Traditional versus Heterodox Motives of academic patenting: Evidence from the Netherlands

Isabel Maria Bodas Freitas*
Alessandro Nuvolari**

*Grenoble Ecole de Management, France & Dispea, Politecnico de Torino, Italy; Email: i.m.freitas@tue.nl
**Eindhoven University of Technology, The Netherlands; Email: a.nuvolari@tue.nl

Abstract[1]

This paper investigates the motives for the patenting of research results (developed in collaboration or not with industry) by academic researchers. In particular, it studies how "traditional" market-related and "heterodox" signalling motivations for patenting relate to different types of innovations, forms of research financing and patents' ownership. Using in-depth data on 16 cases, this paper shows the existence of a relationship between patenting motivations, types of innovation, and the role of industrial partners in proposing the project, financing and in performing research. In particular, this paper suggests the existence of three motivational spaces for patenting: the demand-pull, the supply-push, and the collaborative development.

1. Introduction

Recently, as the responsibility of universities for economic development is increasingly acknowledged and the financing of research activities is becoming increasingly reliant on the commercialisation of university activities, studies of academic patenting activity have multiplied. In the US, the passage of Bayh-Dole act in 1980s, by setting new rules of ownership for university research results, has marked the beginning of a new context for academic patenting. In many other OECD countries, revisions of the regulations intellectual property rights on university research results are currently taking place.

Several authors argue that patents, especially university patents, represent only the commercial and codified aspects of innovation, and that knowledge transfer between university and industry

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require other more informal and collaborative means of interaction that licensing. In particular, Cohen et al. (2001) find that publications, informal contacts, open communication and consulting are cited as channels of knowledge transfer that are more important than patents. Analysing in depth, through case studies, the importance of university patents for knowledge transfer, Colyvas et al. (2002) suggest that patents are particularly important for the effective transfer of "embryonic" inventions, whose further development require some exclusivity rights for protecting the follow-up research efforts of companies, and much less important for the transfer of "ready to use" inventions. Similarly, technology transfer offices play an important role in technological areas in which linkages university-industry are weak.

Patents are generally understood as a legal mechanism that grants a commercial monopoly to exploit an innovation for a period of time. However, less traditional and more heterodox motives such as signalling specific research capabilities, gaining access to research networks or enhancing reputation may also lead to patent research results (Anton and Yao, 2002; Penin, 2005; Fontana et al., 2006). These motives appear to be particularly important in the case of academic patenting. Still, little is known on the motivations of university researchers that decided to patent their research results. In this paper, we suggest that the role of patents for knowledge transfer might be related to the type and function of the patent, and consequently with the motivations of university researchers for patenting.

This paper analyses the motives for patenting research results developed by universities in collaboration or not with industry, in the Netherlands. Moreover, it explores how these motives (traditional versus heterodox) relates to different types of innovation (embryonic versus ready-to-use), forms of research financing and patent's ownership. For this purpose, we analyse micro-level detailed data on 16 case studies of successful transfer of knowledge, developed or co-developed at university, which involved the publication of patents. *Prima facie*, the Dutch case seems a particularly interesting one for studying this research question because, in the European context, Dutch academic researchers and Dutch universities appear to be particularly alert to possibilities of taking patents on research findings. A recent estimate suggests that 4.3% of Dutch patents at the EPO can be ascribed to academic inventors and that Dutch universities are assignees of 1% of Dutch patents at EPO. For countries like France and Italy the corresponding figures are lower (Baselli and Pellicciari, 2007).

This paper suggests that traditional and heterodox motives are not always exclusive. Moreover, we find that while traditional motives are a characteristic of most academic patents, heterodox motives for patenting are more likely to be found among embryonic innovations. Heterodox motives for patenting reveal the need of university researchers to find industrial partners for

future knowledge development, to increase the likelihood to access public R&D sponsoring, or support to spin-off creation and growth (venture capital and public supports).

2. Motives for patenting

According to traditional economic theory, a patent is a legal tool which grants to the inventor the exclusive right to produce/use or market a specific invention. The rationale for the establishment of this legal monopoly from a public policy point of view is the need of providing would-be inventors with economic incentives for recouping their investment in inventive activities. Without patent protection, so the traditional viewpoint goes, competitors could immediately copy or use the invention at almost no cost and this would clearly give to the original inventor little hope of recouping her investment in inventive activities. In this perspective, patents seem to perform a rather straightforward role of providing firms with an effective mean of protection of their inventive efforts.

However empirical research on patents and motivation for taking patents has revealed a much more complex picture. The first point to be noted is obviously that in most industries (the two notable exceptions being chemicals and pharmaceuticals) patents are not regarded as very effective methods for protecting inventions (Levin et al. 1981, Cohen, Nelson and Walsh, 2000). First-mover advantages and secrecy are typically considered by firms far more effective methods of protecting inventions than patents. The second point is that, in practice, patents are increasingly used by firms not only for protecting inventions but in order to perform other strategic roles. For example, the Carnegie-Mellon survey has revealed, that motives for taking patents, besides the two orthodox ones of preventing copying and of generating revenues by means of licensing, include: the blocking of rival patents, the possible use of patents in negotiation with other companies, the use of patents as threats for preventing infringement suits, the use of patents for enhancing reputation and the use patent for measuring the performance of R&D departments (Cohen, Nelson and Walsh, 2000).

