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The influence of academic staff's personal and professional characteristics on the decision to cooperate with industry

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Abstract: University–industry cooperation is important for economic development, particularly at the regional level. Despite this relevance, there is still a lack of understanding regarding the underlying factors that drive the transfer of knowledge and technology. Therefore, this research aims to identify factors related to academic staff's personal and professional characteristics that influence the decision to cooperate with industry. To attain this objective, we built up a unique dataset of academic staff, based on a survey of the total population of a higher education institution in Portugal. Based on a logistic regression, the results reveal that variables such as gender, age and the school influence academic staff's propensity to cooperate with the business sector. We present theoretical and practical implications for academics, policy-makers and practitioners.

Keywords: university–industry cooperation; knowledge and technology transfer; academic staff; Portugal.

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1 Introduction

In the economic literature, it is widely recognised that a country's development, in terms of innovation and productivity is greatly influenced by the character and intensity of interaction between the science and business communities (Debackere and Veugelers, 2005). Scientific knowledge is seen as an important contributor to technological progress (Etzkowitz, 1998; Feldman, 1999). In this context, universities are considered the main sources of up-to-date knowledge and technology. Particularly at the regional level, they have become important drivers of economic development and growth (Bleaney et al., 1992; Etzkowitz, 2001). How universities can contribute to economic progress and structural change, especially in their immediate proximity, is illustrated by some outstanding examples (e.g., Chrisman et al., 1995; Feldman and Desrochers, 2003; Marques et al., 2006; Hsu et al., 2007; Bramwell and Wolfe, 2008).

The interaction between universities and industry can take a variety of forms. These include both direct and indirect mechanisms (Guenther and Wagner, 2008) and depend on resource deployment as well as the length and formality of agreements (D'Este and

Patel, 2007). Changes in the institutional framework have facilitated such cooperation (Geuna, 2001; van Looy et al., 2003; Wright et al., 2004; Guenther and Wagner, 2008). Research in various sectors of activity suggests that the interaction between universities and industry has intensified over time (Etzkowitz, 1998; Debackere and Veugelers, 2005; D'Este and Fontana, 2007; Giuliani et al., 2010).

Nevertheless, there is still a lack of understanding of the underlying factors that drive university–industry linkages. In particular, some studies have explored the issue of the individual attributes of university researchers who work with the private business sector (e.g., Lee, 2000; D'Este and Fontana, 2007; D'Este and Patel, 2007; Landry et al., 2007; Bekkers and Bodas Freitas, 2008; Bercovitz and Feldman, 2008; Boardman and Ponomarev, 2009; Giuliani et al., 2010). However, in empirical terms, the question as to how the characteristics of academics influence collaboration remains underexplored and inconclusive. Consequently, our paper aims to fill this research caveat.

More precisely, the objective of this study is to identify factors related to academic staff's personal and professional characteristics that have an influence on the decision to cooperate with industry. To this end, we selected as the context of analysis a Portuguese higher education institution, the Polytechnic Institute of Bragança. In this way, we contribute to a better understanding of university–industry cooperation, in order to design effective policies and measures to foster the universities' role in economic development.

The remainder of the paper is organised as follows: Section 2 presents a literature review in order to determine the factors which may influence university–industry cooperation. Section 3 describes the methodology followed in carrying out this study. Section 4 analyses and discusses the data obtained. Finally, Section 5 presents some conclusions, implications and suggestions for future research.

2 Theoretical background

2.1 University–industry cooperation

The propensity to collaborate with industry is embedded in the university context, which can both facilitate and constrain the links between these spheres. Thus, institutions are an important determinant in this cooperation process. Drawing on research within the conceptual framework of this approach, our study refers to the Institutional Economic Theory (North, 1990; North, 2005) applied to the analysis of university–industry cooperation. North defines an institution as any type of rule or norm designed to enable human interaction. From this institutional perspective, it is the socio-cultural environment within the university that determines whether or not a member of academic staff cooperates with the private business sector.

