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Scientists' perspectives concerning the effects of university patenting on the conduct of academic research in the life sciences

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Abstract This paper explores scientists' perspectives on the possible "unintended effects" of university patenting on the definition of academic research agendas, and the norms of open science. Based on a survey of life science researchers in Denmark, we found that a substantial proportion of scientists were skeptical about the impact of university patenting. The most skeptical respondents were scientists oriented towards basic research (particularly the less productive ones), recipients of research council grants, scientists with close relations to industry, and full professors. Highly productive scientists were less concerned. Our results have implications for understanding the ultimate success or failure of academic patenting policies, including how increased university patenting may be affecting how scientists conduct academic research.

Keywords Universities · Academic patenting · Scientists' perspectives · Life sciences

JEL Classifications I23 · L30 · O31 · O34

1 Introduction

Recent years have witnessed a surge in the patenting and commercialization of academic research, bolstered by a range of policy initiatives and legislative changes. The most notable of these is the American Bayh-Dole Patent and Trademark Amendments Act of 1980, which granted universities the right to patent and license discoveries resulting from federally funded research. A number of European countries, such as Belgium, Germany,

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and Denmark, have taken similar measures, and others are presently considering doing so (Geuna and Nesta 2006; Verspagen 2006).

As academic scientists have come under increasing pressure to apply for patents, a lively debate has emerged in the academic literature about the possible implications of this change. But while numerous studies have examined the effects of patenting on the transfer of academic science to industry (e.g., Di Gregorio and Shane 2003; Etzkowitz and Leydesdorff 2000; Etzkowitz et al. 2000; Meyer 2006; O'Shea et al. 2005; Shane 2004), less is known about its long-term, unintended consequences on academic freedom.

We label these consequences "unintended" because according to the supporters of the Bayh-Dole Act, stronger intellectual property rights should enhance the commercial exploitation of academic research (Mowery et al. 2001). But arguably, this Act (and similar measures in other countries) reflects an implicit assumption by policy-makers that scientists' research activities per se, and into the future, will not be affected. In other words, scientists are expected to continue to generate a stream of original (and potentially exploitable) research results. This assumption has been challenged, raising concerns that university patenting may have negative effects on the progress of science itself (Azoulay et al. 2007; Mowery et al. 2001)—the focus our analysis. As far as we are aware, this study is the first to explore how scientists perceive the unintended effects of university patenting on how they define and carry out their research.

But how can these effects best be investigated? Like Behrens and Gray (2001), who studied how US graduate students view the unintended consequences of cooperative university–industry research on academic freedom, we decided to poll the scientists directly. The term "academic freedom" has two main components: freedom to conduct research ("academic choice": the ability to choose one's own research topics), and freedom to communicate research (whether the scientist feels constraints in disclosing, communicating and sharing this research with others, what is more generally referred to as the "norms of open science") (Behrens and Gray 2001). Drawing on an original survey of university researchers within the life sciences in Denmark, we found that 27% of our respondents believed that patenting had a negative impact on academic choice, while 41% believed it had a negative impact on the norms of open science.

We then sought to determine what characterized the scientists who were more negative, and more positive, in these regards. We found that scientists oriented towards basic research, and scientists who had previously worked in industry, were highly concerned that university patenting would negatively affect both aspects of academic freedom. Highly productive researchers, by contrast, were less apprehensive about either effect. The less productive basic researchers were especially worried about the effects on academics' ability to choose their own research agendas. Scientists who had received research council grants, and full professors, were skeptical as well as regards the effects on academic choice.

Our arguments are organized as follows. In Section 2, we explore the two possible unintended consequences of university patenting on the conduct of academic research that form the focus of our analysis. In Section 3, based on the theoretical and empirical literature on the nature and effects of university patenting, we build an analytical framework to explain what might characterize the scientists who are more (or less) skeptical. This forms the basis for our hypotheses. Section 4 presents our research design, and Section 5 our results. Section 6 discusses some of the implications of our analysis, followed by the conclusion.

2 The impact of university patenting on academic research

Ideally, university researchers are motivated by a different set of values than their counterparts in business (Dasgupta and David 1994; Merton 1973; Siegel et al. 2003). Industrial scientists operate within a community of "proprietary science," and are therefore concerned chiefly with the appropriation of rents from their inventions. Research agendas are determined according to their companies' larger missions and goals. Academic scientists, by contrast, have traditionally defined their own research priorities, and operated within a community of "open science," governed by the "Mertonian" norms of universalism, disinterestedness, originality, skepticism, and communalism, the belief that knowledge and discoveries generated through publicly funded research should be placed in the public domain.

How might university patenting influence how scientists define and carry out academic research? While no previous study has specifically asked this question, our work can be seen as part of the larger stream of literature that investigates how changes in the social and institutional context might affect scientists' approach to their research. Elzinga (1984), for example, analyzed how scientific research generally may be affected by pressure from public sector agencies. If scientific paradigms may be stabilized or destabilized due to events in the research community (Kuhn 1962), there is no reason not to assume that events *outside* the research community might have a substantial effect as well. Further developing this theme, Elzinga (1997) reflects on some of the problems engendered by the new "policy-driven" science and its demand for relevance, where government bureaucrats have sought to influence not only the definition of what problems are important to investigate, but also the standards of performance of the resulting research in that field.

In related work, Slaughter and Leslie (1997) and Slaughter and Rhoades (2000) have critically explored the emergence of "academic capitalism," where public universities are increasingly treating higher education policy as a subset of economic policy. Similar concerns have been expressed in Europe (e.g., Ferné 1995; Bennich-Björkman 1997). A Danish study by Jacobsen et al. (2001), based on responses from 250 academic researchers, determined that while most found it important to engage in research relevant for society, they felt that this should not be part of a detailed, planned program. The overwhelming majority emphasized that academic freedom is crucial to the conduct of university research.

Yet the increasing politicization and commercialization of academic research may not, necessarily, lead to "worse" results. For example, focused government-sponsored research programs, like the World War II Manhattan project to develop the first atomic bomb, directed by American physicist J. Robert Oppenheimer, attracted the top scientists of the day and stimulated vast amounts of related research. Moreover, at the level of the individual researcher, scholars have shown that high autonomy per se is not necessarily linked to excellent research. Work by Andrews and Farris (1972), Pelz and Andrews (1966) and Pelz (1964) suggests that there is a curvilinear relationship between the degree of autonomy a researcher enjoys, and the degree of excellence in research performance; both too little autonomy, and too much, lead to inferior performance.

