



Commercialization of university inventions: Individual and institutional factors affecting licensing of university patents



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ABSTRACT

This paper conducts a unique study using the university patent as the unit of analysis to determine how individual and institutional factors affect the likelihood that a patent will be licensed. Using a 2010 national survey of academic scientists in the United States in which respondents were asked specific questions about 2006 patents for which they were listed as inventors, we find that the likelihood of licensing is significantly determined by individual factors including inventors' attitude towards commercialization of research, additional research conducted during patent review, and collaboration with industry scientists on the underlying research. Among institutional factors, university Technology Transfer Office's cost-saving measures positively influence licensing, but industry funding and TTO service effectiveness do not. We also identify two types of inventions: opportunity-based inventions are discoveries that are not foreseen patentable at the outset of projects; intention-based inventions occur on research projects that anticipate commercial outcomes before the start of research. Findings demonstrate that different individual and institutional factors contribute to licensing of these two different inventions. This study provides new insights into the process of commercialization of university inventions.

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1. Introduction

Universities, especially major research universities, play a key role in national and regional economic development. One important mechanism through which universities contribute to economic growth is by converting scientific inventions to innovation through patenting and licensing of research outputs. Enacted in 1980, the Bayh–Dole Act encourages universities to patent publicly-funded research and engage with industries in technology transfer and research commercialization. By 1998 every Carnegie I and II research university had established a Technology Transfer Office (TTO) to facilitate patenting and commercialization of university research (Bercovitz and Feldman, 2007). Although university patenting activity has increased since the passage of the Bayh–Dole Act (Henderson et al., 1998; Mowery et al., 2001, 2002; Mowery and Ziedonis, 2002; Shane, 2004), only a limited proportion of university patents have been licensed. For instance, slightly over one-third of the patents awarded to the University of

California – one of the most profitable universities on research commercialization – had been licensed between 1984 and 1988 (Mowery and Ziedonis, 2002). Analysis of the Association of University Technology Managers (AUTM) 2006 survey shows that the average licensing level across major research institutions tends to be much lower. Given that licensing by industry is a fundamental means by which university inventions contribute to economic growth, and recognizing that licensing levels can likely be increased, there is a need to further investigate the factors that contribute to licensing of university patents.

Most prior work in this area has taken the university or the individual scientist as the unit of analysis and has shown that successful licensing of university patents is influenced by institutional factors, such as university incentives and administrative support, and by individual factors including scientists' willingness to engage in patenting and licensing activity (Carlsson and Fridh, 2002; Elfenbein, 2007; Friedman and Silberman, 2003; Sine et al., 2003; Swamidass and Vulasa, 2009; Thursby and Kemp, 2002; Thursby et al., 2001; Thursby and Thursby, 2002). This study contributes to that literature by examining the patent as the unit of analysis.

The study proposes a framework in which licensing outcomes are jointly determined by two main concepts, *applicability* and

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marketability of the underlying technology. Then, based on the framework, it develops six hypotheses that capture how individual and institutional factors influence the likelihood of licensing university patents. The hypotheses are tested using data from a 2010 patent-specific national survey of academic scientists and engineers who are inventors of patents awarded to U.S. universities in 2006 by the U.S. Patent and Trademark Office (USPTO). The dependent variable is whether or not the patent was licensed within the four years since being awarded. The statistical results show that university patent licensing is primarily determined by individual factors including *inventor's attitude* towards commercialization of academic research, *further research* conducted by the inventor during patent review, and *researcher engagement with industry* on the underlying research. At the institution level, *unwillingness of TTO to cover patenting fees* leads to higher licensing potential, while *industry funding* and *service effectiveness* of TTO do not have significant effects.

As a second exploratory step in the analysis, the paper conducts more refined analysis by distinguishing between two types of inventions – “opportunity-based” and “intention-based” – as identified by the inventor. A patentable opportunity-based invention is not foreseen at the outset of the research project whereas the patentability of an intention-based invention is anticipated early during project development and design. Findings demonstrate that different individual and institutional factors are relevant for predicting the likelihood of licensing for these two different categories of inventions. The discussion and conclusion sections present the implications of the study for theory and practice.

