Proactive versus reactive motivations for patenting and their impact on patent production at universities

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Abstract: This paper deals with patenting behaviours of university researchers and distinguishes between two motivations that academic scientists may adopt when dealing with patents: a proactive one, where scientists are patent enthusiastic and a reactive one, where scientists are more reluctant to patent, even if they might be forced to do that anyway. We use an original dataset on 173 French academic inventors (in life sciences and electronics and engineering sciences) in order to test whether the scientist’s motivations to patent affect the number of patents she invents.

Our econometric results indicate that a very positive perception of university patenting or a reported willingness to perform patentable research does not lead to more invented patents. Conversely, past patenting experiences seem to matter a lot: academic inventors, who already experienced successful technology transfer due to patents, are more likely to invent patents. Some slight differences emerge across scientific disciplines.

Keywords: university; patent; strategy; technology transfer; academic inventors; motivation.


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## 1 Introduction

Since the recognition of the university ‘third mission’, namely technology transfer, both theoretical and empirical studies on academic entrepreneurship and university patenting have flourished. Many papers sketched the profiles of scientists who patent or analysed whether patenting activities might have a – positive or negative – impact on the traditional publishing mission of universities (Siegel et al., 2007; Baldini, 2008). But only a limited – though growing – number of them investigate scientists’ motivations to patent.

Among existing papers on the topic, Owen-Smith and Powell (2001), Baldini et al. (2007) and Figueiredo Moutinho et al. (2007) provide some original empirical research (on respectively US, Italian and Spanish data) on the factors explaining the faculty members’ patenting activity. They show, among others, that scientists tend to balance the benefits of being involved in patenting activities (which mostly stem from reputation effects and less from financial arguments) with the costs of interaction with technology transfer offices. Refining those findings, Baldini (2011) argues that different researchers exposed to different contexts are not uniformly driven by the same motives.

The present paper completes this literature and makes a contribution to the analysis of academic patenting and the motivations of academic inventors, by distinguishing between two main types of motivations to patent and analysing their respective impacts on academic patent production. Indeed, so far, empirical studies mostly assumed (rather than providing tests on this assumption) that academic inventors who patent are interested in patenting and that scientists who are not stimulated by patents choose not to use this instrument. Conspicuously absent from this literature is the idea that some academic inventors might invent patents without actively wanting to do so. This paper is an initial attempt to fill that gap.

We distinguish patenting scientists according to two types of motivations: First, those who perceive and use patents as a proactive and offensive strategic tool to deliberately
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improve their forthcoming (economic and scientific) situation; second, those who adopt patenting strategies in a reactive and defensive way, as an opportunistic answer to external constraints. Indeed, scientists are not equally comfortable with the development of entrepreneurial activities. This may be linked to the fact that most scientists are not similarly educated about the stakes of academic patenting (Stephan et al., 2007). Consequently some of them are rather patent enthusiastic and others are more reluctant, but nevertheless constrained to adopt this new way of research valorisation because of the generalisation of patents in science, but also because they are stimulated to do so by new university policies (for instance, the Bayh-Dole Act passed in 1980 in the USA and the ‘Loi Guillaume sur la recherche et l’innovation’ passed in 1999 in France put strong emphasis on patenting academic research). In such an environment some scientists might adopt patenting activities, backwards and unwillingly, to adapt and cope with this new working context.

Having drawn a distinction between offensive (or proactive) motivations to patent and defensive (or reactive) ones, our research question then consists in exploring, whether the type of motivation explains the number of invented patents (the offensive type of motivation leading to a higher patenting activity, or on the contrary the differences in the numbers of patents disappearing when the university enforce reluctant scientists to patent?)

Our paper contributes to the literature in a second way, namely by exploring a new empirical context. Actually, we chose to run our analysis on the French case, in order to see whether French scientists adopted specific behaviours in terms of patenting. Indeed, most French scientists are civil servants and their wages and career advancement are very marginally determined by their patenting dynamism. Besides, technology transfer offices are rather recent in the French landscape (they were generalised by law in 1999), which might limit the support they give to academics willing to patent, or might impact either the motivation of French scientists to patent, and/or their effective patent production level.

To explore the motivations of French scientists to patent, we conducted an empirical study based on a survey administered in Spring 2008 to French academic professors who were also inventors of at least one European patent. Through this survey (detailed in Pénin, 2010) we collected in depth personal and professional information on 173 academic inventors, including their opinions and motivations for patenting. We indeed directly questioned scientists to assess their perceptions and uses of patents so as to better understand their more or less active involvement in patenting activities. We then ran an econometric analysis of the determinants of the number of patents invented by scientists, distinguishing between two main types of potential underlying motivations (offensive versus defensive) and two scientific disciplines (life sciences and engineering sciences).

Improving our knowledge on the origins of patenting behaviours among the academic community, may be quite useful for policy makers and technology transfer officers to design appropriate incentives to catalyse the three complementary missions of universities simultaneously. Indeed, understanding whether scientists do (or do not) actively choose to patent could provide insights for building appropriate (differentiated?) managerial tools to give support to scientists involved in a patent application either by interest or by constraint.
The rest of the paper is organised as follows. Section 2 reviews the existing literature on the rationales for academic patenting activity at university and devises the assumptions to be tested. Section 3 provides detailed information on the methodology and data selected for the study. In Section 4 we conduct the econometric analysis and discuss the results. Section 5 concludes.

2 Why do academic scientists choose to patent? Theory and hypotheses

2.1 The recent increase of university patenting and its origins

The traditional model of public research (the open science model) considers universities as places devoted to creating a reservoir of public knowledge which firms can tap into to develop industrial applications. In this sense, patents used to have almost no place in the ‘republic of science’ (Polanyi, 1962), scientists favouring the rapid and free publication of their research results in journal articles. Moreover, outcomes of basic research are hardly patentable by nature, as they usually do not have any precise tangible application.

Yet, in the past three decades there has been a steadily growing trend toward patenting research undertaken at university. The Bayh-Dole Act passed in the USA in 1980 symbolises this rupture, which is now observed worldwide: Universities and public research organisations all over the world routinely patent the results of their research (Geuna and Nesta, 2006). Such a phenomenon might be explained by recent changes in the practices of patent offices, which contributed to facilitating the patenting of upstream, more fundamental research (Jaffe and Lerner, 2004). Moreover, the emergence of new technologies such as biotechnologies and information technologies, in which the border between basic and applied research is largely blurred, also contributed to enlarging the scope of potentially patentable academic research.

