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What are the antecedents of collaboration intensity between industry and universities in public subsidized projects?

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Abstract

â?•What are the antecedents of collaboration intensity between industry and universities in public subsidized projects?â?•, Davide Andrea Cannito, Copenhagen Business School, Ino department, enrollment 01/01/2014, expected final date 01/01/2017, e-mail dc.ino@cbs.dk.

University-industry collaboration has attracted in the last decades an increasing attention both from scholars and public policy. An increasing number of national and European programs has been designed to increase public-private collaboration. The extensive literature on University Industry relationship shows that links with university have an important impact on the economic sphere in terms of increased sales, higher research productivity and patenting activity for firms.

Previous literature on the determinants of university-industry pointed out that innovation strategy dimensions such as openness and signaling through patents are important factors that explain propensity to engage in such collaborations. Empirical investigations mainly employed two sources to test these hypotheses: CIS survey, mostly at the national level, and Framework Programs data. Survey design allows to construct indicators and proxies for managerial strategy and perceptions. On the other hand, it does not offer a clear picture of collaboration portfolio and the true extent to which organizations collaborate. Data on collaboration at the European level allows for construction of panel data and clearly defines the set of collaborators, but by focusing on a single program, the EU Framework Program, such literature introduce biases in terms of selection. In addition, such data suffer from limitations in terms of variables at the firm levels, such as patent data or other proxy for search strategy, that are relevant for explaining firmsÂ´ decision to engage in university-industry collaboration.

This paper contribute to the antecedents of U-I collaboration by investigating whether a scientific oriented knowledge base is an important factor for explaining the intensity of collaborations. In line with the theory, we expect that science based firms are better positioned to gain from this collaboration because of superior absorptive capabilities and alignment of incentives. We address this question exploiting a unique dataset that incorporate all public funded projects in Denmark, ranging from regional to European level from 2008 to 2012. We merge it with Danish Register Data and Patent Data from the European Patent office. The richness of Danish data offer the possibility to unambiguously connect with financial data, educational composition of labor force composition. First, this setting offer a clear picture of the

portfolio of collaborators and the relative relevance of university partners. Second, register and patent data allows to analyze both firms´ characteristics and search strategy.

We perform a cross sectional econometric analysis to investigate the impact of the degree of scientific involvement, as proxied by the pattern of citations, on the intensity of university industry collaboration, in terms of share of university collaborators. We control for program fixed effect and previous co-patenting with university. We expect a positive relationship between scientific orientation and intensity of collaboration with universities.

1. INTRODUCTION

The benefits of science-technology interactions have been investigated and unambiguously established (Nelson and Winter, 1982; Jaffe 1989, Cohen et al. 2002). Governments and public authorities have dedicated increasing efforts and resources to strengthen the connections between industry and science according to the triple helix model (Leydesdorff and Etzkowitz, 1996, 1998). Financial support for collaborative research receives most part of the resources for industry science links: the advanced technology program (ATP), the cooperative R&D agreement between federally funded laboratories and firms (CRADAs) and the industry university cooperative research centers (IUCRSs) in the US and the framework programmes in Europe (Horizon 2020 being the last). Universities and scientists are gradually, but consistently, accepting a new scientific paradigm that encourage the engagement with industrial firms (Stuart and Ding, 2006).

Despite the documented advantages of U-I collaboration, we observe that only a small fraction of firms actively collaborate with university and, more striking, among the collaborating firms, few really central actors account for a disproportionate share of the university-industry links (Breschi and Cusmano, 2004).

The aim of this paper is to contribute to better understand the determinants of the intensity of university-industry collaborations, based on objective measures of collaboration intensity. Specifically I concentrate on public sponsored projects. Following Bruneel and co-authors (2010) I explore the factors that affect the barriers to university-Industry collaboration, namely, transaction-related barrier, orientation-related barriers and cognitive barriers (Meyer-Krahmer and Schmoch, 1998). In so doing this study attempts to contribute to the literature in several ways.

