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Cyclical IPR-public Grant Engine Driving R&D Innovation in Small Research-intensive Private Enterprises

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Abstract

A reciprocal relationship has been documented between registering formal intellectual property rights (IPR), obtaining public grants, and undertaking publicly subsidised R&D innovation projects. Focusing on SMEs as key beneficiaries of such grants, this paper provides an original conceptual framework to rationalise this relationship based on the core criteria to obtain and successfully exploit both grants and formal IPR. R&D innovation grants from several European countries display common elements conducive to securing formal IPR status. Novel observations of several European SMEs demonstrate an innovation engine cycling between formal IPR management and publicly subsidised R&D innovation, sometimes for multiple cycles over several years. This was seen for varying grant sizes, technological sectors, and geographical locations. The framework and observations presented herein are of potential interest to research-intensive SMEs, public grant bodies, and professional service providers for public subsidies and IPR management.

Keywords: R&D Innovation Project; SME; Grant; Public Subsidy; Proposal; Intellectual Property Rights; Patent.

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1 Introduction

The balance of the literature concurs that public R&D innovation grant funding is associated with subsequent improvements in a firm's economic performance (Duch et al., 2009; Doh and Kim, 2014; Criscuolo et al., 2016). Contrary to earlier studies, recent research employing improved econometric techniques suggests that public subsidies promote further private investment in firms (Becker, 2015). In a recent study of private firms' participation in publicly funded R&D innovation projects over 2004-2016, Vanino et al. (2019) compared 6000 UK firms participating in their first R&D innovation project funded by UK Research Councils against an equal number of similar firms that did not receive a grant. The firms were matched on multiple criteria that can influence their capacity to secure public R&D innovation grants, such as turnover, age, location, and the R&D innovation intensity of the specific industrial sector or region where the company operates. Employment and turnover were increased in firms participating in funded projects, particularly for small firms in R&D-intensive industries. As a result, it is of interest to understand the characteristics and activities of small firms that secure public R&D funding.

In the above UK study, previous patent activity increased the likelihood of participation in at least one publicly funded project during the studied period (Vanino et al., 2019). Patents are commonly used as a barometer of technological innovation as they possess both technical and market attributes (Kuznets, 1962), there are extensive databases of publicly available information, and they cover most industries over extended periods (Grilliches, 1990; Paci et al., 1997). Park et al. (2005), for example, used patent citation analysis to study structural and dynamic innovation patterns across industries. In relation to public R&D grants, a positive effect on subsequent patent activity of industry partners has been documented for publicly funded R&D innovation projects in Germany, South Korea, the US, and China (Czarnitzki and Lopes-Bento, 2014; Doh and Kim, 2014; Howell, 2017; Wang et al., 2017). Bronzini and Piselli (2016) observed increased patent applications in small firms in northern Italy receiving subsidies with a total value exceeding €206,000. This pattern appears to stand regardless of regional innovation performance. The European Innovation Scoreboard (EIS) is a comparative index of national innovation performance across Europe and beyond. It uses 'Intellectual Assets' as one of three core categories to measure firms' innovation activity. This category covers different forms of Intellectual Property Rights (IPR), including Patent Cooperation Treaty (PCT) patents. In 2018, South Korea and Germany were strong overall innovators that also scored well in patent applications relative to other elements of innovation output (EIS, 2019). The US was also a strong innovator overall, but US patent output was not a relative strength versus other innovation measures such as public-private co-publications and private R&D expenditure. For China, a moderate innovator, the number of patent applications was not identified as a national strength compared to, for example, private R&D expenditure and trademarking. Taken together, these studies suggest that, regardless of baseline national innovation capacity, public grants positively contribute to promote patent activity as a commercially oriented innovation output.

Although the relationship between public R&D innovation grants and patenting has been quantified extensively, relatively little attention has been paid to the underlying nature of this relationship. Howell (2017) speculates that grants reduce financial and technological uncertainty in SMEs, which helps attract private investment and promotes further technological and commercial development, including developing the companies' formal IPR assets. However, possible direct links between the management of IPR assets and public grants have not been examined in detail. This paper considers the nature of this relationship based on a conceptual framework and detailed observations of several publicly funded industrial R&D projects.

2 A conceptual relationship between novel IP ownership and grant funding

The general requirements to successfully generate and exploit formal IPR assets are well defined in the academic and legal professional literature. The OECD Patent Statistics Manuel (2009, pp 43-45) provides a useful overview of processes followed to obtain a patent and commonly applied patentability criteria. A positive patentability evaluation and the eventual approval of a patent application typically requires:

1) Technological novelty.
2) Inventive step.
3) Industrial applicability.

In addition, the true value of most patents rests on the ability of the owner to commercially exploit the underlying invention. Al Aali and Teece (2013) summarise numerous challenges facing the strategic management of IP assets to maximise their commercial exploitation. This includes recent trends such as an increasingly complex IP landscape, citing as an example the increasing number of published patents per year in many technological sectors (400 USPTO motor vehicle patents per year in the 1920s versus ~7000/year in semiconductors today). As such, the authors advocate a "proactive IP audit around business model design and strategy" to "reduce the chances that... [R&D] will run up against patents owned by others". Supporting this:

4) Freedom to operate (FTO) analyses, which consider the full landscape of background art and related third-party patents to the technology at hand, shed important light on commercial competitor and/or pre-commercial state-of-the-art. This supports secure technology exploitation and commercial success.