This enlargement went hand in hand with the creation or reinforcement of structures dedicated to technology transfer, and the evolution of national legal frameworks towards higher financial returns for university research, i.e., policy measures targeted at motivating and supporting scientists in undertaking the patent writing process, which is a time-consuming and very specific process, compared to publishing in scientific journals.

Promoting the further development of patenting activities at university (which seems to be the objective of most governments around the globe) now requires deepening our understanding of the reasons why academic scientists choose to patent. The literature unanimously suggests that patenting determinants are of various natures. Baldini (2011) distinguishes between intrinsic and extrinsic motivations, the first ones dealing with scientists’ individual perceptions of this activity, whereas the second are provided by the organisation scientists belong to (through remuneration of a good performance for instance). Figueiredo Moutinho et al. (2007) conclude in the same vein that the patenting decision is explained by contextual explanatory factors (disciplinary, organisational, institutional, etc.) and individual explanatory factors (characteristics of the scientist, past behaviours, subjective perception).

Searle Renault (2006, p.229), who proposes a finer description of organisational influences, explains that: “there are three possible institutional influences on university researchers that could explain their decisions to patent. Researchers make choices within the context of constraints imposed by the university. Some constraints are policy-based incentives; others are based on the researcher’s discipline. Less understood, however, are
the constraints imposed by the norm of the university. Further constraints are also imposed by the individual’s capabilities and the publish or perish paradigm”. Schild (2004) complements this analysis when she explains, based on in depth interviews run at a Swedish university that: “when asked why they patented, respondents gave two sets of replies [...] those who saw patenting as a necessary evil which went hand-in-hand with the increasing industrial orientation of their work, and those who identified strongly with industrial interests and wanted to patent”. This verbatim suggests that sometimes scientists do not have any willingness to patent, but nevertheless patent their results ex-post.

This conclusion encourages us to go one step further in the present contribution, by testing first whether French scientists have various and different patenting motivations (offensive versus defensive), and second whether patent motivations have an impact on patent production (offensive scientists holding effectively more patents than their counterparts).

In the following two sections, we therefore specify scientists’ motivations to patent by distinguishing two categories: First we consider the motivations which reflect an offensive or proactive patenting strategy and then we focus on those which rather account for a reactive or defensive behaviour from scientists who are in a sense reluctant to patent but compelled to do so by the context.

2.2 University patenting as an economic and scientific opportunity: the proactive/offensive strategy

Scientists who adopt a proactive or offensive strategy foresee the advantages of developing an active patenting behaviour. They deliberately choose to engage in this activity with a view to gaining profits out of this experience. Among the main motives to patent, we find here:

2.2.1 To increase personal earnings

The literature in economics of science shows that scientists select the research they want to perform according to three main criteria: gold, puzzle and reputation, with an important weight given to reputation and puzzle considerations (Stephan, 1996). This specific objective function induces scientists to choose not the more remunerative problems to solve but the more challenging ones from an intellectual point of view. Hence, the tacit functioning of the ‘republic of science’ ensures – although in an imperfect manner – that scientists have incentives to perform basic research, even though this kind of research yields, at least in the short run, weak monetary benefits to scientists.

According to the objective function defined above, scientists may hence be interested in patenting their research because it may result in a financial reward for them. There are numbers of ways by which it is possible for a scientist to make money out of a patent: academic inventors may be directly remunerated by royalties or a percentage of the sales generated by the patent, and/or indirectly rewarded by additional research funds, better position in academia, etc.

Therefore, one can expect that academic scientists who grant more importance to immediate earnings would be more willing to engage into patenting activities than those with a strong ‘taste for science’ (Levin and Stephan, 1991).
H1 Scientists looking for immediate earnings patent more than those primarily motivated by puzzle solving.

This first hypothesis is all the more interesting to test that many empirical studies consider it as too simplistic. For instance, for Lach and Schankerman (2008) the exact impact of the growth of royalties devoted to inventors on the number of patent disclosures by those scientists remains unclear. Similarly, Baldini (2011) finds that Italian academic inventors rank personal earning as their last motivation to patent (the second one being the opportunity to get support for (their) research).

2.2.2 Faith in ‘entrepreneurial science’

Another motive for scientists to apply for patents is the intimate conviction that academic patenting does not have any negative effect on science or may even have a positive impact. In the literature and in public opinion, university patenting is seen as a threat to scientific progress due to its potential restrictions on sharing and using new knowledge (Baldini, 2008). ‘Academic capitalism’ (Slaughter and Leslie, 1997) emphasises intellectual property rights and the additional wealth reached through the commercialisation of results, whereas open science builds upon the communism of intellectual property. Owen-Smith and Powell (2001) confirm that many faculty members worry about a possible loss of openness and knowledge dissemination. On the contrary, Etzkowitz and Leydesdorff (2000) assume that entrepreneurial activities will bring new opportunities and autonomy to universities. Finally, as shown by Roach and Sauermann (2010) all scientists do not share the same beliefs, some of them being less worried by the potential negative consequences of patents, or being more comfortable in taking up simultaneously their academic identity with their ‘commercial persona’ (Jain et al., 2009). In such a context, we expect that:

H2 Scientists who do not see any contradiction between the rules of science and exclusion through patents, i.e., who adopt a positive attitude towards academic capitalism invent more patents than their less patent-enthusiastic counterparts.

Among those researchers who do believe in the promises of more entrepreneurial scientific activities, some may not change their research habits. They may not hesitant to apply for patents when they have the opportunity to do so, but at the same time they may not modify their research agenda in order to be able to apply for more patents. Here, the patent application is in a sense a by-product, a welcome but unexpected outcome of the research performed by the scientist. It is a consequence of the ‘individual productivity effect’ developed by Breschi et al. (2005) according to which, best researchers, who produce more knowledge, are likely to be granted patents and publications at the same time.