The ideal of academic freedom may be difficult to achieve in practice. Mitroff (1974), in a study of the elite scientists who participated in US. Apollo lunar missions in the 1960s, discovered that while respondents clearly embraced Mertonian norms, they also noted that certain of their colleagues engaged in fiercely personal, sometimes acrimonious, competitive races, hoping to prove that their "pet" theories would be validated by the empirical evidence. Interestingly, respondents viewed this positively—as a sign of the scientists' commitment to find answers to the identified problems!

Increased university patenting is one example of how changes in the social and institutional context might affect scientists' approach to their research, and it represents a key aspect of the commercialization of academic endeavor. But following the logic set forth above, it is not necessarily a "given" that university scientists will see this as negatively affecting their ability to conduct academic research. Perhaps some would welcome the opportunity to perform research more relevant to business. Some might realize that pressure to patent, even if it reduces autonomy, might actually improve their research performance. Others might be realistic about their ability to work according to Mertonian norms, given the highly competitive nature of scientific research, where success in patenting is part of that competitive dynamic. Scientists' perspectives on the effects of increased pressures to patent might also differ, depending on which of the two aspects of academic freedom that we have chosen to investigate here are involved.

The first aspect of academic freedom that might be affected by increased patenting is the freedom to choose research subjects according to academic criteria. As Merton (1973) and Dasgupta and David (1994) argue, the freedom to choose research subjects is central to university research. Aghion et al. (2008) define the freedom to choose as the granting of control rights to researchers, that is, the right to pursue lines of research based on a personal assessment of the research potential. Traditionally, scientists have been motivated to engage in research by a combination of intrinsic rewards (satisfying their curiosity to solve intriguing puzzles) and external rewards ("winning the game" by being the first to publish their results, leading to both peer recognition and, possibly, financial gains) (Stephan and Levin 1992; Stephan et al. 2007). Whatever her motivation, however, the university scientist should maintain the right to choose her topic.

A key concern is that increased pressures to patent might adversely affect the efficiency of this incentive structure, skewing research priorities towards commercially viable, marketable research at the expense of fundamental research, effectively curbing scientists' ability to pursue their curiosity-driven academic agendas (e.g., Florida and Cohen 1999; Henderson et al. 1998; Lee 1996). Academic patenting might thereby contribute to a less efficient division of labor between public and private science, shifting academic scholars away from the activities in which they are best—that is, supplying a collective good (Feller 1990; Metcalfe 1998; Nelson 1959, 2001)—and causing universities to "behave more like firms" (Verspagen 2006, p. 8). The traditional university research model enables the individual professor to choose research questions based on her judgment as to whether the research will have scientific merit. The freedom to choose research subjects may come under pressure if universities are encouraged or even forced to produce patentable research results, which may mean that non-patentable research activities are discouraged.

The second possible effect of academic patenting concerns how scientists disclose, share and publish their research. In the Mertonian logic, not only are university scientists free to choose their line of research, but they are free also to communicate their research results without interference from others. Traditionally, in exchange for adding to the stock of public knowledge, academic researchers have been rewarded with peer esteem, promotions, research grants and scientific prizes, based on the magnitude of their achievements. Because other scientists can test these published results, disclosure also creates social value. Peer review ensures the cumulative quality and reliability of scientific results, since scientists do not wastefully repeat previous work. But university patenting might, for example, lead scientists to restrict communication with colleagues due to confidentiality clauses required by business partners (Blumenthal et al. 1996), limit or delay publication of findings (e.g., Calderini and Franzoni 2004; Lee 2000; Thursby and Thursby 2002), engage in increased secrecy with regard to research methodology and results (Blumenthal et al. 1986), and/or withhold data (Campbell et al. 2000).

Closely related to these concerns is the anti-commons hypothesis, which argues that patenting may hinder the flow and diffusion of scientific knowledge (e.g., David 2003; Heller and Eisenberg 1998). Increased use of intellectual property rights "privatitizes" the scientific commons and limits scientific progress (Argyres and Liebeskind 1998; Heller and Eisenberg 1998). Specifically, this may inhibit the free flow and diffusion of scientific knowledge and the ability of researchers to build cumulatively on each other's discoveries (David 2003; Etzkowitz 1998; Krimsky 2003; Murray and Stern 2007; Murray et al. 2008). Thus, university patenting may obstruct rather than promote continued scientific advance, particularly when combined with restrictive licensing terms (e.g., Mazzoleni and Nelson 1998; Mowery et al. 2001).

What, more specifically, might influence scientists' views on university patenting? This forms the subject of the next section.

3 Analytical framework

3.1 Possible determinants of scientists' attitudes towards the effects of university patenting

In analyzing scientists' perspectives as regards how university patenting might affect academic freedom, we recognize that attitudes are subjective measures, not objective facts. But as Elzinga (1997: 412) points out, a key channel by which social changes affect science is by influencing how scientists themselves view the nature and purpose of the research process:

> Transformations in society generate transformations in science, not directly but, rather, indirectly through changes in general outlook, central sets of values, like those associated with an ethos in scientific practices, organizational changes, impacts of policy-making, as well as changing methodologies and structures and contents of fields of research.

Numerous studies have examined different aspects of scientists' perspectives on academic patenting, university–industry collaboration and technology transfer. Scientists' attitudes towards disclosing inventions have been found key to the success or failure of academic patenting policies (e.g., Baldini et al. 2005; Bercovitz and Feldman 2008; Blumenthal et al. 1996, 1997; Campbell et al. 2000; Gulbrandsen and Smeby 2005; Lee 1996, 2000; Louis et al. 1989; Moutinho et al. 2007; Owen-Smith and Powell 2001; Renault 2006; Siegel et al. 2003; Van Dierdonck et al. 1990).

Several scholars have emphasized the importance of the individual researcher for the commercialization of academic research. The success of patenting and licensing policies is ultimately a matter of personal choice (Lee 2000), dependent on the scientist's willingness to disclose patentable inventions to his university, so that the inventions may, if desired, be commercialized (Renault 2006). This willingness, in turn, is based on the scientist's own perceptions of the effects of academic patenting, and the costs and benefits that patenting activities may entail for him, as an individual (e.g., Bercovitz and Feldman 2008; Moutinho et al. 2007; Owen-Smith and Powell 2001; Thursby et al. 2001). But individual attitudes are also influenced by interactions with other scientists. As Levinthal and March (1993) have argued, organizations and the individuals within them learn by drawing on personal experience or inferences from information about experience gained by others (see also Simon 1955, 1979).

For this study, we sought to identify what key experiences in the scientists' professional lives might best help us to understand their attitudes towards the "unintended" effects of university patenting on the conduct of academic research. Since there is no previous scholarship on this particular issue, our hypotheses will be based on those related studies we find most relevant.

