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# Forget R&D – pay my coach: young innovative companies and their relations with universities

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# Forget R&D – Pay My Coach: Young Innovative Companies And Their Relations With Universities

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**Abstract:** Young innovative companies (YICs) are attracting attention in their role of industry regenerators. However, we have little information about their relations with universities as sources of information. This paper explores university-industry interaction involving YIC in the Valencian Community, using YIC founders' personal attributes and motivations as explanatory variables. The Valencian Community has a relatively high degree of university-industry interaction, but surprisingly little technological innovation. A survey of YICs in the region shows that, in their case, firm size does not affect the probability of contracting with universities, and that R&D intensity is not significant if we consider firm founders' personal characteristics and motivations. YIC founders exploiting market opportunities recognized in previous business activities, and necessity entrepreneurs, are the least likely to interact with universities. We highlight the role of external advisory services to highlight the benefits of universities.

# 1  Introduction

In this paper we discuss the determinants of university-industry interaction on the basis that they encompass the personal characteristics of the firm's creator as well as the usual firm characteristics, e.g. degree of openness and research and development (R&D) investment. Among these personal characteristics, we focus on educational attainment and motivations for setting up a firm. We explore this latter by combining elements of the strategy, psychology and entrepreneurship literature and provide a study which, in our view, extends the work on university-industry interactions.

We focus on young innovative companies (YICs) because they are important for transforming the industrial structure, and contribute to economic growth and innovation within a territory. The academic community and policy makers are devoting increased attention to YICs (BEPA, 2008, Schneider and Veugelers, 2010) and several EU member states have implemented programs to promote the establishment, consolidation and development of YICs (Veugelers 2009, Schneider and Veugelers, 2010). However, many of these support measures are aimed at facilitating access to R&D funding sources and do not include other types of indirect actions such as advice and consultancy services.

Since we believe that these other types of actions deserve further analysis, we focus on the determinants of YICs' interactions with universities. We find that, despite their different endowments, YICs' frequency of working with universities is similar to that of the typical innovative firm, although YICs are often very small and very R&D intensive. The existing evidence on YICs and other similar firms is limited and not conclusive about these aspects.

Our study contributes to the literature in several ways. First, it provides a measure and explanation of the level of YICs' interaction with universities, including a comparison with other innovative firms. Second, the inclusion of founders' personal characteristics as explanatory variables in the estimation, offers some insights into the lack of significance of R&D intensity in this respect. Third, we analyse a particular regional context that is characterized by a relatively low technological level, but a high level of university-industry interaction, a rather surprising and underexplored combination.

The paper is organized as follows. Section 2 discusses our choice to study YICs compared to other firms, and the influence of firm characteristics and founders' personal traits on interaction with universities. Section 3 describes the regional context and

Section 4 presents the data, method and variables used in the analysis. Section 5 presents the main results and Section 6 discusses some limitations of our study, offers some conclusions and suggests some managerial and policy implications.

## 2 How much and why do YICs interact with universities?

There is evidence of the positive effects of links with knowledge centres for firm innovation (Radas and Bozic, 2009; Wagner and Bukó, 2005). However, there are some aspects that need further research, such as the degree of interaction between particular types of firms, such as YICs, and universities. We look at firm characteristics as the determinants of university-firm interaction and the influence of founders' personal traits on knowledge sharing (an important and understudied aspect according to Lin, 2007).

### 2.1 *University-industry links: YICs versus other firms*

The focus in this paper is on YICs. EU state aid regulations define a YIC as a small firm, aged six years or less, and certified by external experts on the basis of a business plan, as capable of developing new -or substantially improved- technological products or processes, but which runs the risk of technological or commercial failure.

Other terms are used in the literature to refer to other closely related types of firms. Some authors have studied what they call New Technology-based Firms (NTBFs), which are young companies in high-tech sectors (see, e.g., Colombo and Grilli, 2005). Our study covers a wider range of firms because it covers all productive sectors irrespective of their technological level. In our view, belonging to a high-tech sector should not be seen as synonymous with being an innovative company; many firms that operate in R&D intensive sectors are only adopters of already available innovations. YICs include young companies that also are active innovators. This definition is sufficiently flexible to allow for different degrees of innovation.

Several articles on collaboration among innovative firms refer to start-ups. However, we prefer the term YICs because it encompasses the dimension of innovation that does not necessarily apply to start-ups. For example, the start-up variable constructed by Cohen et al. (2002) defines a start-up as a young firm, with fewer than 500 employees in a baseline period, and typically as active in one industry

A distinctive characteristic of a YIC is its length of establishment. Some studies that consider the influence of firm age on its contacts with universities show that younger firms are more likely to exploit universities, but the evidence is not conclusive. Audretsch et al. (2005) note that new firms often rely on external knowledge produced by other firms or by universities since they are less able than larger and more established enterprises to generate their own formal R&D. Similarly, Pérez and Martínez (2003) provide evidence that networking with universities and R&D centres was more intensive and more important during the early years of university spin-off foundation. Motohasi (2005), for a sample of Japanese NTBFs finds that young/new firms are more likely to interact with universities than firms of a similar size that are longer-established.

On the other hand, Cohen et al. (2002) in a study of US manufacturing industries report importance of university-firm interaction only for start-ups in the pharmaceutical sector, but not other sectors, and Laursen and Salter (2004) provide similar results for universities as a source of knowledge for UK manufacturing firms. Laursen and Salter include a variable to measure whether or not the firm is a start-up, but the results show that start-ups are not more likely to engage in contacts with universities.

YICs have been compared to the average firm, but in this paper we compare them with other innovative firms.

## 2.2 *YICs' characteristics and their influence on interaction with universities*

To our knowledge, there are no studies that investigate the firm characteristics that determine interaction between YICs and university, and the evidence for start-ups is limited. Among the few papers that study R&D cooperation among start-ups, only Okamuro et al. (2011) investigate the determinants of cooperative R&D between start-ups and other organizations including universities. The more general literature, which includes some work on innovative firms and start-ups, highlights three firm characteristics: openness, R&D intensity, and size.

Openness, according to Fontana et al. (2006), refers to the set of activities that firms undertake to acquire knowledge from, voluntarily disclose knowledge to, and/or exchange knowledge with the external world. In other words, it refers to the firm's ability

to network. It is clear that more open firms are more likely to enter into university-firm collaboration. This is confirmed by Laursen and Salter (2004).