In the case of academic patents, the situation becomes even more complex. As pointed by Verspagen (2006), university research can be regarded as a prime example of a system of patronage. That is to say as a case in which the development of new knowledge is directly supported by means of public funds. This means that university research is knowledge that is typically created by an incentive system that, at least originally, has emerged as an *alternative to the patent system.* In this perspective, the current public policy measures geared towards the encouragement of the patenting of university research, therefore, appears to follow an ambiguous rationale. They provide an incentive for investment in the production of new knowledge to actors, whose knowledge production efforts had been *already* supported by public

funds (Verspagen, 2006). Not surprisingly, a large bulk of research on academic patents has actually focussed on the effects of the co-existence of these two different incentive systems (public funds and patents) on the actual behaviour of academic researchers, examining issues such as the possible delays in the publication of research results, the possible diversion of research efforts from basic, fundamental research in more "applied" directions, etc. (Geuna and Nesta, 2006).

However, at least so far, empirical research on academic patents has regarded patents exclusively as a tool for the protection of innovation. Instead, as noted before, research on industrial patenting has revealed that patents are not only taken or used as tool for protecting innovation, but for a variety of other "heterodox" motives.

When all this considered, it seems relatively straightforward to ask the question whether a similar pattern is also characteristic of the phenomenon of university patenting. In other words, are university patents mostly taken for protection of new knowledge produced by universities or are they also the outcome of other motives? Clearly, this represents a particularly critical point for assessing the potential effects of the recent public policy measures geared towards the encouragement of university patenting. If the influence of heterodox motives turns out to be significant, it may well be possible that policies formulated on the basis of the notion that academic researchers and university are going to make use of patents exclusively for the protection of new knowledge will produce a number of unintended consequences.

In this paper, we provide a preliminary exploration of this research issue. Our aim is to provide a broad, preliminary sketch of the possible role played by heterodox motives on university patenting.

3. Data and Methodology

The goal of this paper is to explore the motives for patenting university research results developed in collaboration or not with industry, as well as how these motives (traditional versus heterodox) relates to different types of innovation ('embryonic' versus 'ready-to-use'), forms of research financing and patent ownership. Are traditional (heterodox) patenting motives more likely when knowledge developed is less (more) 'embryonic' and more (less) 'ready-to-use'? Are heterodox signalling motives for patenting more likely to be found in cases in which innovation was developed with public research funds or the patent issued is owned by the university?

To analyse in depth this issues, we collected in-depth information on specific cases. Thus, the focus in this paper is limited to a set of 16 innovations for which the university or its industrial partner applied and obtained patents. The unit of analysis in the case study is the piece of

knowledge developed or co-developed at university, and patented, independently on whether or not it has been commercialised.

The cases were chosen independently of their relative weight on the population of university innovations, following some criteria. We chose cases that show variety in terms of the forms of financing, diversity in the disciplinary origin, and diversity in terms of the efforts of university and firms on the project origin and development (university-driven research; the firm address the university with the idea; results from on-going collaborative project). Thus, 11 cases were collected at the University of Eindhoven, 3 at the University of Leiden, and 2 at the Delft University of Delf.

Concerning the disciplinary origin, four cases are mainly affiliated to Mechanical engineering, three to Biology and Medicine, three to Applied Physics, three to Electrical engineering, two to Chemistry and Chemical engineering, one to Bio-mechanics. Concerning university and industry initial efforts, in nine cases, the idea to set up the collaborative project came from university researchers, three of which involved former industrial researchers, and two part-time professors. The other five cases were mainly proposed by firms, and three emerged from results of previous or on-going collaborative research. Regarding financing, two cases were performed with only public subsidies, while five cases were fully financed by firms.

Table 1 provides information on the technology, disciplinary affiliation, type of funding used during its development, relative size of research team in yearly full-time man, and on the timing of the project. Moreover, it provides information on the timing and ownership of publication of patents.

