Norwegian Commercialization of Academic Research: A Policy Brief

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1. Executive Summary

Decades ago, few higher education institutions (HEIs) would have predicted that they would find themselves actively involved in the commercialization of research. However, the Bayh-Dole act of 1980 in the US shifted this perception (Grimaldi, et al., 2011). Politicians worldwide realized that capitalizing on the research from HEIs could help drive economic growth. Norway, one of the world's wealthiest countries, was no exception to this trend (World Bank, 2021). With the passing of The University and University Colleges Act in 2005 and subsequent amendments, Norwegian universities had to fulfil a new societal role (Norwegian Ministry of Education and Research, 2018). The implementation of this has, however, not been as straightforward as one could have hoped. We, therefore, set out to explore how to identify and remedy the challenges to the implementation. We approached this using a mix of literature searches and interviews. Through our literature search we identified relevant literature which we then compared, through interviews, to the experiences of our Interviewee TTO. The interviews were conducted as semi-structured interviews where new knowledge and ideas were discussed. Through this, we created the following policy recommendations, which we believe may aid in facilitating the commercialization of research. Our main policy recommendations for this policy brief:

- Create a framework supporting spin-offs based on academic patenting; and
- Increase technology transfer office (TTO) visibility.

These two policy recommendations are supported by a series of policies which we recommend implementing. These are explained in detail at the end of this policy brief. Firstly, we suggest aligning the objectives of academics and TTOs through a focus on highlighting patenting as an important part of academic performance and highlighting the effects, other than monetary, of patenting, such as societal impact. Secondly, we suggest a mandatory Declaration of Expected

Invention as a method of informing academics of the possibility of patenting and the TTO of a possible patentable invention early. This may be supported by offering innovation and entrepreneurship courses for staff and students alike to create entrepreneurial awareness. We also propose that a more radical change may be carried out with a two-fold paradigm shift. Using the Innovation Readiness Level framework to evaluate new inventions and shifting focus from technology transfer to innovation transfer for TTOs. These should result in a higher degree of visibility of the TTOs.

The increase in TTO visibility and innovation and entrepreneurship courses, would also create better support for academic spin-offs. We also recommend that there be a focus on creating a transitional framework for academics engaging in spin-offs. Currently, academics either work on spin-offs as a hobby or quit their position and go full-time. However, this carries a lot of risk for the academics. Therefore, we suggest a framework wherein academics may be given a leave of absence for 3-6 months to work on the spin-off, however, they may return at any given point in time during this period. Lastly, we suggest that further monetary resources be given to support spin-offs. This may be triggered by the successful filing of a patent, after which the TTO is awarded seed capital for spin-offs.

2. Case Introduction

Concerns about the energy transition and grand societal challenges have necessitated knowledge to address them. Higher education institutions (HEIs), as one of the most important knowledge producers, are in a unique position to contribute to addressing these challenges as well as the technological, social, and economic development of societies (Guindalini et al., 2021; Akimoto, 2007). However, while HEIs have accomplished much in terms of teaching, research, and, to some extent, outreach activities (Clark et. al. 2009), commercialization of research remains a challenge (Jung, 2015; Rasmussen et al. 2006). While being far from without challenges, the commercialization of research has an impact at both the societal and institutional levels, according to Baycan and Stough (2012). Commercialization of research has had enormous societal impacts on economic development, for example, by creating specific industries for regions and creating jobs. At the institutional level, research commercialization increases the attractiveness of HEIs to large industrial partners; it enables infrastructure sharing; and it leads to new ideas, creates incentives, and increases motivation for university employees.

Thus, HEIs may be drivers of economic development, however, the importance of the commercialization of HEIs' research differs depending on the mix of products a country relies upon to generate income i.e. their economic complexity. For countries which are reliant upon fossil fuels such as oil and natural gas, the ongoing energy transition necessitates a shift towards other industries. These countries have to reinvent themselves to adapt to a post fossil fuel world within which knowledge is of utmost importance. One such country is Norway, where the discovery of oil has not been all positive. While Norway is oftentimes lauded as a country which has successfully escaped the negative impact of the discovery of natural resources i.e. the Dutch Disease and Resource Curse. This is not necessarily the case, as Norway has had reversed relative growth and a contraction in industrial activity since at least the late 1990s (Holden, 2013; Larsen, 2006; Mork, 2022; Ramírez-Cendrero & Wirth, 2016).

