The impact of legislative framework conditions on the technological performance of European Universities: An empirical assessment

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Abstract

Nowadays one observes an increasing interest in the entrepreneurial behaviour of universities. In this contribution the role of entrepreneurial universities within national innovation systems is situated. Specific attention is paid to the role of legislative framework conditions that might foster a more active role of universities in terms of technology development. Our analysis, covering a number of European countries, strongly suggests a positive impact of 'Bayh Dole'-like legislative framework conditions on the technological activities undertaken by universities within (national) innovation systems.

Introduction: The phenomenon of entrepreneurial universities

Collaboration between science and industry, and the phenomenon of 'enterprising universities', have been studied extensively over the last decades. This growing interest is connected to the increasing acknowledgement of the fundamental role of knowledge and innovation in stimulating technological performance, international competitiveness and economic growth. Researchers in the domain of innovation (including Freeman, 1987, 1994; Lundvall, 1992; Nelson, 1993; Nelson and Rosenberg, 1993; Mansfield & Lee, 1996; Mansfield, 1995; Mowery and Nelson, 1999; Dosi, 2000) stress the role of science and the importance of interaction between a variety of institutional actors underlying the innovative capacity and consequent economical performance of an economical system. This more encompassing view on innovation dynamics has resulted in a growing popularity of the 'innovation system' concept that gained acceptance by scholars and policy makers as a guiding framework for understanding innovation dynamics on an aggregated level (OECD, 1999; European Innovation Scoreboard, 2002).

In these models, knowledge generating institutions like universities, research laboratories, industrial research centres and more recently government institutions are acknowledged – besides firms and entrepreneurs - as important players in developing and stimulating the innovative capacity of a particular region or country. Likewise, the Triple Helix model, which emerged in the second half of the 1990s (Leydesdorff and Etzkowitz, 1996, 1998; Etzkowitz and Leydesdorff, 1997; Leydesdorff and Etzkowitz, 1998), emphasizes the complementary roles of firms and knowledge institutes, as well as the importance of constructive interactions among them.

There are several reasons of the relevance of universities within innovation systems and hence their contribution to the national innovative capacity. First, research institutions produce information and ideas upon which the development of new products, processes and services can build. Second, research institutions can work on certain research agendas for a longer period of time, which can lead to the creation of new scientific insights. The latter can over time lead to economic applications. Notice in this respect that universities are well placed to address market failures that occur in the field of innovation (Arrow, 1962; Freeman, 1994;

Baumol, 2002). Such market failures arise especially in relation to basic research, characterized not only by high levels of uncertainty both in terms of technical and commercial success, but also spanning long time frames to bear fruit (often decades). In addition, the properties of knowledge or information as an economic good - i.e. its non-excludability, non-rivalry and its cumulativeness - complicate investment decisions even further (Foray, 2004). All of the above reasons imply specific challenges for private investors, who tend to refrain from becoming involved in basic research activities. In order to avoid a loss of social welfare – due to non investment behavior of private firms – most national innovation systems nowadays invest considerably in basic research performed at universities and public research institutes.

At the same time, for effectively contributing to the innovative capacity of an innovation system, universities need to be willing to become more 'entrepreneurial'. The notion of 'entrepreneurial universities' (Branscomb, Kodama & Florida, 1999; Etzkowitz, Webster & Healy, 1998) refers to the development of the following spectrum of activities: more intense commercialization of research results, patent and license activities, spin-off activities, collaboration projects with the industry, and greater involvement in economic and social development. As such, one observes a 'second academic revolution'[46] whereby education and research become complemented with service and valorization activities aimed at transferring scientific knowledge to economical activity realms.