However, some researchers may be so patent enthusiastic that they may choose to change their research agenda in order to increase their probability to apply for patents. In this case, the patent application is definitely the outcome of a proactive behaviour of the scientist. Our third hypothesis tests therefore whether or not the scientist’s willingness to patent really leads to a more effective patenting activity:

H3 Scientists who deliberately choose to orient their research toward patentable areas invent more patents.
2.2.3 To renew with successful past experiences of technology transfer

In connection with the former hypothesis, the literature also suggests that patent perception is substantially influenced by past experiences in patenting: Researchers who were never involved in patenting tend to overestimate the costs and problems associated with patent applications as compared with those who already patented (Figueiredo Moutinho et al., 2007). Conversely, past patenting activities may have been very successful, revealing the importance of patents to help technology transfer for instance. Such a positive experience should induce researchers to look for patents again and to valorise the competences they developed for their first patent applications. For instance, in their paper on the determinants of a scientist’s decision to start his/her own company (another entrepreneurial activity that scientists may choose), Krabel and Mueller (2009) confirm that the outcomes of their past activity strongly matter.

Similarly, if past patent applications were not harmful, scientists may be more willing to patent again. For instance, the literature mostly documents the problem of publication delay induced by patenting university research (Cohen et al., 2002; Pénin, 2010; this problem being even more acute in Europe, where the US ‘grace period’ does not exist, Franzoni and Scellato, 2010), which might deter scientists from repeating their patenting experience. But for researchers who did not experience such delays, the motivations to patent should not be affected. Our fourth hypothesis becomes therefore:

**H4** Faculty members who experienced a successful episode of technology transfer due to a patent are more likely to invent patents (H4a); Faculty members who did not experience publication delays due to past patents are more likely to invent patents (H4b).

2.3 University patenting as a necessary evil enforced by the context: the reactive/defensive strategy

Reactive or defensive scientists do patent as a response to the context or to others’ (patenting) behaviours. The logic that drives those reluctant academic inventors to patent is very different from the motives displayed above: their patenting activity is less enthusiastic and corresponds to a reaction to a (eventually bad) past experience. Sometimes it can even be an *ex-post* choice which drives the decision to patent, the scientist not being interested in patenting when performing her research, but discovering at the end of the discovery process that her scientific result is patentable. Here, the main motives to patent are:

2.3.1 To mimic the others and to fit the institutional context

The patenting culture at work within the lab or the university (i.e., the level of acceptance and support of such activities) might shape the faculty members’ choices to patent. Indeed, Carayol (2007) shows that lab characteristics largely affect individual patenting production in universities, whereas Callaert et al. (2009) highlight that patenting activities in universities compared to engineering/technical schools strongly differ. Bercovitz and Feldman (2003) talk about ‘observational learning’ to account for this influence of the social context in terms of tolerance and support of patenting activities on scientists’ individual decisions to disclose knowledge through patents. Being aware of patenting
experiences of colleagues may indeed influence one’s own perception of patents, and the priority order that one assigns to the different possible missions and activities. This point is confirmed by a Swedish scientist’s verbatim collected by Schild (2004), and according to which “the central importance of patenting was never made explicit to him when he started his job at university, but is something he had gradually grown to realise as he learned how ... fundamental to the economic well-being of his department it was”. Also, if most of the time scientists are free to choose their scientific contests, more or less explicit rules developed within their organisations might influence their decision to patent. So we test the following hypothesis:

H5 Belonging to actively and systematically patenting labs leads a scientist to become more patent productive.

This hypothesis also indirectly accounts for the impact of costs associated with patenting activity on patent production. More precisely, Owen-Smith and Powell (2001), among others, clearly demonstrated that a negative perception of the costs can offset a scientist’s willingness to patent and finally limit her effective patenting activity. Thus, we assume that scientists who belong to labs which are not used to patent probably over-perceive the costs and problems associated with the transformation of a patentable idea into a patent and thus are less motivated to engage in the patenting process.

2.3.2 To acquire bargaining power and to secure freedom to operate

An important illustration of defensive and reactive patenting motivation is when a scientist decides to patent his research in order to protect himself from external threats. We just mentioned in the previous section that a bad past experience linked, for instance with difficulties in the interaction and communication with technology transfer offices, may deter scientists from getting involved again in patenting activities (Owen-Smith and Powell, 2001). However, we also believe that scientists can be confronted with other painful situations, which on the contrary may stimulate them to patent on their own. For instance, researchers who may have been blocked in their own research by an existing patent in the past may be forced to realise the importance of patents as a defensive tool (Kingston, 2001), which in turn may induce them to patent more. Yancey and Neal Stewart (2007) hence report “regular infringement of patents by university researchers”, that might lead to patent litigation problems. In such a conflicting context, patenting one’s research might be seen as an appropriate defensive strategy to develop the researcher’s bargaining power and to secure his freedom to operate. Thus we analyse whether:

H6 Researchers who have already been confronted to legal problems generated by an existing patent are more inclined to patent.

This hypothesis may sound extreme at first glance. Indeed, patents make it possible to prohibit any commercial use of the patented inventions, but basic research undertaken at universities should not be concerned by such commercial uses and thus may not frequently be blocked. On the contrary, patents contribute to the dissemination of scientific and technological knowledge (since patent applications are published and then become nice references and research materials for subsequent research) and academic research is, by law, protected by a research exemption for scientific inquiry, which authorises academic scientists to use and rely on patented knowledge without paying any
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licence. However, in practice, it is increasingly likely for a researcher to be blocked in her research by existing patents (at least in the USA). Indeed, the definition of the research exemption was strongly reduced and patent litigations between universities and firms are sharply increasing (Eisenberg, 2006), most probably because the borders between basic science and commercial use has become blurred (in the biotech or software sectors for instance). Nowadays, firms do not hesitate to sue universities for patent infringement which, in turn, makes universities more and more cautious about intellectual property issues.

We expect the above hypothesis to be more particularly relevant in sectors where the technology is ‘complex’ (i.e., based on multiple patents as it is the case in electronics for instance) than in sectors where the technology is ‘simple’ (i.e., when one technology leads to a unique patent and a unique product, as it is the case in pharmaceuticals). It is indeed well-known in the literature that defensive patenting strategies are linked to complex technologies where freedom to operate may not be granted by the patent right (Kingston, 2001)3.

To summarise, we argue here that some of the determinants that affect scientists’ decisions to apply for patents refer to intrinsic motivations of the researchers (who may be more or less patent enthusiastic), whereas others rather suggest that those decisions are guided by the context surrounding scientific activity (and that in this case the decision to patent may be more a reactive than a proactive one). In the next section we present the methodology and original dataset we use to test whether or not the motivations to patent affect the number of invented patents.