Previous literature at the firm level has explored mainly the determinants of the propensity to collaborate (Veugler & Cassiman, 2005; Segarra-Blasco & Arauzo-Carod; Meyer-Krahmer and Schmoch, 1998, Santoro and Chakrabarti, 2002) and most of the time the focus was on general R&D cooperation(Busom and Fernandez-Ribas, 2008; Fritsch and Lucas, 2009; Miotti and Sachwald, 2003). Few papers explicitly look at the intensity of collaboration within the restrict domain of U-I links(Fontana et al, 2006). I contribute to this literature by exploring mechanisms that specifically characterize the knowledge transfer between academic institutions and firms rather than general mechanism of R&D collaborations.

Second, the concept of absorptive capacity (Cohen and Levinthal, 1990) has been widely employed to explain firms´ ability to internalize incoming spillovers (Veugler & Cassiman, 2005), often measured in terms of R&D intensity. I will try to pinpoint specific dimension of the concept of

absorptive capacity, namely potential absorptive capacity (Zahra and George, 2002), as by the degree to which the knowledge base of the firm is scientifically oriented.

Third, a number of prior studies examine the effect of previous experience in lowering the barriers to collaborate with universities (Bruneel et al, 2010; Tartari et al, 2012). I will try to disentangle different channels through which previous collaborations can be beneficial. Specifically I look how previous transactions with university TTOs and pattern of university-industry co-publication affect different transaction costs at the organizational and individual respectively.

Third, empirical contributions has mainly employed two sources of data to test hypotheses on U-I links: survey data, especially CIS (Laursen and Salter, 2004; Cassiman and Veuglers 2005), mostly at the national level, and Framework Programs data (Hernan, Marin and Siotis, 2003; Marin and Siotis, 2008). Survey design allows to build indicators and proxies for managerial perceptions and strategies. On the other hand, it does not offer a clear picture of the collaboration portfolio nor an objective measure of the intensity of collaboration. Data on collaborations at the European level (allows for construction of panel data and clearly defines the set of collaborators, but by focusing on a single program (the EU Framework Programs) such literature introduce selection. In addition, this approach suffers from data limitations at the firm levels, such as patent/publication data or other proxy for search strategy. Strategy related variable are relevant for explaining firms´ decision to engage in university-industry collaboration.

I investigate the barriers to U-I intensity of collaboration exploiting a unique dataset that incorporate all public funded projects in Denmark, ranging from regional to European level from 2008 to 2012. I merge it with Danish Register Data, Patent Data from the European Patent office and publication data from Scopus. The richness of Danish data offer the possibility to connect unambiguously with financial data and educational composition of labor force. First, this setting offers a clear picture of the portfolio of collaborators and the relative relevance of university partners in terms of number of projects. Second, register data allows to analyze in depth firms´ characteristic. Finally, publication and patent data not only provides meaningful and objective measures of firms' knowledge base, they also provide a picture of different type of previous links between university and industry.

The paper is structured as follows. I start in section 2 with a brief overview on the determinants of university industry collaboration and the different barriers that hinder U-I knowledge tranfer. Section 3 formulates the hypothesis. Section 4 describes the data and the empirical strategy. Section 5 (will) presents the results (when they will be available). Section 5 (will hopefully) concludes.

2. LITERATURE REVIEW

The literature on cooperation between industry and science hasn't still developed a distinctive theoretical framework, most of the research on the topic explicitly or implicitly refers to the more abundant literature on general R&D cooperation. The Industrial Organization literature analyzes collaboration focusing on two characteristics: imperfect appropriability of results and incentives to collaborate. The imperfect appropriability increases the incentives for cooperation. Firms try to appropriate the benefits of cooperation by capturing informational flow originating from the partners. When spillover are high enough, i.e. above a critical threshold, they increase the relative profitability of R&D cooperation and in turn cooperating firms are more profitable compared to non-cooperating firms (D'Aspremont & Jacquemin, 1988; Kamien, Muller & Zang, 1992). Firms face the problem of maximizing incoming spillover while minimizing outgoing spillover (i.e. the information leakage out of the company). Cohen and Levinthal (1989), and later theoretical development by Kamien and Zang (2002), stress the role of absorptive capacity to fully exploit the benefits of incoming spillovers. The engagement in internal R&D activities is crucial to increase the effectiveness of knowledge absorption and recombination. Also Mowery and Rosenberg (1989) stress:"cooperative research programs alone are insufficient… more is needed, specifically the development of sufficient expertise within the firms to utilize the results of externally performed research."