We investigate three sets of factors that we believe might be important. The first concerns the nature of the scientists' research. Scientists can choose to specialize mainly in basic research, in applied research, or in some combination. To the degree that they see university patenting as compatible with the kind of research they do, they will arguably be more positive about its impact, both on the definition of their own research agendas, and the norms of open science. To the degree that they see patenting as detracting from their research, they will probably be more negative.

The second factor concerns publication activity. Publishing and patenting represent the two major ways by which scientists can report their research results. Arguably, if they see patenting activities as contributing to or enhancing publication productivity, they are more likely to be positive about the impact of university patenting. But if they regard patenting more as a burden, taking precious time away from publishing in refereed journals, they are likely to be more negative.

The third factor concerns the scientists' relations to industry. Some scientists keep their research activities mainly within the academic community. Others are more involved with business, where patents have long been central to R&D choices and marketing. Logically, scientists who have worked closely with companies are likely to be more aware of the constraints that patenting can put not only on the freedom to define academic research agendas, but also on the ability to share and communicate research results.

3.2 The relationship between research focus and attitudes towards university patenting

First, scientists highly oriented towards basic research are likely to have a different attitude towards the effects of university patenting on academic freedom than scientists who focus more on applied research. For several reasons, we predict that basic researchers will be more skeptical. For one thing, it may be more difficult to patent the results of basic research. To be patented, an invention must be novel, non-obvious, and industrially useful. This third requirement may exclude much basic research from patentability. If scientists perceive that increased pressures to patent are somehow forcing them to change their research agendas so as to produce more patentable research, they might well be apprehensive about the possible effects of patenting on the definition of academic research agendas.

In addition, basic researchers will probably tend to subscribe more to the Mertonian norms of universalism and disinterestedness than applied researchers, and thus see patenting as placing limits on the openness which is vital for basic research. The growing privatization of the scientific commons (Nelson 2004) might be particularly disquieting when patented inventions are embryonic, typically requiring extensive development and refinement before commercialization is possible (Mazzoleni and Nelson 1998), something which is often the case for university inventions (Jensen and Thursby 2001). Basic research can potentially provide key building blocks for future research, inspiring other scientists to pursue related puzzles, sometimes advancing in unexpected directions. If other scientists do not have full public access to the fruits of basic research, work on these new areas of inquiry may be delayed, or even abandoned. Applied research is by definition more incremental, as well as ripe for commercial exploitation, though without the same potential to open up promising new lines of research.

This leads us to pose our first hypothesis:

Hypothesis 1 Scientists who are predominantly oriented towards basic research are more likely to be *negative* towards the effects of university patenting on academic freedom.

3.3 The relationship between publishing productivity and attitudes towards university patenting

Second, we maintain, extensive publishing activity can help to explain attitudes towards the effects of university patenting on academic freedom. Based on the growing body of literature that explores the link between researchers' proclivity to apply for patents and to publish articles in refereed journals, we believe that this effect will be positive. The same research program may generate results that are both publishable and patentable (e.g., Agrawal and Henderson 2002, Azoulay et al. 2007; Fabrizio and DiMinin 2005; Murray and Stern 2007). As a result, both activities might well arise together naturally, as the scientist moves along a particular research trajectory (Zucker and Darby 1996; Azoulay et al. 2007).

Thus scientists might not see patenting as a threat to their ability to choose their own research agendas, but rather as a complement—or even a benefit, to the degree that they can *ceteris paribus* generate a greater quantity of measurable results from the same research effort. In biotechnology, according to Murray and Stern (2007), most of the key milestones in research have been disclosed as patent-paper pairs, including the techniques of recombinant DNA and the discovery of the HIV retrovirus. Similarly, as regards the norms of open scientists, if scientists see patenting as an integral part of their research, they might accept the associated constraints in communicating with peers.

This leads us to pose our second hypothesis:

Hypothesis 2 Scientists who have published extensively in refereed journals are more likely to be *positive* towards the effects of university patenting on academic freedom.

3.4 The relationship between close links with industry and attitudes towards university patenting

Third, we believe that close links with industry—like research collaborations, the receipt of an industry grant, or previous work experience with a company—will affect scientists' perspectives in this regard. A few scholars have explored how academic-business relations might affect academic freedom (see Behrens and Gray 2001), without providing a clear consensus. Allen and Norling (1991), for example, determined that faculty who actively collaborated with industry as consultants, or in industry-sponsored research, continued to be fully engaged in academic activities, and support traditional academic ideals. Similarly, Behrens and Gray (2001) found little to indicate that industry sponsorship negatively affected how graduate students conducted their research. By contrast, Gluck et al. (1987), in a study of university–industry relationships in the life sciences, discovered that students directly supported by industry (through scholarships, salary or research support) had experienced more constraints on discussing their work; In two separate studies, Blumenthal et al. (1996) found that faculty whose research had been supported by industry were more likely to report that their choice of research topic was influenced by the project's commercial potential. Results from Blumenthal et al. (1997), based on the same data, suggest that scientists who received industry funding had experienced publication delays.

More recently, however, Göktepe-Hulten and Mahagaonkar (2009) argue that patenting activities could be independent from private economic incentives for researchers. They found that scientists who patent do so to bolster their scientific reputation and visibility, and not because of expectations of achieving financial rewards. These results lend support to other recent findings by Fini et al. (2009) and O'Gorman et al. (2008) that university researchers who engage in entrepreneurial activities are motivated to enhance their academic position. O'Gorman et al. (2008) argue that entrepreneurial scientists are driven not by the ambition to appropriate returns from their work, but by the desire to further their own research, by demonstrating its value and by attracting additional funding for research.

While no work has specifically explored the link between industry cooperation and scientists' perspectives on the effects of increased university patenting, we believe that, on balance, the effect would be negative. For one thing, it seems reasonable to expect that the attitudes of scientists who have worked for (or cooperated with) a company would reflect their experiences of how the prospect of patentability can influence corporate research priorities. Perhaps they witnessed excessive management interference in the determination of research agendas. Perhaps they experienced publication delays, or restrictions regarding which of the joint research results researchers could openly discuss at scientific conferences. While such restrictions are necessary for commercial research, university scientists might well oppose the extension of the same logic to academic research. Assuming that our respondents have deliberately chosen to be university researchers, we therefore predict that the more our respondents know, based on their own experiences, about the role of patents in industrial research, the more they will tend to be negative towards university patenting.

This discussion leads to our final hypothesis:

Hypothesis 3 Scientists who have been involved in close relationships with industry are more likely to be *negative* towards the effects of university patenting on academic freedom.