Commercialization of HEI research ideas is one way to reduce the country's reliance on oil while also addressing the country's technological, social, and economic development needs. To address commercialization, HEIs must undergo institutional reorganization in order to provide support to researchers and collaborate with industry. However, funding is required to assist HEIs in this endeavour. As a result, the Research Council of Norway (RCN) has requested that two problem statements be explored:

1. How can the **HEIs** themselves improve their institutional structure to better facilitate the **commercialization** of ideas from research?
2. What can RCN do to improve their funding schemes for supporting **early technology transfer**?

Using these two questions as the basis for understanding the desired outcome of the requestee, it was extrapolated that the **desired outcome is: increase the utilization of scientific knowledge in industry, and it should be measurable and financially beneficial**.

This paper is divided into four sections. The first section is the problem formulation, which is presented in the introduction. The second section provides theoretical background on three interrelated topics: (i) the societal impact of knowledge and motivational factors for incentivizing patenting at HEIs; (ii) TTOs in Norway and the level of technological readiness; and (iii) patent exploitation challenges. Finally, detailed policy recommendations for increasing scientific knowledge exploitation and commercialization are presented, with a focus on spin-offs and TTOs.

3. Theoretical background

3.1. Societal impact of knowledge

Based on the work of van de Burgwal et al. (2019a), this policy brief introduces a framework for understanding the different domains of knowledge production, exchange, and use, and the societal impact that can result from the application of research knowledge in practice, i.e. knowledge valorization with respect to (1) Academia, (2) Society, (3) Entrepreneurship, and (4) State-governance.

The domain of knowledge production includes the production of new knowledge or the application of existing knowledge to create new ideas, products, or services. The domain of knowledge exchange refers to the processes and mechanisms used to transfer knowledge between different actors or groups, such as researchers, industry, policymakers, and the public. The domain of knowledge use refers to applying knowledge for a specific purpose, such as developing new products or services, improving public policy, or addressing societal challenges. The aim of fostering commercialization of research clearly directly falls into the "entrepreneurship" category; however, indirectly, also, for example, scientific publications can benefit economic development by making research publicly available to a wide range of actors. Within the "entrepreneurship" category, knowledge production, knowledge exchange and knowledge use can be seen as equally important, all requiring distinct measurements and policy incentives.

Table 1 - Framework for a broad societal impact of knowledge (adapted from van de Burgwal et al., 2019a)

	Academia	Society	Entrepreneurship	State-governance
Knowledge production	Scientific publications	Lay publications	Patents, products,	Guideline development, professional publications
Knowledge exchange	Lectures, scientific consultancies	Speeches, courses	Consultancy, contract research	Membership in associations, participation in policy research
Knowledge use	Citations	Use of books	Use of patents and products (licensing, spin-offs)	Use of guidelines, implementation of advice

3.2. Incentivising Patenting

Various academic papers explore how different motivational drivers impact the effort and performance of researchers engaged in knowledge valorisation, which refers to the commercialization of scientific knowledge (Leydesdorff and Meyer, 2006; Neck and Greene, 2011; O'Shea et al., 2005). The distinction between intrinsic, pro-social, and economic motivational drivers is a common framework in the literature on knowledge commercialization and technology transfer. In the following, we focus on an influential paper by van de Burgwal et al. (2019b). The authors differentiate between the aforementioned three motivational categories and their influence on effort (defined as the amount of time and energy that researchers are willing to invest in commercialization activities, such as patenting, licensing, and starting a company based on their research) and performance (the success of these commercialization activities, measured in numbers).

Intrinsic motivation is the internal drive or interest in knowledge valorisation related to personal satisfaction, a sense of achievement, or the desire to solve a challenging problem. The authors suggest that researchers who are intrinsically motivated to engage in knowledge valorisation are likely to be driven by factors such as the opportunity to apply their research in real-world settings, the potential to see their research impact society, or the opportunity to collaborate with other researchers or stakeholders. In the study, intrinsic motivation had the

strongest positive effect on effort and a positive effect on performance concerning knowledge valorisation.

Pro-social motivation is the desire to engage in knowledge valorisation activities for the benefit of others or society at large. The authors suggest that researchers who are driven by pro-social motivations are likely to be interested in using their research to solve real-world problems or to contribute to the betterment of society in some way. In the study, pro-social motivation had a positive effect on effort and a positive effect on performance concerning knowledge valorisation.