Table 1. General information on the 16 projects that involved the publication of patents

Technology	Discipline	Funding	Size of research team	Starting	Time	Previous patents	Previous patents based on Univ. Knowledge	Previous Univ. owned patents	Number of OUTPUT patents	OUTPUT Univ. owned patents	Spin off
Flywheel	control system, mechanical engineering	R&D sponsoring of 60%	3	1997	5				2		End
guide-wire mounted sensor for measure pressure and temerature in the coronary artery	biomechanics and tissue engineering, biomedical engineering	mainly R&D sponsoring	2	2002	4	YES			1		
supervisory control of wafe scanners	systems engineering, mechanical engineering and mathematics and computer science	mainly private	1	2002	3				7		
rare earth activated-(oxy) nitride materials for LED applications	Materials and Interface Chemistry, chemical engineering and chemistry	half private half public	1	2001	2+3	YES	YES		2		
manufacturing method of photovoltaic foil	Plasma and Material Processing, Applied Physics	1st part R&S sponsoring; 2nd, 50%private; 3rd 100% private	5 to 8	1998	11	YES	YES	YES	12		
fully integrated in-line solar cell machine for high rate deposition of silicon Nitride	Plasma and Material Processing, Applied Physics	100% private	0.2	2002	2	YES	YES	YES	4		
method to lower the melt viscosity with nano-sized particles	Polymer s and Functional Materials, Chemical engineerign and Chemistry	public	1	2001	4+2	YES			1		
MIMO-OFDM for enhancing wireless local area networks	Radio communication, Electrical Engineering	mostly the firm, but also R&D sponsoring and university	2	1999	5	YES			10		

Composition analysis using low energy ions probing	Physics of Border Layers, Applied Physics	mostly public, several R&D sponsoting and some private financing	30	1981	16	YES			1		Impl.
stepper of a wide format printer	control system, mechanical engineering	university, firm	1	2004	1				1		
Actuators for deformable mirrors	control system, mechanical engineering	university, firm	1	2002	1+4				1	YES	
protein for cell apoptosis	Medical centre	private and research sponsoring	7	1989	7+3+5	YES	YES		23		Impl.
on-line measuring system of located partial discharges	Electrical Power systems, Electrical engineering	half private half public	2	2002	4				9		
inorganic phosphors as labels for antigens	Medical centre	public and R&D sponsoring	1	1986	5 +5+4	YES	YES	YES	0		
replication technology for biomolecules	Gene Therapy, Department of Molecular Cell, Biology	mainly R&D sponsoring but also venture capital	15	1992	10				1		Impl.
maskless lithography technique	Imaging Science and Technology, Applied Sciences	university and public R&D sponsoring	2	1998	1+2+7	YES			25	YES	Impl.

In relation to the timing of patent application, in ten cases, projects were built up on previous related patents; six of which on patents based on university knowledge (two owned by the industry). In fifteen cases, the publication of patents occurred during or towards the end of the project, but only in two cases, the university owned the patent.
In four cases, the project led to the creation of spin off, one of them being a start-up. In three cases, a spin off was the form in which the research project was implemented, since the creation of a spin off facilitated access to research sponsoring and collaborative agreements.

To allow for codification and statistical comparison of the cases, we developed a standardise protocol for collecting data from university researchers and industrial researchers and managers participating in the specific cases. This protocol focuses on the following elements of the process of knowledge transfer between university and firms (Kingsley *et al.*, 1996; Bozeman, 2000; Bercovitz and Feldman, 2006): i) characteristics of innovation developed; ii)identification of the origin of the project; iii) design and performance of the development project; iv) degree and the forms of knowledge transfer between university and firms; v) impact of the knowledge transfer process;vi) the main characteristics of university researchers, and of participating firms. For details on the process of identification of the cases and on the protocol for data collection, please see Bodas Freitas and Verspagen (2008).

In this paper, we explore the relationship between types of innovation and motives for patenting, as well as at how these two dimensions relate to the forms of research financing and ownership of patent.

The categorisation of innovations into 'embryonic' or 'ready to use' innovations is difficult, as their meaning differs across disciplinary fields and industrial contexts. Thus, we create two objective proxies. One variable, defined in terms of knowledge application rather on knowledge characteristics**,** considers whether the existing innovation is complementary or substitute to existing technologies in the market. The other variable, reflecting the different development phases in which the technology and knowledge is found at the end of the collaborative project, considers whether the project resulted in a proof-of-concept rather than a developed crafted technology or industrial applications. These variables, capturing the degree of substitution/complementarity with existing technologies and the degree of technology development, allow comparability across disciplinary fields and industrial contexts.

Among the sixteen cases collected, twelve cases focus knowledge related to technologies substitute to existing ones, and eight cases led mainly to the development of proof-of-concepts of new technologies rather than to developed prototypes or industrial applications.

As discussed in section 2, we expect that innovations, leading to substitutes of existing technologies, are more likely to be patented for heterodox reasons, such as signalling and attracting partners and financers for research and development. Similarly, we expect that heterodox motives for patenting are more frequent when among innovations in the phase of proof-of-concepts rather than among industrial developed applications. Instead, we expect that traditional motives will be generally common across different types of innovation.
Moreover, we expect that innovations developed with public funded research are more likely to be patented for heterodox motives. As technology transfer capabilities are increasingly used as criteria for assessing the performance of public research sponsors activities, the patenting of innovations developed with public research funds, allows to academic researchers and universities TTOs to signal to public research sponsors the quality and the potential for industrial application of their ongoing research programmes. Moreover, patenting allows attracting industrial partners for further innovation development projects. For similar reasons, we expect that university owned patents are more likely to be motivated by heterodox motives that industry owned patents of university developed knowledge.