In this connection, the university has greatly changed over the last decades, with academics leaving the traditional 'ivory tower'. This change is largely due to the political will of various governments (Henkel, 2007). From the 1980s, there has been growing concern about economies' competitiveness and the commercial exploitation of scientific research generated within academia has become a focal point in pondering the role of the universities (Etzkowitz, 1998; Vallas and Kleinman, 2007). Many countries have tried to strengthen economic growth through universities being linked to the business sector, in this way providing an exchange of knowledge (Henkel, 2007; Acworth, 2008). In their seminal papers, Etzkowitz and Leydesdorff (2000) and Etzkowitz (2001) describe this development as the 'second academic revolution'.

The institutional framework of academia has witnessed some major changes in order to facilitate university–industry cooperation. Such initiatives are found at the global level, including above all the introduction of laws to stipulate knowledge and technology transfer, the attribution of intellectual property rights to the university and permission for staff in the public sector to collaborate with private businesses (Geuna, 2001; van Looy et al., 2003; Wright et al., 2004; Guenther and Wagner, 2008). At the same time, public policy is moving towards increasing the incentives for academic staff to produce knowledge with commercial value, as an alternative form of financing academia (Powell and Owen-Smith, 1998; Kenney and Goe, 2004; Henkel, 2007). Needless to say, the intensity of these changes has been forming the working behaviour of academics over the last years (Geuna, 2001; Lam, 2010).

Researchers at universities are now challenged to cooperate with industry for several reasons. Firstly, faced with the reduction in public funding, academic staff have to find firms to finance their research. In fact, in a study among university faculty members in the United States, Lee (2000) found that the most significant drivers are securing funds for research assistants and lab equipment. Secondly, acquiring third party funding enhances reputation. Thirdly, due to fixed-term positions in the university, researchers must seek out career opportunities outside academia. According to Lam (2011), this situation may even result in a ‘virtuous circle’ of attracting promising young researchers to laboratories in the private sector rather than in academia. In general, Wright et al. (2004) advocate that knowledge and technology transfer should not necessarily be assessed only by the economic return for the university, but also by the social and economic benefits for the general public such as the spread of knowledge.

Consequently, the question of how the interaction between industry and universities functions is an important issue. Several studies have examined different forms of knowledge and technology transfer mechanisms. They comprise the exchange of codified academic research results in the form of publications, licensing and patents (e.g., Agrawal and Henderson, 2002; Stephan et al., 2007; Lach and Schankerman, 2008). Interestingly, with regard to publications, Bekkers and Bodas Freitas (2007) examined knowledge transfer channels in the Netherlands and found that both university and industry Research and Development (R&D) performers attached very similar importance to scientific and professional publications.

Other frequently cited proxies for university–industry cooperation are basic and applied R&D projects, meetings and conferences, student, graduate and researcher mobility, consultancy and training, joint supervision of final degree theses as well as informal contacts (Freeman, 2000; Rynes et al., 2001; Cohen et al., 2002; Mora Valentin, 2002; D’Este and Fontana, 2007; D’Este and Patel 2007; Bekkers and Bodas Freitas 2008; Wright et al., 2008). Moreover, academic start-ups are becoming increasingly important as a transfer mechanism (Di Gregorio and Shane, 2003; Guenther and Wagner, 2008). For the purposes of our paper, we conceive university–industry cooperation as a wide-ranging activity, covering both codified and non-codified transfer mechanisms.

2.2 Characteristics of academic staff

In light of these numerous possibilities for interaction between universities and industry, the literature has identified a broad range of factors influencing the probability of such cooperation. Among them, D’Este and Patel (2007) found that the characteristics of

individual members of academic staff are more relevant in explaining the variety of links than those of the department or university. However, according to Boardman and Ponomariov's (2009) premises, there is sometimes a substantial individual-level variation amongst university scientists that governs interaction with the private business sector. Consequently, our study addresses the importance of academic staff's individual characteristics.

Regarding academics' personal characteristics, age is a determining variable for the propensity to collaborate with industry. However, the existing empirical evidence is quite mixed and far from being conclusive. Classifying the existing literature leads to the identification of two opposing streams. On the one hand, there is the argument of experience. Older academic staff have accumulated more skills and competences which are useful for industry. Levin and Stephan (1991) say that older university scientists may be more likely to capitalise on their reputation, and the need to publish becomes less as age increases, allowing older academic staff to dedicate more time to working with industry. In fact, Landry et al. (2007) examined Canadian universities and found that a researcher's years of experience in research after completing their PhD are significantly and positively related to engagement in knowledge transfer activities.