3 Empirical work and research methodology

3.1 The context: patenting at French universities

As in most developed countries, French public research organisations are actively engaged in patenting activities. In the last decade, the CNRS was systematically ranked in the top ten of French patent applicants, INSERM and INRA reaching also high rankings. Regarding French universities, they are now intensively patenting their research and there is various evidence that this trend is growing (Azagra-Caro et al., 2006; Carayol, 2007; Lissoni et al., 2007; Bach and Llerena, 2010).

This recent change in the behaviour of French universities can be attributed at least partially to the law on innovation and research passed in 1999, which puts strong emphasis on university-industry technology transfer and, in particular, on patents. Contrary to the US case, before this law French universities were already allowed to patent their inventions and, if they did, to own and manage their patents with considerable freedom. Yet, the 1999 legislation led to the creation of technology transfer offices and incubators in most French scientific universities (some of which already had such structures before the law was passed) and explicitly asked university researchers to exploit their research findings, by allowing them to create their own companies (strong provision is made to help researchers do so) and to have their inventions patented or co-patented. Indeed, today, French universities are encouraged to retain sole ownership of the patent rights on the inventions academic scientists take part in, or at least to share it with the firms they collaborated with. Finally, the law introduced a new strategic orientation, and placed stronger emphasis on technology transfer and patent ownership.
Regarding the individual remuneration of academic inventors, French authorities decided in 2005 to harmonise the local practices of each public research organisation and to fix one single rule. More precisely, when the university grants a licence to a firm, the income is shared following a simple principle: First, the technology transfer office is reimbursed for its expenditure. Then, if there is some money left, 50% of the remaining sum is shared among the inventors (up to a given ceiling) and the other half is shared among the institutions, which took part in the patenting process, namely the different labs and universities of the inventors, other public research organisations, etc. As a consequence, in the current legislative context, French academic scientists can earn a significant share of the income yielded by their invented patents, which might motivate them to engage in such an activity.

Moreover, the 2000s decade saw the progressive introduction of patents (besides publications and conferences) in the assessment grids used at university to allocate promotions, allowing thus a form of academic recognition of the patenting activity.

3.2 The sample

Our analysis focuses on the behaviours of French academic inventors, i.e., tenured university (associate and full) professors, active in a French university in 2004 and designated as inventors on at least one patent application submitted to the European Patent Office between 1993 and 2005 (according to the methodology developed in Lissoni et al., 2007). The name-matching between tenured university professors and inventors led us to identify 1228 confirmed French academic inventors, i.e., people who confirmed in cases of doubt (due to homonymy problems for instance) that they were both university professors and inventors of a European patent. We then sent a questionnaire to all of those confirmed French academic inventors during Spring 2008. The questionnaire was divided into three parts: In a first section we collected individual information such as age, gender, status, etc. Then we focused on scientists’ motives to patent. In the third part we questioned academic inventors on their past experiences with patents. A preliminary version of the questionnaire had been sent to three faculty members of our institution, as a pilot test, to improve its content.

The data collection ended with a total number of 269 complete questionnaires and 11 incomplete ones, i.e., with a response rate higher than 20%, covering seven scientific disciplines. Our study is limited to the analysis of a subsample of 173 responses, corresponding – exclusively but exhaustively – to complete questionnaires filled by scientists in life sciences (95 answers) and engineering sciences (78 answers). We decided to focus on life sciences (medical sciences, biotechnologies and pharmaceuticals and drugs) versus electronics and engineering because the literature suggests that patenting behaviours in those sectors exhibit significant differences. As emphasised in Section 2, inquiries on firms’ patenting behaviours usually highlight that the primary motive to patent in life sciences is of an offensive nature (to exclude other firms), whereas in electronics patents are used in a more defensive way (to prevent being excluded). Our work thus aims at investigating whether such differentiated behaviours remain valid in the case of academic patents, and at analysing the consequences of offensive versus defensive motivations on patent production. Moreover, the area of biotechnology and pharmaceuticals tends to be an area of extremely high university patenting activity in many countries (see Geuna and Nesta, 2006 for European data) and Searle Renault (2006) explains that life sciences, pharmaceuticals and biotechnologies,
are substantially more entrepreneurial-oriented: “Life sciences have been more supportive of entrepreneurial behaviour over the past 20 years compared to engineering” (p.230). All those reasons support our decision to compare the rationales to patent in life sciences versus engineering and electronics.

Table 1 gives the profiles of the 173 respondents and of the French population of academic inventors according to their age, gender, academic position and scientific disciplines.

**Table 1** Profiles of French academic inventors in life sciences, engineering sciences and electronics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>% in the sample</th>
<th>% in the surveyed population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30–39</td>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td>40–49</td>
<td>34</td>
<td>31</td>
</tr>
<tr>
<td>50–59</td>
<td>32</td>
<td>27</td>
</tr>
<tr>
<td>60–69</td>
<td>17</td>
<td>28</td>
</tr>
<tr>
<td>70 or more</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Female</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Academic position</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Associate professor (Maître de conférences)</td>
<td>43</td>
<td>36</td>
</tr>
<tr>
<td>Full professor (PU)</td>
<td>57</td>
<td>64</td>
</tr>
<tr>
<td>Scientific discipline</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Life sciences</td>
<td>56</td>
<td>61</td>
</tr>
<tr>
<td>Electronics and engineering</td>
<td>44</td>
<td>39</td>
</tr>
</tbody>
</table>

The comparison between the whole population of confirmed French academic inventors and the respondents does not exhibit significant differences (Pénin, 2010). Most of our respondents are male (90%), University professors (57%) and over 40 years old (84% of the respondents is more that 40 years old).

At this stage, we want to stress the fact that personal information on academic inventors were collected only once even if some scientists invented several patents during the period. Indeed, when testing our questionnaire on academic inventors holding several patents, we noticed that they had difficulties in remembering the different situations they had faced for each patent they had been involved in. Thus, we chose to simplify our questionnaire and to collect information once per inventor rather than every time an inventor developed a patent. Yet, according to the study conducted by Searle Renault (2006, p.233) on US data, “most of the professors indicated that their attitude about academic capitalism had remained constant throughout their career”, meaning that our data, even if not longitudinal, do not generate too much bias, as perceptions and behaviours remain quite stable through time.

