High Educ (2008) 56:205–220
DOI 10.1007/s10734-007-9098-9

University–industry relations in Bolivia: implications for university transformations in Latin America

Jaider Vega-Jurado · Ignacio Fernández-de-Lucio · Ronald Huanca

Published online: 20 September 2007

Abstract This article examines the implications of how academics respond to the debate on the production of knowledge and its transfer to the productive sector, for the transformation of Latin American universities. The empirical analysis is based on a survey of 349 lecturers from Bolivian public universities, which inquired into aspects of university–industry relations (UIR). Although the results indicate that lecturers are in favour of relations with firms, there are several barriers to such relationships, such as lack of institutional support, generally unfavourable atmosphere in universities, and an industrial structure comprising few firms in knowledge-intensive sectors and firms with low absorptive capacity. In the context of Bolivia, unlike what occurs in developed countries, UIR have been configured around scientifically unimportant activities—technological support and internship schemes to place students in firms—which has had a negative effect on the consolidation of research, an academic activity, to which lecturers devote little of their time. The results of our study show the tensions that exist in efforts to change the university model; there is a reluctance to intensify the commercialisation of research results, and a lack of enthusiasm for introducing complex relationship mechanisms, such as the creation of hybrid structures.

Keywords Latin American universities · University–industry relations · University transformations · Scientific research · Hybrid practices

Introduction

Throughout the history of universities, not only the structural features that define them as an institution, but also their very purpose have changed substantially. In the mid nineteenth

J. Vega-Jurado (✉) · I. Fernández-de-Lucio
INGENIO (CSIC-UPV), Institute of Innovation and Knowledge Management, Ciudad Politécnica de la Innovación, Camino de Vera s/n, Valencia 46022, Spain
e-mail: javega@ingenio.upv.es

R. Huanca
Universidad Técnica de Oruro, Oruro, Bolivia

century a huge transformation took place when the medieval universities, focussed on the processes of teaching, assumed the additional role of knowledge generating institutions through the principle of unity between teaching and research. This transformation, referred to by some authors as the first academic revolution (Etzkowitz 1990), involved important organisational changes in universities, such as the adoption of a disciplinary structure defined in terms of the different fields of knowledge and the acquisition of a nationally defined legal status (Geuna 1999). Since the mid 1980s new changes have been taking place in the production of knowledge and in university institutions themselves. Etzkowitz (1990) has equated these new transformations to 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. 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 et al. 2002). As a result of this dynamic, new structures are appearing within universities (technology transfer offices) and hybrid structures are being created with other agents (science and technology parks, joint institutes) which transcend the institutional frontier of the university and promote the economic exploitation of its knowledge (Tuunainen 2005).

These transformations have provoked substantive changes in the universities' relationships with the different social actors, especially those that are configured with the business environment. Studies of these transformations have introduced approaches such as the Triple Helix (Etzkowitz and Leydesdorff 1997) and they have occupied a prominent place in more general approaches such as National Innovation Systems (Lundvall 1992; Nelson 1993). However, these approaches have been constructed in the context of developed countries and, in large measure, represent descriptive approximations designed to achieve a coherence in relation to the academic transformations that have taken place. In the contexts in which they emerged, these approaches constitute ex-post models (Arocena and Sutz 2002), which, although they offer a useful study perspective, must be approached with caution in the case of scientifically and technologically lagging nations.

In Latin America, universities have evolved based on a trajectory derived from the University Reform Movement (URM) of the first half of the twentieth century. Unlike what had happened in the developed world, the URM was perhaps the first and only "academic revolution" in Latin America, and gave rise to an "original idea of university" which continues to have important repercussions (Arocena and Sutz 2005). As a result of the URM the Latin American universities defined themselves as entities of democratisation and social reform, guided by the activities of teaching, research and "extension", the latter being understood as direct participation in the resolution of social problems. These principles were adopted, to a greater or lesser extent, by nearly all Latin American public universities, and caused acute tensions between them and governmental and productive institutions. The universities were conceived as a platform for social debate, where relations with private firms were considered undesirable.

However, during the 1960s an ideological debate was generated in Latin America on the subject of science, technology and society, which attempted to legitimise a linkage between the universities with the productive sector. The most explicit and pragmatic result of this debate was the "Sábato Triangle" (Sábato and Botana 1968). This approach underlines the need to insert science and technology as engines of national development based on the coordinated action of three fundamental elements: government, the productive structure, and the science and technology infrastructure. The "Sábato Triangle" was fundamentally a normative approach, which provided general guidelines for science and technology (S&T)

policy. However, despite its influence in many national contexts, relations between governments, universities and industry did not develop, firstly because research was not consolidated as an university mission, and secondly because the economic characteristics of the environment were not the most amenable. Though there are differences within and between nations, the productive specialisation of Latin America has centred on traditional sectors with low technological content, whose innovation dynamics depend to a large degree on suppliers of goods and equipment located in other geographical contexts. An economic structure with this type of configuration does not produce demand from firms for university knowledge, and does not contribute to the establishment of common interests between the public research system and the productive sector (Azagra et al. 2006).