There is evidence that more intensive firm R&D activity has a positive influence on R&D cooperation with universities (Fontana et al., 2006; Laursen and Salter, 2004; Tödtling et al., 2009). These studies show that the propensity to cooperate with a university for innovation seems to depend positively on the firm's R&D intensity. However, Nakamura et al. (2003) report a non-significant relation for cooperation with universities. In a study of start-ups, Okamuro et al. (2011) report R&D intensity to be a non-significant variable and exclude it from their model; they find instead that R&D expenditure is significant.

The evidence relating to firm size indicates that it has a positive influence on the propensity to engage in cooperation and networking in the innovation process (Tödtling et al., 2009), and to interact with public institutions (Cohen et al., 2002; Laursen and Salter, 2004; Levy et al., 2009), and this result applies to innovative firms in particular (Motohasi, 2005). However, in the specific case of start-ups, the empirical evidence seems not to follow this general pattern: Okamuro et al. (2011) find that size is a non-significant variable.

Based on this empirical evidence, we hypothesize that:

**Hypothesis 1** The characteristics of YICs that contract with universities are similar to those of other firms that use universities as external sources of knowledge. The more open the search strategy, the higher the R&D intensity and the larger the size of the YIC, the higher will be the probability that the firm will contract with universities.

## 2.3 Education and motivations of YIC founders as drivers of interactions with universities

Several authors have investigated the influence of the characteristics of university researchers (Ponomariov, 2008; Grimpe and Fier, 2010), and Lin (2007) argues that more research is needed into the influence of personal traits on industry-university linkages. In this study we focus on firm founders' education and motivations for setting up a firm. Colombo and Grilli (2005) examine the role of human capital in firm growth and Tödtling et al. (2009) identify employment of former university researchers as a key factor in the level of knowledge interactions with universities. Doloreux et al. (2008)

show that knowledge-intensive business services (KIBS) in the R&D sub-sector in Quebec have a larger share of employees with at least a bachelors degree, than KIBS in other sub-sectors, and Radas (2005) shows that recruiting highly educated workers can be crucial for establishing more intense collaboration. She finds that if employees are au fait with the work of the university scientists they can bridge between the firm and the university.

While the above findings refer to firms' employees, Okamuro et al. (2011) show that in the case of start-up firms, the firms' creators have a crucial influence on their firms' strategies, including R&D cooperation. Colombo et al. (2010) include a set of characteristics of NTBF founders (including years of university education of founder) to control for the positive impact on firm growth of the human capital of the founding team.

In other words, highly educated firm creators may attract R&D partners and foster different forms of R&D cooperation. We therefore hypothesize that:

**Hypothesis 2** Better educated YIC creators are more likely to enter into contracts with universities.

Next, we discuss the how the reasons for establishing a firm affect the interaction with universities (on the motivations for interacting with a university see, e.g., Arza, 2010). In the work on entrepreneurship, which spans the fields of economics, psychology and sociology) there are several approaches aimed at identifying what motivates the entrepreneurial decision. We are interested in personal motivations, and we draw on this literature to link firm founders' motivations with university-firm interaction.

We consider motivations related to the so-called push and pull factors, and those related to the entrepreneur's previous experience. Shapero (1984) indicates that an 'entrepreneurial event' occurs when a potential firm creator establishes a firm based on a series of drivers which may be negative (or push factors) or positive (pull factors). An example of the former is the desire to make money. Chiesa and Piccaluga (2000) and Shane (2004) report this to be the motivation respectively for university spin-offs and a group of MIT entrepreneurs. The strongest push factor is probably the need for employment, described as 'necessity entrepreneurship' (Reynolds et al., 2005), which occurs when establishing a new firm is not necessarily the preferred option (Acs et al., 2007). Firm founders driven by push factors tend to adopt reactive strategies. They may

not recognize market opportunities or seek out external sources of knowledge. We hypothesize that:

**Hypothesis 3** YIC creators motivated by push factors such as creating employment for themselves or earning more money are less likely to contract with universities.

At the other end of the spectrum are pull motivations, which are characterized by voluntary participation in entrepreneurial activities. Various studies show that there is a positive relationship between internal commitment to establishing a new firm and entrepreneurial activity (Amabile et al., 1994; Prabhu et al., 2008; Rauch and Frese, 2007) and that it is linked (De Koning and Muzyka, 1996; Herron and Sapienza, 1992; Manimala, 1996) to a greater capacity to identify and explore opportunities. Here, we focus on so-called 'opportunity entrepreneurship' (Kirzner, 1973), where the entrepreneur detects a market opportunity which leads to the establishment of a new firm.

It is tempting to see pull factors as exactly opposite to push factors in terms of their effect on cooperation with universities. However, although pull factors are related to YIC creators more open to market opportunities, including cooperation, we cannot predict a preference for university-firm cooperation on this basis alone. The institutional context also plays a role and has different effects on different types of pull factors.

In relation to the firm founder's professional experience this set of motivations is related to socio-demographic features and predicts a certain entrepreneur profile (see Collins and Moore, 1964, for a seminal study in this field, and Colette et al., 2003, for a more recent analysis). This approach identifies previous work experience as important.

We assume that the previous or main employment of the firm's founder may create a firm culture that determines collaborative interaction. Tödtling et al. (2009) indicate that more sophisticated innovations are likely to be based on scientific knowledge generated in universities and research organizations. Geiger (2010) identifies the 'informational challenge' (understood as the inability of firms to understand that external sources might help to resolve problems) as limiting university-industry collaboration, and Decter et al. (2007) report the existence of 'cultural' differences between business and university, which act as barriers to technology transfer. Rappert et al. (1999) report that university spin-offs tend to interact more with universities than non-university start-ups, showing that previous experience in academia may reduce these cultural barriers and foster linkages. We hypothesize that:

**Hypothesis 4** YIC creators motivated by the pull factor of building on previous experience as university professors or researchers, are more likely to contract with universities.

If the firm founder has a business background, the cultural gap with academia may hinder interactions with universities. We hypothesize that:

**Hypothesis 5** YIC founders motivated by the pull factor of previous business experience will be less likely to enter into contracts with universities than YIC creators motivated by the pull factor of building on previous experience as university professors or researchers.

Hypothesis 5 is the only one of our propositions that does not predict a purely positive or negative impact on interaction with academia; it predicts only a reduced likelihood of firm founders with a business background interacting with universities, compared to those with an academic background. The final sign will be determined by the opposing influences on university-firm relations: a proactive entrepreneur may seek out knowledge linkages, but the cultural gap may deter interaction with universities. The data demonstrate the relative strengths of these two influences.