In line with theoretical predictions, the empirical literature finds that R&D intensity, both in terms of R&D expenses and R&D employees, is one of the main determinants of firms´ propensity to collaborate with academic institutions (Fritsch & Lukas, 2001; Belderbos et al., 2004; Segarra-Blasco & Arauzo-Carod, 2008, Laursen, Reichstein, Salter, 2011). It's interesting to stress that these studies looked at the relative importance of R&D intensity for different type of partners (customers, suppliers, research institutions) and find very similar effects. A similar regularity refers to firm size (Veugler & Cassiman, 2005; Fritsch & Lukas, 2001; Belderbos et al., 2004). For firm size the underlying mechanism is not theoretically clear, but is sometimes used as proxy for absorptive capacity. Belderbos et al. (2004) and Leiponen (2001) find both a positive size effect and R&D intensity effect on Dutch and Finnish survey data. The relationship between absorptive capacity, R&D intensity and size tend to blur when properly accounting from simultaneity and endogeneity between own R&D and R&D cooperation (Veugler & Cassiman, 2005). Correcting for simultaneity Veugelers (1997) finds that firms that spend more on R&D have a significantly higher probability to cooperate and that once correction has been made for this, size (which typically positively influences internal R&D) no longer is relevant for explaining R&D co-operation.

Cassiman and Veugelers (2002) provide evidence of a strong positive effect of own R&D activities on cooperation in R&D, but the effect looses significance when endogeneity problems are correctly addressed.

Other factors that positively affect the probability of collaboration commonly found in the empirical literature are geographical proximity (Laursen, Reichstein & Salter, 2013), public funding (Segarra-Blasco, 2008, Busom & Ribas, 2008; Capron and Cincera, 2003) and industry characteristics such as R&D intensity and propensity of the firm to draw from scientific knowledge (Pavitt, 1984, Meyer-Krahmer and Schmoch, 1998).

A separate but yet strictly related literature explores barriers that specifically pertain to the relationship between private firms and individual scientist on the one hand, and with the universities as organization on the other. Bruneel et al. (2010) and Tartari et al. (2012), drawing from the contribution of Dasgupta and David (1994) and transaction cost theory (Williamson, 1979), identifies two type of barriers: Mertonian Barriers and Williamson Barriers.

Since the Bayh-Dole act in the US and the abolition of the professor's privilege in Europe (Denmark was among the first in Europe, 2000) the property of IP is granted to the University and generally managed by a technology transfer Office (TTO). In this sense, there are two different layers of transaction costs because industrial firms must deal with two agent: one at the individual level (the academic) and one at the organizational level (TTO).

Mertonian or orientation-related barriers refer to conflicts about the orientation of the research. Even if the academic world is gradually accepting an increasing engagement with industrial R&D, there are contrasting norms and incentives (Merton, 1973) that still prevent the alignment of goals and procedures. The harsher conflict refers to the secrecy problem (Tartari and Breschi, 2009), i.e. the extent to which collaboration with industry could be associated with restrictions on the disclosures of research findings and, more generally, on the dissemination of research results. The scientific system has a powerful incentives regime that focus on the priority of establishing reputation through publications that is critical to academic success. The competition among academics is shaped by the priority system: scientists engage in "status competition" with their peers in terms of publications, institutional affiliations and prices. This stand in deep contrast with the incentives for private firms to keep the knowledge "private", avoiding leakage of information that could undermine the firm's competitive advantage. The involvement of industry in open science is most of the time instrumental to gain advantage over competitors or signal competencies (Chesbrough, 2006; Cockburn and Henderson, 1998)

Williamson or transaction-related barriers refer to transaction costs of dealing with the rules and regulations of the university and as well as conflicts over IP with industry partners (Tartari et al, 2012). The nature of these costs is similar to those that R&D alliance partners face in the private sector: uncertainty and asymmetrical information in terms of quality and outcomes of the project. The additional problem is that industrial firms may have difficulties to manoeuvre in different institutional context with unfamiliar rules and procedures, especially when TTOs are inefficient because often understaffed and underfunded. In most of the cases firms are naturally in a position of disadvantage in term of information asymmetry and hence ability to evaluate the commercial potential. As a result, it could be hard to stipulate contracts that define the distribution of benefits and IP rights, especially given the disposition of TTOs to overvalue the commercial potential of university research (Clarysse et al. 2007).