In the 1990s a change in Latin America's S&T policies took place, inspired by advances in the theory of innovation and by the analytical approaches produced by the experience of developed countries (Thomas et al. 1997). Models such as Systems of Innovation and the Triple Helix were adopted, in most cases without adequate critique or reflection, as normative frameworks that set the paths to be followed by Latin American universities.[1] Thus, in recent years the creation of innovation spaces (incubators, science parks, joint research centres) has become a central element in the Latin American rhetoric on the contribution of universities to socio-economic development, provoking tension in the universities between the external stimulus favouring a mode of linkage based on the principles of *academic capitalism* (Slaughter and Leslie 1997), and internal reticence, derived from the URM tradition, towards the adoption of any type of business practice.

It is within this context that this paper tries to answer the following questions: How does the Latin American academic community respond to the current debate on the production and transfer of knowledge to the productive sector? What are the implications for university transformations? To reply to these questions we analyse the perceptions of Bolivian lecturers in relation to four general aspects of university–industry relations (UIR) in their country. The first refers to universities' R&D activities and the possibility of cooperating with firms in this field. The second refers to lecturers' preferences in relation to activities designed to enable interaction with the productive sector. Both these aspects are related, and demonstrate how much coherence there is between the activities that academics say they are involved in and their preferences for firm interaction. The third aspect is related to the objectives pursued by lecturers through UIR and the factors that influence their valuation. The fourth and final aspect we examined relates to university mechanisms and services which, according to the academics, favour UIR. These mechanisms embrace both those supporting the management of UIR and those that directly or indirectly favour R&D.

Although Latin America is far from being a homogeneous region, we consider that the characteristics of the Bolivian university system (mainly a public and mass access model) permit us, on the one hand, to analyse the aforementioned tensions, and on the other to extrapolate the results obtained, with some restrictions, to a large part of the Latin American area.

Characteristics of the context

Bolivia has approximately 8.3 million inhabitants, according to the 2001 National Census, and a GDP per capita of less than 30% of the average for Latin America. Its economic

[1] In this sense, Thomas et al. (1997) have pointed out that (unlike what happened in the 1960s) during the 1990s a Latin American thought on science, technology and society hasn't emerged, but only an uncritical adoption of theories based on experiences of developed countries.

structure is such that the services sector contributes 52% of GDP, the manufacturing sector 18%, the primary sector 26% and construction 4%. The industrial structure of Bolivia is characterised by huge duality. On the one hand, micro and small firms employ 87% of the economically active population of the industrial sector and contribute 24% of national GDP, and on the other, large firms generate 65% of GDP and employ only 7% of the working population. Most firms belong to traditional economic sectors such as agrofood, timber and plastics and drinks, with a very sparse presence of firms in the knowledge-intensive sectors. Also, according to a study carried out by Mendoza (2002), at least 86% of the working population in Bolivia received no education or training in the state education system, which, added to the fact that only 5% of Bolivian researchers are to be found in firms, denotes poor capacity of the productive sector to incorporate available knowledge and technologies into its processes.

Expenditure on scientific and technological activities represented $US 46 million in 2001, 0.52% of GDP, a figure comparable to the 0.65% average for Latin America, but much lower than for the developed countries. In the same year, Bolivian scientific publications in SCI journals constituted 0.3% of the scientific production of Latin America and the number of (full time equivalent, FTE)[2] researchers was 1,000, less than 0.7% of the Latin American total (RICYT 2001).

In this fragile scientific and technological scene, universities are the most important agents. In recent years, these institutions have participated most in both the funding and the execution of R&D expenditure, with participation higher than the Latin American average.[3] Also, 70% of Bolivians researchers are in the universities, the remaining 30% being distributed across public research centres (15%), non-profit private organisations (10%) and only 5% in firms (5%).

An important characteristic of the Bolivian Higher Education System (BHES) is its mainly public nature. The 10 public universities, together with the country's two most important private universities, account for some 80% of university registrations, 8,000 lecturers (800 full time researchers) and 141 R&D centres (77% of the national total)[4] (Tellería 2001). In recent decades, these institutions have experienced some transformations derived from the changes in both models of economic development and the political regime. The 1980s saw the first manifestations of a process that transformed the higher education system from an elite access model to a mass access model.[5] Between 1982 and 1990 registrations in Bolivia rose from 60,000 to 100,000, and in 2002 about 300,000 students were enrolled in the higher education system in Bolivia. This process was mirrored in nearly all of Latin America, the only differences being that in some countries (e.g. Colombia, Chile, and Brazil) the increase in registrations was absorbed by private institutions, ending the state monopoly of university provision.