# 3 Research context

The Valencian Community is a European region with low absorptive capacity (Azagra-Caro et al., 2007b). Some of its main technological and industrial features are of interest for this study, including:

- low-tech economic structure and high proportion of microfirms in services and traditional manufacturing;

- weak innovation; innovation mostly incremental in the form of machinery and equipment acquisition; low level of expenditure on R&D;

- lack of qualified personnel even in firms in the knowledge-intensive sectors;

- policy emphasis on increased technology transfer, to the level in high-tech regions or countries, but aligned to the Valencian industry (Fernández de Lucio et al., 2010), through the establishment of a strong network of technology institutes (TIs) in the early 1980s.

The TIs act as a bridge between firms and public research institutions and were founded mostly as industry-based firm associations. They were set up as private, non-profit associations with independent management (Mas-Verdú, 2007).

There have been some pioneering actions related to the establishment of technology transfer offices, spin-off incubators, etc. located in universities, which have fostered academia-industry links. A report for the Valencian R&D Council (ACCID, 2005), shows that 3% of Valencian firms' sales are based on product innovations that could not have been developed without the input of academic research. Other studies provide similar results for the US and Germany (see, e.g., Beise and Stahl, 1999). The ACCID report shows also that industry funding of Valencian university R&D (6%-8%) was similar to the Spanish average and higher than the EU and OECD averages. The latest figures show this still to be the case and that Valencian firms tend to contract out low-tech, short-term oriented R&D to Valencian universities. There are some good academia-industry links because universities have adapted to the regional level of absorptive capacity.

Most university faculty are in favour of university-industry interaction (Azagra-Caro et al., 2006), but firms do not show the same willingness to interact with universities. Also, some Valencian universities have linkages outside the region (Azagra-Caro, 2007a) which provides access to higher technology and larger firms (Azagra-Caro, 2007b). Also, and contrary to the findings for leading innovative regions, there is an 'alocalization' effect in terms of knowledge flows (Azagra-Caro et al., 2009) and university-industry links (Todt et al., 2007). Therefore, the Valencian Community –five public universities– is an interesting case for the study of university-industry links.

# 4 Data and methodology

The data are from a survey carried out by the Valencian Institute for Small and Medium Sized Enterprise (IMPIVA), a Valencian Regional Government organization created to promote innovation in small and medium sized enterprises. In 2009, IMPIVA began to compile a detailed directory of YICs in the region. Our cooperation in this endeavour provided allowed access to these firms and the opportunity to collect the necessary firm-level data to test our hypotheses. We designed a brief survey which was pre-tested and modified based on the feedback from experts and some randomly selected firms. The questionnaire was submitted to a target sample.

A crucial phase of the data collection process consisted of delimiting the population and sample. Identifying the population of firms was not straightforward because of the lack of an official list of such companies in the Valencian Community. After some consultation with academic (Belso-Martínez et al., 2011) and IMPIVA experts, we agreed on a number of sources of information to construct the target population. These included lists of academic spin-offs (provided by universities), business incubator centres, industry associations, applications from firms for public funding. We identified 210 YICs created during the period 2005-2008.[1] Note that the combination of different sources of information minimizes the risk of potential bias and distortions in our results. The process also ensures that almost all YICs established in the region at the time were identified.

Following this initial process, individual entrepreneurs were contacted, the profile of the company confirmed and the questionnaires administered. Of the total 210 distributed, we received 173 completed surveys. This high response rate (82.3%) was down to the IMPIVA monitoring process.

Despite some idiosyncrasies, our dataset includes a large and heterogeneous sample of YICs, spanning several mature industries. As well as those firms we initially identified as YICs, we included other innovative firms in the survey; the response to the question about their year of creation allowed us to decide whether they fitted the definition of a

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[1] The YICs analysed were 4 years or younger. As already indicated, EU state aid regulation defines a YIC as a firm established for less than 6 years. The literature on start-ups uses a range of 5 (Cohen et al., 2002) to 1.5 years (Okamuro et al., 2011). Thus, there is no clear cut off age for a 'young' firm.

YIC. Only YICs went on to complete the questionnaire, but using this method we were able to obtain information on the characteristics of other innovative firms, which we use as a benchmark. Wherever possible, we present descriptive and econometric results for the full sample and distinguish between YICs and other innovative firms.

## *4.1  Dependent variable*

One question in the survey asked: 'In relation to the gathering of technology and strategic information, have you signed any contract with some of the following institutions?' Responses were tick boxes corresponding to the categories listed in Table 1, including universities. On average, a large proportion of the full sample of innovative firms interacts to acquire technology and strategic information (42%). Among the organizations consulted, universities scored high and well above the average at 51%. This is consistent with Spain (and the Valencian Community in particular) having a very high share of business funding of higher education expenditure on R&D.

{Table 1 around here}

Contracts with TIs is the only category that ranks higher than universities. This is peculiar to the Valencian Community with its strong network of TIs created in the early 1980s. Contracts with other institutions, such as public administration, chambers of commerce, business innovation centres, etc., are less frequent.

Therefore, our dependent variable is:

- University contracts, where the binary variable is 1 if the respondent ticked the box for universities and 0 otherwise.

Table 2 shows the average value is 0.52.[2] It also provides a first breakdown by whether the firm is a YIC. The difference between YICs (0.51) and other innovative firms (0.53) is not significant.

{Table 2 around here}

Given the dichotomous nature of the dependent variable, we use a probit model for our estimations.

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[2] It corresponds to 1 percentage point above the figure in the previous table because here 'don't knows' are excluded from the total.

## *4.2 Independent variable*

The literature review shows that there are advantages from considering different types of explanatory variables. Here we consider firm characteristics, firm founder's personal characteristics (including education), and firm founder's motivations.

