to undertake development of UIR activities without penalising their research activities, at least in the context analysed.

In order to determine whether there are significant differences among the different groups in terms of researchers' characteristics, we carried out statistical comparison of means tests. In this case the null hypotheses tested are the equality of means between the different groups of lecturers for the variables *EXP* and *POS* (Table 4).

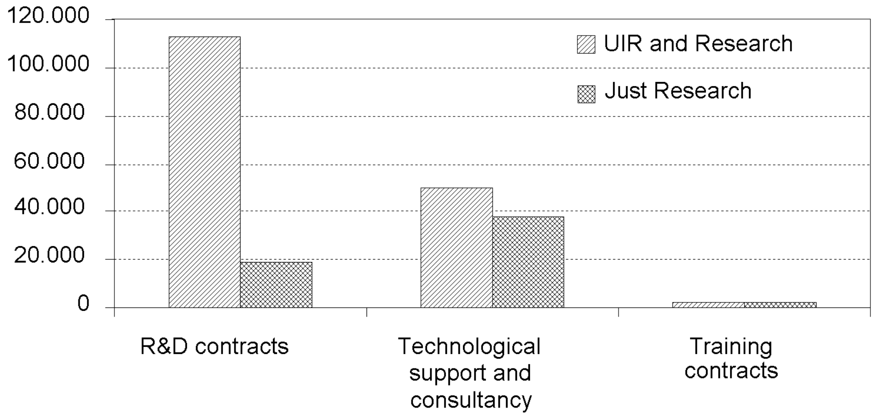

Figure 1. Mean values of contracts

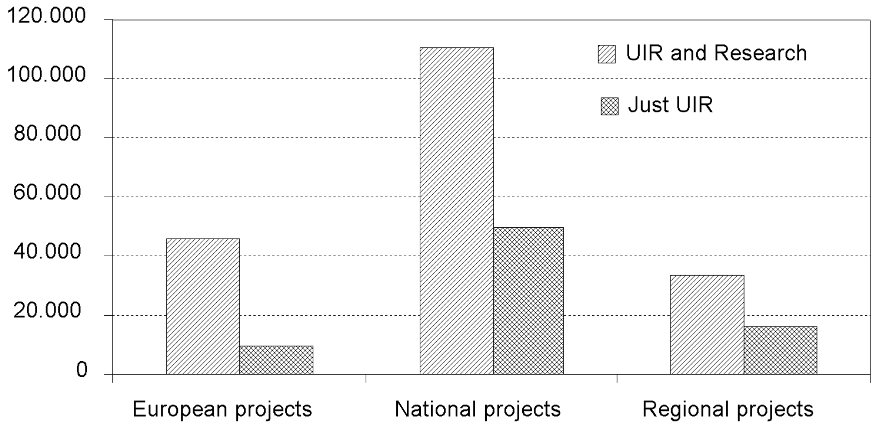

Figure 2. Mean values of research projects

Table 3. Comparison of means of scientific productivity in the different group of researchers

Group	Scientific productivity ANOVA F-probability 0.000	
	Mean	Sheffé test: significant differences
1. Researchers engaged in both research projects and activities contracted by external agents.	1.52	(1) and (2)***,
2. Researchers that participate only in activities contracted by external agents.	0.23	(1) and (3)*, (2) and (3)***
3. Researchers that only engage in research projects.	1.23	

***Significance at 1%, * Significance at 10%

Table 4. Comparison of means of researcher's characteristic in the different group of researchers

Group	Work experience ANOVA F-probability 0.000		Position Kurskal Wallis Sig. Asint 0.000	
	Mean	Sheffé test: significant differences	Mean	Bonferroni test: significant differences
1. Researchers engaged in both research projects and activities contracted by external agents.	3.7	(1) and (2)***, (1) and (3)***, (2) and (3)***	3.1	(1) and (2)***, (1) and (3)***, (2) and (3)***
2. Researchers that participate only in activities contracted by external agents.	2.3		1.7	
3. Researchers that only engage in research projects	3.2		2.7	

***Significance at 1%

Similar to the results for scientific productivity, researchers that combine research with UIR activities have higher average positions and longer experience.[9]

These results indicate that lecturers that participate in both research and UIR activities, not only receive higher funding and have a higher level of scientific production, but also have higher status within the institution. This is in line with CARAYOL & MATT'S [2006] findings that a higher position increases recognition in the academic sphere and makes researchers better able to exploit external resources.