In the 1990s the process of transformation that had begun in the previous decade was consolidated, and a new pattern of convergence was generated in the model of university development, guided by the application of recommendations from international bodies

[2] This indicator is calculated based on only the proportion of each person's time that is dedicated to R&D per year.

[3] According to data from the Ibero-American Network of Science and Technology Indicators (RICYT), for the period 1999–2002, Bolivian universities financed more than 30% of R&D expenditure and conducted more than 40% of it; in Latin America as a whole these percentages were 20% and 38% respectively.

[4] These universities are grouped into the so-called Bolivian University System (BUS).

[5] The model of access to higher education is considered to be elitist when enrolment is lower than 15%, and massive when enrolment is between 15 and 35%.

(World Bank, Inter-American Development Bank) and characterised by a further reduction in state funding, which fell from 1 to 0.5% throughout Latin America. In this period, in Bolivia, as in all other Latin American countries, political actors were promoting a process aimed at institutionalising, strengthening and incentivising science and innovation as a basic strategy for national competitive development. In 1991, Supreme Decree 22908 was passed, creating the National System of Science and Technology, and the National Council for Science and Technology.[6] Ten years later, the first Law on Promotion of Science, Technology and Innovation was promulgated and in 2004, with the support of the Inter-American Development Bank, the Science, Technology and Innovation Plan 2004–2009 was formulated. However, the application of these policies has been very modest, due to the absence of specific mechanisms for political and economic support for R&D activities; for example, the 2004 Plan has never been put into practice. This situation has been repeated in most countries of Latin America, where very little of what is legislated or planned in these matters is actually put into practice.

Data and methodology

The data in the empirical analysis are from a survey of lecturers from four of the 10 public universities in the Bolivian University System (BUS). To guarantee a representative sample, the population analysed (approximately 5,000 Individuals) was segmented by lecturer scale (full lecturer, contracted lecturer, interim lecturer and guest lecturer), and the university to which they belonged. The sample represents 10% of the population and was selected by means of simple random stratified sampling. The questionnaire was sent by e-mail and followed up by telephone contact. A response rate of 70% was obtained and a data base was constructed that included 349 observations. The study was carried out between January and July 2002 and was supported by the National Department for Research, Science and Technology of the Bolivian University Executive Committee (CEUB).

The empirical study was designed taking account of the characteristics of the Bolivian academic community and its opinion on the linkages between the university and the productive sectors. This approach is congruent with other studies; see Lee (1996) for the USA and Azagra et al. (2006) for Spain. According to the information we wanted to elicit, we drew up a questionnaire that was structured in four blocks. The first block included general questions relating to personal characteristics (sex, age, and academic degrees), scientific discipline and the time dedicated to different academic activities. These latter two aspects constitute key classificatory variables in the analysis. In the second block, we asked about the development of R&D activities, their importance within the set of academic activities and the possibility of collaborating with firms in this field. The third block analysed the activities preferred by the lecturers for implementing UIR, and the objectives pursued through these interactions. The fourth block included questions about the most suitable mechanisms and university services for fostering UIR.

[6] Note the normative character of the proposal, which does not stop at energising or articulating the System, but **creates** it. This characteristic has been present in many of Latin America's S&T policies. In Colombia, for example, the 585 Decree of 1991 created the National Science and Technology System and four years later the National Innovation System. These attempts to create "Innovation Systems" reveal the ignorance of what this really means, being also an evidence of the above mentioned uncritical adoption of foreign models.

Table 1 presents the general characteristics of the sample. Forty per cent of the lecturers surveyed were between 40 and 50 years of age, followed by 32% who were under 40, which reflects the relative youth of the Bolivian academic community. Only 11% of the lecturers surveyed were women, most of whom were under 50. These figures show the recent inclusion of women into academia in Bolivia; they are increasing represented in the younger group.