Bruneel et al (2010) find that orientation-related barriers are sensibly reduce when industrial partner has experience in collaborating and when interaction with university is developed through a wide range of channels (joint research collaboration, consultancy, informal interaction, …). More importantly trust, which generally arise from preferential attachment with familiar partners (Gulati and Gargiulo, 1999) and personal interaction, reduces both type of barriers.

A third type of obstacle pertain to the cognitive obstacles that firms need to overcome when trying to access, absorb and recombine academic knowledge. Industry counterparts could face difficulties interacting with state-of-the-art technology, methods and procedures that characterize academic research, or they could be even totally unfamiliar with a particular field that exists only in the academic domain. One of the main advantages of science is that it provides a map (Fleming and Sorenson, 2004) that technological search can use to reduce the search space, identify useful direction and avoid wasting effort in costly trial and error experimentation. Industrial firms must possess a knowledge base what is coherent with their university counterpart; in summary, it must develop dedicated absorptive capacity to be able to read the map that science provides. Trust reduces as well cognitive barriers to the extent that increases individuals' willingness to incur costs to transfer, receive and absorb knowledge (Appleyard, 1996; Kachra and White, 2008) and enhances the effectiveness of joint problem solving.

3. HYPOTHESIS DEVELOPMENT

Based on the literature review I stress the importance of three barriers that reduce the effectiveness (and sometimes the viability) of university-industry collaboration. I formulate the hypothesis that this barriers as well constraint the ability of industrial firms to interact intensively (i.e. on a large

number of projects) with universities. In the following of this section I examine each of this barrier and identify the factors that can reduce such barriers and, as a result, increase the intensity of U-I collaboration

3.1 SCIENTIFIC ORIENTED KNOWLEDGE BASE AND COGNITIVE BARRIERS

In the previous section, I stressed how firms need specific absorptive capacity to interact effectively with academics. I also focus on the broad nature of absorptive capacity and especially the extent to which such concept, measured in term of R&D intensity, has similar effects on the propensity to collaborate irrespectively of the partner type. We are then looking for a specific type of absorptive capacity that better explains U-I intensity of collaboration. In this respect, it can be useful to refer to the refinement of the absorptive capacity concept developed by Zahra and George (2002). According to the authors is possible to distinguish two components: potential absorptive capacity (PACAP), the firm ability to value and acquire external knowledge, and realized absorptive capacity (RACAP), i.e. the firm capacity to transform the knowledge absorbed and exploit it for profit generation. The former components create the necessary conditions to interface with partners. Following Lane and Lubatkin´s notion of relative absorptive capacity (1998), I expect PACAP not to be absolute, but must be defined according to the type of knowledge base of the "partner firm". According to the literature on cognitive distance, the relationship between distance and effectiveness of learning follows an inverted U-shaped relationship (Nooteboom, 1999; Nooteboom et al, 2007). This curvilinear effect is rooted in the definition of technological distance (see Stellner, 2014 for a review): in general, such measure is built on the base of the firm´s patent portfolio and refers to the relatedness of patent classes. I believe that this measure is not appropriate when the "teacher organization" is a university and I prefer to look at the extent to which the knowledge base of the firm draws from academic knowledge, i.e. scientific closeness. The fact that industrial partners operates in similar technological areas implies that their cognitive capabilities are also proximate. The same does not necessarily hold when thinking at university-industry knowledge transfer: both partner can operate in the same technological field but still be cognitively very distant. Differently from PACAP, RACAP is more likely to be a more homogeneous capacity since it relates to the ability of the firm to transform the absorbed knowledge and recombine it according to the specific characteristics of the firm and the market that it serve. For this reason RACAP is more likely to be related to intramural R&D.