4 Data and method

4.1 Data

This paper draws on data collected via a questionnaire sent to academic researchers in Denmark, working within the life sciences. Following the U.S. National Science Foundation (NSF), the "life sciences" were defined as consisting of the biological sciences, medical sciences, agricultural biology, and environmental biology. Despite its small size, Denmark holds a strong position in the life sciences, with a university system that places heavy emphasis on medical research, especially clinical research, as well as agriculture-related research. Similarly, the Danish industrial landscape features important pharmaceutical companies, such as the (primarily) diabetes-producing Novo Nordisk, as well as numerous drug-discovery firms. Interaction between universities and industry is a widespread phenomenon, and university researchers are well aware of patenting as a vehicle for appropriation, communication and dissemination of research results.

Our survey was carried out just 5 years after the introduction of a new Danish law on university patents. Heavily influenced by the American Bayh-Dole act of 1980, this law effectively replaced a system based on professors' privilege (to own the patent rights to their university-financed inventions), with a system granting the right of ownership to the universities. The new law sparked an intense debate in Denmark, and Danish university scientists became well acquainted with the international discussions of patents and their possible effects on university research.

The survey was developed by two of the authors and carried out by UNI-C, an institution under the Danish Ministry of Education that provides a broad range of services for the educational and research community. A main challenge in the design of the survey was the identification of "life science" researchers. The term "life sciences," as defined by the NSF, includes researchers from several different scientific disciplines. With the help of UNI-C, we drew up a list of all Danish academic institutions that were likely to have researchers on their staff specializing in the life sciences. Approaching all scientists in these institutions, however, would be problematic. For one thing, lists of individual scientists in these institutions were by no means readily available. But more importantly, sampling all scientists in the selected institutions would require the individual respondents to assert whether they in fact belonged to the target group of "life science" scientists. In all likelihood, this would lead to a non-trivial number of flawed decisions by respondents, resulting in inaccurate sampling. In one situation, some life-science researchers might decline to participate either because they did not understand the selection criteria, or simply because they would not take serious a questionnaire that only potentially was directed to them. As a "mirror" problem, non-life-science researchers might wind up participating, either because they misunderstood or overlooked the selection criteria, or maybe even chose to participate out of sheer curiosity. Faced with this problem, we decided to involve local expertise in the form of the heads of the relevant departments and other institutions to carry out the selection of life-science researchers.

Therefore, in October 2005, we sent a letter to the heads of all of these institutions, asking them to participate in the survey and to count the number of potential respondents from their institutions. A few declined to participate, typically with the excuse that life-science was a marginal—or even non-existing—activity of their institution. Shortly after receiving their responses, we sent information packets to the accepting heads, for distribution to those staff members they had pre-identified as relevant. The potential respondents were provided a printed questionnaire for their perusal, but the survey itself was internet-based. Each researcher was given a log-on code to access to the questionnaire; when ready, the researcher sent the filled-in questionnaire directly to UNI-C. The survey was completed by the end of January 2006.

This way of collecting data is unusual but was chosen after careful consideration, in an effort to generate the most reliable data. As discussed above, it was important to us to identify researchers in Denmark who did research in the life sciences, irrespective of the name or apparent research focus of the institution that employed them. In our opinion, the selection by heads is more consistent than self-selection, and we have identified no reasons why heads should not be objective in their selection.

As another aspect of the sampling method, it allowed us to grant respondents full anonymity. Not only could we promise not to identify respondents, but even if had wanted to, we would not have been able to identify them since we did not have a list of potential respondents. We took this to be important since some of our questions involved potentially sensitive issues, for example: whether those scientists who had cooperated with firms felt that the firms had misused, or deliberately shelved, their research; or whether those who declined to cooperate did so because they felt that the cooperation was ethically suspect. This method guaranteed respondents anonymity, both in relation to us and to the heads of their departments and institutions, thereby encouraging our respondents to be candid.

The drawback of this procedure was the loss of a number of institutions from the sample, where the head of the institution was not interested in participating (see number below). Anonymity also prevented us from collecting further data on each respondent. But these costs, we decided, did not outweigh the benefits of obtaining high quality data.

The survey covered three types of institutions: universities, hospitals and non-profit research institutes. Because of the significant variation in scientists' perspectives toward academic patenting in these three types of academic organizations, we decided, in this paper, to restrict our analysis to scientists employed by a university (43% of the final sample). Of the 48 university departments identified as potentially relevant to our inquiry, 31 (65%) departments agreed to participate.[1] A qualitative inspection revealed no bias in terms of geographical location, university affiliation or research area in the participating departments. The university department heads identified 863 relevant respondents, of which 251 filled out the questionnaire, for a response rate of 29.1%.[2]

For this paper, to increase the chances that the responses were based on at least a minimum amount of research experience, we decided to include only respondents aged 30 or above. In all, this yielded 239 observations.

4.2 Dependent variables

We employ two dependent variables. Among a series of questions on the possible effects of university patenting, questionnaire respondents were asked to indicate what they believe to have been the impact of university patenting on academic freedom. More precisely, respondents were asked to "evaluate what you believe has been the impact of patenting activities by academic researchers on your field as regards (1) the freedom to choose research subjects according to academic criteria and (2) the norms of open science". These two questions received the highest response rates in the section about the possible effects of patenting on different aspects of academic life.

We realized that a potential problem in using these responses as our dependent variables, as hinted at in Sect. 2, is that university personnel tend to be perpetually concerned about many different developments, including reduced autonomy, increased accountability, and increased external/policy steering—the effects of which might become entangled in their minds with recent trends in patenting. However, for our analysis, the absolute levels of skepticism are not important. We are interested only in exploring the *differences* in attitudes between the scientists polled.

To measure these effects, we used a Likert scale ranging from 1 to 7 (1 indicating a very negative effect, 4 indicating no effect, and 7 indicating a very positive effect). To simplify the representation of the results and to isolate very negative and very positive effects, we re-grouped the responses into one of three categories: a negative effect (responses of 1 and 2), a neutral effect (responses of 3, 4 and 5), and a positive effect (responses of 6 and 7). Other re-groupings of the categories, as well as the original seven-point Likert scale, were tested and yielded results very similar to the ones presented below.

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[1] The targeted university departments included most of the medical and veterinary departments in Denmark, and a wide range of natural science departments including biology, chemistry and agricultural science.

[2] For the survey as a whole (covering universities, hospitals and research organizations) we had 1,744 pre-identified, potential respondents, from which 581 questionnaire responses were received, for an overall response rate of 33%.