Economic motivation is the desire to engage in knowledge valorisation activities for financial gain or career advancement. The authors suggest that researchers who are driven by economic motivations may be more likely to prioritize short-term financial rewards over long-term societal impact. In the study, economic motivation had a positive effect on effort but did not have a significant effect on performance. Partially echoing this finding, Arqué-Castells et al. (2016), using an academic inventors' survey from Portugal and Spain, find that current royalties incentivise only one-third of respondents, higher royalties would incentivise one-third, and royalties do not incentivise the remaining third. While royalty-sharing policies do have a positive impact on patenting activity, it is not clear if higher royalties would lead to a further increase in patenting activity. Thus, given that the commercialization of patenting oftentimes is very slow or results in little royalties, the positive effect of increasing royalties on increased patenting activity is questionable.

To incentivize researchers to engage in commercialization of academic knowledge increasingly, policymakers can use a combination of strategies that tap into different motivational factors. One approach is to provide researchers with opportunities to engage in commercialization activities that align with their intrinsic motivations, such as pursuing research with practical applications or commercial potential (Leydesdorff and Meyer, 2006; Neck and Greene, 2011). For example, policymakers could establish technology transfer offices or entrepreneurship programs that provide researchers with the resources and support they need to translate their research into commercial products or services.

Another approach is to appeal to researchers' pro-social motivations by highlighting the potential societal impact of commercialization activities. This approach is supported by research that suggests that researchers who are motivated by a sense of social responsibility or

who have a strong pro-social identity may be more likely to engage in commercialization activities (Neck and Greene, 2011; O'Shea et al., 2005). For example, policymakers could establish funding programs or grants that prioritize research projects with clear social impact or that involve collaborations with industry partners that prioritize social or environmental responsibility.

The incentivization of patenting is greatly linked to the individual academics' motivation, however, other factors are also highly important. Murat et al. (2021) explored the role of supporting factors in patenting activities in universities at the early stages of engaging in the commercialization of research, i.e. emerging entrepreneurial universities. They found that clear rules and regulations providing additional credits to researchers who pursue patenting and the inclusion of patenting activities in academic performance mechanisms was positively linked to an increase in patenting. Furthermore, echoing other research, Boh et al. (2016) found that education aimed at innovation, entrepreneurship, and intellectual property rights (IPR) also increased patenting activity (Murat et al., 2021). Walter et al. (2013) find that there exists a need for creating an ambidextrous solution to bridging the apparent dilemma of patenting vs. publishing which academics may find themselves in. These create a framework within which the targeting of motivational factors may be effective.

3.3. Technology Transfer Offices

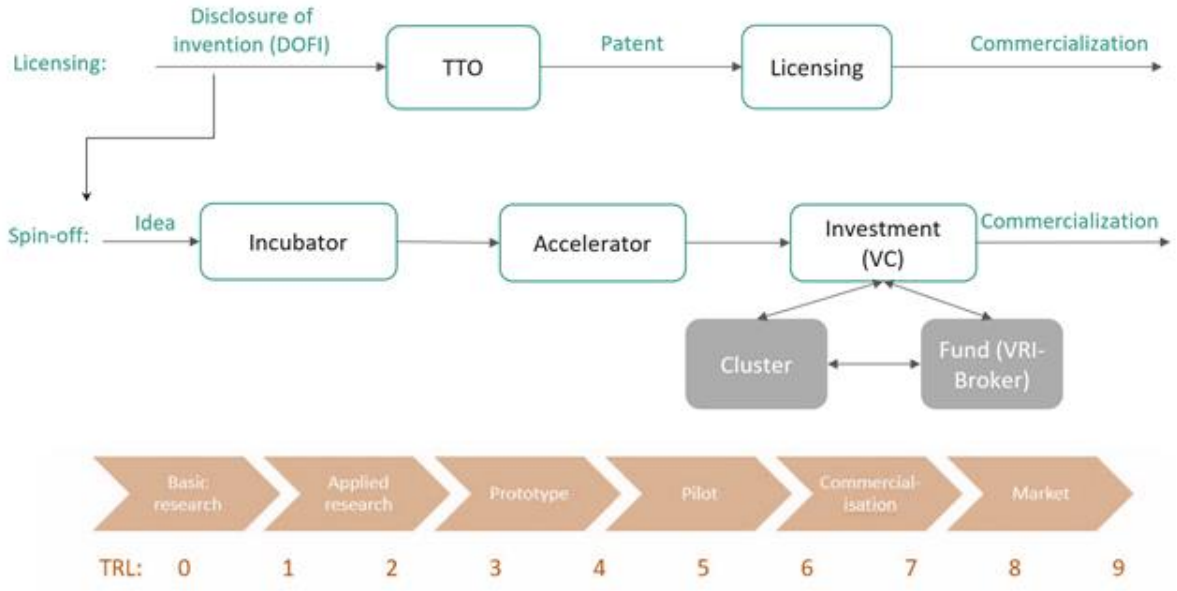
Incentive structures are not exclusive to individual academics. Universities have created technology transfer offices (TTOs) to bridge the gap between researchers and commercialization. The TTOs are special units inside or outside the university that facilitates and coordinates the transfer process of research results into the industry. Generally, we can differentiate two concepts of TTO: the broader one, by the definition of WIPO, TTO moves innovations from the lab to society; and the narrow one, a TTO is a department within the university that helps license patents. In a broader definition, within the commercialization sphere of activity, there are two main functions of the TTO: the first one is "marketing, negotiating and licensing" and the second one is "creation of spin-offs". Some of the key tasks that TTOs fulfil are: it brings researchers into contact with companies that are interested in the results of the research, it advises researchers on steps of patent filing and licensing. The TTOs aim at simplifying bureaucracy and helping the university to commercialize its patent portfolio effectively. However, sometimes TTOs may be incentivized to patent in order to project an