Using information on sixteen case studies of innovations for which the university or its industrial partner applied and obtained intellectual property rights, we analyse the motivations for patenting research results. In particular, we analyse how the presence of traditional-market and heterodox–signalling motives for patenting relate to different types of innovation, forms of research financing and patent's ownership. For this purpose, and given the type of data and the limited number of observations, we build on results from rank Spearman's correlation coefficients and cross tabs on the main aspects of cases.

4. Motivations for patenting

4.1 Motivations for patenting, types of innovation, research funding and patent ownership

Consistent with the literature, we analyse three traditional market-related and four heterodox-signalling motivations. In particular, the traditional-market related patenting motivations analysed are the following ones: "Secure benefits from future product development", "Guarantee ownership of IPR of new products" and "Sell Innov./ Get market returns from R&D expenses". "Secure benefits from future product development" refers mainly to the pre-emptive goal of entitling the owner of the patent to the exclusivity on future developments of that

innovation. "Guarantee ownership of IPR of new products" points to the goal of warranting the owner of the patent to product commercialisation without fearing IPR related issues (others claiming or using inappropriately their IPR). "Sell Innov./ Get market returns from R&D expenses mentions" identify mainly the strategy of getting (partially) the return on early research investments, mainly because the firm is not anymore interested in using directly the innovation.

The Heterodox-signalling motivations analysed are: "Publication of market research results", "Signalling research partners (industrial)", "Attract venture capital", "Attract research funds". "Publication of valuable research results" refers to the aim of diffusing of valuable research results, and building scientific and industrial reputation. "Signalling research partners" identifies mainly the aim to attract partners by assuring exclusivity of future research results, and by providing indication of their technical capability. "Attract research funds" mentions the objective of patenting for getting funding (mainly public) to start new research projects on similar research lines. "Attract venture capital", which is mainly a motivation of spin offs for patenting, refers the objective of patenting for getting funding but in mainly for cash-flow, rather than only for R&D.

Table 2 provides information on the correlation coefficients between motivations. In fifteen cases, innovation was patented for at least one traditional motivation, while in ten cases at least one heterodox motivation was found. In particular, "Secure benefits from future product development", as well as "Guarantee ownership of IPR of new products" were motivations for patenting in 11 cases. "Signalling research partners" as well as "Attract R&D sponsorships" were patenting motivations in 8 cases, followed by 7 cases in which "Publication of valuable research" was the motivation.

Heterodox and Traditional patenting motivations are not mutually exclusive. In this sense, our results are fully in line with what has been revealed by research on the motivation for industrial patents (Cohen, Nelson and Walsh, 2000). Only the traditional patenting motivation "Guarantee ownership of IPR of new products" is significantly and negatively correlated with heterodox motivations. It is also somewhat surprising that traditional motives are not significantly correlated among themselves, while some heterodox motives are.

Table 2. Spearman's correlation coefficients of motivations for patenting

	Secure benefits from future product dev.	Guarantee ownership of IPR of new products	Sell Innov./ Get market returns from R&D expenses	*Traditional Motives*	Publication of valuable research results	Signalling research partners	Attract venture capital	Attract research funds	*Heterodox Motives*
Secure benefits from future product development	1	0.13	-0.15	0.38	0.32	0.41	0.16	0.14	0.31
Guarantee ownership of IPR of new products		1	-0.15	0.38	-0.22	-0.14	0.16	-0.41	**-0.52***
Sell Innov./ Get market returns from R&D expenses			1	0.1	-0.33	-0.38	0.15	0	-0.1
Traditional Motives				1	-0.29	-0.26	0.17	-0.26	-0.2
Publication of valuable research results					1	**0.63****	0.22	0.38	**0.68****
Signalling research partners						1	0.41	**0.75****	**0.78****
Attract venture capital							1	**0.67****	**0.52***
Attract research funds								1	**0.78****
Total	11	11	2	15	7	8	5	8	10

Note 1: ** p<0.01, *p<0.05.

Table 3 provides information on each motivation and the characteristics of innovation, as well as the respective correlation coefficients. Correlation coefficients suggest that heterodox motivations for patenting are more likely for proof-of-concept as well as for innovations that underlie substitute to existing technologies. Instead, there is no negative significant relationship between the presence of traditional market-related patenting motivations and the characteristics

of innovations. Only, "Getting market returns from R&D expenses" is mainly a motivation for patenting of complementary to existing technologies rather than substitute ones.