Table 1 Scientists' perceptions of the impact of academic patenting (row %)

	Negative	Neutral	Positive	Total (*N*)
Impact on academic choice	27	58	15	100 (172)
Impact on norms of open science	41	49	10	100 (161)

As can be seen in Table 1, the majority of the respondents believed that patenting had little or no effect. About 27% (of 172 respondents) felt that patenting had a negative impact on the freedom to define research agendas according to academic criteria, and 41% (of 161 respondents) felt it had a negative impact on the norms of open science within their research fields. Sixty-seven respondents chose not to answer the questions regarding the impact of patenting on academic choice, and 78 chose not to answer as regards the norms of open science. The 153 respondents who answered both questions form the basis for the summary statistics and multivariate analyses, which are presented in Sect. 5.[3]

To understand the reasons for these attitudes, we turn to other information gleaned from our survey.

4.3 Independent variables

To test our first hypothesis regarding the relationship between scientists' (basic) research orientation and their attitudes towards the effects of university patenting, we use a dummy variable to isolate *basic researchers*, equal to one when the self-reported share of articles published in the last 10 years in journals specializing in basic research is 50% or higher. We recognize that the self-reported basis for this variable entails certain limitations on its reliability, particularly in view of the blurred nature of the distinction between basic and applied research in the life sciences. We therefore not only asked respondents to indicate the distribution of their publications across basic and applied research journals, but also to enter a percentage for journals with a mixed basic-applied perspective. Only 12% of the respondents indicated that more than 50% of their research publications appeared in journals with a mixed research orientation. Moreover, the number of missing values on this question is very low (about 3%). The distinction between basic and applied research thus seems to be valid for the surveyed group.

For our second hypothesis, we needed to identify respondents who have published extensively in scientific journals. Publications are measured as the self-reported number of articles in refereed journals in the last 10 years. To identify scientists with *high publication productivity*, we use a dummy variable equal to one when a scientist's number of publications lies in the upper quartile of the number of publications for university respondents.[4] In addition, we include an interaction effect for publishing productivity and research orientation, to examine the importance of combinations of the two variables.

For our third hypothesis, we look first at the possible effect of *collaborating with industry* in the form of joint research projects, using a dummy variable equal to one when

[3] Almost identical results were obtained by running the regressions on the two slightly larger samples of valid responses to the two questions separately (172 and 161 respondents, respectively).

[4] For scientists within this upper quartile of publication counts, differences in publication counts had no significant impact on the dependent variables examined in the study, suggesting that this is an appropriate threshold for identifying highly productive scientists.

a scientist has engaged in at least one instance of cooperative research during the past 10 years.[5] Second, we use a dummy variable to identify and control for scientists who have received one or more *industry research grants* of minimum EUR 13,500 (DKK 100,000) within the past 10 years. Third, we examine the effects on scientists' perspectives of having prior *industry work experience*, using a dummy variable equal to one when a scientist has been employed in industry for at least one full year within the past 10 years.

4.4 Control variables

Because attitudes towards patenting might also be influenced by previous experience with patenting, we include as a control a dummy variable which identifies scientists who are *patent inventors*, that is, who have been listed as inventor on at least one patent application in the past 10 years. Second, we incorporate a dummy variable that identifies researchers who have received one or more research grants of minimum EUR 13,500 (DKK 100,000) within the past 10 years from Danish research councils. *Research council grants* are particularly interesting because they represent a reasonable approximation of "no strings attached" funding, since the Danish research councils (at least in this period) generally emphasized high-quality, investigator-driven research applications and required communication of openly according to the norms of open science. We have used this as a control rather than an independent variable, to eliminate the possibility of the scientist's predisposition for investigator-driven and no-strings-attached research. We use an additional dummy variable to identify scientists who are *full professors*, to control for the possible impact of holding a more independent senior position. Finally, we control for the respondent's *age*, given that attitudes towards patents might vary according to age.[6]

4.5 Method and results

Because of the ordinal nature of the dependent variables, we use an ordered probit model.[7] Regressions were run on each of the two dependent variables in three steps: first using only the control variables, then including the independent variables, and finally incorporating the interaction effect between two of the independent variables (*basic researcher* and *high productivity*). Summary statistics for all variables are reported in Table 2. The results of

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[5] We also incorporated similar dummies to indicate other forms of interaction with industry, including contract research and consulting. These variables were not significant predictors of scientists' perspectives and therefore left out of the final model.

[6] We controlled for additional factors that might be important. For example, scientists' perspectives on university patenting may differ across research fields. Researchers specializing in medical science, for example, might be more positive towards patenting than researchers specializing in environmental biology, simply because research results from medical science are more readily applicable commercially. We controlled for this by including dummy variables for the *biological sciences*, *medical sciences*, and *environmental biology*. *Agricultural biology* constituted the reference group in the analysis. We also controlled for the location of the research units. As the greater Copenhagen hosts the largest Danish pharmaceutical companies, it might be easier for scientists to work with industry. Finally, we controlled for differences between individual research units by including dummies for departments with more than 10 respondents to the survey. None of these factors were significant, and were therefore omitted from the models.

[7] We also ran approximate likelihood-ratio tests of equality of coefficients across response categories on all models as well as Brant tests on each independent and control variable, to ensure that none of the models or variables violated the proportional odds assumption.

Table 2 Summary statistics and simple correlations

	Dependent variables		Independent variables					Control variables			
	1	2	3	4	5	6	7	8	9	10	11
No. of observations	153	153	153	153	153	153	153	153	153	153	153
Mean	1.89	1.69	0.63	0.27	0.51	0.26	0.12	0.20	0.73	0.20	46.70
Standard deviation	0.62	0.64	0.48	0.44	0.50	0.44	0.33	0.40	0.44	0.40	10.85
Minimum value	1	1	0	0	0	0	0	0	0	0	30
Maximum value	3	3	1	1	1	1	1	1	1	1	72
Academic choice	+1.00										
Norms of open science	+0.60***	+1.00									
Basic researcher	−0.18*	−0.16*	+1.00								
High productivity	+0.20**	+0.20*	+0.12	+1.00							
Collaboration with industry	−0.05	−0.05	−0.04	+0.15†	+1.00						
Industry grants	−0.01	−0.13	−0.20*	+0.04	+0.23**	+1.00					
Industry work experience	−0.25***	−0.13	−0.17*	−0.14†	+0.01	−0.09	+1.00				
Patent inventor	−0.12	−0.03	+0.01	+0.10	+0.27***	+0.14†	+0.21*	+1.00			
Research council grants	−0.16	+0.05	+0.18*	+0.23**	+0.03	+0.06	−0.09	+0.12	+1.00		
Full professor	−0.09	−0.01	+0.04	+0.40***	+0.07	+0.14†	+0.01	+0.19*	+0.23**	+1.00	
Age	+0.03	−0.06	+0.13	+0.35***	+0.03	+0.07	−0.12	+0.12	+0.29***	+0.48***	+1.00

Spearman rank correlation coefficient; significance levels: † $p \leq 0.10$, * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$

simple correlations are not surprising, and in line with our hypotheses and other expectations (for example the positive correlation between academic position and age). It should be noted that there is a strong correlation of 0.60 between our dependent variables. Nonetheless, as shown by our results from the multivariate analysis (see Table 3), there are significant differences in the factors that explain scientists' attitudes towards academic choice and the norms of open science.