outward image of patenting performance, however, the patents may only present limited marketing potential (Soares, et al., 2020).

Currently, Norway has 11 active TTOs: Kjeller Innovation (Kjeller), Ard Innovation (Ås), Inven2 (Oslo), Innoventus Sør (Kristiansand), Norinnova (Tromsø), Nord Innovation (Bodø), NTNU TTO (Trondheim), Sintef TTO (Trondheim), Molde University College, VIS Innovation (Bergen), Validé (Stavanger). TTOs are heterogeneous in their structural and ownership composition. Depending on regional specialization and socio-economic circumstances, TTOs adapt their structure accordingly. For example, among Validé key owners are: Stiftelsen Rogaland Kunnskapspark, Rogaland fylkeskommune, SIVA, Universitetet i Stavanger (UiS) and some other organizations. The owners might have their own interests, thus it is very important to have a mechanism of goal alignment and incentive structures.

To provide a clearer understanding of the functions and processes of the TTOs, we can model a TTO as a black box that has intellectual property on the input side, transforms input, and outputs commercialization. There are diverse types of intellectual property. These include: patents, industrial design rights, copyrights and original works, including software, database rights and databases, layout designs and integrated circuits, plant breeders' rights and new plant varieties. Patents represent only a part of intellectual property that can be potentially commercialized. So, the narrow understanding of a TTO (as a department that commercializes research results only through licensing patents) cannot be applied to other types of intellectual property. We can see how the broader and the narrow definition coexist in the example of Interviewee TTO. The narrow TTO is a part of a bigger structure that can better fulfil two functions of commercialization activity.

Figure 1 – Technology Transfer Office Tracks for Commercialization of Research



Within this structure we have two kinds of tracks: one for licensing and one for spin-offs. The Disclosure of Invention (DOFI) can serve as an input for both. On the first track the DOFI is transformed into a patent; commercialization is achieved through licensing of the patent. On the second track, the DOFI or idea in any form is transformed through first an incubator, then accelerator, after which investment may be found. Afterwards it can be supported by a cluster or financially from a fund. Commercialization is achieved through spin-off creation.

During the work on the policy brief we conducted an interview with the CEO and employees of Interviewee TTO. Here, some of the main findings are summarized. Firstly, commercialization effect from spin-off creation is significantly higher than from patent licensing (sometimes allocated funds within existing programs are not enough to cover operational costs of filing a patent). Secondly, only one out of five applicants come from a university environment (either a researcher or a student) and four of them come from the industry. Therefore, we can conclude that there might be some challenges to successful patent exploitation and there is a need to properly incentivise academics to commercialize their research and to create awareness of such a possibility inside a university and within an industry.