On the other hand, some studies present opposing arguments. Bercovitz and Feldman (2008) surveyed faculty members of two medical schools in the United States, in which younger academic staff were more likely to be involved in university technology transfer, as they were already trained under the premises of interaction between both spheres. D'Este and Patel (2007), in their study among academic researchers in the UK, found that the younger the researcher the higher the probability of engaging in a greater variety of collaboration with industry, particularly in applied disciplines. According to these scholars, such collaboration contributes to enhancing the scientist's reputation. Giuliani et al. (2010) collected data from researchers in wine-related areas in Italy, Chile and South Africa. They likewise detected that that younger researchers are more likely than their older colleagues to form university–industry linkages, which can be explained by the fact that younger university scientists conceive such industrial links as an inherent part of the research mission.

Then again, Boardman and Ponomariov (2009) analysed the characteristics of a sample of scientists interacting with the private sector in the United States and found rather mixed effects for age. According to these authors, older academics are more likely to have worked with industry on patents and co-authored papers, whereas younger scientists are more receptive to industry contacts and requests for information. To sum up, the available empirical evidence is quite heterogeneous, which does not allow us to make predictions about the influence of age on university–industry cooperation.

Another contingency factor on the propensity to collaborate with industry is academic staff's gender. As women have a harder time entering the male-dominated academic environment (Cole, 1981) and do not progress in academic careers as much as their male counterparts due to structural constraints (Long et al., 1993), there is likely to be a gender gap in university–industry cooperation. Some studies have addressed this issue, and their outcomes do not present a clear-cut picture. Kyvik and Teigen (1996) detected that female academic staff interact less with people outside their organisation and tend to have lower collaboration rates in general. In the study by Landry et al. (2007), being male was one of the explanatory variables significantly and positively related to knowledge transfer.

Relativising these clear-cut findings to a certain extent, Buttel and Goldberger (2002) and Boardman and Ponomarev (2009) found that at least in certain types of interaction with industry, male scientists have significantly more links. The latter scholars add that paid consultancy, placing graduate students in jobs in industry, entrepreneurial activities and commercialising research working with industry personnel are male-dominated areas of cooperation. However, Gulbrandsen and Smeby (2005), studying tenured university professors in Norway and van Rijnsoever et al. (2008), focusing on scientific employees at a Dutch university, had gender as a control variable in their analyses of university–industry cooperation and did not reveal noteworthy gender differences. Interestingly and contrary to the majority of studies, Giuliani et al. (2010) controlled for age and found a higher propensity among women to establish links with industry. Thus, in light of these considerations we are not able to hypothesise on the influence of gender.

Besides the personal aspects which might influence the probability of academic staff collaborating with industry, there are certain indications that professional characteristics also play a role in this process. However, the empirical evidence in this regard is also ambiguous, presenting arguments for both a positive and a negative influence of academic staff's level of formal education.

Klofsten and Jones-Evans (2000) stated that the level of formal education determines academic staff's cognitive background and, at the same time, fosters attitude and propensity to work with industry. With respect to spin-off creation and patenting activities, such a relationship seems to exist (Levin and Stephan, 1991; Azoulay et al., 2009). Due to better analytical and methodological skills, Giuliani et al. (2010) suggest it appears likely that academics with a PhD will raise more research funding from industry than scholars with lower level degrees, and therefore collaborate more intensively with industry. In their study, D'Este and Patel (2007) brought to light the fact that academic status always had a significant and positive impact on the variety of interaction with industry.

Nonetheless, Giuliani et al. (2010) suggest it may also be possible that academic staff with higher degrees and higher scientific quality focus more on 'blue-sky' research and publishing research outcomes in scientific journals, rather than cooperating with industry. In fact, having a PhD was not statistically significant in their research. Then again, Landry et al. (2007) scrutinised the influence of the level of seniority in academic ranks, building up the argument that senior scientists may be induced to invest a larger fraction of their time and resources in knowledge transfer. Nevertheless, these authors did not find a link between seniority and knowledge transfer engagement. Faced with this mixed evidence, we leave our assumption open concerning the influence of the level of formal education on university–industry cooperation.