5 Findings

5.1 The models compared

The summary statistics indicate that scientists in general were more concerned about the impact of patenting on the norms of open science than on the freedom to choose research subjects. But the model on the impact of patenting on academic choice has greater explanatory power. (This difference in explanatory power remains consistent under other specifications of the models, and with different re-groupings of the responses that form the basis for our dependent variables.) It indicates that uneasiness regarding the norms of open science is not only more widespread than uneasiness regarding academic choice of research subjects, but also less correlated with the variables included in our analysis. We will return to this issue in Sect. 6.

5.2 The perceived impact of patenting on academic choice

The results of our first set of regressions indicate, as expected, that scientists oriented toward basic research were *more* likely to be skeptical about the implications of university patenting for the freedom to choose research subjects according to academic criteria, while highly published researchers were *less* likely to be skeptical. However, in our third model, which includes the interaction effect between these two independent variables, we found a surprising pattern. Highly productive researchers, whether they specialized in basic or applied research, were essentially neutral. Less productive applied researchers were also neutral. The less productive basic researchers stood out—as highly skeptical. The same result appears in a simple cross-tabulation of the key variables, reported in Table 4.

Only one of the three independent variables concerning relations to industry was a significant predictor of scientists' attitudes. Scientists who had prior experience working full-time in industry were more likely to be skeptical. Additional findings from this set of regressions reveal that both recipients of Danish research council grants, and full professors, were more skeptical.

5.3 The perceived impact of patenting on the norms of open science

In our second set of regressions we found, again, that basic researchers tended to be more skeptical, while highly productive researchers were less skeptical. The interaction effect between the first two independent variables in this set of regressions was not significant.

Two of the three indicators of interaction with industry were significantly and negatively associated with this dependent variable. Both the award of an industry research grant and prior industry work experience increased the likelihood that the scientist would be skeptical about the impact of academic patenting on the norms of open science.

Table 3 Ordered probit regression, explaining individual scientists'perceptions of the impact of university patenting on (a) academic choice and (b) the norms of open science, with robust standard errors

	(a) Perceived impact on academic choice			(b) Perceived impact on the norms of open science		
	(1) Controls only	(2) All variables	(3) With interaction	(1) Controls only	(2) All variables	(3) With interaction
Basic researcher (BR)		−0.67** (0.22)	−0.84** (0.26)		−0.66** (0.21)	−0.65** (0.24)
High productivity (HP)		+0.88*** (0.21)	+0.38 (0.33)		+0.75*** (0.23)	+0.78*(0.32)
Interaction BR*HP			+0.73† (0.41)			−0.04 (0.41)
Collaboration with industry		−0.18 (0.21)	−0.17 (0.21)		−0.17 (0.21)	−0.17 (0.22)
Industry grants		−0.14 (0.23)	−0.13 (0.23)		−0.52* (0.24)	−0.51* (0.24)
Industry work experience		−1.04** (0.36)	−1.06** (0.37)		−0.65* (0.33)	−0.65* (0.33)
Patent inventor	−0.29 (0.20)	−0.09 (0.22)	−0.08 (0.21)	−0.10 (0.23)	+0.11 (0.25)	+0.11 (0.25)
Research council grants	−0.36 (0.24)	−0.44† (0.25)	−0.49* (0.25)	+0.19 (0.23)	+0.23 (0.22)	+0.23 (0.23)
Full professor	−0.33 (0.27)	−0.60* (0.27)	−0.65* (0.27)	+0.08 (0.27)	−0.08 (0.27)	−0.08 (0.27)
Age	+0.01 (0.01)	+0.01 (0.01)	+0.01 (0.01)	−0.01 (0.01)	−0.02 (0.01)	−0.02 (0.01)
Intercept 1	−0.34 (0.49)	−1.25 (0.51)	−1.33 (0.51)	−0.53 (0.47)	−1.34 (0.49)	−1.34 (0.50)
Intercept 2	+1.43 (0.51)	+0.75 (0.52)	+0.69 (0.52)	+1.00 (0.47)	+0.34 (0.49)	+0.34 (0.50)
No. of observations	153	153	153	153	153	153
Log pseudolikelihood	−139.20	−124.42	−123.30	−143.45	−131.58	−131.58
Wald chi-square	(4 *df*) 6.84	(9 *df*) 37.20***	(10 *df*) 38.37***	(4 *df*) 1.48	(9 *df*) 25.36**	(10 *df*) 26.52**
Pseudo R^2	0.02	0.13	0.14	0.01	0.09	0.09
Maximum likelihood (Cox-Snell) R^2	0.05	0.21	0.22	0.01	0.15	0.15
Mean VIF (and maximum VIF)	1.22 (1.37)	1.24 (1.47)	1.79 (4.04)	1.22 (1.37)	1.24 (1.47)	1.70 (4.04)

Significance levels: † $p \leq 0.10$, * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$. All regression results are reported with robust standard errors to account for possible heterogeneity in the models. Running the models with robust standard errors resulted only in minor changes to the *p*-values for the coefficients, suggesting that the models do not suffer from any important heteroscedasticity issues

Table 4 Mean response on a scale from 1 (negative) to 3 (positive) to the question regarding the impact of patenting on academic choice (in parentheses: standard deviation, frequency)

	Basic researcher	Not basic researcher	Total
Highly productive	2.07 (0.58, 30)	2.18 (0.60, 11)	2.10 (0.58, 41)
Less productive	1.69 (0.58, 67)	2.00 (0.64, 45)	1.81 (0.62, 112)
Total	1.80 (0.61, 97)	2.04 (0.64, 56)	1.89 (0.62, 153)

6 Discussion

The most important finding of our analysis is that basic researchers were significantly more skeptical about the impact of university patenting on academic freedom, and highly productive scientists were significantly less skeptical (Hypotheses 1 and 2). Several studies have touched on related themes. As regards basic research, for example, our results are in line with Thursby and Thursby (2002), who found that faculty who specialize in basic research may choose not to disclose inventions because they are unwilling to spend the time on the more applied R&D that is required to interest businesses in licensing the invention. These scientists were thus less willing to engage in patenting, not only because of the need this implies to engage in more market-oriented research, but also because of a reluctance to spend the time and costs involved in filing for patents, and in dealing with technology transfer offices and potential licensees.