In respect of academic qualifications, 57% of the lecturers in the sample held a bachelor's degree and only about 5% a doctorate. Fifty-one per cent of the academics are full lecturers (the highest category in the BUS), 36% are interim lecturers and the remaining 13% are contracted or guest lecturers. These last categories represent the lowest lecturer's

Table 1 Characteristics of the sample

Characteristics (number of observations)	Number of responses	Percentages
University (349)		
Univ1	207	59.3
Univ2	62	17.8
Univ3	19	5.4
Univ4	61	17.5
Sex (349)		
Man	310	88.8
Woman	39	11.2
Age (349)		
<40 years	111	31.8
40–49 years	139	39.8
≥50 years	99	28.4
Age v Sex		
Men <50 years	*218*	70.3
Women <50 years	*32*	82.1
Academic degree (349)		
Technical diploma	41	11.7
Engineers-graduates	198	56.7
Masters	94	26.9
PhDs	16	4.6
Lecturer scale (349)		
Full lecturer	179	51.3
Contract lecturer	39	11.2
Interim lecturer	125	35.8
Guest lecturer	6	1.7
Discipline (349)		
Engineering and technology	172	49.3
Exact and natural sciences	104	29.8
Social Sciences and humanities	73	20.9
Research activities (349)		
Carry out R&D	214	61.3
Teaching only	135	38.7

scales in the BUS, and imply a partial bonding of academics with their university, limited to the development of particular chair. Guest lecturers are generally linked to other institutions, educational or productive, and their participation in the academic world is brief and irregular. Both these features explain the low representation of this category in the sample selected.

Scientific disciplines were classified in three groups: engineering and technology (ENT), representing 49% of the sample, exact and natural sciences (ENS), representing 30%, and social sciences and humanities (SSH) which correspond to 21% of the sample. In the ENS group we included the disciplines of medical sciences and agrarian sciences in order to facilitate comparison with Lee's (1996) and Azagra's (2006) studies. A very high percentage of the lecturers that responded to the survey (61%) carry out some R&D activity, though with different levels of dedication in terms of time. This sample represents approximately 28% of the research population of the BUS and nearly 15% of the national total.

Results and discussion

UIR and R&D activities

As already indicated, one of the key aspects in the new dynamic of academic transformation is the active participation of the university in the processes of production and transfer of knowledge to the productive sector. This involves a substantial change in the university culture, which in the case of Latin American public universities is additionally problematic if we consider that the URM led to an isolated university model, not convergent with the interests of private firms.

Nevertheless, the data from our empirical study show that Bolivia's teaching community has aligned itself with international tendencies based on the acknowledgement of UIR as an academic activity. Ninety-three percent of the lecturers surveyed consider that the university should carry out R&D activities for firms, and indicated that this positive attitude is the result of a change in recent years.[7] These data show that the new patterns of academic transformation and new social demands—which in these contexts tend to be a response to political guidelines—have permeated the university world and demonstrated that a closer relationship with the productive sector is required.

Lecturers were also asked whether they carried out R&D activities and cooperated with firms in such activities. The number of positive responses was 61% and 48% respectively. Considering the characteristics of the BUS, these percentages would seem to be surprising. Nevertheless, although 61% of those surveyed were involved in R&D, on average, only 16% of their time was spent on them, in contrast to teaching which consumes 64% of their time.[8] This promotes unease in the academic community, which, for the most part, would prefer to reduce the time spent on teaching activities and increase by 100% the time devoted to R&D activities. This is a manifestation of the traditional dichotomy between teaching and research functions, and shows that in Bolivia universities have not made a

[7] Lecturers were asked whether 5 years ago they would have believed that the universities should carry out R&D activities for firms. 82% of respondents answered affirmatively. This percentage is 11 points lower than the current perception.

[8] The above percentages are lower than those found by Azagra (2003) for the Spanish case, where 89% of lecturers carried out R&D activities and devoted 30% of their time to them.

Table 2 Barriers to UIR

Barriers	Number of observations	Importance*
Insufficient institutional support	349	2.05
Lack of suitable firms for cooperation	349	1.85
Unfavourable internal atmosphere	349	1.85
No firms interest in university research	349	1.80
Lack of time due to teaching	349	1.67
Difficulties of communication with the firm	349	1.60
Consider UIR not one of their responsibilities	349	1.17
Lack of motivation	349	1.14
Average score		1.64

* Importance given to the different barriers to UIR, valued as follows: 0 (No importance); 1(Little importance); 2 (Fairly important); 3 (Very important)

complete transition to the research university model which was mooted in the first academic revolution.

R&D activities, moreover, are not institutionally consolidated, and most result from individual efforts that have neither the direction nor the backing of a clearly defined university policy. The 60% of lecturers engaged in R&D activities do so on an individual basis; they are not members of a stable research group or even an ad hoc group created for a specific project. This behaviour can play a negative effect on the progress of the academic research in Bolivia, owing to the importance of the collaboration in the development of this type of activities.[9]

Lecturers were asked to score a series of factors in order of importance that they saw as barriers to cooperation with firms in R&D activities, on a scale of 0 "no importance", 1 "little importance", 2 "some importance", 3 "very important". The results are presented in Table 2. The greatest barriers were internal factors related to insufficient institutional support and a university atmosphere unfavourable to cooperation. This result shows that the perceptions of the teaching community do not reflect an equally strong change at institutional level to that support and encourage the process of linkage with the productive sector. Lecturers identified also two closely interrelated external factors, in particular: absence of suitable firms to cooperate with, and lack of business interest in university research. These are a result of the productive configuration of Bolivia, which has a predominance of technologically undeveloped traditional sectors, in which R&D is not seen as a competitive tool.