Regarding professional background, the school or faculty academic staff belongs to might also be influential. We can expect applied and technology-based areas to show a higher propensity to collaborate with the private business sector. Here, the empirical results are more coherent. Meyer-Krahmer and Schmoch (1998) found such interaction to be more important in science-based technologies. Both Landry et al. (2007) and D'Este and Patel (2007) revealed that engineering researchers showed the highest levels of engagement in knowledge transfer and industry linkages.

Besides the academic discipline, another education-related variable that might trigger university–industry cooperation is the supervision of student work placements by academic staff. Such work placements are an important pedagogical measure, as they allow the practical application of knowledge and gaining experience and skills in the

‘real’ world. Through the supervision of work placements, academic staff are in contact with industry, and this is likely to facilitate university–industry cooperation leading to mutual knowledge and technology transfer. However, the empirical evidence concerning these aspects is weak, and we would like to identify such potentially determining factors in our research.

3 Methodology

3.1 Research design and data

In order to identify the characteristics of academic staff which might influence university–industry cooperation, we decided on a quantitative method. In doing so, we gathered data from a questionnaire applied to the population of all academic staff at a higher education institution in Portugal, the Polytechnic Institute of Bragança (IPB). IPB is a public polytechnic university established in 1979. In the academic year 2010/2011, IPB had a total of 7.437 students distributed over five schools: (a) School of Technology and Management (ESTIG); (b) School of Agriculture (ESA); (c) School of Education (ESE); (d) School of Health (ESSA) and (e) School of Communication, Administration and Tourism (ESACT). The university offers more than one hundred undergraduate and master programmes as well as specialisation courses.

The study covered the entire population of academic staff at IPB ($N = 519$), distributed over the five schools of the university. For data collection, we used the questionnaire method. The questionnaire we developed included items about the dimensions to be analysed, i.e. detailed questions about the type of academic staff involvement in cooperation with industry, the geographical area of these links and also socio-demographic factors that might influence cooperation.

The questionnaire underwent pre-testing with five academic staff at IPB, in order to determine its consistency and reliability. We asked them to fill in the questionnaire and to provide their opinions on its completeness and clarity as well as on the time needed to complete it. Afterwards, the questionnaire was electronically distributed to all academic staff at IPB in April 2011, with one reminder in May 2011. In total, we received 123 valid questionnaires, yielding a response rate of 23.7%. Table 1 shows the overall population and the sample, classified by the five schools of IPB.

Table 1 Population and sample

<i>School</i>	<i>N</i>	<i>n</i>	<i>Percentage</i>
School of Technology and Management (ESTIG)	151	48	31.8
School of Agriculture (ESA)	96	29	30.2
School of Education (ESE)	114	21	18.4
School of Health (ESSA)	87	12	13.8
School of Communication, Administration and Tourism (ESACT)	71	13	18.3
Total	519	123	23.7

3.2 *Measurement and data analysis*

We used the following independent variables: gender, age, academic qualifications, the school and supervision of work placements in the private business sector. Like Giuliani et al. (2010), we included age squared in our analysis in order to assess non-linear and marginal effects of age.

For the dependent (or explanatory) variable, we employed a binary (or dichotomous) scale to determine academic staff's engagement in a given set of university–industry links, which is 1 if the member of staff participates at least in one of these collaborations or 0 if not. As for the particular types of university–industry cooperation, in line with D'Este and Patel (2007), we examined joint publications as well as meetings and conferences with industry. Furthermore, we consider basic and applied R&D projects, patents and licensing as well as the joint supervision of theses. From our literature review in Section 2.1, we believe these links are particularly relevant in knowledge and technology transfer.

For data analysis, we firstly provide descriptive statistics for the variables concerning IPB academic staff's characteristics and their cooperation with industry. Then the variables were subjected to a logistic regression. This estimation process assesses the relative weights and significance of the independent variables in influencing the probability of university–industry cooperation. As our dependent variable is of a dichotomic nature, the logistic regression appears to be the most appropriate procedure.