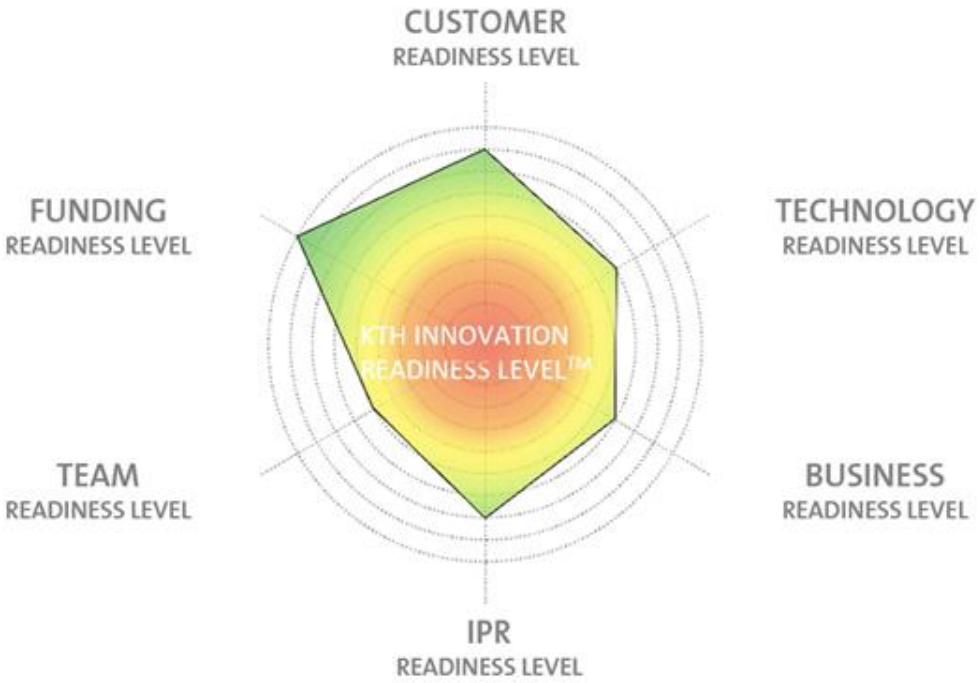
3.4. Innovation Readiness level

The definition of commercialization by Datta et al. (2015), configurations of university-industry interaction by Liu et al. (2021), the classification of five commercialization strategies

of Jarchow & Röhm (2019) and suggestions based on the findings Miranda et al. (2021) directly support the shift from technology readiness to innovation readiness paradigm.

KTH Innovation Readiness level (Lunner & Worrmann, 2018) is a recently developed example of a framework that helps to identify the extent of idea development. It comprises several sublevels. Customer readiness level (RL) shows how well-developed solutions understands and solve customer needs. Technology RL is the stage of development of a technology. Business RL is its economic viability. Intellectual property rights (IPR) RL concerns types of intellectual assets, and the ability to use and control them. Team RL reflects how the team configuration suits the given task. Funding RL assesses financial resources availability.

Figure 2 – Kungliga Tekniska Högskolan Innvation Readiness Levels (Lunner & Worrmann, 2018)



To sum it up, the main conclusion of this section is to broaden the notion of TTO to include all kinds of intellectual property and to align the structure of the TTO that can focus not only on Technology Readiness Levels but include a wider spectrum of Innovation Readiness Levels. KTH's Innovation Readiness Level framework serves as a solid example. Such broadening of the notion of the TTO will inevitably lead us to the focus shift from licensing to creation of spin-offs as this method of commercialization shows better financial results.