Table 2 presents the descriptive statistics for firm characteristics, which include those related to Hypothesis 1:

- Openness: related to the question, 'In relation to the gathering of technology and strategic information, have you signed any contract with some of the following institutions?' The response choices (ranging from 0-3) include consultants, TIs, and other organizations. The average score of 1.20, indicates a degree of openness: most firms have interacted with at least one of these types of institutions;

- R&D intensity: this is proxied in the survey. Respondents were asked to classify their company according to one of the following labels: technology-based company (high R&D intensity), very innovative company (medium R&D intensity) and innovative company (low R&D intensity). This typology is familiar to Valencian innovative firms because it is used for applications for local public R&D grants. The classifications were validated by technicians from the regional innovation agency. Our variable takes the values 2, 1 and 0, respectively. The average firm in the sample is medium R&D intensive;[3]

- YIC: a dummy variable that is equal to 1 if the firm was created after 2005: 36% of the firms in the sample were YICs;

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[3] This classification is based on self-assessment, unlike studies that give precise numbers for R&D intensity. However, many studies using Community Innovation Survey (CIS) data or similar are based on self-assessments. Our results may be more reliable since offering a choice of category can be less prone to inaccuracies than asking for unaccounted numbers. Also, we compare categories based on self-assessment, with the level of financial support received by firms through competitive tenders. We chose this method because, according to the literature (Hyytinen and Toivanen, 2005; Takalo and Tanayama, 2010), being awarded financial support (subsidy) for innovative activity can be seen as reflecting the high quality of the innovative efforts made by the company.

- Firm size: number of employees, in the categories: 0 (less than 10 employees), 1 (10-49 employees) and 2 (50 employees or more). This corresponds to Eurostat's distinction between micro, small, and medium/large firms. The average firm is between categories 0 and 1, i.e. even within innovative firms, microfirms predominate in the Valencian case.

When we differentiate between YICs and other innovative firms, we see that the former use more closed search strategies, are more R&D intensive and are smaller in size than the latter. Hence, YICs are interesting because, despite their different endowments, their frequency of contracts with universities is similar to the typical innovative firm.

Table 3 shows that the correlation between variables is small.

{Table 3 around here}

The second group of variables refers to the personal characteristics of the firm founder:

- Age of entrepreneur: an ordinal scale of four categories: 0 (less than 30 years), 1 (30-39 years), 2 (40-49 years) and 3 (more than 49 years);

- Sex: 1 if female;

- Education: an ordinal scale of three categories: 0 (no university degree), 1 (graduate university degree), 2 (post-graduate university degree).

While age and sex are control variables, education refers to Hypothesis 2.

The questions were addressed only to YICs. Table 4 shows that the average YIC founder is aged between 30 and 39 years and has a university first degree; 10% are women.

{Table 4 around here}

The third group of variables, motivations (applying only to YICs), comes from a question in the survey asking firm creators their reasons for setting up their companies. We grouped the variables as follows:

- Self-employment push: 1 if the respondent chose 'I chose to create my own workplace', 0 otherwise.

- Monetary push: 1 if the respondent chose 'Expectations to gain money through an own business', 0 otherwise.

  (Both the above refer to Hypothesis 3);

- Academic pull: sum of two categories: 'To benefit from my specialist knowledge acquired from my activity as a university professor or researcher' plus 'application of doctoral thesis or university R&D project'. This refers to **Error! Reference source not found.**;

- Business pull: sum of five categories: 'To benefit from my specialized knowledge acquired from my R&D activity in my former company/work at technology centres/consultancy work/integration of several sources' plus 'Opportunity arisen in the professional environment'. This refers to Hypothesis 5.

Table 4 shows that business pull is the more frequent motivation. The means are not comparable among motivations because of the different range of variation for each variable, but a breakdown of business pull would still show that many of its single components are ranked first in the hierarchy of motivations. Academic pull motivations are ranked second if we sum the two components: 'university professor or researcher' and 'application of doctoral thesis or university R&D project'. Separately, each ranks below the two push motivations.[4]

Table 5 shows that the correlations between the variables in the YIC sample are small.

{Table 5 around here}

We control for industry fixed effects. The survey distinguishes 27 economic activities, including manufacturing and services. Since some activities involved only a very few firms, we grouped the activities into seven sectors: three corresponding to Pavitt's (1984) taxonomy of industrial activities, plus four service sectors (ICT, R&D, Engineering,

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[4] For the estimations, we tried different breakdowns of the academic and business pull variables; the results did not change. We prefer to present the current aggregates because this results in models with more degrees of freedom. The descriptive and econometric results and the breakdowns are available from the authors on request.

architecture, environmental services, and a fourth category of Other services).[5] We created dummies for each of the seven types listed in Table 6.

{Table 6 around here}

According to Table 6, there is large variation in the percentage of firms that contract with universities, by economic sector. The highest shares correspond, as expected, to R&D services, followed by science-based and production-intensive manufacturing and ICT services. Supplier-dominated firms, 'engineering, architecture and environmental services' and 'other services' rank lowest. As for the aggregate, differences between YICs and other innovative firms are not significant, except for the case of supplier-dominated firms, where YICs are less likely than other innovative firms to contract with universities.

# 5 Econometric results

## 5.1 The distinctive insignificant effect of YIC firm size on contracting with a university

Table 7, column 1, shows that innovative firms with more open search strategies and are more R&D intensive, have more employees and are more likely to enter into contracts with universities. Notice that in our case (similar to the case of start-ups in Laursen and Salter, 2004) being a YIC is not significant.

{Table 7 around here}

In column 2, we reproduce the model for the YIC sample (obviously, we drop the YIC variable from the model because it always takes the value 1). The coefficients of openness and R&D are still positive and significant (with R&D slightly less significant); firm size is not significant. The evidence only partially supports Hypothesis 1. For YICs, if we do not control for YIC founder's education and personal motivations, openness and

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[5] 15% of respondents chose 'other' rather than any of the 27 initial categories; they were required to make a qualitative response. This information and the response to another question about the firm's economic activity, allowed us to reclassify this 15% into the initial categories or to drop unclear cases. One of the authors with many years practical experience at IMPIVA, and direct contact with Valencian companies, helped in this reclassification exercise.

R&D are as important for contracting with universities as for the average innovative firms, but size has no effect.

The results for non-YIC innovative firms are shown in column 3. They confirm the average behaviour: a significant, positive effect of openness, R&D intensity and size on contracts with universities.

It is questionable, perhaps, whether the observed lack of significance of size is an idiosyncrasy of the geographic origin of the sample. However, the fact that the aggregate and the non-YIC innovative firm samples follow the results for the UK sample in Laursen and Salter (2004) –including the significance of size– seems to indicate that this is not the case: it is the fact of being a young company rather than geography that is having an effect. Also, Okamuro et al. (2011) find that the effect of size on interaction with universities is not significant for Japanese start-ups.