Our results also shed intriguing new light on the *interrelationship* between patenting, publishing and research orientation. Several scholars have previously addressed this issue. Breschi et al. (2007), for example, found that not only was there a positive relationship between patenting and publishing, but that this was also true for researchers who published in basic science oriented journals. However, according to Azoulay et al. (2006), there are indications that scientists may be refocusing the content of their research *after* patenting in ways that make their output more commercially relevant, suggesting that the academic incentive system, in practice, may be evolving in ways that deviate from the traditional scientific norms of openness.

Our findings suggest a possible explanation for these contradictory results. We found that top scientists, whether they specialized in basic or applied research, were little concerned about the possible effects of university patenting. Applied researchers were also unconcerned. But average or below-average performers who specialized in basic research felt that patenting pressures negatively affected their ability to define their own research agendas. Our reading of this result is that even if the long-term effects of university patenting may not be so worrying after all for top-tier research, when seen in a broader perspective, it may well contribute to shifting the focus of overall scholarly endeavour towards research agendas that lend themselves more easily to patenting. It should also be noted that because our respondents are all from the life sciences, our results might reflect the fact that certain types of academic research in this field might be more compatible with university patenting than would be true for other types of research. More than other types of research, the life sciences might well belong to 'Pasteur's Quadrant' (Stokes 1997) where science is driven both by scientific curiosity and a concern for application.

As regards Hypothesis 3, our major finding is that industry work experience negatively affected scientists' attitudes on both dimensions of academic freedom. Perhaps scientists who previously worked in a company—thereby gaining first-hand knowledge of the requirements and problems associated with industrial patenting—and then left, are “predisposed” to pursue the more curiosity-driven academic way of research. Conversely, this finding may reflect a difference in the level of knowledge about the way commercial research works. Scientists who never worked directly for industry may have had a hard time imagining what is required in commercial research, and thus have no reason to be skeptical. As O’Gorman et al. (2008) point out, when scientists lack market knowledge, they are likely to also lack the resources needed to assess the commercial relevance or value of their research and therefore less likely to engage in technology transfer (see also Vohora et al. 2004). Similarly, Martinelli et al. (2008) find that scientists with no external linkages generally have a more negative view about the effects of external linkages than scientists who do engage in exchanges with external parties. However, as they point out, differences between the two groups of scientists were not very large.

Again, our results may be influenced by the fact that our respondents worked in the life sciences. Empirical studies have underlined how critically important patents are for the pharmaceutical industry, as compared to other sectors (e.g., Cohen et al. 2002; Levin et al. 1987; Mowery et al. 2001). Those university scientists who worked in pharmaceutical-related biotechnology would thus have had substantial opportunity to observe first-hand how a company’s R&D priorities can be skewed towards patentable projects.

We found no effect on either dependent variable from experience with collaboration in joint research projects with industry. This may reflect a selection bias problem, since the collaboration in most instances was not randomly imposed on the scientists, but was the result of a deliberate choice. This result also seems contrary to the findings of empirical studies that university–business cooperations can provide important benefits to both parties (Fabrizio and DiMinin 2005). According to Mansfield (1995), for example, scientists and engineers report that interaction with industry has positively influenced their research, contributing new perspectives and important feedback. Since our focus differs from the focus of these scholars, who did not study attitudes towards patents, however, these results are not strictly comparable.

The effect for recipients of industry grants is negative, but only significant with regard to the norms of open science. This makes sense to the degree that if industry grants are given on the basis of investigator-driven applications, they do not restrict the free choice of research subject. But grant recipients might well be wary that restrictions could be associated with industry grants about how the resulting research is to be exploited (for example, that industry funds were granted conditional on first-hand insight into the results). Perhaps grant recipients felt that they were restricted by provisions limiting their ability to share and communicate their research results with other scientists, and to present their results openly at scientific conferences.

As mentioned above, the factors included in our three hypotheses can only partially explain the attitudes of individual researchers. Turning to our controls, recipients of research council grants were rather skeptical about the effects of patenting on academic choice, but not on the norms of open science more generally. This result is not surprising, since Danish research council grants are allocated to investigator-defined research projects; as such, recipients of research council grants are likely to place value on the freedom to define their own research agendas.

It is also interesting to note that full professors were skeptical as regards the effects of university patents on academic choice of research agendas, while age had no effect. Full professors may have more influence in defining their research agendas than their lower-ranked colleagues (who may well be part of the professor’s research team), and therefore feel they have the most to lose. Alternatively, professors can be more reflective about patents. Since they have made it professionally, they don't face the same fierce pressures as their younger, untenured colleagues both to publish and to patent. Junior researchers have no choice but to "play the game." Senior researchers can afford to step back and take the longer view of what patenting might actually be doing to academic research, and be more aware of the possible distortions it might cause.

We realize that these controls do not exhaust the full range of factors that might explain scientists' perspectives towards patenting. For example, local norms and behaviour in the scientist's departments and current academic peer groups might be important. This has been emphasized by, among others, Bercovitz and Feldman (2008) and Owen-Smith and Powell (2001). If other scientists in the department feel either open (or pressured) to engage in commercial activities, the individual researcher might feel more inclined to do so as well. Azoulay et al.'s (2007) analysis of the effects of institutional affiliation and scientists' social networks showed that the presence of co-authors who had patented in the past increased the likelihood of a patent application, and that scientists employed at universities with large patent portfolios were themselves more likely to patent. While our survey data do not permit us to test for this directly, when we controlled for research unit (i.e., department), we found no systematic differences in scientists' attitudes to the effects of university patenting across institutions. This implies that peer groups either have limited influence on our respondents' perspective toward patenting, or that their peer groups lie within or across department boundaries.

Scientists' perspectives might also be influenced by more "personal" factors such as their own or family members' economic interests in patenting, or scientists' character traits, values or ideology. Some researchers might simply be biased against intellectual property rights per se, perhaps believing that they block innovation more than they stimulate it. In addition, our respondents' attitudes might be influenced by the more general concerns discussed in Sect. 2 about the problematic emergence of "academic capitalism" (Slaughter and Leslie 1997; Slaughter and Rhoades 2000) and/or government pressures for research "relevance" (Elzinga 1984, 1997). Such factors could profitably form the focus of future research.