3.5. Challenges to patent exploitation

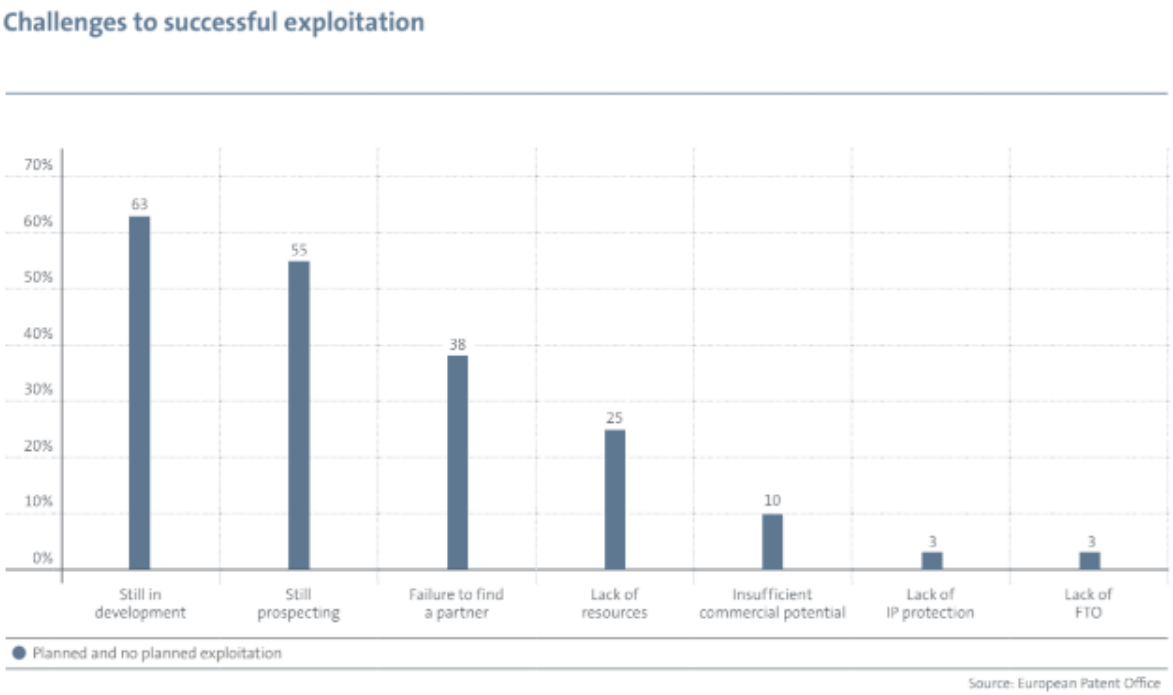
Universities and research institutions can contribute to improving society and the lives of its citizens by exploring and exploiting the *Academic Assets* they own. Academic Assets are defined as tangible or intangible resources that can be owned or controlled by an institution, managed and utilized in collaboration with another party for the purpose of generating societal and/or economic value. Beyond the usual perception in the academic technology transfer/knowledge transfer field, Academic Assets can be separated into Intellectual assets, which comprise intellectual property and knowledge assets, and non-intellectual assets including collections, infrastructure & human capacity, financial assets, operational assets, and strategic assets (WIPO).

Intellectual property, in particular, is patentable, identifiable and protectable by law, after review and approval by government, and can be divided into the following sub-fields: patents, industrial design rights, copyrights and original works, including software, database rights and databases, layout designs (topographies) and integrated circuits, and plant breeders' rights and new plants varieties. A patent is an exclusive right granted by a sovereign state for an invention, which is a product or a process that provides, in general, a new way of doing something, or offers a new technical solution to a problem. To obtain a patent, technical information about the invention must be disclosed to the public in a patent application. Patentable inventions are not protected under patent law unless applications are filed, and patents issued. Getting patents issued requires the invention to be patentable subject matter, novel, involved an inventive step, and susceptible of industrial application in European patent law (WIPO).

3.5.1. Status Quo of Patenting Exploitations

According to European Patent Office 36% of all patents from universities are being exploited, 42% are planned for exploitation, and 22% are not planned for exploitation. These numbers show that roughly 1/3 of the total number of patents are being exploited and probably successfully commercialized. The main problems with exploitation are reflected in Figure 3. It shows that 38% of attempts face a failure to find a partner and 25% experience the lack of resources. It is logical to assume that failure to find a partner may mean that functions of networking and creating necessary awareness are not carried out well enough. Potential reasons are summarized in the following figure.

