How academic patents shape innovations

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Summary

This thesis studies four factors that can determine and contribute to the successful commercialisation of academic patents in pathways of research commercialisation to novel innovations in the market place.

The importance of innovations for companies has been described in the 1920's by Schumpeter[1] in his ground breaking theory on 'creative destruction'. The use and appropriation of patents and other Intellectual Property Rights (IPRs) by companies, which allow them to capture market positions, gain profitable margins and returns on investment have been studied by Teece and has become a part in the body of the economic literature[2]. Too dominant IP positions by a minority of companies inducing excessive exploitation of IPR resulting in negative effects e.g. marginalisation and uneven prosperity distribution within and between countries has been studied by Stiglitz and Henry, and are presently under dispute[3]. Considering the staggering high prices of some innovative medicines for so called orphan drug diseases, some policymakers regard patents as instruments that grant 'big pharma' too strong monopolies.

Many governments in the OECD countries formulate science and innovation policies which, within the 'triangle' of stakeholders with governments, companies and universities, can stimulate the research commercialisation (RC) and subsequently the prosperity in a society *(policy factor)*. At a global level, universities have become important engines for innovations and since the 1980-s the formal tasks of universities[4] in most European countries now also entail ‘research commercialisation’ In the USA, research from Mazzucato (2014) demonstrated that publically financed research contributes to almost all recent innovations, e.g. medicines, iPhone. Due to business-economic and financial reasons, many multinational companies restructured their Research & Development departments and opted for more public-private-partnerships with universities in a so-called open innovation system, in which access to and ownership of IPRs are of key importance. The various types of quantifiable RC output include contract research, collaboration with industrial partners, consultancy, creation of spin-offs and filing of patents.

However, the institutionalisation of RC activities via university Technology Transfer Offices (TTOs) is of more recent date and empirical evidence on links between patent-based RC and its socio-economic impacts is scarce (*organisational factor*). The intricate relationships between the engagement of scientists with the commercialisation of their research and university IP regimes, on the one hand, and the socio-economic impact of academic patents in

[1] Schumpeter, J.A. (1920) Theory der Wirschaftlichen Entwickelung
[2] Teece, D. (1993) Profiting from technological innovation; implications for integration,collaboration,licensing and public policy, *Research Policy*, (22), 2, 112-113
[3] Stiglitz, J. and Henry, C. (2006). Intellectual Property, Dissemination of Innovation and Sustainable Development, *Global Policy*, 1, (3), 237-251
[4] Education and research

relationship with TTO governance models, on the other hand, are not clear and merit more extensive, empirical and longitudinal research.

Although the impact of national IP laws and regulations in Europe on academic patenting (*institutional factor*) has been studied extensively, there is still a scarcity of data explaining why scientists engage with RC. Studies on scientists' drivers (*individual factors*) to engage with RC cover fragmented topics: impact creation in e.g. the biotechnology sector; importance of patents for academic careers and non-financial incentives to involve scientists into invention disclosures. Studies in the USA show that drivers for scientists to engage with RC related to access to extra funding, or legal obligations. The effectiveness of policies stimulating RC (*policy factor*) also depends on the effectiveness of university-industry technology transfer including IPRs; characteristics of innovation systems and IP awareness of scientists, but data about the impact of policies to stimulate RC, technology transfer (TT) and the use of academic patents are limited. Acknowledging above described knowledge gaps, the general overarching research question of this thesis is:

"How do academic patents shape innovations and what factors effectively determine their use in pathways of research commercialisation"

Hence, this thesis addresses three interrelated issues: (a) why scientists engage with academic patenting; (b) influence of TTO governance on the use of academic patents; (c) impacts of innovation policies aiming to boost patent based RC in Europe. This thesis presents a theoretical framework and empirical data from patent-based studies, surveys, questionnaires and semi-structured interviews. All chapters in this thesis have been based on articles addressing scientific research on the relationships between institutional (policy, legal, financial), organisational (support from university board and TTO, RC services) and individual factors (motivation, time, experience) and the use of patents and IP-based spin-offs at universities in Europe. In order to generate more scientific insight and bridge abovementioned gaps, eleven sub-projects have been conducted between 2012 and 2017 to examine these relationships (see **table 1.1., page 23 in PhD thesis**) and collect necessary data.

The commercialisation of academic patents has been studied longitudinally in relationship with their utilisation in a business sector in a country and within a technology (**chapters 2 resp. 6**). The thesis describes how:

- Some 66 % of Dutch academic patents has been appropriated by companies between 2000 and 2010;
- The exploitation of academic patents of Dutch origin by university spin-offs may create jobs on the condition that the entrepreneurial scientist have used the patent successfully for funding; The average revenue per Dutch academic patent amounts to some € 42 000

- The value of academic gene therapy patents was significantly and positively correlated with the number of patent licensees and number of third party citations;

Although results on the impact of innovation policies stimulating RC through the use and exploitation of academic patents in the biotechnology sector shows non-conclusive evidence (**chapter 3**), the implementation of policy instrument BioPartner in the Netherlands contributed to:

- An increased IP awareness amongst scientists;
- An increased number of academic biotechnology patent applications;

In a framework the output effects of novel typologies of university IP regimes and existing university TT governance models on patents and spin-offs has been quantified at university and TTO level, followed by the acquisition and analysis of patent-based RC data at the level of European scientists (**chapters 4 and 5**). In addition to the body of literature, here the findings show that:

- Psychosocial factors that motivate individual scientists (e.g. entrepreneurship-driven) to use patents are much more associated with their RC than the institutional and organisational factors for technology transfer (IP regimes);
- The creation of IP-based spin-offs is only associated with these individual factors of scientists and not at all with the institutional and organisational factors for technology transfer;
- The IP (= patent) output of TTOs can be associated with obligatory contact between scientists and a centrally located university TTO;
- The distribution patterns in transfer of academic patents seems to be associated with their governance models of their university TTOs

Analysing longitudinal, empirical data extracted from some 3,650 scientists across 150 universities in 30 European countries, who are involved as inventors in some 5,500 academic patents in the years between 1995-2015, this thesis *concludes* that:

(a) *Science and innovation policies may result into higher levels of scientists' engagement with- and output in academic patents and spin-offs, if these policies contain dedicated instruments e.g. research funding, promotion of scientists' IP awareness, reimbursement of patent applications' costs and incentives to contact a TTO;*

(b) *Since the year 2000 the category of entrepreneurial scientists has become more engaged with patents and contributed to employment growth, if these patents could have been used as collateral for external funding and revenues during the process of spin-off development;*

(c) *Successful exploitation -and value creation- of academic patents by spin-offs can be correlated with the number of citations by third parties. The creation in numbers of IP based spin-offs is associated with the motivations of (entrepreneurial) scientists only, and not with the IP regimes of their universities.*

Previous research in the body of literature [5],[6] shows that the majority of academic patents will be commercialised or used by SMEs and multinationals, as compared to university spin-offs. If policymakers develop new policies aiming to boost and unleash the societal impact of scientific research, this thesis has shown that the *individual factors* that can motivate scientists to file academic patent for the commercialisation of their research and creating IP-based spin-offs research, are (much) more important than *organisational* and *institutional* factors. Future case studies will show that the utilisation of academic patents by empowered (academic) entrepreneurs in their spin-offs will over time create societal impact, like novel innovations and jobs.

[5] OECD (2013). Commercialising Public Research: New trends and Strategies

[6] Lissoni, F. (2012). Academic patenting in Europe; an overview of recent research and new perspectives. *World Patent Information*, 34, 197-205