### 3.3 Description of the variables

To test the different hypotheses presented in Section 2, we mainly relied on information collected through the survey described above. Overall, we used twelve explanatory variables, all displayed and described in Table 2, in order to explain the number of invented patents (correlation matrix available in Annex).
<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Average</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>PATENT</td>
<td>Integer = number of EPO patents invented by the researcher between 1993 and 2005</td>
<td>1</td>
<td>22</td>
<td>2.30</td>
<td>2.56</td>
</tr>
<tr>
<td>MONEY</td>
<td>Integer = {0,1,2,3,4,5}, according to whether or not the researcher considers that to increase his immediate earning through royalties is an important motivation to apply for a patent. 0 = not important at all; 5 = very important</td>
<td>0</td>
<td>5</td>
<td>0.90</td>
<td>1.45</td>
</tr>
<tr>
<td>PAT ENTHUS</td>
<td>Integer = {0,1,2,3,4,5}, according to whether or not the researcher believes that university patenting undermines the culture of open science. 0 = strongly disagree; 5 = strongly agree.</td>
<td>0</td>
<td>5</td>
<td>1.60</td>
<td>1.41</td>
</tr>
<tr>
<td>WILLING</td>
<td>Dummy; 1 = researcher acknowledges that he tries to orient his research in fields where he knows it will be possible to apply for patents</td>
<td>0</td>
<td>1</td>
<td>0.18</td>
<td>0.39</td>
</tr>
<tr>
<td>GOOD-EXP</td>
<td>Dummy, 1 = researcher has already experienced technology transfer (commercialization or industrialization of an invention) directly due to academic patenting</td>
<td>0</td>
<td>1</td>
<td>0.33</td>
<td>0.47</td>
</tr>
<tr>
<td>PUB DELAY</td>
<td>Integer = {0,1,2,3,4}, according to whether or not researcher has experienced a delay in the publication of his research directly attributable to a patent. 0 = no delay; 1 = delay lower than six months, 2 = delay between six months and one year, 3 = delay between one and two years, 4 = delay higher than two years.</td>
<td>0</td>
<td>4</td>
<td>1.85</td>
<td>1.28</td>
</tr>
<tr>
<td>LAB POL</td>
<td>Dummy, 1 = researcher’s lab has a policy of systematic patent application</td>
<td>0</td>
<td>1</td>
<td>0.35</td>
<td>0.47</td>
</tr>
<tr>
<td>PAT LITI</td>
<td>Dummy, 1 = researcher has already been involved in a patent litigation</td>
<td>0</td>
<td>1</td>
<td>0.12</td>
<td>0.33</td>
</tr>
<tr>
<td>BLOCK PAT</td>
<td>Dummy, 1 = researcher has already been obliged to reorient his research in the past to get round a patent held by another researcher</td>
<td>0</td>
<td>1</td>
<td>0.26</td>
<td>0.44</td>
</tr>
<tr>
<td>AGE</td>
<td>Integer = {1,2,3,4,5}, age of the respondent in 2008. 1 = between 30 and 39, 2 = between 40 and 49, 3 = between 50 and 59, 4 = between 60 and 69 and 5 = older than 70</td>
<td>1</td>
<td>5</td>
<td>2.25</td>
<td>0.99</td>
</tr>
<tr>
<td>GENDER</td>
<td>Dummy, 1 = male</td>
<td>0</td>
<td>1</td>
<td>0.90</td>
<td>0.29</td>
</tr>
<tr>
<td>SCI-EXC</td>
<td>Integer = number of past publications SCI before 2005</td>
<td>0</td>
<td>155</td>
<td>17.13</td>
<td>22.28</td>
</tr>
<tr>
<td>SCIENTIFIC DISCIP.</td>
<td>Dummy for technological field: {life sciences or engineering sciences}, See Table 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.3.1 Dependent variable

We proxied the outcome of researchers’ patenting activity by the number of patents they invented during the period under study (PATENT). We constructed this dependent variable by taking all the EPO patents invented by each faculty member between 1993 and 2005. As shown in Table 2 the production of patents by academic inventors in our sample ranges from 1 to 22 with a standard deviation of 2.56, testifying to a huge behavioural diversity, which we ambition to explain more deeply.

As is usually done in this case, we estimated our econometric model of the determinants of patent numbers by relying on count data models and more precisely on a negative binomial specification. A zero inflated model is not relevant here since we only consider academic inventors, i.e., scientists who already invented at least one patent.

3.3.2 Independent variables

3.3.2.1 Proactive strategy

To test the importance of the earning motivation on patent production, we used the answers to a question in which we asked respondents whether or not their motivation to apply for a patent was to increase immediate earnings via licensing royalties (MONEY). It provides an indicator (on a five-point Likert-scale) of the importance that academic inventors grant to immediate earnings as opposed to other motivations, such as reputation or scientific curiosity. We can see, that on average, academic inventors of the sample do not consider the increase of immediate earning as an important motivation to patent (mean = 0.9). But again the dispersion of answers is rather important (standard deviation = 1.45).

Similarly, we measured the scientist’s individual attitude toward ‘academic capitalism’ by using the answers to the following question of the survey: “Do you believe that university patenting may undermine the norms of open science, i.e., may decrease trust and exchanges among scientists and decrease the rate of diffusion of research results”? (Again respondents had to answer on a five-point Likert scale). The answer to this question reflects the scientist’s enthusiasm towards university patent and allows us to distinguish between patent enthusiastic and patent reluctant but compelled-to-patent scientists. More precisely, our variable PAT_ENTHUS equals 0 if respondents strongly disagree with the proposed statement and equals 5 if they strongly agree. If on average scientists rather disagree (mean = 1.6), some of them however clearly see patents as a threat for the republic of science (even if they do patent!), as shown by the maximum value of the variable. It should be noted that, if our Hypothesis 2 holds, the sign of this variable should be negative.

Furthermore, to test Hypothesis 3, i.e., whether or not researchers who patent the most are those who deliberately orient their research towards patentable areas, we relied on the answers given to the following question: “Does the possibility to be granted patents influence the nature of your research? (only one possible answer)”. Respondents had the choice between three answers: “Yes, I try to orient my research in fields where I know it will be possible to apply for patents”, ‘No’ or ‘I don’t know’. We thus built a dichotomised independent variable (WILLING) based on the answers provided. This variable scores 1 if the inventor acknowledges orienting her research towards patentable areas and 0 otherwise. Only, 18% of the respondents answered ‘yes’ suggesting that
patenting is a rather reactive strategy in the sense that the scientists do not deliberately modify their behaviours so as to be able to patent their research but rather realise *ex-post* that their results are patentable and thus start writing a patent application.