UIR and scientific productivity

To evaluate the effect of UIR on scientific productivity, we estimated the econometric model outlined in previously. Due to the ordinal character of the dependent variable (*SP*) we chose ordinal logistical regression as our estimation technique [MCCULLAGH, 1980; PETERSON & HARREL, 1990]. The model of regression was estimated for the total sample and for each of the universities.

Table 5 presents the results. The values of the Nagelkerke pseudo-R^2 are high or equal to 0.30, which indicates that the models have acceptable prediction power. The Chi-squared values for degrees of freedom corresponding to the model, suggest rejection of the null hypothesis that all parameters, except the intersection, are equal to zero at a significance level of 1%.

[9] We cannot infer causality relations from methods of comparison of means; these methods do not provide the direction of the causality arrow.

Table 5. Ordinal logistical regression of the variables that influence in the scientific productivity of the university professors

	Scientific productivity		Scientific productivity		Scientific productivity	
	Total sample		UV		UPV	
	B	S.E.	B	S.E.	B	S.E.
μ_0	2.38***	0.15	2.85***	0.234	1.79***	0.197
μ_1	4.31***	0.17	4.57***	0.260	4.26***	0.249
μ_2	5.40***	0.19	5.552***	0.282	5.61***	0.300
Researcher's characteristics						
POS	0.479***	0.06	0.463***	0.081	0.457***	0.088
EXP	–0.093***	0.04	0.007	0.047	-0.127***	0.062
UIR activities (fundng from external contracts)						
R&D	0.462***	0.13	0.400***	0.16	0.747***	0.214
TSC	–0.120***	0.03	–0.001	0.04	–0.267***	0.038
ST	–0.03	0.07	–0.045	0.08	–0.014	0.15
$(R\&D)^2$	–0.09***	0.03	–0.07**	0.03	–0.153***	0.045
Academic activities (funding from public grants)						
EP	0.14***	0.04	0.15***	0.05	0.118**	0.055
NP	0.25***	0.02	0.23***	0.03	0.322***	0.038
RP	0.20***	0.02	0.16***	0.03	0.288***	0.04
Pseudo- R^2 Nagelkerke	0.3		0.3		0.44	
-2 log likelihood	3249.856		1928.774		1245.4348	

***Significance at 1%, **Significance at 5%

First, the results obtained for the total sample indicate that the two researcher characteristics analysed in this study exercise contrary effects on scientific productivity. While the position occupied by the researcher has a positive influence, experience has a negative effect. This result is interesting because it shows that although there is a positive correlation between these variables,[10] when their effect on scientific productivity is evaluated they function in opposite ways. These results are in line with the findings from previous studies and demonstrate that, more than the time dedicated to academic activity or the age of professors, what really influences scientific productivity are those aspects related to position or recognition within the institution [CARAYOL & MATT, 2006; KNORR & AL., 1979; ZUCKERMAN & MERTON, 1972].

On the other hand, the parameters calculated in the regression model show significant and positive relationships between the three types of research projects supported by competitive public grants, and the researcher's scientific productivity. In addition, the estimated coefficients show that national projects have a higher positive effect on scientific productivity than regional or European projects.

The results also indicate that the effects of UIR depend on the instruments used to establish the relationship. When UIR is based on low scientific–technological content activities, the activity does not increase scientific productivity and may even act to reduce it. As can be seen from Table 5, technological support and consultancy contracts (*TSC*) exercise a negative and significant effect on scientific productivity, while the

[10] The Spearman coefficient of correlation between these variables is 0.679 and is significant at the 1% level.

coefficients for specific training activities (*ST*), although not significant, suggest a possible negative effect on scientific productivity. Thus, too much emphasis on the development of routine activities for industry can detract from the "entrepreneurial university" model and render the institution simply a "consulting university" with poor scientific indicators [GEUNA, 1999; AROCENA & SUTZ, 2005].

On the other hand, when the linking is accomplished through R&D contracts (*R&D),* UIR have a positive and significant effect on scientific productivity. A possible explanation for this phenomenon is that R&D contracts are the only joint activities that generate new knowledge. However, it should be remembered that these types of contracts invariably include confidentiality clauses, which hinder the diffusion of results. Consequently, the high significance of this variable in our regression model could be due to indirect effects, derived from the higher level of resources obtained and the learning that is embedded in these types of activities. Nevertheless, these results reinforce the fact that engaging in UIR does not penalise university research *per-se*.