Activities preferred for UIR

One key element in the pattern of linkages between universities and the productive sector is undoubtedly the identification of those activities preferred by lecturers for interaction with firms. In Bolivia, internship schemes to place student in firms, and technological advice

[9] Several authors have highlighted that collaboration is a key element to research units' performance. Osca et al. (2002) and Guimerá et al. (2005) found that the researchers that establish collaboration links with researchers within their units or with those from other research groups, use resources more efficiently and tend to publish in higher impact factor journals.

Table 3 Activities preferred by lecturers for interaction with firms

Activities	Number of observations	Percentage*
Student work experience in firms	349	0.62
Technological support and advice	349	0.62
Joint research	349	0.48
Contract research	349	0.38
Interchange of research personnel	349	0.33
Business training	349	0.21
Combined centres	349	0.16
Informal contacts	349	0.13
Licensing of patents	349	0.04

* The sum is greater than 1 because three options could be chosen

and support were seen by the academic community as the most valuable activities (Table 3). The first is one of the traditional ways of interacting and is widely accepted and seen as an activity that complements the training process, and which allows students to confront and solve (with the help of their lecturers) real problems posed by the firms.

The second activity, providing advice and support, is a particular feature of UIR not only in Bolivia but in most other Latin American countries where technological weakness in the productive sector, and the low level of development of university research have produced a vicious circle constituted of a process of linkages based on activities of low scientific content. As Arocena and Sutz (2005) point out, that in Latin America, a "consulting university" rather than an "entrepreneurial university", is developing which carries out routine activities for firms with the aim of obtaining additional economic resources to make up the deficit in public funding.

It was noticeable that informal contacts scored very low, despite being the basis for the majority of current efforts. This may be because academics do not rate informal relationships very highly, and prefer to give an institutional character to their various contacts. Finally, the interaction activity rated lowest by lecturers was patent licensing, which is not surprising given the negligible number of patents in Bolivia.

Objectives pursued by UIR

The survey questioned lecturers about the importance of cooperation with firms for the development of: oriented research in universities, participating in the economic development of the region, intensifying the commercialisation of the results of academic research, creation of firms derived from university research, obtaining additional funding for R&D activities, and adapting teaching programmes. These aspects were valued on a three point scale: 0 "low or no importance", 1 "medium importance" and 2 "high importance". Some of the aspects considered are objectives of UIR based on greater intervention by universities in the development of their socio-economic environment, while others are more traditional academic community objectives. Our aim was to determine to what extent the Bolivian academic community's perception of relationships with firms was convergent with the linkages in developed countries.

Table 4 shows the aggregate results of the responses. For lecturers, the aspects where UIR is most prominent are: oriented research (1.28), participating in regional economic

Table 4 Objectives that support UIR

Objectives	Number of observations	Support*
To favour oriented research	349	1.28
To participate in economic development	349	1.20
To obtain funding for R&D	349	1.17
To adapt teaching programmes	349	1.14
To favour the creation of firms	349	1.06
To intensify the commercialisation of the results of academic research	349	0.93
Average score		1.13

* Importance given to the different objectives of UIR, valued as follows: 0 (No, or low, importance); 1(Medium importance); 2 (High importance)

development (1.20) and obtaining additional funding for R&D activities (1.17). These results reflect the development of a favourable attitude towards the search for practical benefits deriving from academic activities, which could be assimilated, to some extent, within the production of knowledge in the "application context". The scoring for seeking additional funding, as is the case in developed countries, seems to have been influenced by the reduction in public funding of scientific activities, which is forcing universities to seek economic support in the productive sector. However, commercialisation of the results of academic research and the creation of firms were the least valued objectives of UIR in our survey, indicating the limits, from the teaching perspective, to the privatisation of knowledge. This demonstrates that, even though in academia perceptions of cooperation with firms have improved, there is a certain reluctance among universities to the adoption of direct business practices. These results agree with Lee's (1996) and Azagra's (2006) findings, and reflect the general tension in universities in relation to reaching an equilibrium in the adoption of new patterns of linkages based on market dominated relations, and preservation of the academic values developed during the last century.

A particular characteristic of the Bolivian academic community is seeing the adaptation of teaching programmes as fulfilling an objective of UIR, and being almost as important as obtaining resources for the development of R&D activities. This did not emerge in Azagra's (2006) results for the Spanish case, and is a product of the traditional importance of teaching among the academic functions of universities in Latin American.