Recalling the observations from the survey, the respondents were generally more concerned about the negative effect of patenting on the norms of open science than on the academic freedom to choose. This result probably reflects the fact that all scientists benefit for open access to other scientists' work, but not all scientists actually choose their own research agenda. As noted, the explanatory power of our model is stronger for academic choice than for the norms of open science. Per definition, this means that our variables better explains the variation in opinions on the freedom to choose than on the norms of open science. This means that while the personal and "functional" position of researchers (such as academic rank, type of research, productivity, and experience) matters for whether the freedom to choose research agenda is taken to be important, the norms of open science are valued much more equally across these positions, and more prevalent. Or, in other words, the concerns for attacks on the norms of open science are very widespread and unrelated to the position of the researcher, but may well be influenced by other factors not gauged in the study, such as personal traits or ideological positions. Regarding the academic freedom to choose research agenda, the concerns were still strong, but not as widespread, but more interesting, they were clearly concentrated in groups of respondent for which this aspect of academic freedom may be taken to be vital for the way they conduct their research.

Years ago, as discussed in Sect. 2, scholars such as Elzinga (1984, 1997), Slaughter and Leslie (1997), Slaughter and Rhoades (2000), Ferné (1995), and Bennich-Björkman (1997) warned about the problems that might arise with the new “policy-driven” science and its demand for societal and economic relevance. Our results allow a more refined discussion of these developments. We found that both applied scientists and highly productive basic scientists see little problems in conducting research which is both patentable and publishable. Conversely, not-so-productive basic scientists were worried. These observations may be the result of several processes. To the degree that scientists deliberately redirect their inquiry towards patentable research, this may influence both the definition of the problems to be investigated, and the performance standards of the resulting research (Elzinga 1997). If the prospect of patentable results generates more research funding, this trend will be intensified. If scientists can bolster their CVs by listing patents as well as publications, they will have every incentive to pursue it. This trend might even lead to a further polarization among academic researchers, divided between a “top tier” of highly productive scientists who both patent and publish, and a “second tier” who pursue non-patentable research—possibly eventually leading to a situation where researchers who do not patent can no longer be regarded as top scientists. Competing with this explanation it might well be that the performance records of highly productive scientists provide them with a certain degree of independence and insulation from external interference in their work. Thus they might see themselves as somehow immune to potential requests for patenting, and therefore care little about the demand for patenting.

This raises the question: do highly productive scientists already view patenting as a natural (and therefore non-threatening) part of their research, or are they “high-flyers” beyond the reach of patenting demands? Both explanations would account for their less apprehensive attitude toward university patenting—but the implications for understanding the impact of increased patenting on academic research would be quite different. Relatedly, one could ask: are less productive basic researchers less productive because they are unable to attract the necessary resources for their research (since it will not necessarily lead to patentable results)? Or are they unable to attract resources simply because they are less productive? If the latter is the case, a skepticism towards patenting might reflect a more general disenchantment with other aspects of the debasement of academic life (like budget cutbacks), rather than a specific complaint about the nature of the patent system per se.

Individual scientists’ views on patenting will clearly also affect their willingness to disclose inventions and engage in patenting activities. This has implications for understanding the ultimate success or failure of academic patenting policies. While it is not possible to determine precisely the extent to which scientists’ perspectives on patenting reflect the actual implications of increased university patenting, or the extent to which these perspectives influence scientists’ disclosure and patenting behavior, our results suggest that there may be a linkage here; thus this topic should be subject to further investigation.

Several limitations to our work should be noted. The relatively low sample size and the limited explanatory power of our models should be acknowledged, along with the general limitations associated with trying to identify causal relationships between individuals’ performance and experience on the one hand, and their perceptions and attitudes on the other. Since our analysis cannot provide any information about the underlying causality in the significant relationships identified, we cannot know, for example, whether highly published scientists are less skeptical towards patenting because of their high level of scientific performance, or whether they are high performers because they are also open to and possibly involved in patenting activities.

Finally, as has been emphasized, it is important to keep in mind that our findings may not be fully generalizable to research in areas other than the life sciences. The life sciences represent a field where scientific and technological advances have combined with supportive regulatory developments (such as the 1980 *Diamond* vs. *Chakrabarty* decision, where the US Supreme Court ruled that genetically modified micro-organisms can be patented) to enable the patenting of some forms of fundamental research (Levin et al. 1987; Mowery et al. 2001; Nelson 2001; Owen-Smith and Powell 2003). Scholars have stressed the greater ease by which much basic research in the life sciences can be patented (e.g., Mowery et al. 2001). One might speculate that this in itself could provide an important explanation for our finding that the most productive basic researchers are not particularly concerned about the effects of university patenting.

7 Conclusion

This paper sheds new light on how university patenting might affect the "inner workings" of academic research in the life sciences by asking the scientists directly about their perspectives on patenting. In order to disentangle the reactions to the pressure to patent in academia, we looked at two distinctively different features of academic research: the freedom to define the research agenda, and the norms of open science. In general, we found a substantial portion of our respondents to be skeptical about university patenting. But the two aspects were not considered to be of same importance to all groups of university scientists.

Our findings provide one indication that a distinction exists between researchers who subscribe to a traditional, Mertonian approach to research, and researchers who take a more applied, commercially oriented approach to university research. Researchers belonging to these two worlds, we believe, have received the introduction of increased university patenting very differently. While applied researchers apparently care little about the changes, at least some of the basic researchers fear that patenting might interfere with their freedom to choose research subjects. In particular, basic researchers and scientists who have industry work experience find increased patenting worrying in this regard. But when it comes to the norms of open science, an issue closely related to the anti-commons debate, we observe that the widespread concern for the norms of open science is shared among all kinds of researchers, not just a particular sub-group with special positions or research conditions.

These findings have implications for both government policy and university management. On the government level, it seems appropriate to consider whether or not patenting should be promoted in all areas of university research. Our results identify an opposition to patenting in more basic research, driven by a fear that more patenting will jeopardize the freedom to chose research agendas. Given that scientist-defined research agendas are more productive—which probably holds true in the more basic research areas—governments should entertain differential treatment of different scientific areas. (If scientist-defined research is found not to be more productive, means other than more patenting are probably more appropriate.) Similarly, university management could explicitly develop patenting policies adapted for particular fields instead of one-size-fits-all policies. An important element in such policies is the reward structure, which should support the different modes of research, rather than to try to interfere and change the way in which research is carried out. When it comes to the second aspect of academic research, the norms of open science, the widespread anxiety among university scientists should be addressed more directly, both by governments, by the scientific communities, and by university management. We need to know more about whether this concern is grounded in a development towards less openness, and if so, steps to restore openness should be considered.

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