4 **Findings and discussion**

4.1 *Descriptive statistics*

In this section, we provide a description of the academic staff's characteristics and investigate commonalities and differences among the five schools within IPB. As already shown by Table 1, the School of Technology and Management and the School of Agriculture provided most respondents. Classified by Schools, Table 2 summarises academic staff's personal and professional characteristics as the explanatory variables in our research. With regard to our dependent variable, this also contains the number of academics cooperating with industry and the respective percentages.

In the responses making up our sample, the School of Technology and Management and the School of Agriculture have the highest percentage of male academics and the School of Education and the School of Health most female academics. These results show that at IPB, the male respondents surveyed are more prevalent in the technological disciplines. Overall, a high percentage of staff surveyed is aged between 36 and 45 years, with the School of Agriculture having the oldest academic staff in our sample. This situation is probably influenced by the fact that the School of Agriculture was the first school of IPB. In the total number of respondents, concerning academic qualifications, Master and PhD degrees are most frequent, with the School of Agriculture having the relatively most highly qualified academic staff. Supervising student work placements as a potential antecedent of university–industry cooperation was frequently found in the overall sample, with the School of Communication, Administration and Tourism and the School of Technology and Management presenting the largest shares.

Table 2 Academic staff characteristics

	<i>Technology and management</i>	<i>Agriculture</i>	<i>Education</i>	<i>Health</i>	<i>Communication, administration and tourism</i>	<i>Total (n = 123)</i>
<i>Age</i>						
<25 years	0 (0.0)	1 (3.4)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.8)
26–35	8 (16.7)	4 (13.8)	11 (52.4)	7 (58.3)	7 (53.8)	37 (30.1)
36–45	32 (66.7)	11 (37.9)	6 (28.6)	3 (25.0)	6 (46.2)	58 (47.2)
46–55	5 (10.4)	13 (44.8)	2 (9.5)	2 (16.7)	0 (0.0)	22 (17.9)
>56	3 (6.2)	0 (0.0)	2 (9.5)	0 (0.0)	0 (0.0)	5 (4.1)
<i>Gender</i>						
Male	33 (68.7)	16 (55.2)	3 (14.3)	2 (16.7)	7 (53.8)	61 (49.6)
Female	15 (31.3)	13 (44.8)	18 (85.7)	10 (83.3)	6 (46.2)	62 (50.4)
<i>Academic qualifications</i>						
Graduate	0 (0.0)	0 (0.0)	4 (19.0)	3 (25.0)	2 (15.4)	9 (7.3)
Post-graduate	1 (2.1)	0 (0.0)	1 (4.8)	0 (0.0)	1 (7.7)	3 (2.4)
Master	23 (47.9)	6 (20.7)	11 (52.4)	7 (58.3)	10 (76.9)	57 (46.3)
PhD	24 (50.0)	23 (79.3)	5 (23.8)	2 (16.7)	0 (0.0)	54 (43.9)
<i>Staff supervising work placements</i>						
Yes	34 (70.8)	14 (48.3)	10 (47.6)	6 (50.0)	11 (84.6)	75 (61.0)
No	14 (29.2)	15 (51.7)	11 (52.4)	6 (50.0)	2 (15.4)	48 (39.0)
<i>Staff cooperating with industry</i>						
Yes	15 (31.3)	21 (72.4)	9 (42.9)	8 (66.7)	2 (15.4)	55 (44.7)
No	33 (68.7)	8 (27.6)	12 (57.1)	4 (33.3)	11 (84.6)	68 (55.3)

As for the academic staff's cooperation links with industry, less than half the respondents are involved in at least one such activity ($n = 55$). Distribution of the links varies widely across the different schools, with the School of Communication, Administration and Tourism and the School of Technology and Management having the lowest share of staff engaged in industry cooperation. At first glance, this occurrence seems to stand at odds with the findings of Landry et al. (2007) and D'Este and Patel (2007), who stressed the predominance of engineering disciplines in knowledge transfer and industry links. However, when analysing the particular interactions per school, it turned out that despite the lower number of academics involved in cooperation at the School of Technology and Management, these individuals have the biggest diversity of links with industry. Likewise, academic staff from the School of Agriculture also participates broadly in cooperating with the private business sector. Table 3 illustrates these outcomes.