As well as identifying the objectives of UIR, we wanted to determine the aspects that influence their valuation. For this purpose we defined the following econometric model:

$$Objectives_i^d = f(University_i, Sex_i, Academic\_degree_i, Management_i, Prestige_i, Discipline_i, Activity_i, R\&D_i, R\&DF_i, Univ\_Policy_i,)$$

where i = 1,...,N (number of observations); d = 1,…, D (number of objectives);

The dependent variable is represented by the different objectives of UIR. We took general aspects relating to the university to which the lecturer belongs, the lecturer's personal characteristics, the discipline, the academic activities carried out, and university policy as explanatory variables. The description of these variables is presented in Table 5

Taking into account that the dependent variables could take three possible values, we used ordinal logistical regression as the technique of estimation (Peterson and Harrell 1990). Table 6 shows the results of the estimation of the model.

Table 5 Econometric model variables

Category	Variable	Scale of measurement	Mean	Error
University	Univ1	Dichotomous: 1–0	0.59	0.03
	Univ2	Dichotomous: 1–0	0.18	0.02
	Univ3	Dichotomous: 1–0	0.05	0.01
	Univ4 (reference)	Dichotomous: 1–0	0.17	0.02
Lecturer characteristics	Sex	1(man) and 0 (woman)	0.89	0.02
	Academic_degree	0 (Technical Diploma), 1 (Engineer - graduate), 2 (Master's or PhD degree).	1.19	0.03
	Management	1 (the lecturer holds a managerial post), 0 (otherwise)	0.29	0.02
	Prestige	1 (if more than 50 years old, more than 10 years' teaching experience and is a Full Lecturer)	0.21	0.02
Discipline	Exact and natural sciences (ENS)	Dichotomous: 1–0	0.30	0.02
	Social sciences and humanities (SSH)	Dichotomous: 1–0	0.21	0.02
	Engineering and technology (reference)	Dichotomous: 1–0	0.49	0.03
Activity	Regulated teaching (reference)	Percentage of time dedicated to scheduled teaching	54.47	1.45
	Unregulated teaching (UT)	Percentage of time dedicated to unscheduled teaching	8.71	0.73
	Research and development (R&DT)	Percentage of time dedicated to R&D activities	16.52	1.12
	Management	Percentage of time dedicated to managerial activities	11.33	0.93
	Others	Percentage of time dedicated to activities other than the above	8.98	0.79
	R&D	1 (Habitually does R&D) 0 (Otherwise)	0.64	0.03
	R&DF	1, if he/she considers that the university should do R&D for firms; 0, Otherwise	0.93	0.014
	Univ_Policy.	1 (university policy favourable to cooperation) 0 (policy irrelevant or unfavourable)	0.28	0.02

Table 6 Results of the ordinal logistic regression analysis

Explanatory variables		Oriented research		Participate in development		Commercialisation		Creation of firms		Additional funding		Adapt teaching	
		Coefficient B	Exp. B	Coefficient B	Exp. B	Coefficient B	Exp. B	Coefficient B	Exp. B	Coefficient B	Exp. B	Coefficient B	Exp. B
	μ_0	0.698	1.133	0.525	0.660	0.963	2.027	0.421	0.446	–0.156	0.060	0.859	1.879
	μ_1	2.174***	10.668	2.175***	10.985	2.288***	11.182	1.673***	6.926	0.916	2.072	2.416***	14.284
University	Univ1	0.015	0.002	0.164	0.231	0.058	0.029	0.399	1.443	–0.094	0.074	0.422	1.598
	Univ2	–0.396	1.038	–0.279	0.542	–0.399	1.128	0.033	0.008	–0.386	0.996	–0.265	0.512
	Univ3	0.068	0.015	–0.223	0.171	–0.989*	3.011	–0.272	0.265	–0.375	0.483	–0.165	0.099
Lecturer characteristics	Sex	–0.322	0.711	–0.480	1.637	–0.462	1.622	–0.269	0.549	–0.443	1.335	0.218	0.363
	Academic degree	0.226	1.299	0.143	0.550	–0.031	0.027	–0.048	0.063	0.139	0.512	–0.149	0.607
	Management	0.428	2.531	0.544**	4.274	0.323	1.572	0.310	1.474	0.656***	6.044	0.390	2.282
	Prestige	–0.339	1.554	–0.108	0.163	–0.477*	3.135	–0.486*	3.351	–0.520**	3.692	–0.276	1.071
Discipline	ENS	0.098	0.138	0.028	0.012	0.336	1.724	0.205	0.655	0.205	0.620	0.520**	4.151
	SSH	–0.560**	3.592	–0.160	0.302	0.232	0.639	–0.050	0.030	–0.295	1.011	0.698***	5.626
Activity	UT	0.005	0.363	0.003	0.103	–0.012	1.960	0.009	1.160	0.009	1.042	0.015*	3.219
	R&DT	0.008	1.095	0.009	1.509	0.004	0.347	0.009	1.488	0.006	0.615	0.006	0.738
	Management	–0.002	0.071	–0.008	1.098	0.011	2.177	0.003	0.188	–0.002	0.046	0.005	0.425
	Others	0.001	0.020	0.000	0.001	0.005	0.376	–0.001	0.014	–0.014*	3.443	0.000	0.000
	R&D	–0.011	0.001	–0.087	0.089	0.073	0.064	–0.017	0.003	–0.047	0.026	–0.012	0.002
	R&DF	2.03***	19.491	1.943***	18.005	1.668***	10.736	0.907**	4.313	1.040***	5.738	1.140***	7.001
	Univ_Policy.	0.599***	5.634	0.435*	3.190	0.396*	2.763	0.469**	3.849	0.373	2.298	0.304	1.589
	Observations	337		337		337		337		337		337	
	Chi-squared (gl)	48.430 (16)		40.421 (16)		41.133 (16)		25.944 (16)		33.220 (16)		32.065 (16)	
	Pseudo R^2	13.4		11.3		11.5		7.4		9.4		9.1	