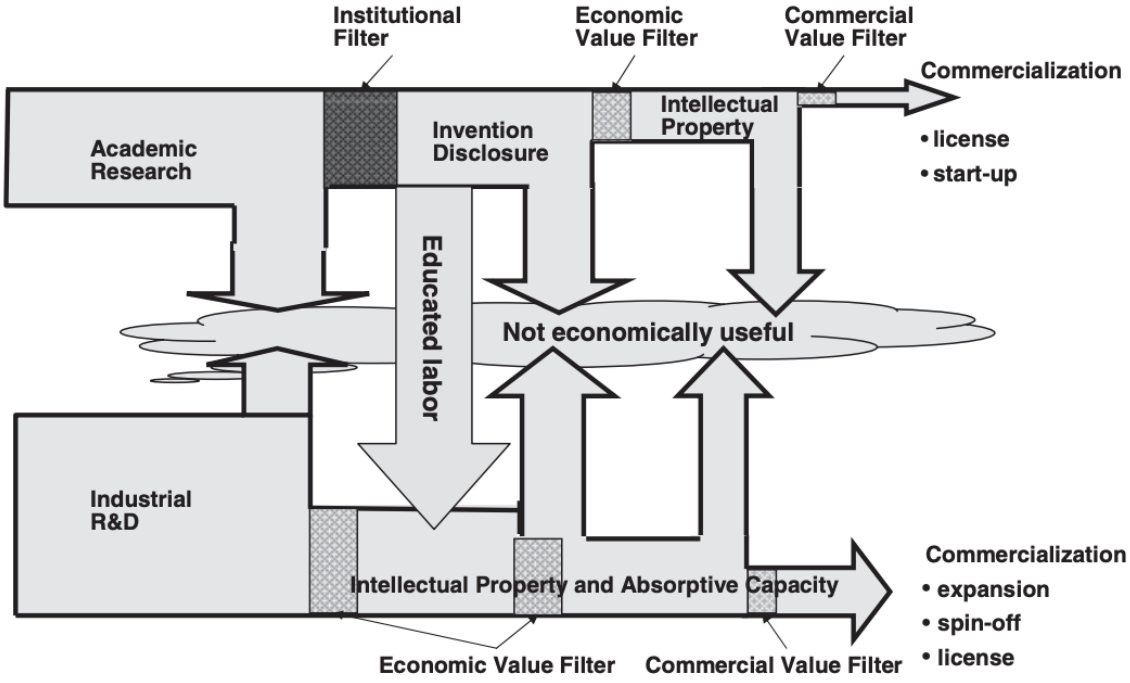
Figure 3 – Challenges to Succesful Exploitation (WIPO)



3.5.2. Knowledge Filter

From the law requirement, it is clear that being eligible for industrial application is an explicit nature of patents. However, it is always challenging to apply patents to industrial practice. Firms in Europe fail to commercialize knowledge generated in university and higher education institutions compared with their counterparts in the US. There exist broad reasons preventing knowledge from being economically useful, which include but are not limited to institutions, geography, and entrepreneurial ecosystem. Scholars describe such barriers to converting research into commercialization as the knowledge filter (Carlsson et al., 2009). The following figure shows the potential role of the knowledge filter in the knowledge system.

Figure 4 – Knowledge Filter in the Knowledge System (Carlsson et al., 2009)



The first component of knowledge filter is institutional filter regarding academic research. Except for lacking incentives for researchers to engage in commercialization of scientific knowledge that is discussed above, it consists of organizational barriers, university policies, and attitudes against commercialization of research. The second and third components of the academic knowledge filter are the economic and commercial value, which reflects the capability to convert inventions into intellectual property and then commercialise via license and spin-offs to start new ventures. When the academic research has a low capability, the knowledge filter is thicker, thus decreasing the chance of commercialisation (Carlsson et al., 2009).

TTOs, in narrow sense (university departments that help to file in and license patents), mainly foster commercialization via license because spin-offs or start-ups are not the primary mission of their work and TTOs are financially constrained to support spin-offs. However, licensing is demanding for TTO staff. Staff needs to be self-motivated and prepared to take initiative often. They need to handle a variety of projects across campus and constantly communicate the progress they are making on projects. More importantly, TTO staff helps build the institution's research base as the activity is unfamiliar to most researchers, administrators, and leadership, when the success is unclear. Hence, staff should show characteristics of patience, modest ego,

the ability to collaborate with people, paying attention to detail, taking initiative and having the ability to sell a concept of "what might be" if the utilization works (WIPO).

An often negligible knowledge filter is the university-industry linkages where knowledge can flow through. Another function of universities and higher education institutions is to teach and transport educated labour to industries. Research alliances between universities and industries are scare to accelerate technology transfer. Potential alliances can include informal information sharing among research partners, one-on-one research ventures, contract research on solving a specific problem of firms, or seminars for industry (Mueller, 2007). The high-skilled labour in industries has the ability to select knowledge from academic research and realize licenses from universities. They can also start their business with patents that are licensed from universities or created by them at universities as spin-offs depending on the absorptive capacity of different companies and startups.

Overall, patents are dcritical intellectual property generated by universities and higher education institutions that can contribute to improving society and the lives of its citizens. However, the knowledge filter that spreads over universities and industries proposes challenges to prevent research from economically useful commercialization. More policies should be applied to penetrate the knowledge filter and encourage knowledge commercialization via licenses and startups.