Table 3. Motivations for patenting and the characteristics of innovation

		Proof of concept rather than developed crafted technology		Substitute ratter than complementary to existing technologies	
	Total	Observations	Correlation coefficient	Observations	Correlation coefficient
Secure benefits from future product development	11	7	0.405	9	0.418
Guarantee ownership of IPR of new products	11	4	-0.405	7	-0.164
Sell Innov./ Get market returns from R&D expenses	2	0	-0.378	0	**-0.561***
Traditional Motives	*15*	*7*	*-0.258*	*10*	*-0.174*
Publication of valuable research results	7	7	**0.630****	7	**0.595***
Signalling research partners	8	4	**0.750****	8	**0.674****
Attract venture capital	5	7	0.405	4	0.164
Attract research funds	8	8	**0.750****	7	0.405
Heterodox Motives	*10*	*8*	***0.775****	*9*	***0.592****
Total	16	8		11	

Note 1: ** p<0.01, *p<0.05.

4.2 Typology of university-industry collaborative projects and Motivations for patenting

To analyse the impact of ownership and timing or patents on the motivations for patenting, we compute the correlation coefficients between patenting motivations and the existence of previous patents (all, based on university developed knowledge, university-owned), and the existence of university-owned patents as output of the research project (Table 4).

Correlation coefficients suggest that the motivations for patenting research results of university and collaborative projects do not seem to depend on the ownership of previous patents (i.e. of patents that existed before the new research results being found). University and collaborative research projects, designed to develop previous existing patents, are more likely to lead to patenting of results to secure benefits of future product development.

Patenting of research results, during or at the end of university and collaborative research project, seems to have different motives according to the ownership of results. When research results belong to the university (leading to a university-owned patent), patenting is more likely to be motivated by the objective of publishing valuable research results and building scientific

and industrial reputation. Moreover, traditional-market patenting motivations are less important for university-owned patents.

Table 4. Motivations for patenting and the characteristics of patents

	Existence of Previous patents			
	All	Based on Univ. Knowledge	Univ. owned patents	OUTPUT Univ. owned patents
Secure benefits from future product development	**0.592***	0.2	-0.022	-0.153
Guarantee ownership of IPR of new products	0.035	0.2	0.324	-0.153
Sell Innov./ Get market returns from R&D expenses	-0.098	-0.3	-0.182	-0.143
Traditional Motives	0.333	0.2	0.124	**-0.683****
Publication of valuable research results	0.163	-0.1	-0.101	**0.429**[a]
Signalling research partners	0.258	0.4	0.16	0.378
Attract venture capital	-0.035	0.1	0.022	0.153
Attract research funds	0	0.1	-0.16	0.378
Heterodox Motives	0.2	0.2	0.041	0.293
Research done with only public/univ. funds	-0.098	-0.3	-0.182	**0.429**[a]
TOTAL	10	5	3	2

Note 1: ** p<0.01, *p<0.05, [a] p<0.1.

To understand better the differences between research projects that led the publication of patents for traditional-market and for heterodox-signal motivations, we analyse three groups of projects. Cases, in which no heterodox motivations were found, cases in which at least three heterodox motivations were found, and cases in which one or two heterodox motives were found.

First, we analyse the characteristics of six cases, in which innovation patenting was not led by any heterodox motives. Five of these research projects were proposed to the university by firms and they fitted the firms' research agenda. None of the projects led only to proof-of concept outputs, but to more crafted technologies, in 3 cases it led to commercialisation of new product. In two cases, innovation referred to substitute to existing technologies.

Four of these cases were mainly financed by the firm, who also participated in directly in the performance of the R&D; in particular, in three cases university researchers joined the firm's research team. The fifth case, which was mainly financed by public research sponsors and performed at the university, was initiated and undertaken by part-time professor working also at the industrial firm. The sixth case refers to a university department that for more than a decade

works on an industry related problem, when the methodology to address the problem allows provision of industry-services a spin off was created; almost a decade later, a product was developed and patented and the university department closes down.

Second, we study the six cases in which at least three heterodox motives for patenting were found. All these cases referred to proof-of concepts of existing to complementary technologies. All, but for one case, projects were financed with public research sponsoring or university funds. These projects were mainly developed at the university. When there were industrial partners, these did not perform directly research; they provided material, equipment or testing facilities, and feedback. Three cases refer to innovations in Biology and Medicine, one in Chemistry, one in Mechanical and other in Electrical engineering.

Correlation coefficients support the relationship between heterodox motives and Biology and Medicine and use of public funds. In particular, research projects financed only with university or public research sponsoring are more likely to patent research results for heterodox-signalling motives in particular attracting research funds and venture capital. Instead, Correlation coefficients doe not corroborate the existence of a relationship between university idea for the project and high number of heterodox motives for patenting.