* Significance at 10%; **Significance at 5%; ***Significance at 1%

The influence of the university variable was analysed taking as the reference the oldest university, and therefore the one with the longest tradition within the sample considered. The results indicate that none of the universities presents a significant effect, either positive or negative, in comparison with the reference university. Thus it can be said that the value placed on the different objectives of UIR seems to be a generalised perception among the Bolivian academic community, regardless of which university is being considered. Nevertheless, it should be remembered that only public universities were included in the study, and it is possible that there may be differences among private institutions.

In relation to the personal characteristics of lecturers, only two variables show a significant effect: management and prestige. The lecturers that hold managerial posts are more likely to support participation in regional development and the obtaining of additional funding for R&D activities. On the other hand, prestige exercises a significant and negative influence on the support given to the objectives of commercialisation, creation of firms and obtaining of additional funding for R&D activities. For the remainder of the objectives considered, the estimated coefficients of the variable prestige are negative, though not significant. This result indicates reluctance among lecturers increasing with age and experience, and higher position in the university, to support the different objectives of UIR, i.e. they do not consider that linkages with the productive sector will bring substantial benefits for the development academic activities. This is understandable if we consider that these lecturers have lived for longest with the "original idea" of the Latin American University and are therefore those for whom the new dynamic of linkages with the environment represents an important ideological change.

Measured by scientific discipline, the *ENS*, and *SSH*, are shown to be more supportive of the adaptation of teaching programmes than the discipline of ENT, which was selected as the reference variable. Also, SSH have a negative influence on the objective of favouring oriented research. These results agree with some of the findings in Lee (1996) and reveal that the disciplines with a more basic orientation value relationships with the productive sector basically as an instrument for updating and improving teaching, whether through the interchange of knowledge or the perfecting of methods of learning.

Unexpectedly, neither conducting R&D activities (*R&D*) nor the time devoted to them (*R&DT*) influences the valuation of the different objectives of UIR. This shows that the idea of UIR is valued similarly by the lecturers involved in R&D and those fully dedicated to teaching.

Finally, both the lecturers that considered that the universities should carry out R&D activities for firms (*R&DF*) and those that thought that university policy favours cooperation (*Univ_Policy*), supported the different objectives derived from UIR. This result shows that the greater the institutional support for university links with the productive sector, the more favourable to this objective are the lecturers.

Mechanisms and services of promotion of UIR

The fourth aspect investigated in this study was the mechanisms and university services were most effective, from the lecturers' points of view, at promoting the linkage of universities with industry. In relation to mechanisms, the results show that Bolivian lecturers consider that mechanisms aimed directly at the promotion of UIR were more effective than those oriented towards the strengthening of R&D activities. The former included such mechanisms as the development of government policies and the creation of a body of coordination between the universities and business, which were valued more highly than

the hiring of qualified personnel to carry out R&D activities (Table 7). These results, although seem to be counter-intuitive, are in line with the activities preferred by lecturers for interaction with firms. Owing to the fact that in this context the UIR are not based on research activities, for Bolivian lecturers the strengthening of the universities' scientific capacities does not constitute a key element in the promotion of UIR.

Among the mechanisms seen as least valuable were endowment of more resources from the Universities' Directorates of Research, Science and Technology (DICYT), and the presence of their personnel in the faculties. If we take into account that lecturers maintained that the universities' resources for the promotion of UIR were sparse, the above results indicate that the present DICYTs are considered to be inefficient structures.