Many factors have contributed to the development of the phenomenon of entrepreneurial universities. At least in the US, it can be considered a logical consequence of the successful involvement of universities in the 1940s, 50s and 60s[47] in domains such as the space industry, defense and energy. Shifts in the federal financing policy and taxation changes for R&D expenses have contributed to more entrepreneurship at US universities. Moreover, in the 1980s policy priorities shifted to R&D activities that contribute to the productivity and worldwide competitiveness of the American industry (Cohen and Noll, 1994). Likewise, European considerations of competitiveness in today's globalized knowledge economy resulted in the well known Lisbon targets; but also, the role of universities within the European Research Area is increasingly being discussed and reflected upon (see for instance, EC Green paper, 2007; Aghion et al., 2007; Dosi et al.; 2007). This can be seen in recent recommendations published by the EC, in which a more entrepreneurial orientation of European universities is explicitly advanced: "Knowledge transfer must improve in order to accelerate the exploitation of research and the development of new products and services. To that end, European universities and other public research institutions should be given incentives to develop skills and resources to collaborate effectively with business and other stakeholders, both within and across borders" (EC Green paper, p. 7).

It is self evident that research centers and universities can only achieve this status if they acknowledge service and entrepreneurship as part of the university's responsibilities and if they translate this enterprising attitude into a more entrepreneurial university culture. This includes creating the required supporting transfer mechanisms for facilitating and stimulating enterprising activities (Bozeman, 2000; Etzkowitz, 1983, 1999; Debackere, 2000; Debackere & Veugelers, 2006).

The role of legislative framework conditions

The rise of the entrepreneurial university phenomenon is often associated with the Bayh-Dole Act (1980) and the Stevenson-Wydler Act (1980). These American legislative initiatives

[46] During the first academic revolution (19th century) research became a part of universities activity profile.

[47] One could even go back to the 19th century to explain the phenomenon of entrepreneurship at universities; see Hane, 1999; Kodama and Branscomb, 1999; Rosenberg and Nelson, 1994 for historical overviews extending longer time frames.

created transparency with respect to the ownership of intellectual property rights originating from publicly funded research; whether performed by universities or companies, the involved institutions obtain in principle the right of ownership. This new legislation was an important stimulus for adopting and/or further professionalising intellectual property-related procedures and regulations. Together with the rise of science-intensive fields of economical activity (like biotechnology), the introduction of the Bayh-Dole act undoubtedly contributed to the strong increase of patenting activity undertaken by American universities from the 1980's onwards (Branscomb, 1999; Mowery et al., 1998; 1999; 2001). Indeed, when looking nowadays at patent activity undertaken by universities, the strong performance of American universities is striking. To illustrate this, table 2 provides an overview of universities whose portfolio of patents (published after 2000) exceeds 100 EPO applications.

Table 1: Overview of most active universities within the EPO Patent System.

Applications > 100, published from 2000 onwards.

1	US	THE REGENTS OF THE UNIVERSITY OF CALIFORNIA
2	US	BOARD OF REGENTS, THE UNIVERSITY OF TEXAS SYSTEM
3	US	THE JOHNS HOPKINS UNIVERSITY
4	US	MASSACHUSETTS INSTITUTE OF TECHNOLOGY
5	US	WISCONSIN ALUMNI RESEARCH FOUNDATION
6	US	CALIFORNIA INSTITUTE OF TECHNOLOGY
7	US	THE BOARD OF TRUSTEES OF THE LELAND STANFORD JUNIOR UNIVERSITY
8	IL	YISSUM RESEARCH DEVELOPMENT COMPANY OF THE HEBREW UNIVERSITY OF JERUSALEM
9	UK	OXFORD UNIVERSITY
10	US	THE REGENTS OF THE UNIVERSITY OF MICHIGAN
11	US	THE TRUSTEES OF COLUMBIA UNIVERSITY IN THE CITY OF NEW YORK
12	US	THE BOARD OF TRUSTEES OF THE UNIVERSITY OF ILLINOIS
13	US	TRUSTEES OF THE UNIVERSITY OF PENNSYLVANIA
14	US	UNIVERSITY OF FLORIDA
15	CH	ETH ZURICH
16	US	DUKE UNIVERSITY
17	US	PRESIDENT AND FELLOWS OF HARVARD COLLEGE
18	US	YALE UNIVERSITY
19	US	THE UNIVERSITY OF NORTH CAROLINA
20	US	CORNELL RESEARCH FOUNDATION, INC.
21	BE	K.U. LEUVEN
22	US	UNIVERSITY OF UTAH RESEARCH FOUNDATION
23	US	UNIVERSITY OF SOUTHERN CALIFORNIA
24	US	UNIVERSITY OF ROCHESTER
25	CH	ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE
26	CA	THE UNIVERSITY OF BRITISH COLUMBIA
27	US	UNIVERSITY OF PITTSBURGH
28	US	REGENTS OF THE UNIVERSITY OF MINNESOTA
29	US	UNIVERSITY OF VIRGINIA PATENT FOUNDATION
30	US	THE RESEARCH FOUNDATION OF STATE UNIVERSITY OF NEW YORK
31	US	NORTH CAROLINA STATE UNIVERSITY
32	US	UNIVERSITY OF MARYLAND