4. Policy Recommendations

Thus, based upon our findings, we propose a series of policy recommendations aimed at supporting our main policy recommendations: to **create a framework supporting spin-offs based on academic patenting** and to **Increase TTO visibility**. However, to achieve this, there exists a series of barriers which have to be overcome.

The current incentive structure, which creates the basis for academic participation in TTO activities, is flawed. There exists a need to **align objectives.** Most academics are motivated to stay in academia due to reasons other than those of monetary nature. Thus, when the main incentive structure for engaging in TTOs is monetary, this may decrease academic participation. We, therefore, suggest that there is an increased focus on recognizing patenting activities as being equally valued to academic publications when measuring academic performance. Furthermore, highlighting the benefits, other than monetary ones, of patenting, such as a potentially larger societal impact from inventions, is also highly recommended. This

may be achieved through initiatives such as incorporating the positive impact commercialization can have on society in funding calls.

Once the objectives of the participants have been aligned, there also exists a need to increase the visibility of the TTO and its related activities. We propose that this is achieved through three remedies to this.

Firstly, implementing a mandatory **Declaration of Expected Invention** signed by academics when receiving funding should increase awareness of TTO activities. This forces academics to consider the possibilities of patenting. Furthermore, this would also aid the TTOs in identifying potentially patentable inventions at an early stage. Through this, the TTO could work together with the academics at an early stage to increase the likelihood of patents emerging from research. It would also serve as a preventive measure as TTOs could intervene before potentially patentable inventions are presented to the public domain and, thus, become no longer patentable.

Secondly, we also propose that there be an increased focus on offering **innovation and entrepreneurship courses** for students and staff alike. These courses, which an entrepreneurship department could facilitate, would increase awareness and decrease foreignness of entrepreneurship activities to students and staff.

A more radical initiative, which we believe may also be helpful, is a two-fold paradigm shift. We propose that the definition of TTOs be broadened to better fit the changes in reality and adopt the WIPO definition, which focuses on innovation transfer rather than knowledge transfer. This should be accompanied by the introduction of the Innovation Readiness Level framework instead of technology readiness levels. The new function of the TTO would be to align goals among various participants in the commercialization process. This paradigm shift should also be reflected in changing the name of Technology Transfer Office to Innovation Transfer Office. Such a conceptual change will remove the differentiation between the narrow and broader understandings of the initial TTO notion and can ease out complications of responsibility identification.

While the visibility of the TTO is of utmost importance, the commercialization of academic research remains highly reliant upon academic patent-based spin-offs. Thus, to **create a framework supporting spin-offs based on academic patenting,** we propose that, in addition to the aforementioned, the following also be implemented.

Firstly, create a **less exclusive transition from academia to industry**. Academics who agree to participate in the creation of a university spin-off take a significant risk. Either the spin-off is a hobby project or the academic quits their job to focus fully on the spin-off. No in-between solution seemingly exists. Thus, a compromise to between these two outcomes is desirable. This may be achieved through a 3-6 month leave of absence period for the academic to create their spin-off where the academic is either paid in full, partially paid or unpaid; however, throughout that period, the academic resume their function at the university at any given time. This would decrease risks for academics as they would always be able to return to their old job – combined with proper support, this could be a viable option.

Secondly, **align resource distribution.** TTOs are supported financially in their endeavours of obtaining patents and operating costs, however, this is flawed. As has been established, spin-offs are an effective means of commercializing, which is not supported. The little funding which is obtainable (approximately 10 000 Euros) is usually far from enough. Instead, the TTOs are required to use revenues from licensing deals to finance spin-offs. This creates a bottleneck. Licensing might be beneficial in the long term; however, as it currently stands, the process is far too long. The TTO and academics see basically no return for years. There is a need to incentivise this, e.g., university or RCN pays a licensing bonus to academics whose patent is deemed patentable by the TTO – could be evaluated by another TTO from another university to avoid a conflict of interest. The bonus would be for further research (like a grant), which would decrease the workload on academics as the need for seeking grants would be reduced, and they could continue their research.

Lastly, we would like to remind the readers that this policy brief has focused on measurable commercialization of academic research, i.e. academic entrepreneurship. Contrasting this, there exists academic engagement which focuses on less measurable knowledge transfer through, e.g. informal information sharing among research partners, one-on-one research ventures, contract research on solving a specific problem of firms, or seminars for industry (Mueller, 2007). While we do not focus on academic engagement in this report, it has great positive impact in relation to knowledge sharing and exchange, ultimately benefiting the economy and society, and should not be forgotten.

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