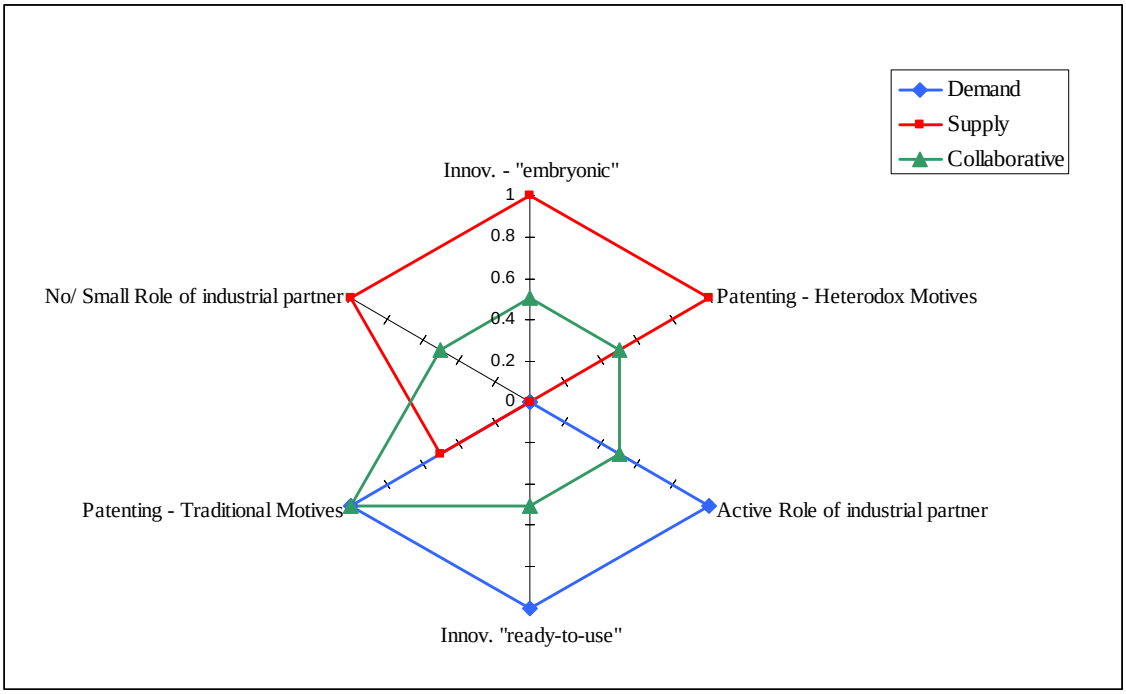
Finally, we focus on the remaining four cases, in which innovation was patented for traditional-market related as well as for one or two heterodox motives. Concerning the type of innovation, three cases focus on substitute to existing technologies and two cases produced mainly to proof-of concepts (one project was interrupt by the firm as soon as it got knowledge on the proof-of-concept). This intermediate group of cases, in terms of heterodox motives for patenting, seems to have elements of the other two previous analysed groups. In particular, in one case, before engaging in a collaborative project, the firm patented existing university-knowledge. The university allowed for heterodox reasons, and the firm did it for pre-emptive traditional-market motives. In other case, a university patent, which was patented for heterodox motivations, existed before the analysed collaborative research project. During the collaborative project, the firm patented the emerging results for traditional-market reasons, but also for heterodox ones, as it searched industrial research partners and benefited/applied for public sponsoring. The other two projects were collaborative projects financed mainly by public research funds and the publication of research results and attraction of more research funds were also motivations.

4.3 Discussion

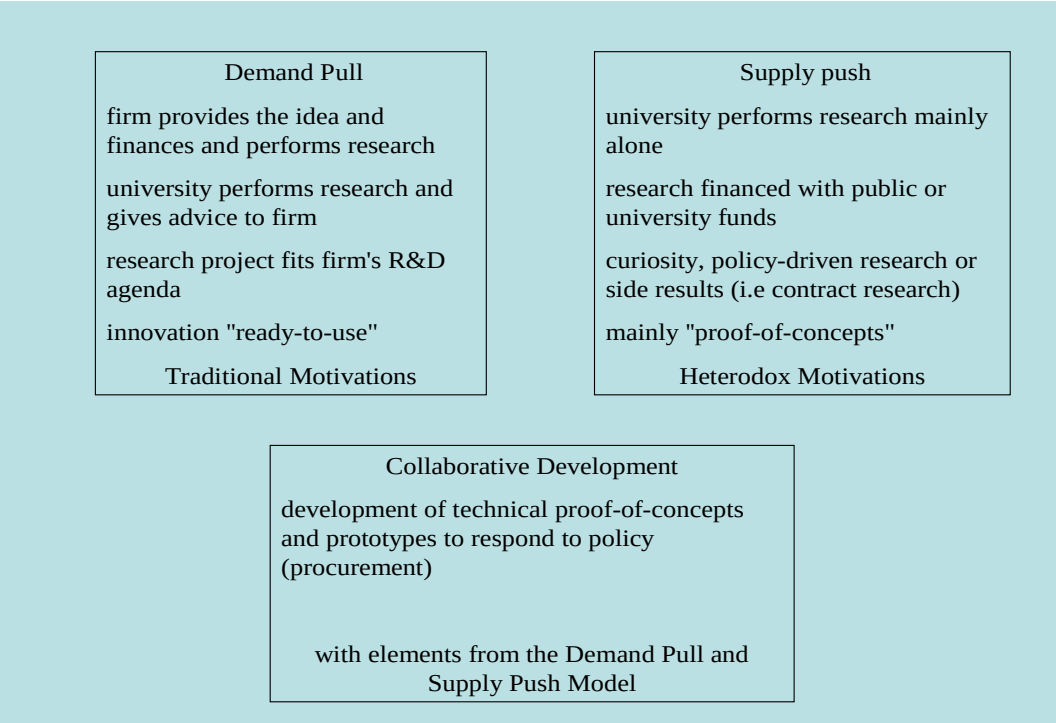
This exercise of clustering cases according to the presence of heterodox motive for patenting brought some insights on how and why different types of innovation affect motivation for