In relation to university services, lecturers prefer instruments such as information on public aid, both national and international, oriented towards the encouragement of UIR, and the design of an explicit normative framework. Services allied closely with negotiation processes, such as contracts or management of patents, were seen as less valuable (Table 8). This result reflects the fact that when UIR is at an early stage of development, mechanisms that are more general than specific are favoured; specific actions imply a higher degree of difficulty.

Table 7 Mechanisms for promoting UIR

Mechanisms	N	Effectiveness*
Government policies	349	0.96
Coordinating body	349	0.93
S&T Park	349	0.82
Joint institutes	349	0.81
UIR support personnel	349	0.68
R&D personnel	349	0.68
More resources for DICYT	349	0.64
DICYT personnel in faculty	349	0.58
Average score		0.77

* 0 (no or low effectiveness), 1 (quite effective) and 2 (very effective)

Table 8 UIR promotion Services

University Services	N	Importance*
Information on international aid	349	2,22
Information on public aid	349	2,10
Explicit and adequate regulatory framework	349	1,99
Search for firms	349	1,98
Effective and flexible economic/administrative Management	349	1,92
Creation of firms	349	1,78
Support for preparation of project proposal	349	1,77
Management of patents	349	1,68
Negotiation of contracts	349	1,63
Average score		*1,90*

* 0 (Unimportant), 1 (Low importance), 2 (Medium importance) and 3 (High importance)

Conclusions

The academic transformations that have occurred in the industrialised countries have led to universities becoming more aggressive agents of regional development and adopting functions that go beyond the traditional fields of teaching and research. However, in Latin America the dynamic has been different, partly because of the way they have evolved and partly due to the characteristics of their environment. Thus, before forcing a process of transformation on the universities in Latin America that is based on the new patterns emerging within universities in industrialised countries, an assessment should be made of whether the conditions of the Latin American context are appropriate for the adoption of such changes.

The results of this study raise serious doubts in this respect. Lack of consolidation of research as a university activity, reluctance among the teaching community to adopt business practices, and weak demand for technological knowledge and low absorptive capacity in the productive sector, make it difficult for countries such as Bolivia (and most other Latin American countries) to strengthen UIR under the same conditions prevailing in the developed countries.

While in developed country contexts UIR is based on the commercialisation of the results of scientific research, i.e. a process based on the direct contribution of universities to innovation activities, in Bolivia lecturers prefer to interact with the productive sector through such practices as student work experience in firms, and provision of technological advice and support. The adaptation of the public universities in Bolivia, and probably in most of Latin America, to the needs of the market, has negatively affected the consolidation of research as an academic activity. This has created a vicious circle: the universities do not produce new knowledge that can be offered to firms, and at the same time firms do not demand it, so that UIR is driving these universities to become "consulting universities".

Evidence from the Bolivian teaching community, however, shows that there is a broad and growing acceptance of UIR. It would seem that the attitudes deriving from the URM, which actively discouraged any attempt to commercialise knowledge, or forge any direct linkages with private firms, are disappearing. The changes are gradual, and are less obvious among those lecturers with longer experience and more senior positions in the universities. University policies, however, have defied change, and lecturers find them to be one of the most important obstacles to cooperation with firms.

Acknowledgement by many academics of the internal and external barriers to furthering UIR demonstrates that UIR is a phenomenon that is subject not only to the dynamic of the university institution, but also to the socio-economic characteristics of its environment. Though it may seem obvious, this aspect has often been overlooked by recent Latin American S&T policies, which, based on the successful experiences in other contexts, have focussed on the promotion of academic transformation, taking little account of their particular productive contexts. Governments, which have an important role to play as facilitators and promoters of UIR, should therefore refrain from blindly copying foreign models and define linkage strategies that accord with local socio-economic conditions.

It should not be about copying the most recent successful mechanisms in whatever developed country, but about laying down the foundations to enable subsequent facilitation of a suitable framework for the effective development of UIR, that is in harmony with the historical evolution of the universities. Bolivian lecturers agreed that one of the most appropriate mechanisms to foster UIR would be the introduction of university policies that create a favourable institutional framework, facilitate contracting with the productive

sector, and offer academics the possibility of devoting more time to research activities. Lecturers place a higher value on services of a general character than those related to complex linkage mechanisms. Thus, the development of hybrid structures is not widely favoured, because, among other reasons, they are based on socio-economic circumstances that are very different from those found in countries such as Bolivia.

Finally, we would underline that most of the literature on UIR in Latin America is abstract and qualitative in nature, in part due to the difficulty of obtaining quantitative information directly from the agents involved in the process. Therefore, as far as we know, this study constitutes a first attempt to analyse empirically how the Latin American academic community responds to the current debate on the creation and transfer of knowledge and its implications in the process of linkage of universities with the environment.

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