2. Literature review

U.S. universities have increasingly sought to capture the rents from discoveries and promote research commercialization since the 1980s. Slaughter and Leslie (1997) conceptualize this phenomenon as university capitalism referring to “institutional and professorial market or market-like efforts to secure external moneys (p. 8).” Many early studies on research commercialization focused on the change in total quantity and overall quality of university patents and licenses after the Bayh–Dole Act (Henderson et al., 1998; Mowery et al., 2001, 2002; Mowery and Ziedonis, 2002; Shane, 2004). However, other work, much of which is more recent, examines how institutional factors affect university-level variation in research commercialization and how individual researcher characteristics matter for commercialization outcomes.

Institutional studies have emphasized university reward structures that incentivize research commercialization (Baldini et al., 2007; Friedman and Silberman, 2003; Markman et al., 2004; Macho-Stadler et al., 2007), university TTO support structures (Ambos et al., 2008; Carlsson and Fridh, 2002; Friedman and Silberman, 2003; Siegel et al., 2003), university organization structures or laboratory size (Azagra-Caro et al., 2003; Bercovitz et al., 2001), and campus-wide norms towards research commercialization (Argyres and Liebeskind, 1998; Owen-Smith and Powell, 2001). Research has also shown that industrial funding promotes interest in applied research, production of commercializable outputs and demand for intellectual property protection (Friedman and Silberman, 2003; Siegel et al., 2003; Agrawal and Henderson, 2002). Patentability varies across fields of science and because research in the life sciences tends to generate more readily commercializable inventions (Azoulay et al., 2007; Moutinho et al., 2007; Stephan et al., 2007) it receives greater sustained collaboration interest from potential licensees (Juanola-Feliu et al., 2012). Pries and Guild (2011) also demonstrate that the

technological characteristics of university inventions determine the business models and the subsequent commercialization outcomes. In sum, there is substantial evidence that institutional factors explain variation in university licensing outcomes.

Individual-level studies have shown that scientist perceptions, background and experiences explain propensity to engage in commercialization activity. For example, senior faculty are more likely to get involved in patent-related activities because they have achieved a certain degree of career security (Allen et al., 2007; Bercovitz and Feldman, 2008; Stephan et al., 2007). Scientists whose past training has instilled a positive value for technology transfer are also more likely to engage in commercialization activity (Bercovitz and Feldman, 2007). Individual scientists who are more willing to engage in research commercialization, those who accept the legitimacy of research commercialization and those who perceive research commercialization and scientific research to be compatible missions for universities are more likely to engage in patenting and licensing activity (Bercovitz and Feldman, 2008; Moutinho et al., 2007; Thursby and Thursby, 2002; Ambos et al., 2008; Huang et al., 2011). Previous research has also indicated that faculty propensity to engage in patenting and licensing activities is shaped by their perceptions of the benefits and costs of research commercialization (Baldini et al., 2007; Owen-Smith and Powell, 2001; Siegel et al., 2003). Hence, the literature clearly demonstrates the importance of individual-level determinants of university licensing outcomes.

Although prior work has significantly improved our understanding of commercialization of university inventions, there is lack of a synthesized framework to guide empirical studies on the determinants of patenting and licensing behavior in universities. An integrated framework would identify mechanisms through which the institutional and individual factors determine decisions to pursue research commercialization. Additionally, most prior studies capture involvement in research commercialization using a count of invention disclosures, patent applications, patent awards or license agreements held by a university (Friedman and Silberman, 2003; Foltz et al., 2000) or an individual scientist (Azoulay et al., 2007; Stephan et al., 2007). There is an opportunity to examine further why some university inventions are taken up by the market but others are not.

In this study, we propose a comprehensive framework to illustrate that licensing of university inventions is a function of the applicability and marketability of the underlying technology that are determined by institutional and individual factors. We pay particular attention to licensing activity because it relates directly to the transfer of scientific knowledge for commercial use. We develop six hypotheses based on the conceptual framework and then test them using data from a national survey in which the patent is the unit of analysis. Specifically, the study examines the extent to which individual and institutional factors determine whether patents awarded to university inventors in 2006 are licensed by 2010, the date of the national survey.

3. Conceptual framework and hypothesis development

3.1. Conceptual framework

At the outset, this framework recognizes the multi-stage process of producing and licensing university inventions. Thursby and Thursby (2002) identify three stages of technology transfer with output of each stage being disclosure, patent application, and license and option agreement. The pre-disclosure stage may refer to any point in the research process. Hence the pre-disclosure stage could describe an early point in the research life-cycle where scientists decide to develop or select projects that are more or less likely to produce inventions. Alternatively, pre-disclosure could describe the discovery of a

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