patenting. Indeed, different research projects, in terms of the role of industrial partners in proposing the project, financing and in performing research, tend to lead to projects aimed at different types of innovations; and consequently being characterized by different types of patenting motivations. Based on these three main axes, we can suggest a typology in which three broad categories relating motivations for patenting with types of innovation and research projects are found: *Demand-pull*, *Supply Push* and *Collaborative development*. The typology is sketched in Graph 1 bellow. The *Demand-pull* projects lead patenting mainly for traditional motives. The *Supply push* projects in which patenting of results involve certainly several heterodox motives. The *Collaborative development* projects in which patenting of results may be done also with some heterodox motives. Graph 2 presents briefly the characteristics of each motivational space for patenting university research results.

Graph 1: Dimensions of Patenting motivations of university research results



Graph 2: The three proposed Patenting motivational spaced of university research results



Briefly, the *Demand pull* model refers to projects in which the firm, which is aware of the research competencies of the university, through previous collaborative projects or professional contacts, proposes a research topic for a project to the university researchers (or asks for support in dealing with some technological problem). As these projects fit and tend be a priority on firms' research agenda, in-house research groups are likely to work on these projects directly. Moreover, depending on the type of the required research work (discipline), university researchers also perform research at the firm. The firm tends to finance most of the research costs. These projects tend to result in crafted-technological application, prototypes, and even in product commercialization. Patents are published by firms mainly with traditional-market related motivations.

The *Supply push* model can be characterised as follow. Innovation is usually developed in research projects performed almost uniquely by university researchers. The idea of the project tends to be of academic or governmental institutes. Still, there was a case in which the university project emerged from results of contracted research, which lead to a side innovation. When being research partners, firms do not participate in performing research, instead they provide material, equipment or technical feedback. These projects are usually financed by public research grants or university resources such as master and research students. Patenting the research results of these projects, usually proof-of-concepts of substitute to existing

technologies, tends to be led by heterodox motives, rather than be limited to the traditional market ones.

Finally, the *collaborative development* model refers to projects set to develop technical proof-of concepts and prototypes, often fitting the research agenda of public research sponsors. These projects rely on different mixes of private and public funding, and they preview different forms of organisation for the performance of research between university and the firm. They tend to lead to innovations related to substitute to existing technologies, more or less crafted. Patenting research results in these projects may also be led by some heterodox motives, but not always.

In order to give to the reader a more specific characterization of our typology we shall provide a short summary of a case of innovation projects fitting each of the proposed categories

Demand-side Innovation

The invention in question was an improved control system for complex manufacturing machines such as wafer scanners. The invention process involved the collaboration between the Department of Mechanical Engineering of a Technical University and a leading Dutch manufacturer of integrated circuits. The roots of the invention were in the company's desire of improving the efficiency of their wafer scanners. Being aware of these technical concerns of the company, the leader of the project from the Technical University side proposed to the company the possibility of setting up an "applied" PhD research project with the aim of designed a more efficient software for control systems. So, formally, the innovation projected was actually initiated by the University partner. However, at close reading, the evidence we collected suggests that the company through previous contacts had clearly made the university researcher aware of their industrial concerns. Thus, we believe the case fits correctly in the demand side innovation category. Once the PhD research project was set up (the salary of the PhD researcher was covered by the company), the project proceeded relatively smoothly. The project led to the creation of number of working prototypes of software control systems and related applications, some of which had been effectively adopted by the industrial partner. The knowledge generated by the project was protected by means of six patents. The ownership of all these patents was taken by the industrial partner. To sum, this case seems to represent a clear-cut of what we label as demand-side innovation. We have an industrial partner with a clear-cut technical concern. The university partner is solicited because it is perceived (through previous contacts) to have the potential for providing a workable solution. For the university partner, working to the solution does not provide any particular tension or distraction from the ongoing research agenda (the phd project was regularly completed without delays). The knowledge generated by the project is clearly geared to the solution of a specific industrial concern and is appropriated by the

industrial partner, who is going to use patent protection in “traditional” way. In this case, it is also likely, that the industrial partner would like to be in control of possible dissemination of this knowledge through publications (in our case all the publications related with the project were systematically checked carefully by the intellectual property department of the company). However, given the relatively “applied” nature of the knowledge developed this does not appear to be a particular source of frustration for the university partner.