Analysing use of the different types of university–industry cooperation, we revealed noteworthy differences. In practically all the schools, the most frequently mentioned by respondents were communications in the form of meetings and conferences with industry. This is in line with D'Este and Patel's (2007) study, who found this type the most widespread form of interaction. Almost equally important, the academic staff in our survey highlighted publications arising from joint university–industry research. Also Bekkers and Bodas Freitas (2008) stressed the general relevance of publications, whereas

patents and licensing were far from relevant as a basis for industry cooperation. In this connection, Cohen et al. (2002) revealed that patents are only considered important in certain industries.

Table 3 Types of university–industry cooperation and geographical area

	<i>Technology and management</i>	<i>Agriculture</i>	<i>Education</i>	<i>Health</i>	<i>Communication, administration and tourism</i>	<i>Total (multiple answers were possible)</i>
<i>Type of cooperation</i>						
Publications	15 (34.1)	13 (29.5)	6 (13.6)	8 (18.2)	2 (4.5)	44 (100)
Meetings/ conferences	15 (28.8)	18 (34.6)	9 (17.3)	8 (15.4)	2 (3.8)	52 (100)
Basic R&D projects	11 (30.6)	14 (38.9)	5 (13.9)	4 (11.1)	2 (5.6)	36 (100)
Applied R&D projects	11 (45.8)	11 (45.8)	2 (8.3)	0 (0.0)	0 (0.0)	24 (100)
Patents/ licensing	2 (66.7)	1 (33.3)	0 (0.0)	0 (0.0)	0 (0.0)	3 (100)
Supervision of theses	14 (35.9)	12 (30.8)	6 (15.4)	6 (15.4)	1 (2.6)	39 (100)
<i>Geographical area of cooperation</i>						
Regional	5 (17.2)	14 (48.3)	3 (10.3)	5 (17.2)	2 (6.9)	29 (100)
National	8 (33.3)	7 (29.2)	5 (20.9)	2 (8.3)	2 (8.3)	24 (100)
International	7 (41.2)	7 (41.2)	2 (11.8)	1 (5.9)	0 (0.0)	17 (100)

Another aspect enquired of respondents was the geographical area in which they perform their cooperation with the private business sector. Prior research indicates that spatial proximity is an important variable in university–industry cooperation. Mansfield and Lee (1996), exploring the co-operation between large corporations in the United States and university scientists, found that a university's geographic proximity positively influences its chances of being chosen as a collaborator. Similar findings were reported from Germany (Fritsch and Schwirten, 1999). In their study of new technology-based firms in Sweden, Lindelöf and Löfsten (2004) discovered that firms cooperating with universities in their vicinity achieve certain advantages. In fact, as shown by Table 3, in our sample most interaction takes place at the regional level. This holds true in particular for the School of Agriculture and can be explained, on one hand, by this school's historic roots in the region. On the other hand, the nature of this discipline, agriculture, appears particularly linked with the local environment. However, the schools are not limited to cooperation with industry in their immediate area; some links are also in place at the national level.

4.2 Explorative analysis

Regardless of the variety of links, the focus of this paper is on the cooperating academics themselves. To analyse how academic staff's personal and professional characteristics influence university–industry cooperation, a logistic regression was used. This

proceeding is appropriate because the dependent variable (involvement or not in at least one of the above-mentioned collaborations with industry) is dichotomic, i.e. 1 corresponding to 'yes' and 0 referring to 'no'.

Before running the regression, we specified reference groups (base categories), which should be carefully selected and meaningful. Firstly, we decided on 'PhD' within the set of academic qualifications, as this variable was already the subject of scientific scrutiny (Landry et al., 2007; Giuliani et al., 2010). Secondly, we selected the School of Technology and Management among the set of schools as the reference group, because certain evidence shows that staff from engineering schools are particularly engaged in cooperation with industry (Landry et al., 2007; D'Este and Patel, 2007). As the indicators of the logistic regression reveal, the analysis possesses a high reliability. Table 4 shows the respective outcomes.