## 5.2 How do entrepreneur's education and motivations reduce the significance of R&D in relation to contracting with a university

The first estimation includes YIC founders' personal and motivational characteristics (Table 8, column 1). Firm size is not significant, which is consistent with Table 7, column 2. However, that R&D intensity is also not significant is surprising. The higher value of the Bayesian Information Criteria (BIC) indicates that in spite of the higher pseudo $R^2$, the fit is worse than in Table 7, column 2, due to the inclusion of too many variables. In order to achieve a more parsimonious model, with more degrees of freedom, we perform a selection strategy. Starting from the model in column 1, we drop the insignificant variable with the lowest t-ratio and estimate a new model. We replicate the procedure successively until we achieve a model with only significant variables.

{Table 8 around here}

The results are shown in Table 8, column 2.[6] The lowest value of BIC indicates also that this is the best model (compared to the models in Table 8, column 1 and Table 7, column 2). Openness is significant and R&D intensity is excluded from the model. Hence, when we control for the personal characteristics and motivations of the YIC founder, the effect

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[6] As a robustness check, we carried out another selection strategy: we introduced the independent variables separately into the regressions and retained only those with a significant effect in the joint model. The results were the same as Table 8, column 2.

of R&D intensity for the YIC is not relevant. Size is also insignificant and can be excluded from the model.

Two personal characteristics are dropped because of their lack of significance, leaving only a positive coefficient of education. This evidence supports Hypothesis 2. The better educated the firm founder, the more likely that his/her company will interact with a university.

Regarding motivations, self-employment tends to lead to less contact with universities, which supports Hypothesis 3, and earning money has no influence, which does not. Hence, there is only partial support for Hypothesis 3. If our data and methods are correct, the theory could be refined by establishing a ranking among push factors: YIC creators aiming at earning more money are not as reactive as necessity entrepreneurs in their collaborative efforts.

Benefiting from specialized knowledge acquired from academia promotes interaction with universities, confirming **Error! Reference source not found.**. Benefiting from specialized knowledge acquired from a former non-academic environment or from opportunities arising in the professional environment is detrimental for contracting with universities. This implies, first, that the business pull is less likely than the academic pull to foster interaction (confirming Hypothesis 5) and, second, that the negative effect of differences in the business and university cultures outweighs the positive effect of the pull motivation.[7]

# 6 Conclusions

This study explored the theoretical determinants of contracts between YICs and universities. It provides an empirical analysis of a sample of innovative companies in the Valencian Community to compare YICs with older innovative companies and allows the inclusion of the personal characteristics and motivations of the firm creator as explanatory variables, as well as firm characteristics. To our knowledge, the use of this

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[7] In the estimations, only 3 industry sector dummies are significant (see Table 8, column 2): Science-based manufactures, ICT services and R&D services. Although further development of this idea is beyond the scope of this study, it is in line with some evidence that the study of university-industry interaction should not be restricted to manufactures, but expanded to services (see D'Este and Camerani, 2010).

combination of variables is novel. Furthermore, this is the first empirical analysis of YIC cooperation.

First, we can highlight that current thinking about university-industry interaction is valid for YICs in relation to its positive influence, but that there are differences related to YIC size and R&D intensity. Size is not a determinant of YIC-university contracting and when we control for the personal characteristics and motivations of firm founders, R&D intensity is not significant. Our study extends the theory by examining the role of firm founders' education and types of motivations. The evidence confirms the hypotheses that higher education and the pull motivation of founders from academia increase the frequency of university interaction, while the pull motivation of founders from the business sector and push motivations lead to fewer contracts with universities. However, the empirical validation applies to necessity entrepreneurship not to the desire to make more money, which suggests a further refinement to the theory.

There are two main limitations to our study. First, the dependent variable, the binary answer to the question, 'have you signed any contract with universities' does not give any idea of the frequency, length, size or results of contracts with universities. It provides no information on when a contract was signed, which does not allow us to make dynamic comparisons among firms. However, this type of dichotomous variable does provide valuable information on university-industry links, as shown by Nakamura et al. (2003), Motohasi (2005) and Okamuro et al. 2011. Also, even with the broad formulation of the question, our variable shows high percentages for each possible outcome (yes/no). This is and the high industry variation (e.g. the science-intensive manufacturing and services score higher) are signs of the appropriateness of the variable.[8]

A second limitation is that the number of YICs in the sample is small (less than 200 observations). However, due to our survey design, we are confident that the sample is very representative of the full population of this type of companies in the region. Also, comparison with the larger population of innovative firms that are not YIC suggests that

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[8] It might be that studies based on more fine-grained information, e.g. variables with more points on a Likert scale, would be more useful. In our case, we included a question in the survey about satisfaction with services provided by universities to be ranked on a 5-point Likert scale, ranging from 'Not satisfied' to 'Very satisfied'. We found that most firms that had interacted with universities were 'very satisfied', while most firms with no experience of university contracting expressed an opinion of 'neither very satisfied or very dissatisfied'. Ordered models predict both outcomes, meaning they perform no better than a simple dichotomous variable.

our results are plausible. Finally, reduction of the econometric models to those with significant variables only shows that the estimations have sufficient degrees of freedom.

Nevertheless, we cannot claim that this study provides definitive evidence of what determines contracting between YICs and universities. Since this is new evidence, more research is needed using different data. We believe that our analysis is useful; it has been argued that an increased level of university-industry cooperation would require changes to the motivations of faculty members (sometimes with no clear idea of the direction of change, Uyarra, 2010). Our study highlights that change is needed in the motivations of firm creators, starting with YIC creators. Based on our findings, we can derive some implications for policy and corporate governance and provide tools for further methodological exploration.

Regarding the design of public policies, this research suggests that in a given region a relatively high degree of university-industry relation may coexist with low levels of technological innovation, when the entrepreneur's motivation for creating a YIC is not positively related to contracts with universities. We show that if the firm's founder is or was a university professor researcher, motivated by commercializing research results then it is likely that the firm will have high levels of interaction with universities. Other firm founder motivations are either negatively associated or not associated with firm-university interaction. For example, if the motivation for founding a firm is to make more money this does not necessarily lead to more contracts with universities. Policy should try to understand whether this is desirable. In terms of policy instruments to foster the growth of university-firm links that lead to major (as opposed to minor) technological innovations, in our view, the emphasis should be on indirect actions (i.e. advice and consulting services) rather than on direct actions such as R&D subsidies and fiscal incentives, even though provision of the former is less straightforward (Lerner, 2009).