33	US	THE UAB RESEARCH FOUNDATION
34	US	EMORY UNIVERSITY
35	CH	UNIVERSITY OF ZURICH

These figures suggest that adopting Bayh-Dole like legislative framework conditions might be an interesting option for European countries as well, to further stimulate innovative activity. Economic theories on innovation provide additional arguments in this respect. The seminal work of Arrow (1962) already pointed out that market failures occur frequently within innovation. When one scrutinizes the nature of technology developed by academic scientists, it becomes apparent that these technologies are often of an embryonic nature, requiring additional investments to arrive at market applications (see Jensen, Thursby & Thursby (2003) for a revealing account). Without ownership rights, incentive issues arise both on the level of the academic inventor and on the level of his/her principal (i.e. the university). Stated otherwise: if scientific inventors are not acknowledged as 'owners', their incentives to engage in further development efforts are absent. The extent of follow up efforts – towards market exploitation – will then be driven by voluntarism only. It is by granting IP rights that entrepreneurial agency is stimulated.

The next question then relates to who should acquire such rights: individual inventors or their principal (the university)[48] ? Situating these rights at the level of individual inventors might result in under-investment due to risk averseness and/or the lack of capabilities to further invest in the development of the technology. In addition, excluding universities may lead to conflicts of commitment between agent and principal if with academic inventors pursue technology development activities while universities limit their scope to education and research. Moreover, an advantage of situating IP rights at the level of the university is that it becomes feasible to address specific concerns stemming from the nature of scientific work (e.g. rules on disclosure, impact on science and education). Stated otherwise, university specific regulations seem justified to guarantee the co-presence of multiple academic missions (science, education & knowledge transfer) and to avoid potential conflicts (including secrecy and skewing). Notice finally that granting rights to universities creates a more transparent 'market' situation towards industrial partners. Being explicit on the level of terms and conditions not only seems fair from a funding perspective; it might also reduce transaction costs[49].

While conceptual arguments might be advanced in favor of granting IP rights to universities, an empirical assessment of their impact is highly relevant as well. This study contributes by considering national innovation systems and addressing the question whether or not different legislative framework conditions coincide with differences in the amount of technological activity undertaken by universities. Countries under study include all EU-15 countries. Patent data are extracted from the PATSTAT database (October 2009) and pertain to EPO applications and USPTO grants from 1980- 2008. The allocation of patents to activity sectors (HEI, Companies, Individuals, …) is based on the sector allocation methodology developed by ECOOM (Van Looy et al., 2006: Du Plessis et al., 2009).

Table 2 reports the results obtained from applying an ANCOVA model with the different legislative framework conditions acting as independent variable and the number of university patents as dependent variable. Business expenditures on R&D (BERD) and Higher Education

[48] One could also envisage a situation whereby such rights are situated at levels above the principal of the inventors (e.g. a patent organization for a region or country as a whole). This would only make sense if economies of scale are important; these are however limited (and relate to IP procedures). Moreover, by de-multiplexing relationships, new conflict situations (both within and between involved organizations) can and probably will arise like witnessed in the past in the both the UK (BTG) and the US (NRC); see for a revealing account on this issue, Mowery & Sampat (2001).

[49] Whether it will actually do, will of course depend on the behavior of negotiating partners.

Expenditures on R&D (HERD) are included as control variables, as is the patent system (EPO versus USPTO). The results clearly show the significance of legislative conditions on the amount of university patenting activity.