Table 4 Outcomes of the logistic regression

<i>Variable</i>	<i>Odds ratio</i>	<i>Std. Err.</i>	<i>z</i>	<i>P> z </i>	<i>[95% Conf. Interval]</i>	
<i>Personal characteristics</i>						
Age	1.839	0.575	1.95	0.051*	0.997	3.394
Age ²	0.993	0.004	−2.02	0.044**	0.985	0.999
Gender	3.475	1.824	2.37	0.018**	1.242	9.724
<i>Professional characteristics</i>						
Degree	0.529	0.543	−0.62	0.535	0.071	3.957
Master	0.365	0.194	−1.89	0.058*	0.128	1.037
Other qualifications	0.758	1.068	−0.20	0.844	0.048	12.013
School of Health	23.441	21.544	3.43	0.001***	3.869	142.004
School of Agriculture	9.814	6.239	3.59	0.000***	2.823	34.119
School of Education	7.399	5.734	2.58	0.010***	1.620	33.790
School of Communication, Administration and Tourism	0.684	0.636	−0.41	0.683	0.110	4.236
Supervision of work placements	1.674	0.791	1.09	0.275	0.663	4.227
<i>N</i>	123					
LR chi ² (11)	36.95					
Prob > chi ²	0.0001					
Log likelihood	−66.09					
Pseudo <i>R</i> ²	0.2185					

Notes: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; Reference groups: 'PhD' (Qualifications), School of Technology and Management (Schools).

In our theoretical section, we referred to the potential influence of academic staff's age on university-industry cooperation. In fact, the results reveal that older academic staff cooperate significantly more with industry than their younger colleagues. This insight seems to confirm the influence of experience on establishing industry links (Landry et al., 2007). In addition, we tested the influence of age squared. Generating a quadratic curve reveals the marginal effect of age. For our sample, as the odds ratio of age squared

is slightly lower than 1, we conclude that as academics get older the effect of age is somewhat lessened. Hence, much older academics appear not to cooperate more than staff whose ages are between the extremes.

We also consider academic staff's gender among the personal characteristics as a potentially determinant factor of interaction with industry. In our analysis, being male significantly influences the propensity to cooperate. More specifically, the odds ratio indicates that the probability of having industry links is around 3.5 times greater for a male than it is for a female member of academic staff. This finding is in line with Landry et al. (2007), who also found that being a male scientist is significantly and positively related to engagement in knowledge transfer activities.

Concerning professional aspects, the empirical evidence shows that staff's academic qualifications do not have a statistically robust effect on university–industry cooperation, except the Master degree for a level of significance of 10%. Therefore, it is surprising that academics holding a PhD do not have significantly more interaction with the private business sector. Here, we confirm the results of Landry et al. (2007) and Giuliani et al. (2010). This situation reinforces the idea that high qualifications and level of seniority in the academic ranks is not much of a stimulus for cooperating with industry.

It is also of note that the school academic staff belong to is the variable with the greatest statistical significance. For example, the probability of academic staff at the School of Health cooperating with industry is more than 23 times higher than the average for the other schools. Regarding the School of Agriculture and the School of Education, we also revealed a significant relation with the academic staff's propensity to cooperate with industry. Although Landry et al. (2007) and D'Este and Patel (2007) found engineering researchers to have the highest levels of interaction, in our research context other disciplines are more relevant for links with industry. This apparently controversial outcome of our study serves to make an argument for the supposedly high impact of the specific history, culture and structure of an academic school or department on its cooperative activities with industry. Being embedded in schools and disciplines with cultures that are supportive of corporate involvement seems to be fundamental, substantiating the concept of 'nested embeddedness', introduced by Kenney and Goe (2004).

Finally, we wanted to investigate whether the supervision of student work placements has an effect on the overall academic staff's interaction with industry. The results suggest that for the academics we surveyed, this is not a statistically significant contingency factor. Interestingly, although in the School of Health all courses taught have work placements included in their curricula with staff from this school having the highest probability for industry cooperation in our sample, no significance was detected.

5 Conclusions and implications

The objective of this study was to identify factors related to academic staff's personal and professional characteristics that have an influence on university–industry cooperation. To attain this objective, we built up a unique dataset of academic staff, based on a survey of the total population of the Polytechnic Institute of Bragança in Portugal. The descriptive analysis of the data obtained shows, first of all, that a substantial number of academics are not involved in at least one out of the range of cooperation activities we asked them about. In our research context, it seems that

university scientists value their academic career more than the business one. This is supposedly due to the academic culture in Portugal, where an academic is still not well thought of, or duly assessed, for having great interaction with industry.