In order to improve corporate governance, in the cases of YIC creators who are not able to overcome the cultural gap with universities, they might expand their management teams with the addition of people with similar motivations (employment, exploit business opportunities, earning more money) who have learnt how universities can fulfil their needs. Firm creators could try to overcome the cultural gap by improving their abilities and competences through external advisory services, such as coaching. This is in line with the study by Cosh and Hughes (2010), which discusses the differential roles played by intermediaries between firms and universities, in the USA and the UK. US firms

report fewer direct contacts with universities, use coaching services and, also, are more likely to commit resources to supporting innovation related to university interactions.

In this study, the questionnaires were addressed to firm founders. However, many studies that take the firm as the unit of observation administer surveys which are responded to by an employee. Hence, the real unit of observation in these studies is the employee who responded to the survey and not the firm. This means that it is necessary to control for the employee's individual characteristics when assessing the impact of the characteristics of the firm on any possible outcome. In line with this reasoning, our finding that firm R&D intensity is not significant for interaction with university could perhaps be extrapolated to firms in general. Although it may not be applicable, it would open a stimulating line of research and future innovation surveys that include the personal characteristics and motivations of the respondent.

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# References

ACCID, 2005. Análisis de la contribución de la I+D universitaria al desarrollo económico de la Comunidad Valenciana. In: Alto Consejo Consultivo en Investigación y Desarrollo de la Presidencia de la Generalitat Valenciana, Informe anual sobre el estado de la investigación, el desarrollo y la tecnología en la Comunidad Valenciana. Valencia, Generalitat Valenciana.

Acs, Z., O'Gorman, C., Szerb, L., Terjesen, S. (2007). Could the Irish Miracle be Repeated in Hungary? Small Business Economics 28:123–142.

Amabile, T. M., Hill, K., Hennessey, B. and Tighe, EM (1994): The Work Preference Inventory: assessing intrinsic and extrinsic motivational orientations, Journal of Personality and Social Psychology, 66, 950-967.

Arza, V. (2010). Channels, benefits and risks of public–private interactions for knowledge transfer: conceptual framework inspired by Latin America. Science and Public Policy, 37(7), 473–484.

Audretsch, D., Lehmann, E., Warning, S. (2005). University spillovers and new firm location. Research Policy, 34(7), 1113–1122.

Aurum, A., Daneshgar, F., Ward, J. (2008). Investigating Knowledge Management practices in software development organisations – An Australian experience. Information and Software Technology 50, 511–533.

Azagra-Caro, J M, I Fernández de Lucio, F Perruchas and P Mattsson 2009. What do patent examiner inserted citations indicate for a region with low absorptive capacity? Scientometrics, 80(2), 443–457.

Azagra-Caro, J.M., 2007a. The regional dimension of university-industry interaction. In: Suriñach, J., Moreno, R., Vayá, E. (Eds.), Knowledge Externalities, Innovation Clusters and Regional Development. Cheltenham and Northampton, Edward Elgar.

Azagra-Caro, J.M., 2007b. What type of faculty member interacts with what type of firm? Some reasons for the delocalisation of university-industry interaction. Technovation 27, 704-715.

Azagra-Caro, J.M., Archontakis, F., Gutiérrez-Gracia, A., Fernández-de-Lucio, I., 2006. Faculty support for the objectives of university-industry relations versus degree of R&D cooperation: the importance of regional absorptive capacity. Research Policy 35 (1), 37 – 55.

Beise, M., Stahl, H., 1999. Public research and industrial innovations in Germany. Research Policy 28 (4), 397-422.

Belso-Martínez, JA, Molina-Morales, X and Mas-Verdú, F. (2011): Clustering and internal resources: moderation and mediation effects. Journal of Knowledge Management, (forthcoming).

BEPA (2008). Innovation and Growth in the EU: the Role of SME Policy. Brussels: European Commission.

Chiesa, V., Piccaluga, A. (2000): 'Exploitation and diffusion of public research: the chase of academic spin-offs companies in Italy'. R & D Management, Vol. 30, No. 4, pp. 329-339.

Cohen, W., Nelson, R. and Walsh, J. (2002). Links and impacts: the influence of public research on industrial R&D, Management Science 48 (1), 1–23.

Colette, H.; Hill, F.; Leitch, C. (2003): Entrepreneurship Education and Training, Ashgate Publishing Company, England.

Collins, O.F.; Moore, D.G. (1964): The enterprising man. East Lansing: Michigan State University.

Colombo, M.G., D'Adda, D., Piva, E. (2010). The contribution of university research to the growth of academic start-ups: an empirical analysis. Journal of Technology Transfer, 35:113-140.

Colombo, M.G., Grilli, L., 2005. Founders' human capital and the growth of New Technology-Based Firms: a competence-based view. Research Policy 34 (6), 795-816.

Cosh, A., Hughes, A. (2010). Never mind the quality feel the width: University– industry links and government financial support for innovation in small high-technology businesses in the UK and the USA. Journal of Technology Transfer, 35: 66-91.

D'Este, P., Camerani, R. (2010). Knowledge from businesses to universities: an investigation on the two-way knowledge transfer in university-business partnerships. Triple Helix VIII International Conference on University, Industry and Government Linkages, Madrid, December.

De Koning, A., Muzyka, D. (1996). The convergence of good ideas: When and how do entrepreneurial managers recognize innovative business ideas? In N. Churchill, W. Bygrave, J. Butler, S. Birley, P. Davidsson, W. Gartner and P. McDougall (eds.) Frontiers of entrepreneurship research. Babson College, Wellesley, MA.

Decter, M., Bennett, D., Leseure, M. (2007). University to business technology transfer—UK and USA comparisons. Technovation 27, 145–155.

Doloreux, D., Amara, N., Landry, R. (2008). Mapping Regional and Sectoral Characteristics of Knowledge-Intensive Business Services: Evidence from the Province of Quebec (Canada). Growth and Change Vol. 39 No. 3, 464–496.

Fernández de Lucio, I., Mas-Verdu, F. and Tortosa, E. (2010) 'Regional innovation policies: the persistence of the linear model in Spain', The Service Industries Journal, 30: 5, 749 — 762,

Fontana, R., Geuna, A., Matt, M. (2006). Factors affecting university–industry R&D projects: The importance of searching, screening and signaling. Research Policy 35(2), 309–323

Geiger, R. (2010) University supply and corporate demand for academic research. Journal of Technology Transfer, DOI 10.1007/s10961-010-9192-5.