Reframing the proposed link between PACAP and intensity of collaboration I expect that

> Hypothesis 1: There is a positive relationship between scientific oriented knowledge base and intensity of collaboration

As I discussed in the literature review the abolition of the professor´s privilege resulted in a double layer of transaction costs. More importantly, we see that there is a bijective relation between organizational /individual level and Williamson/Mertonian related barriers: IP related transaction costs pertain mainly to the organizational level while conflicts concerning research orientation and disclosure terms are more relevant to the individual academic. The extent to which previous collaboration are effective in dealing with these barriers is then probably related to the type of collaboration and the level at which the collaboration is established (organization or scientist).

Previous engagement with TTO refers to a formal mechanism of knowledge transfer that involve IP related transaction. This type of experience is likely to affect transaction related barriers at the organizational level because it increase experiences in IP negotiation with TTO and ultimately resulting in the development of standard contracts, protocols and routines that serve as starting point for negotiations on IP ownership and alleviate distributional conflicts. It´s worth pointing out that this mechanism is not based on accumulated experience with a specific TTO nor to the development of inter-organizational trust, but relies on the ability to deal with this type of institutions in general. Due to reduction of transaction costs at the organizational level, we expect that

> Hypothesis 2: There is a positive relationship between previous experience with <u>any</u> universities´ TTO and the intensity of collaboration

Co-publishing instead involves a more informal mechanism of knowledge transfer. Differently from engagement with TTOs, this type of cooperation consists of a personal involvement that is likely to initiate and/or strengthen trust-based relations. Trust is essential to facilitate the exchange of complex, difficult-to-codify knowledge and information (Kogut and Zander, 1992). In the case of Mertonian barriers, when academics trust their industry partners, they believe those partners will try to ensure that their needs from a project are met, such as the propensity to publish rapidly results. Tartari et al. (2012) showed that previous experience increases trust and lowers both transaction and oriented related barriers. According to the presented argument and due to to reduction of all barriers at the individual level, we expect that

> Hypothesis 3: There is a positive relationship between previous co-publishing and intensity of collaboration

4. DATA AND EMPIRICAL STRATEGY

The setting we choose for this study is Denmark in the period 2008-2012. Denmark is a good setting for a series of reasons. First, it was one of the first country in Europe to abolish the professor privilege (2000) so that the collaborations I observe in the study period should be immune from transition dynamics that can confound the estimations. Second, Danish authorities have been extremely active in fostering innovation and public-private collaboration. This gives the possibility to analyse more than 20 programs targeting a wide range of goals, industries, firm sizes and organization types. Third, the national institute of statistics, i.e. Statistics Denmark (DST), have one of the most detailed dataset on individual, organization and matched employer-employee in the world (together with the other Scandinavian countries).

We collect information from three main sources.

The core database is Damvad proprietary collaboration database and includes the entire population of public funded projects in Denmark in the study period. "The database keeps track of the various types of projects and initiatives in which Danish companies, universities, and organizations collaborate. The database forms a unique analytical platform that illuminates the different actors' participation in public support instruments in the areas of research and innovation. In addition, the database contains information on CVR-numbers thus enabling a linkage to economic key figures for the companies with the purpose of conducting impact evaluation studies as well as mapping users and potential users of the public support instruments. The database contains more than 5,800 different projects with more than 13,000 Danish participants and more than 8,500 foreign participants" (Damvad, 2014). By identifying organizations within a given project, Damvad DB allows to observe the exact partner portfolio and the number of project involving a given partner.

The source for patent and backward citation data is the European Patent office, specifically the Patstat version.

Finally we employed the APE-INV database to identify "Academic Patents" among EPO patents. The objective of the APE-INV project was to produce an inventor database, comprising all inventors (academic and non-academic), listed on EPO patents since 1978 onward.

[Coming soon – Scopus, IDA matched employers-employee database]

I identify in Damvad Collaboration Database 24 collaboration oriented programs. These programs provide strong incentives for U-I collaboration, but in many case did not have any formal requirement in this sense (20% of the project does not have university participants). This selection results in 3221 unique project with at least two partners and indirectly defines the firms' sample: a firm enters in the sample if it is Danish based and was involved in at least one of the public projects belonging to one of the collaboration-oriented programs. These firms were than aggregated at the parent level for a final sample of more than 1700 firms. The Danish legislation encompass a wide range of legal forms, as a result our definition of firm is quite broad and includes public and private companies, sole proprietor, foundation, commercial association but excludes public bodies, such as region and county administration, and state-owned companies.