Some of the previous variables have a similar effect on the two universities considered in the analysis. Experience (*EXP*) and technological support and consultancy (*TSC*) are the only variables where differences between the universities emerge. While the variable *EXP* does not have a significant effect for UV, in the case of UPV it has a negative and significant effect on scientific productivity. This can be explained if we take into account that in UPV the oldest centres, and consequently those with more experienced lecturers, were based on middle level technical schools which traditionally do not engage in research. On the other hand, the *TSC* variable has a negative effect in both cases, although it is only significant for UPV. A possible explanation of these differences may be due, among other things, to this activity representing more than 50% of total industrial funding in UPV, while in UV it represents less than 20%.

Additionally, in all the estimated models the variable $(R\&D)^2$ is significant and negative, indicating that the financing derived from R&D contracts favours scientific productivity only up to a certain level, after which it has a negative effect. In order to make a preliminary determination of this tipping level we defined another variable calculated as the percentage from R&D contracts in the researcher's total budget (*R&D%*). This variable is measured on an ordinal scale and is linked to scientific productivity through the following econometric specification:

$$SP = \alpha_0 + \alpha_1 EXP + \alpha_2 POS + \alpha_3 R\,\&\,D\%$$

In this model we only included the researcher's characteristics as an additional explanatory variable in order to avoid problems of collinearity with the other variables related to funding. Additionally, as the effect of the variable $(R\&D)^2$ does not vary across universities, we decided to estimate this model only for the total sample. The results are presented in the Table 6.

Table 6. Ordinal logistical regression

	Scientific productivity total sample	
	B	S.E.
μ_0	2.11***	0.13
μ_1	3.83***	0.15
μ_2	4.84***	0.17
Researcher's characteristics		
POS	0.61***	0.05
EXP	–0.04	0.03
Percentage of finance from R&D contracts in the researcher's total budget (R&D%)		
100%	–0.29	0.21
75%–100%	–0.52***	0.29
55%–75%	0.08	0.23
35%–55%	0.12	0.21
15%–35%	0.22	0.19
0%–15%	1.02***	0.16
0%	0.00	
P-seudo R^2 Nagelkerke	0.167	
-2 log likelihood	841.030	

***Significance at 1%, **Significance at 5%

The parameters estimated in the new regression model show that the funding derived from R&D contracts has a negative and significant effect on scientific productivity when it constitutes more than 75% of the researcher's total budget. Only when funding from R&D contracts with external agents does not exceed 15% is scientific productivity favoured. These results provide empirical evidence complementing the findings from previous studies that point to the existence of an inverted U-shaped relationship between industry funding and scientific production [BLUMENTHAL & AL., 1996; BONACCORSI & AL., 2006].

Conclusions

The adoption by universities of the so called third mission has generated concerns about the viability of combining knowledge transfer activities with the traditional university missions of teaching and research. In this paper we analysed whether relations between the university and its socioeconomic environment penalise research activities and inhibit the scientific productivity of university faculty.

The results obtained do not provide evidence, at least in the Spanish context, that engagement in UIR as an additional university activity, negatively influences research performance. On the contrary, the indications are that researchers that combine research and UIR activities obtain higher levels of competitive public funding than those that engage only in publicly funded research. In addition, researchers that combine both types of activity have higher average scientific productivity.

However, this is not to say that greater engagement in UIR will increase scientific productivity. When UIR are based on activities with low technological scientific level (technological support and consultancy, and the like) scientific productivity suffers. UIR only exercise a positive effect when they are based on activities with a high scientific-technological content (R&D contracts), and only up to certain level. Our estimates indicate that R&D contracts have a positive effect on scientific productivity only when the funds obtained through these activities do not exceed 15% of the researcher's total funding. The effect of bigger proportions, although positive, loses significance and after the 75% level the effect is negative. Nevertheless, the relatively low explanatory power of this model suggests that there are other variables, not considered in this analysis, that perhaps influence the quantification of this limit. This will require more research.

Among individual researchers' characteristics, we find that only position within the university has a positive effect on scientific productivity and that this effect is greater for the group of researchers that is involved in both research and UIR. This suggests that, in our context, researchers taking on the activities of the university's second and third missions jointly are those with greater status within both universities. This aspect has important implications if we also take into account that the opinions of these senior faculties are usually decisive in defining the direction of the institution.

The results obtained do not show much variation across universities. Thus, we can conclude that the pattern for the effects of UIR on research and scientific productivity is similar, regardless of the university profile.

Future research in this area could involve similar analyses, but with broader sample data on other types of universities, and including different scientific disciplines as control variables in the econometrics analysis. This last would allow us to identify whether the patterns found in this study vary across the scientific fields of professors' activities.

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