Grimpe, C., Fier, H. (2010). Informal university technology transfer: a comparison between the United States and Germany. Journal of Technology Transfer, 35:637–650.

Herron, L. and Sapienza, H. (1992). The entrepreneur and the initiation of new venture launch activities. Entrepreneurship Theory and Practice 17, 49–55.

Hyytinen, A., and O. Toivanen (2005), Do financial constraints hold back innovation and growth? Evidence on the role of public policy, Research Policy 34(9), 1385-1403.

Kirzner, I. M. (1973). Competition and Entrepreneurship. Chicago, IL: University of Chicago Press.

Laursen, K., Salter, A. (2004). Searching high and low: what types of firms use universities as a source of innovation? Research Policy 33, 1201–1215.

Lerner, Josh. 2009. Boulevard of Broken Dreams. Princeton, New Jersey: Princeton University Press.

Levy, R., Roux, P., Wolff, S. (2009). An analysis of science–industry collaborative patterns in a large European University. Journal of Technology Transfer 34: 1-23.

Lin, H.-F. (2007). Knowledge sharing and firm innovation capability: an empirical study. International Journal of Manpower, 28 (3/4), 315-332.

Manimala, M. (1996). Beyond innovators and imitators: A taxonomy of entrepreneurs. Creativity and Innovation Management 5, 179–185.

Mas-Verdú, F (2007): Services and Innovation Systems. European Models of Technology Centres. Service Business: an International Journal  vol 1 pp 7-23.

Motohashi, K (2005) 'University–industry collaborations in Japan: The role of new technology-based firms in transforming the National Innovation System' Research Policy Volume 34, Issue 5, Pages 583-594.

Nakamura, M., Mohnen, P., Hoareau, C 2003. What type of enterprise forges close links with universities and government labs? Evidence from CIS 2. Managerial and Decision Economics, John Wiley & Sons, Ltd., vol. 24(2-3), 133-145.

Okamuro, H., Kato, M., Honjo, Y. (2011). 'Determinants of R&D cooperation in Japanese start-ups'. Research Policy, 40 (5), 728-738.

Pavitt, K. (1984). 'Sectoral patterns of technical change: Towards a taxonomy and a theory'. Research Policy, 13(6), 343-373.

Pérez, M., Martínez, A. (2003). The development of university spin-offs: early dynamics of technology transfer and networking. Technovation 23, 823–831.

Ponomariov, B.L. (2008). Effects of university characteristics on scientists' interactions with the private sector: an exploratory assessment. Journal of Technology Transfer 33(5), 485-503.

Prabhu, V., Sutton, C. and Sauser, W. (2008): Creativity and certain personality traits: understanding the mediating effect of intrinsic motivation, Creativity Research Journal, 20, 53-66.

Radas, S. (2005). Collaboration between Industry and Science: Motivation Factors, Collaboration Intensity and Collaboration Outcome. Croatian Economic Survey 2005.

Radas, S. Bozic, L. (2009). 'The antecedents of SME innovativeness in an emerging transition economy.' Technovation, 29, pp. 438–450.

Rappert, B., Webster, A., Charles, D. (1999). Making sense of diversity and reluctance: academic–industrial relations and intellectual property. Research Policy 28. 873–890.

Rauch, A., Frese, M. (2007): Let's put the person back into entrepreneurship research: A meta-analysis on the relationship between business owners' personality traits, business creation, and success, European Journal of Work and Organizational Psychology, 16, 353-385.

Reynolds, P.D., Bosma, N., Autio, E., Hunt, S., de Bono, N., Servais, I., Lopez-Garcia, P. and N. Chin (2005). Global entrepreneurship monitor. Data collection design and implementation 1998-2003, Small Business Economics, 24(3), 205-231.

Schneider, C., and R. Veugelers (2010), On young innovative companies: why they matter and how (not) to policy support them, Industrial and Corporate Change 19 (4), 969-1007.

Shane, S. (2004): Academic Entrepreneurship: University Spinoffs and Wealth Creation, Edwar Elgar Publishing, Massachusetts. 335 p.

Shapero, A. (1984): 'The entrepreneurial event'. In: Kent, Calvin A. (Ed). The environment for entrepreneurship, Lexington Books, D.C. Heath and Company Lexington, Massachussets.

Takalo, T., and T. Tanayama (2010). Adverse selection and financing of innovation: is there a need for R&D subsidies? Journal of Technology Transfer 35(1), 16-41.

Todt, O., Gutiérrez Gracia, A., Fernández de Lucio, I., Castro Martínez, E., 2007. The regional dimension of innovation and the globalization of science: the case of biotechnology in a peripheral region of the European Union. R&D Management 37 (1), 65-74.

Tödtling, F. Lehner, P., Kaufmann, A. (2009). Do different types of innovation rely on specific kinds of knowledge interactions? Technovation29, 59–71.

Uyarra, E. (2010). Conceptualizing the Regional Roles of Universities, Implications and Contradictions. European Planning Studies18 (8), 1227-1246.

Veugelers, R (2009). A lifeline for Europe's young radical innovators, Bruegel Policy Brief 2009(1), Brussels.

Wagner, S., Bukó, C. (2005). An Empirical Investigation of Knowledge-Sharing in Networks. The Journal of Supply Chain Management. Fall 2005, 17-31.

# Tables

**Table 1.** Having contracted with an institution for getting technology and strategic information (n=520, don't knows=1%)

| Institution | No | Yes |
|---|---|---|
| Consultants | 55% | 43% |
| Universities | 48% | 51% |
| Technological institutes | 42% | 56% |
| Other institutions | 80% | 19% |
| Average | 56% | 42% |

**Table 2.** Descriptive statistics – independent variables and firm characteristics

| | Full sample | | | | | YICs | | | | | Other innovative firms | | | | | Mean differences test |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | St.dev. | Min. | Max. | Cases | Mean | St.dev. | Min. | Max. | Cases | Mean | St.dev. | Min. | Max. | Cases | |
| University contracts | 0.52 | 0.50 | 0 | 1 | 514 | 0.53 | 0.50 | 0 | 1 | 185 | 0.51 | 0.50 | 0 | 1 | 329 | N.s. |
| Openness | 1.20 | 0.90 | 0 | 3 | 514 | 1.07 | 0.89 | 0 | 3 | 185 | 1.28 | 0.89 | 0 | 3 | 329 | * |
| R&D intensity | 0.96 | 0.90 | 0 | 2 | 509 | 1.18 | 0.91 | 0 | 2 | 184 | 0.83 | 0.87 | 0 | 2 | 325 | ** |
| YIC | 0.36 | 0.48 | 0 | 1 | 521 | - | - | - | - | - | - | - | - | - | - | - |
| Firm size | 0.60 | 0.74 | 0 | 2 | 516 | 0.16 | 0.40 | 0 | 2 | 186 | 0.84 | 0.78 | 0 | 2 | 330 | ** |