Table 2: Impact of legislation framework conditions on patenting activity undertaken by universities (EU-15)

University Patents (Per Mio Inhabitants)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1847.229[a]	28	65.972	47.158	.000
Intercept	3.775	1	3.775	2.698	.101
Law	81.339	3	27.113	19.381	.000
Time	.003	1	.003	.002	.966
Time²	15.690	1	15.690	11.216	.001
Population	2.097	1	2.097	1.499	.221
Country	627.930	13	48.302	34.527	.000
HERD (%)	.060	1	.060	.043	.837
BERD (%)	18.817	1	18.817	13.451	.000
Law * Country	306.638	5	61.328	43.838	.000
Patent System (USPTO/EPO)	151.213	1	151.213	108.089	.000
Error	798.809	571	1.399		
Total	3270.481	600			
Corrected Total	2646.038	599			

a. R Squared = ,698 (Adjusted R Squared = ,683)

As Table 3 further reveals, it is clear that specific HEI-tailored legislative framework conditions have a significant and considerable impact on the amount of university patents. Countries adopting such a legislation display higher levels of academic technological activity (as measured by patents), compared to countries that opt for a professor's privilege legislation (i.e. situating the ownership rights at the level of the individual researcher). Not only does one observe a notable difference compared to the countries which opt for professor's privilege; also the difference with broader employer oriented legislation is significant and outspoken.

Table 3: Observed levels of patent activity undertaken by universities (per Mio inhabitants; EPO applications and USPTO grants) under different legislative framework conditions (EU-15)

University Patents (Per Mio Inhabitants)

Law	Mean	Std. Deviation	N
No Clear Information available (GR, PT, LUX, early years)	.0015	.01214	68
IP ownership University embedded in a specific UNIV/PRO set of regulations	2.5795	3.44825	138
IP ownership University embedded in general employer/employee set of regulations	.4174	.99000	362
IP ownership University embedded in general employer/employee set of regulations but individual universities can complement and modify ownership rights (UK)	1.6878	1.60272	56
Property rights belong to the individual scientist who developed the IP	.1418	.22936	194
Total	.7692	1.84961	818

When focusing on a limited number of countries that changed legislation during the time period under study (Germany, Denmark, Belgium), non-trivial within-country differences are revealed (see Table 4). More specifically the amount of patent activity undertaken by

universities increases with a factor ranging from 3 (Denmark) to 10 (Belgium, Germany) as legislations shift from professors' privilege to HEI-tailored approaches.

Table 4: Within differences in patent activity undertaken by universities (per Mio Inhabitants; EPO applications and USPTO grants) when changing legislation framework conditions: Belgium, Germany, Denmark

	Belgium	Germany	Denmark
IP ownership University embedded in general employer/employee set of regulations	.8592	1.4306	2.5885
IP ownership University embedded in a specific UNIV/PRO set of regulations	8.2088		
Professor's Privilege		.1201	.7801
Multiplicator	9,5	11,9	3,3

The logical next question then becomes whether the observed differences stem from shifts in technological activity from one type of actor towards another(e.g. from individuals towards universities) or whether they reveal an overall net gain in technological activity within the innovation system. The findings reported by du Plessis et al. (2005) are unambiguous for Flanders, showing that the observed impact can indeed be interpreted as an overall net gain. For other European countries, the picture is more nuanced, signalling differences between patent systems (EPO/USPTO) as well. For instance: in Germany, the EPO patent activity undertaken by individuals does not differ significantly between the period before and after the legislation change. But the USPTO patent activity undertaken by individuals does display a decrease after the shift in legislative framework conditions.

So, whether and to what extent there is a net positive effect in terms of technological activity for the innovation system as a whole, requires further analysis. Currently, the authors are engaged in further unravelling effects by country taking into account differences between patent systems as well.. In addition, extending the analysis towards impact characteristics – measured by citations – seems highly relevant in order to shed more light on the 'quality' of the academic technology (compared to other sectors, most notably individual scientists).

(Intermediate) Conclusion

In this paper, we highlighted the role that universities can play within innovation systems, focusing on the role of legislative framework conditions that might foster a more active role of universities in technology development. Overall, more technological activity from universities is observed when HEI-specific legislative framework conditions are installed. To the extent that this implies a net positive effect on technological activity in the innovation system as a whole, more technological activity at universities is not only feasible, but might even be desirable given the ambitions of Europe within the current, global, knowledge economy.

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