Supply-Side Innovation

The innovation in question is the use of inorganic crystalline phosphors for labelling macromolecules in biological systems. The invention represents a major improvement in comparison with other labelling methods such as radioactive methods of labelling. The potential application of this technology is in the medical diagnostic field. In this case the origins of the invention were entirely within University walls. The idea of the invention was the outcome of a university PhD thesis completed at the department of molecular cellular biology of the Medical centre of a major Dutch University. As soon as that the potential of the innovation was perceived, the university department took a number of patents covering the research results. It is worth noting that all these were not “ready to use” patent and that a major work of development was still necessary before the technology could become actually usable as a diagnostic tool. After the granting of the patents, research in this area was continued through grants funded by the NOW (Netherlands Organization of Scientific Research). It is likely, in this perspective, that the patents may have playing a role in the successful awarding of the grant to the University department. At the same time, the University Department begun to research potential industrial partners interested in the development of the technology. After a careful process of scanning, a particularly suitable industrial partner emerged. It was a US company which was already working on the use of crystalline phosphors and whose technology was probably, unknowingly, infringed the University patents. An agreement of cooperation was drafted and the US company bought all the patent rights from the University department. This illustrates nicely the co-existence of traditional and heterodox patent motives. In this case, at the beginning patents were used by the University partner for signalling specific research competencies and building reputation. In a second phase, the patent rights were transferred to the industrial partner who used them in a more traditional for protecting and commercializing the innovation. In this second phase, as the invention was improved, further patents were taken by the industrial partner. Curiously, after a somewhat tortuous history and due to the difficulties in making the technology in question, viable for practical applications, the ownership of the original patent came back to the University Department (in the original contract there was a clause about the “abandon” of the patent), just one year before its expiration. At this stage, the University is still

working on this research project and the have just received a research grant from a US institution.

Collaborative innovation

The innovation in question is a flywheel to be used in automobiles in order to support the propulsion of the engine when a rapid increase in power is needed. This device, which can also retro-fitted in existing cars, has the potential of determining major fuel economies. The innovation was the outcome of a collaborative project involving the Department of Mechanical engineering of a Dutch Technical University and a Dutch manufacturer of transmission systems for autovehicles. The partnership was supported by a government programme designed to support university-industry partnership. Thus, the collaborative dimension university-industry was present since the very beginning. The project was based on the involvement of a number PhD researches whose assigned task was to deliver a 'proof of concept' of a flywheel system. The project led to the application of four patents. An outcome of the project was the creation of a spin-off company from the industrial partner. This was perceived as the best way to commercialize the invention. Accordingly all patent rights were transferred to the spin-off company. In terms of the nature of invention, this third case lies somewhat in between the previous two. The technology in question was not of immediate applicability, but also it was not in an embryonic stage. Also in this case, however, we see a combination of traditional and heterodox motivations for patenting.

5. Conclusions

This paper has studied the motives for patenting university and university-industry collaborative research results. In particular, we have examined how traditional market-related motives and more heterodox signalling motivations for patenting relates to different types of innovation, forms of research financing and patent's ownership.

For this purpose, we relied on in-depth information on 16 cases of innovations developed or co-developed by universities. Our evidence suggests that traditional motives are observed in almost all patents, and that Heterodox and Traditional patenting motivations are not mutually exclusive. Moreover, heterodox motivations for patenting are more likely for innovations that are proof-of-concept as well as for those that underlie substitute to existing technologies. In addition, they are more likely, when research is public financed or leads to the publication of a university-owned patent.

This paper, consistently with the literature, puts through three main typologies explaining differences in types of innovation and research projects and motivations for patenting: the

demand-pull, the supply-push, and the collaborative development. The *demand pull* projects that lead patenting mainly for traditional motives. The *supply push* projects in which patenting of results involve certainly several heterodox motives. The *collaborative development* projects in which patenting of results may be done also with some heterodox motives.

Admittedly our results are exploratory and are clearly in need of being corroborated by further quantitative research. Still we think that, on the basis of what revealed by our case studies, it is possible to work out a number of policy implications. The first one is obviously that both policy-makers and TTO managers should be aware of the existence of heterodox motivation that can push academic inventors to patents. Patents taken for heterodox motivation may actually crowd out financial resources that could be used for the taking and maintaining traditional patents leading to a sub-optimal administration of a TTO patent portfolio. Moreover, they may also crowd out financial resources for the undertaking of further university research. In this sense, the current policy measures directed towards the encouragement of the patenting of research results may actually exacerbate this problem because they tend to favour patents taken in early stages of research. Consequently, we should consider that patents are essentially becoming a double edged policy tool and the balance between the positive and negative effects (in particular in terms of hold up problems that can delay follow-innovations) is becoming increasingly hard to assess (Bessen and Meurer, 2008). One clear policy implications is that the granting of patents should be possibly limited only to those cases in which they genuinely serve as incentive for investments in innovation. In these conditions, given the evidence pointing to the existence of these "Heterodox" factors which can push university researcher to patent, a more restrictive approach towards academic patenting could be actually be in order.

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