** Significant at 1%. * Significant at 5%. N.s. Not significant

**Table 3.** Correlation matrix – firm characteristics – full sample

|  | Openness | R&D intensity | YIC | Firm size |
|---|---|---|---|---|
| Openness | 1.00 |  |  |  |
| R&D intensity | -.03 | 1.00 |  |  |
| YIC | -.10 | .19 | 1.00 |  |
| Firm size | .23 | -.14 | -.44 | 1.00 |

**Table 4.** Descriptive statistics – personal characteristics and motivations

|  | Mean | Standard deviation | Min. | Max. | Cases |
|---|---|---|---|---|---|
| Age | 1.41 | 0.81 | 0 | 3 | 189 |
| Sex | 0.10 | 0.30 | 0 | 1 | 189 |
| Education | 1.16 | 0.65 | 0 | 2 | 189 |
| Self-employment push | 0.19 | 0.39 | 0 | 1 | 189 |
| Monetary push | 0.18 | 0.39 | 0 | 1 | 189 |
| Academic pull | 0.26 | 0.57 | 0 | 2 | 189 |
| Business pull | 0.79 | 0.95 | 0 | 4 | 189 |

**Table 5.** Correlation matrix – YIC sample

| | Openness | R&D intensity | Firm size | Age | Sex | Education | Self-employment push | Monetary push | Academic pull | Business pull |
|---|---|---|---|---|---|---|---|---|---|---|
| Openness | 1.00 | | | | | | | | | |
| R&D intensity | .00 | 1.00 | | | | | | | | |
| Firm size | .04 | -.03 | 1.00 | | | | | | | |
| Age | .02 | .10 | .10 | 1.00 | | | | | | |
| Sex | -.05 | -.02 | -.09 | -.05 | 1.00 | | | | | |
| Education | -.03 | .12 | -.07 | .01 | .08 | 1.00 | | | | |
| Self-employment push | -.14 | -.07 | -.09 | .26 | .18 | -.16 | 1.00 | | | |
| Monetary push | -.06 | .00 | .02 | -.15 | -.11 | .07 | .03 | 1.00 | | |
| Academic pull | -.08 | .24 | -.10 | .06 | .10 | .38 | .02 | .05 | 1.00 | |
| Business pull | .21 | -.14 | -.06 | -.09 | -.09 | -.02 | .05 | .19 | .02 | 1.00 |

**Table 6.** Average value of having contracted with universities (yes/no), by economic sector

| Economic sector | Full sample | YICs | Other innovative firms | Mean differences test |
|---|---|---|---|---|
| Supplier-dominated manufactures | 0.40 | 0.00 | 0.44 | * |
| Production intensive manufactures | 0.54 | 0.58 | 0.53 | N.s. |
| Science-based manufactures | 0.57 | 0.67 | 0.49 | N.s. |
| ICT services | 0.57 | 0.57 | 0.57 | N.s. |
| Research and development services | 0.70 | 0.65 | 0.79 | N.s. |
| Engineering, architecture, environmental services | 0.47 | 0.52 | 0.43 | N.s. |
| Other services | 0.41 | 0.31 | 0.48 | N.s. |
| Average | 0.52 | 0.53 | 0.51 | N.s. |

** Significant at 1%. * Significant at 5%. N.s. Not significant

**Table 7.** Probit model of having contracted with universities (yes/no) − YICs vs. other innovative firms

| | 1 Full sample | 2 YICs | 3 Other innovative firms |
|---|---|---|---|
| Number of observations | 498 | 178 | 320 |
| Log likelihood function | -294 | -104 | -182 |
| Prob[$\chi 2$ > value] | 0 | 0 | 0 |
| Pseudo $R^2$ | 0.68 | 0.70 | 0.68 |
| | Coeff. (t-ratio) | Coeff. (t-ratio) | Coeff. (t-ratio) |
| Constant | -1.05 (-5.55) ** | -0.68 (-1.82) | -1.13 (-5.24) ** |
| Openness | 0.52 (7.08) ** | 0.38 (3.15) ** | 0.61 (6.41) ** |
| R&D intensity | 0.25 (3.48) ** | 0.27 (2.17) * | 0.23 (2.51) * |
| YIC | 0.22 (1.51) | | |
| Firm size | 0.34 (3.54) ** | 0.18 (0.69) | 0.32 (3.05) ** |
| Industry sector dummies | Included (6) | Included (6) | Included (6) |
| BIC | 656 | 261 | 422 |

** p<0.01; * p<0.05

**Table 8.** Probit model of having contracted with universities (yes/no) – the effect of education and motivations in YICs

|  | 1 | 2 |
|---|---|---|
| Number of observations | 178 | 185 |
| Log likelihood function | -90 | -98 |
| Prob[$\chi 2$ > value] | 0 | 0 |
| Pseudo $R^2$ | 0.74 | 0.72 |
|  | Coeff. (t-ratio) | Coeff. (t-ratio) |
| Constant | -0.87 (-1.69) | -1.07 (-3.59) ** |
| Openness | 0.48 (3.51) ** | 0.49 (3.92) ** |
| R&D intensity | 0.1 (0.75) |  |
| Firm size | 0.28 (1.01) |  |
| Age | -0.14 (-0.97) |  |
| Sex | 0 (0.01) |  |
| Education | 0.38 (1.97) * | 0.42 (2.37) * |
| Self-employment push | -0.79 (-2.38) * | -0.75 (-2.54) * |
| Monetary push | 0.11 (0.37) |  |
| Academic pull | 0.62 (2.54) * | 0.67 (2.9) ** |
| Business pull | -0.28 (-2.17) * | -0.27 (-2.42) * |
| Industry sector dummies | Included (6) | Selected (3) |
| BIC | 268 | 243 |

** $p<0.01$; * $p<0.05$