Finally, two questions in the questionnaire accounted for the fact that the respondent may have experienced a successful case of technology transfer or, on the contrary a frustrating case of publication delay. The two exact questions were: “Have you already experienced a successful episode of technology transfer (commercialisation or industrialisation of an invention) directly due to academic patenting?” and “Have you experienced a case of publication delay directly attributable to a past patent application? (and if yes, what was the length of this delay)”.

Answers to those two questions enabled us to create two variables: one dummy which scores 1 if the scientist reports a successful experience of technology transfer (GOOD_EXP). A second variable which takes a value between 0 and 4 according to the length of the reported publication delay (PUB_DELAY). We can notice that only one third of the respondents in the sample were confronted with a positive experience of technology transfer directly attributable to patents. The average publication delay they had to suffer varies from none to more than two years.

### 3.3.2.2 Reactive strategy

To test the mimetic assumption according to which an academic scientist is more actively involved in patenting activities if other members of her lab do patent, we questioned the inventors on the patent policy adopted within the lab they belonged to (LAB-POL). If respondents declared that their laboratory was involved in a policy of systematic patenting of research, the variable scores 1, if not, the variable scores 0. Here, 35% of the collected responses are positive.

Similarly, we tested Hypothesis 6, which posits that scientists’ patenting activity comes in reaction to previous disappointing experiences they had with respect to others’ patents by using two variables built on two questions of our survey. The first question was: “Has the scientist already been involved in a patent litigation?” If yes, PAT_LITI variable scores 1. The second was: “has he/she already been obliged to reorient his/her research due to the risk of patent infringement?” If it is the case, BLOCK_PAT scores 1. Only a limited number of the inventors in our sample were confronted with such negative consequences of patenting, as testified by the average value of both variables (0.12 and 0.26 respectively).

### 3.3.2.3 Control variables

We used several control variables in order to isolate as precisely as possible the influence of each above variables. First we controlled for age and gender. It should be noted that according to the literature we expected that female scientists would patent less than their male counterparts (Breschi et al., 2005; Thursby and Thursby, 2005; Bunker Whittington and Smith Doerr, 2005) and that the age of scientists would have a positive impact on the number of invented patents (Levin and Stephan, 1991; Thursby et al., 2007).

We also included disciplines dummies, since the scientific field might significantly influence the propensity to patent (Stephan et al., 2007). Indeed, scientific and technological domains are characterised by diverse levels of patenting opportunities and by heterogeneous strategic values associated to patenting (Griliches, 1990), as the gap
between academic research and industrial applications and the effectiveness of patents as means of protecting inventions strongly vary (Schild, 2004). Concretely, we included an indicator of scientific disciplines of the researchers (and not of industrial sectors of the patents) based on the disciplinary classification of each scientist’s official position (we used the French ‘Conseil National des Universités’ classification). Life sciences scores one (1) if the scientific discipline of the faculty is one of the following ones: medical sciences, biotechnologies and pharmaceuticals and drugs. Engineering sciences scores one (1) if the scientist’s discipline is either electronics or engineering sciences.

Third, we controlled for the scientific performance of the researcher. The SCI-EXC variable accounts for the scientific excellence of academic inventors, which is proxied using ISI web of science. We collected all the publications of the Science Citation Index attributable to each of the surveyed scientists (until 2005). This publication variable is a classical indicator of scientific excellence. It ranges between 0 and 155, with an average of 17.13, suggesting that patenting scientists are not similar in terms of publishing activity. In line with previous studies, we clearly expected the sign of SCI-EXC to be positive. Most studies indeed found that researchers and labs who patented the most were also those who published the most (Thursby and Thursby, 2002; Breschi et al., 2005; Van Looy et al., 2006; Carayol, 2007; Stephan et al., 2007; Buenstorf, 2009).

4 Results and analysis

The results of the three negative binomial regressions (on the whole population of 173 academic inventors, in life sciences exclusively and in the sub-sample of electronics and engineering sciences) are displayed in Table 3.

First of all, one can mention that many of the dependent variables are not significant, which is likely to come from the small size of our sample and the large dispersion of variables within the sample. Yet, all the signs match the expectations made in Section 2.

The main result of those three models is that both proactive and reactive motivations matter in order to explain the number of invented patents. No strategy clearly dominates the other. To put it differently, offensive and proactive motivations are not more decisive than defensive and reactive ones to explain the number of invented patents. Scientists who believe that university patenting does not undermine the norms of open science and/or who deliberately engage in patentable research areas, are not more patent prolific (as testified by the lack of significance of their respective coefficients). A noticeable exception however is the sub-sample of life sciences, where the willingness to orient one’s research towards patentable areas is positively linked to the number of invented patents (but only at a 10% level). Hence, contrary to what could have been expected, being a patent enthusiast does not mean being the inventor of more patents. Hypotheses 2 and 3 are not validated by our data.

Similarly, scientists whose main motivation to patent lies in increasing their immediate earnings do not invent more patents, thus invalidating Hypothesis 1. Indeed, their respective coefficient, although positive never proves significant. This conclusion holds whatever the discipline considered. A possible explanation for this result is that scientists motivated primarily by money might focus on the development of a limited number of high potential patents (those of better quality which protect key technologies) rather than on multiplying the number of patents they invent. It is indeed well known that
the distribution of patent revenues is highly skewed with only a few numbers of patents yielding important revenue.

**Table 3** The effects of proactive versus reactive motivations on the number of patents in the whole sample (n = 173), in electronics and engineering sciences (n = 78) and life sciences (n = 95)