The set of firms we looked at is then a selected sample of the entire population of firm, but the full population of firm collaborating under a public financed scheme. I think that such selection is not so detrimental once we consider the research question of this paper. I´m looking at the determinants of the intensity of University-Industry collaboration and I´m not interested in modelling neither the choice of collaborating nor the probability of receiving public funding. I see at least three reasons that mitigates the selection problem. First, the well-developed literature on the propensity to engage in U-I links enumerates the main determinants associated with the choice of collaboration and allows to correct for possible omitted variable bias when modelling collaboration intensity. Second, the positive effect of public funding on the probability of collaborate is consistently established in the literature, for this reason, even if we cannot control for it, we are aware of the direction of the bias. Third, being our sample the full population of firms collaborating under public funded scheme, exploring their behaviour could be even more relevant for my purpose. These firms demonstrated both the ability to collaborate and receive public funding, still a large of part of them collaborate with a university only once, while very few collaborates on 40-50 projects. Explaining the observed behaviour is then interesting as such, especially in terms of policy effectiveness, without any need to generalize further.

In summary I am interested in modelling **Pr (Y = y | Firm Collaborate, Firm receive public funding),** where y is the number of project of the focal firm involving at least one university

4.2 VARIABLE DEFINITION

Our dependent variable for the intensity of collaboration is the raw count of the projects that the focal firm establishes with a university (both Danish or Foreign) in the period 2008-2012

For each firm in the sample we then build the patent portfolio and the backward citations to EPO patents and non-patent literature relative to each patent. We consider only patents registered at the European Patent Office. At this point, I have two portfolios both composed of patents, I define them as patents portfolio and citations portfolio.

Among this set I define "*academic*" those patents that satisfies at least one of the following conditions: (I) at least one of the applicants is a university or (II) at least one of the inventors listed in the patent is included in the Ape-INV OR the inventor´s affiliation identifies a university. On the base of this, I compute the variable for hypothesis 1 and 2.

Scientific Knowledge base – pre-sample count (dummy) of backward citations in the citations portfolio of the focal firms that refers to either(i) academic patent (provided is not co-patented with the focal firm) or (ii) non-patent literature (NPL). The presence of NPL indicates that the technical invention is related to − or in some cases initiated and/or stimulated by − research activities performed in related fields (Verbeek et. al, 2002). Collins and Wyatt (1988) found that patents in fields that are young, developing rapidly and with a strong scientific content, generally cite a substantial number of scientific publications. More importantly, in the case of the European Patent Office most of the prior art citations are added by the examiner rather than by the applicant. For this reason this measure provides a proxy of the scientific orientation of the knowledge base, rather than a measure of knowledge flow.

Previous experience with any universities´ TTO – pre-sample count of academic patents in the patent portfolio. Since we don´t have information on the actual interaction between TTOs, we use indirect evidences that the firm experienced IP related transaction

Hypothesis 3 variable is instead based on Scopus publications.

Co-publishing with universities – pre-sample count of papers co-published with academics affiliated with one of the partner universities.

I control for a number possible confounding factors both at the firm and industry level. At the firm level the main determinants of the propensity to collaborate are included: firms size as the number

of employees and R&D intensity measured as a patent dummy/number of patents[1]. At the industry level I implement industry dummy and R&D intensity at the industry level stratified by size. As a further check, I introduce program dummies to control for program fixed effect.

4.3 METHOD

The way I decided to model the phenomenon of interest introduces some issues when choosing how to structure my dataset. Damvad collaboration database includes the application year for any project, which in turn should allow the construction of a dataset with a panel structure. A decision in this sense would undermine my assumptions and the way the phenomenon is modelled.