For all the schools of the university we analysed, meetings and conferences as well as publications were the most frequently mentioned bases for cooperation with industry, while patents and licensing were found to be scarcely relevant. However, we also found great heterogeneity across the different schools in their cooperative activities with the private business sector. It emerged that staff from the School of Technology and Management and the School of Agriculture have the greatest diversity of industry links. For the former, this can be explained by the general propensity of engineering researchers towards knowledge transfer and industry links (D'Este and Patel, 2007; Landry et al., 2007). For the latter, the historic roots of this school in the region and the nature of the discipline apparently matter.

In line with these arguments, throughout the exploratory analysis we revealed that the school the academic belongs to is highly relevant for the university–industry interaction. In our research context, the School of Health possesses the highest proportion of academics having industry linkages. Thus, the prime finding from our study is that the school the academic is attached to is the factor with the greatest explanatory value in determining the cooperation decision. This insight demonstrates the overriding influence of professional, namely institutional factors. It is also relevant as to date only a few studies (e.g., Gulbrandsen and Smeby, 2005; D'Este and Patel, 2007; Landry et al., 2007) have considered disciplinary differences in university–industry cooperation. Combining these prior analyses with our findings allows the conclusion that the academic staff's propensity to cooperate with industry is likely to be path dependent, being influenced by the specific history, culture and structure of an academic institution and its members.

Furthermore, we cannot disregard a certain influence of academics' personal characteristics. This holds in particular for the variables of age and gender. The results of the logistic regression analysis indicate that in our sample older and male academic staff are more likely to cooperate with the private business sector. In Section 2.2 we presented quite contradictory findings hitherto regarding the effect of age and gender on university–industry cooperation. It seems that these variations are not really culture specific, because for example comparing Landry et al. (2007), D'Este and Patel (2007), Bercovitz and Feldman (2008) and Boardman and Ponomarev (2009), varying evidence regarding age bias is found even within Anglo-Saxon countries. Considering the interesting findings from the wine sector by Giuliani et al. (2010) and bearing the results of our study in mind, we rather believe that the context and field account for the variance in the influence of age and gender.

These outcomes allow us to draw several theoretical and practical implications for academics, policy-makers and practitioners. In theoretical aspects, our study contributes to the existing research on the influence of academic staff's individual characteristics on their propensity to cooperate with industry. Based on this, we are able to outline new streams for future investigation. Despite D'Este and Fontana (2007) suggesting that departmental characteristics are less significant once individual scientists' characteristics are considered, in light of our results we would like to draw the research focus towards institutional factors in academia. Owen-Smith (2005) and Giuliani et al. (2010) have already found certain evidence that institutional specificities affect university–industry interaction. Thus, we invite researchers to tackle this issue, analysing aspects related to departmental culture, scientific orientation, structure, financing and location.

From a practical viewpoint, our study is of use in considering and designing public policy. Knowing the influence of academic staff's personal and professional characteristics is relevant insofar as it allows universities to create effective mechanisms to enhance collaborative activities with the private business sector. In addition, awareness about the preferred types of cooperation with industry, in our study publications as well as meetings and conferences, helps to better understand the potential starting points for interaction that policies should consider and promote. It appears that academia and industry have sometimes completely different goals, perceptions and restrictions in cooperating (Feldman, 2001), something that both parties should keep in mind.

Finally, our study has some limitations. Firstly, the results should be interpreted with some reservation, since for an unequivocal reading of the cooperation between IPB and the private business sector, it would be necessary to determine exactly the opinion of the whole IPB academic community. In the absence of these data, interpretation of our results can only be an approximation to understanding the situation. Secondly, as the subject of our research was identifying the individual characteristics of cooperating academic staff, we did not distinguish between the different types of university–industry cooperation. Further studies should overcome this restriction. Thirdly, another limitation is that our study focuses on a single higher education institution and may reflect some peculiarities of the Portuguese context in general and the local situation in particular (cf. also Marques et al., 2006). This limits the significance of our results for generalisation. Inter-university and inter-country studies are needed to compare different institutional settings, particularly in geographical areas such as Europe, where university policies and culture are still very heterogeneous.

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