<table>
<thead>
<tr>
<th>Ind. variables</th>
<th>Whole sample</th>
<th>Electronics and engineering sciences</th>
<th>Life sciences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>Std error</td>
<td>Coefficient</td>
</tr>
<tr>
<td>Offensive and proactive variables</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MONEY</td>
<td>0.05</td>
<td>0.039</td>
<td>0.029</td>
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<tr>
<td>PATENTHUS</td>
<td>−0.043</td>
<td>0.045</td>
<td>−0.035</td>
</tr>
<tr>
<td>WILLING</td>
<td>0.19</td>
<td>0.15</td>
<td>0.177</td>
</tr>
<tr>
<td>GOOD-EXP</td>
<td>0.259***</td>
<td>0.124</td>
<td>0.513***</td>
</tr>
<tr>
<td>PUB_DELAY</td>
<td>−0.071</td>
<td>0.048</td>
<td>−0.112</td>
</tr>
<tr>
<td>Defensive and reactive variables</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LAB POL</td>
<td>0.164</td>
<td>0.131</td>
<td>−0.107</td>
</tr>
<tr>
<td>PAT LITI</td>
<td>0.465***</td>
<td>0.156</td>
<td>0.12</td>
</tr>
<tr>
<td>BLOCK PAT</td>
<td>0.322***</td>
<td>0.131</td>
<td>0.400**</td>
</tr>
<tr>
<td>Control variables</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCI-EXC</td>
<td>0.005**</td>
<td>0.002</td>
<td>0.005</td>
</tr>
<tr>
<td>AGE</td>
<td>0.303***</td>
<td>0.065</td>
<td>0.244***</td>
</tr>
<tr>
<td>GENDER</td>
<td>0.233</td>
<td>0.256</td>
<td>−0.087</td>
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<tr>
<td>Dummy life sci.</td>
<td>−0.186</td>
<td>0.131</td>
<td>/</td>
</tr>
<tr>
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<td>−0.467</td>
<td>0.285</td>
<td>0.075</td>
</tr>
<tr>
<td>Log likelihood</td>
<td>−296.40</td>
<td></td>
<td>−128.32</td>
</tr>
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<td>Pseudo R2</td>
<td>0.10</td>
<td></td>
<td>0.085</td>
</tr>
<tr>
<td>LR (Chi2)</td>
<td>68.96***</td>
<td></td>
<td>23.68***</td>
</tr>
</tbody>
</table>

Notes: ***Significant at the level of 1%  
**Significant at the level of 5%  
*Significant at the level of 10%.

If the faith in entrepreneurial science does not explain the number of invented patents, on the other contrary past patenting experience seems to matter a lot. For instance, researchers who already experienced a successful technology transfer due to a patent tend to invent more patents (as shown by the positive and significant coefficient of GOOD-EXP variable). Similarly, researchers who were already blocked in their past research by a patent held by a third individual or organisation tend to patent more (see the BLOCK-PAT positive and significant coefficient). Hence Hypotheses 4a and 6 do hold.
Proactive versus reactive motivations for patenting

The first result tends to support the importance of offensive motivations. Researchers perceive the value of patents to disclose knowledge and hence tend to patent more. Conversely, the second result rather supports reactive and defensive motivations to patent. By having experienced a blockage in the past researchers realise the importance of patents to secure freedom to operate and then tend to invent more of them.

Furthermore, in both the general and life sciences cases, a past experience of patent litigation is positively correlated to the number of invented patents. Again, this result suggests that reactive motivations do matter to explain the number of invented patents. Scientists who were involved in past litigations do measure the economic and technological power of patents and are thus more patent active. On the contrary, it is interesting to notice that past publication delays due to patent application do not systematically reduce academic patenting activities, as testified by the lack of significance of PUB-DELAY variable, thus invalidating Hypothesis 4b.

It is also worth stressing that the patenting policy of the lab is not significantly correlated with the number of invented patents (even though the sign is positive). This clearly invalidates Hypothesis 5. Scientists who work in departments with an intense and systematic patenting policy are not more patent prolific. The stimulating collective dynamics we hypothesised is not verified.

With respect to control variables, scientific excellence and the age of the scientist do positively and significantly influence their numbers of patents. Those two results are in line with most empirical results in the literature which tend to show that more prolific researchers (the one who publish the most) are also the more prolific inventors (the one who patent the most). It is to be noted that the positive sign of age is somehow spurious because we do not have panel data. Consequently it is obvious to find that, ceteris paribus, older scientists accumulated more patents than younger ones.

We saw in Sections 2 and 3 that it is frequent in the patent literature to oppose simple technologies (for instance in the pharmaceutical sectors) in which patents are used in an offensive way, to complex technologies (like electronics) in which patents are used primarily in a defensive way. Consequently, we expected to find defensive and reactive patenting behaviours as being more important in electronics and engineering than in life sciences. What we found is that, although there are no strong differences, those two disciplines slightly differ on some points. First, the willingness to patent matters to explain scientists’ patent production levels in life sciences, which is not the case in engineering sciences. Hence, we observe that in life sciences, more substantial responsibility falls upon the scientists themselves, as catalysing patenting activities requires patent willing professors. Second, the experience of a positive technology transfer matters in electronics and engineering but not in life sciences. This seems to confirm Jensen et al. (2003) according to whom the support of technology transfer offices (to guarantee a first exciting patenting experience) is mostly useful for scientists who are not very motivated by entrepreneurial activities (in our case, in engineering sciences).

Regarding the patent litigation variable, it is also positively and significantly correlated to the number of invented patents for life sciences but not for electronics and engineering. Yet, those differences do not enable us to conclude whether or not proactive or reactive motivations dominate in one case and not in the other, but they show that patent motives have differentiated impacts on academic patent production in those two disciplines. Stimulating patenting activities in those two disciplines would thus require different managerial tools.
5 Conclusions

5.1 Theoretical contributions

This paper focused on academic inventors’ motivations to invent patents and on the consequences of different sets of motivations on the scientist’s patenting performance. Our main originality lies in distinguishing between two types of motivations to patent: Proactive strategies where the scientists clearly perceive the benefits of patenting activities and thus are actively looking for patents; and reactive strategies where scientists are rather involved in patenting activities as a defensive reaction to their environment. We empirically explored whether or not those two sets of motivations influenced the number of invented patents, i.e., whether offensive and proactive type of motivations did lead to a higher patent production. To do so, we relied on extensive survey data about 173 French academic inventors.

Our main result is that neither proactive nor reactive types of motivations seem to dominate in the explanation of the number of invented patents. In particular, a very positive perception of university patenting does not lead to more numerous patent inventions. On the other hand, past experience seems to matter a lot to explain the number of invented patents (especially in the engineering sciences). Academic inventors who report a successful past technology transfer due to patents and/or who were already – obliged to reorient their research in order to get round a patent held by a third party do invent more numerous patents. Furthermore, we find that prolific patent inventors are also prolific researchers, and that the patenting policy of their respective research labs does not significantly influence the number of invented patents.