Recall from section 4.1 that I´m interested in modelling Pr (Y = y | Firm Collaborate, Firm receive public funding). This conceptualization, if applied to panel data, would result in ambiguous zeros[2]. Nominally, in year t two type of zeros could then be present, observationally equivalent but not conceptually

- True zeros - the firm collaborated in year t but not with a universities
- Ambiguous zeros – in year t the firm does not collaborate at all nor receive public funding (and of course does not even collaborate with a university). These zeros would violate the assumptions in my model, i.e. Pr (Y = y | Firm Collaborate, Firm receive public funding)

This problem does not arise if I adopt a cross sectional data structure: the dependant variable is equal to zero if and only if those firms both collaborate and receive funding but do not collaborate with a university.

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[1] Although R&D intensity is a measure of input and patents is a measure of output, I believe that to my purpose this difference should not be too troublesome. What we really want to control for is the effect of RACAP that I identify with intramural R&D activity (see the section on hypothesis development), which is neither a measure of input nor a measure of output.

[2] The dependant variable for my analysis is the count of project with at least one university partner; hence, a zero refers to no collaboration with a university partner.

FIG 1 - Distribution of dependant variable, relative frequencies
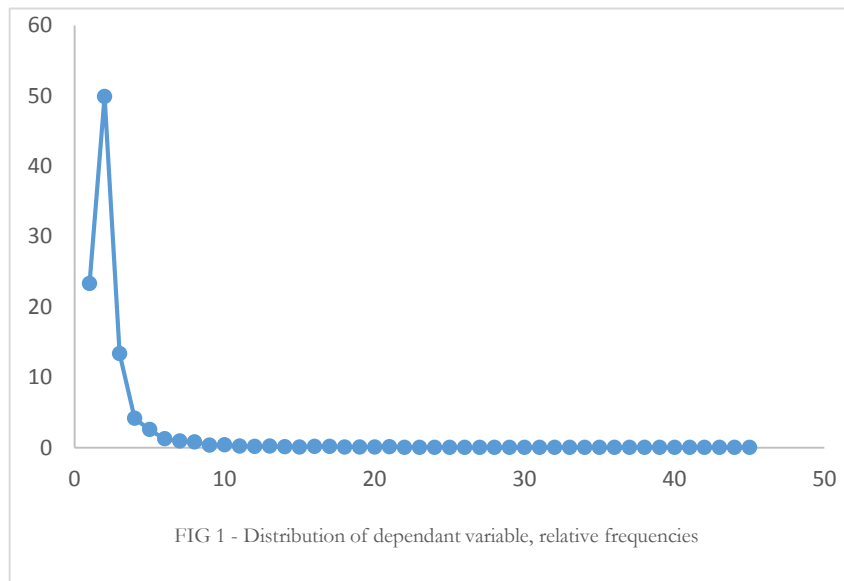
Given that my variable is a count of discrete events, the most relevant model is a count model. The choice of a binomial, compared to a normal Poisson, depends on the characteristics of the distribution of my dependant variable. Poisson models assume equality of mean and variance, but the distribution of dependent variable clearly displays over-dispersion (see fig. 1)

4.4 ADDRESSING ENDOGENEITY

The choice and intensity of collaboration can be determined by unobserved (without a survey) strategy at the firm level (Laursen and Salter, 2004; Fontana et al, 2006). In such a case the estimates would be biased because of an omitted (and unmeasurable) variable that I fail to include in the model.

The biggest source of concern is the likelihood that the variables built on the patent portfolio are correlated with the error terms. This issue could arise in the case that both patenting and collaborating are drive by a common strategy. I address this possibility in two ways

First, independent variable computed from patent and publication portfolio are pre-sample measures and are one period lagged (refers to the period 2001 – 2007). On the one hand, I avoid that dependent variable and independent variable are simultaneously determined. Because bounded rationality and limitation in attention make the knowledge base inert, sticky and difficult to change, previous knowledge base could be a good instrument because it would be correlated to actual knowledge base, but is possibly not correlated with actual patent strategy

Second, I control for post collaboration co-patenting, i.e. if the partners jointly file a patent at the end of the collaboration project. Even if this mechanism does not fully address the endogeneity problem, in the case data shows no relationship between patenting strategy and collaboration strategy, I would obtain suggestive evidences that endogeneity does not drive the results.

5. RESULTS

[Coming soon… Hopefully]

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