Regarding the willingness of scientists to orient their research towards patentable areas, it is not correlated to the number of invented patents (except in life sciences). In other words, scientists who patent are not systemically more inclined to select more patentable research areas. This suggests that in many cases patents are often by-products of the research activity rather than a specific objective that scientists want to address. French scientists apply for patents since their research area offers patenting opportunities not because they are actively looking for it.

Finally, there is no straightforward relationship between the nature of the motivation to patent and the effective number of patents invented by a given scientist, suggesting that several managerial tools might be developed to catalyse French scientists’ patent production.

5.2 Managerial implications

As being patent enthusiastic and patent willing does not systematically increase the number of invented patents, we assume that improving the communication around patents at university and advertising the advantages of such an activity for scientists (so as to convince patent reluctant researchers of the advantages of such a knowledge diffusion tool and reconcile them with patents) do not seem to be required. In line with this is the finding that prolific patent inventors are also prolific researchers. This suggests that favouring patent applications and technology transfer does not imply hiring new profiles of competences. The traditional high publishing profiles are compatible with the newly required ones (high technology transfer potential), even when the former are not particularly interested in disclosing knowledge through patents.
Moreover, the non-significant role played by the lab policy suggests that to encourage patent applications the focus (of the incentives) should be put on the scientist himself rather than on his institution. Sponsoring actively patenting labs would not guarantee an increase of the patenting activity of scientists within those labs.

On the contrary, by showing that remaining patent reluctant does not impede knowledge disclosure through patents (reactive patenting strategies being really effective ones) and that past experience in patenting matters, we believe that the activities of technology transfer offices are the cornerstone of academic patenting in France. Indeed, what seems fundamental is the quality of past experience, meaning that most of the resources should be concentrated on helping scientists during their first applications, and limiting their potentially bad experiences either with competitors or with technology transfer offices members. To do so technology transfer offices should think about recruiting scientists among their teams, so as to ease the creation of shared knowledge code books with faculty members and limit the interaction costs (Owen-smith and Powell, 2001). Finally, we confirm the idea developed by Meyer et al. (2005) according to whom in European universities, which have become too recently involved in entrepreneurial activities, the effectiveness of introducing incentive schemes is limited when support structures are missing or do not possess the required skills. We even go one step further and suggest that technology transfer offices in France should still act in a proactive way by regularly visiting scientists in their labs in order to detect potentially patentable results

1 help patentable research become patented by accompanying scientists in starting the patent application process and leading it to successful completion, in order to make faculty members disclose and protect their inventions (the first and crucial step of the technology transfer process) more systematically.

This conclusion concerning the role that technology transfer offices may play in determining the number of disclosures at a university sounds consistent with the observation by Stephan et al. (2007) on the US case, according to which although academic scientists do not need to be taught how to publish, they do need to be educated concerning the patent process. French academics thus seem to behave quite like US academics, despite their more recent involvement in the technology transfer process. Rather than being reluctant to patent (as a tool), French scientists seem not to be ready to engage and endure the (labour) costs of the patenting process.

5.3 To go further

Additional work is still needed. For instance, we only collected data and opinions of faculty who had a patenting experience as inventors. We therefore lack a control sample in which we would have information on scientists with no experience in patenting activities. Panel data could also be quite useful to limit endogeneity problems. Indeed, with the current dataset the dependent variable we use might explain some of the independent variables (and in particular those related to past patenting experiences), which makes our conclusions more fragile. Unfortunately such longitudinal data are rather difficult to collect. Moreover, our analysis mostly relies on single-item measures of motivations, which may lead respondents to underestimate motivations that they view as less politically correct, and thus may bias our results. The use of multiple-item measures
(requiring the administration of a new questionnaire) or of in depth interviews would be of interest to complete this first picture in subsequent papers.

It may also be interesting to get information on the patents university members invented (whether or not they were exploited by a spin-off, sold to a large firm, abandoned? Did they give rise to a licence agreement? etc.), so as to test whether the result (and ownership) of intellectual property emanating from university research in turn influences the motivations to engage into patentable activities.

Last, but not least, more theoretical and empirical research is still required to explore the consequences of patenting university research on social welfare. Indeed, we do not discuss here this normative point. Our managerial recommendations assume that policy makers and technology transfer office managers want to increase the number of patents invented by university. This assumption seems to be in line with the current context. Yet, it is still unclear whether or not this trend towards a systematic patenting of university research is desirable.

References


Proactive versus reactive motivations for patenting


Notes

1 This distinction between proactive and reactive motives has already been used in the patenting literature. Hence, in the case of interfirms technology licensing, Lichtenhaler (2010, p.55) distinguishes: “proactive licensing, which refers to identifying recipients for technology transactions, and reactive licensing, which relates to offering licenses to infringers of a firm’s intellectual property”. But the previous literature concentrated on firm’s motives to patent whereas in the present paper we analyse the behaviours of academic researchers.

2 A patent is a legal document which gives to its owner a right of exclusion over the invention described in the document. It is valid for a given territory and a given period of time (its duration cannot exceed 20 years after the first application). In Europe, in order to be patentable an invention must be new, non-obvious and have industrial use. The standard economic rationale of the patent system is to increase incentives to both innovate and disclose knowledge to society. Yet, the efficiency of the patent system is frequently questioned (Mazzoleni and Nelson, 1998; Jaffe, 2000) and it is often argued that the patent system, as it used to work in the last two decades, did more harm than good (Jaffe and Lerner, 2004).

3 According to Kingston: “[in complex technologies] The motivation for their extensive use of patents is therefore quite different from that of firms in simple technologies. In the latter, the emphasis may be said to be primarily offensive (to prevent others from using the invention); in complex technologies it is primarily defensive (to avoid being denied the use of an invention).” [Kingston, (2001), p.408].

4 The questionnaire is available on request to the authors.

5 See for instance the lack of significance of the earning motive.
## Proactive versus reactive motivations for patenting

### Data correlation matrix

<table>
<thead>
<tr>
<th></th>
<th>WILLING</th>
<th>PATENT</th>
<th>AGE</th>
<th>GENDER</th>
<th>LAB POL</th>
<th>SCI-EXC</th>
<th>MONEY</th>
<th>PAT ENTHUS</th>
<th>PAT LITI</th>
<th>PUB DELAY</th>
<th>GOOD-EXP</th>
<th>BLOCK PAT</th>
</tr>
</thead>
<tbody>
<tr>
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<td>0.0674</td>
<td>0.006</td>
<td>0.0572</td>
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<td>-0.0583</td>
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