Based on the present author's extensive work with innovative SMEs applying for public R&D innovation subsidies, from across Europe and including various technological sectors such as mechanical engineering, pharmaceuticals, chemistry, agri-tech, ICT, robotics, and telecommunications, all four of the above IPR elements align strongly with key aspects of a successful innovation grant application:

A. You must have something unique, to justify why public R&D innovation funds should support your work over many other applicants for the grant. This directly relates to patentability criterium 1/ Novelty, above.
B. There must be a high degree of difficulty, uncertainty, and risk in the R&D that justifies why public, as opposed to private investor funds, should support the work. This directly relates to patentability criterium 2/ Inventive step, above.
C. The innovation should provide a high degree of value to users, and it should address a relevant commercial opportunity. As such, there is a high potential socioeconomic and/or environmental return-on-investment if the publicly subsidised project is successful, which justifies the use of public funds to cover the proposed high-risk R&D. This relates to criteria 3/ Industrial applicability and 4/ FTO, above.
D. A deep knowledge of the patent landscape and/or commercially relevant competing technologies is highly relevant to develop and navigate a sound business strategy. This is frequently a core requirement for a strong innovation grant application. It is fundamental to successfully navigate relatively generous and ambitious programmes, such as the Innovate UK SMART Grants and European Innovation Council (EIC) Accelerator grants for ground-breaking near market innovations by European SMEs. This relates to criterium 4/ FTO, above.

The above considerations provide a framework to assess possible effects of IPR-related activities on firms' likelihood to attract public funding. The next section of this paper explores a possible inverse relationship, i.e., effects of public R&D innovation funding on firm IPR management.

3 R&D innovation grants support IPR-related activities

Once approved, competitive R&D innovation grants support innovative, high-risk technological development and testing. This often includes personnel costs, materials/consumables, equipment, and travel costs. Many grants also include a generous overheads allowance of around 20-25% of personnel and/or other direct costs for industry partners, regardless of their size. In all, this supports technical R&D innovation work leading to prototyping and proof-of-concept test data that feeds new patent applications.

Many industrial R&D grants also provide some limited support for IPR management itself, including processing new patent applications and/or FTO analyses. UK companies receive a grant on total eligible costs up to £7,500 per project for this in SMART and the European Eurostars grants programme for cross-border collaborative R&D. IPR management costs of several times this amount are typically acceptable as eligible costs in the largest European R&D innovation grants, such as the EIC Accelerator and Horizon Europe Pathfinder programmes.

The total eligible project costs in the granted projects range from £250,000-£600,000 for UK SMEs in SMART and Eurostars, and a similar ballpark total budget is seen for other single or multiple applicant national programmes. Danish Innobooster, for example, supports total project costs of up to the equivalent of €670,000. Danish Grand Solutions and EIC Accelerator are typically €1,700,000-€3,000,000 total costs. The grants cover up to 60-75% of these costs for, as an example, an Innovate UK industrial research project run by a British SME, or an SME involved in a Eurostars project application with collaborators from other countries. Many other European countries in Eurostars offer grants covering 45-60% of total R&D innovation project costs. Some of the most prestigious European R&D innovation grants, such as Pathfinder, Research and Innovation Actions, and some Innovation Actions, cover 100% of total project costs. The Danish Grand Solutions programme typically covers 75% of costs, including various pre-commercial activities such as formal IPR management and FTO studies.

4 Illustrative public R&D projects

An innovative, fast-growing Scandinavian aquaculture feeds SME, Company A, has been prolific in securing large European grants, in each case worth the equivalent of €464,000 to €1,700,000 to Company A for projects implemented over 24-30 months. These projects aimed to support Company A's novel industrial R&D and pre-commercial piloting and scaling activities. Company A filed an initial technology patent covering its novel processes in 2013. Its first large EU grant was approved in 2015. The technology clearly met the core requirements for both milestones, being novel and unique (patent-grant criteria 1-A from Section 2, above, as a previously untapped source of feedstock demanding radically new technological production processes), inventive, difficult, and risky (2-B, overcoming both fundamental processing challenges and a requisite transformation of end user processes to apply the feed), industrially applicable and valuable to end users (3-C, a practically and industrially feasible process delivering significant nutritional, sustainability, operational and economic gains for the target sector), and having confirmed FTO in relation to its core innovation and planned business activities (4-D). Company A also secured the equivalent of €350,000 in private seed finance in 2013-2014.

The following EU project, supported by the grant that was approved in 2015, allowed Company A to further develop its production process and was considered a success by both the recipient company and the grant body. Data from the project directly contributed to a second process patent that Company A filed in 2017. It also supported the company in obtaining further private investment worth €1,600,000 from 2015-2018. The company then built on this success, securing two further large R&D innovation grants in 2019. From the subsequent publicly subsidised industrial R&D innovation work, Company A has so far been unable to patent its latest innovations with respect to an additional aspect of the technology due to potential issues with its FTO in this specific area. Nevertheless, Company A has leveraged the latest publicly subsidised projects to generate valuable data that further validates the pre-existing patents. The latest results, obtained with grant support, have significantly contributed to Company A's frequent follow-up with foreign patent examiners as it expands its international commercialisation efforts. Recent FTO updates, subsidised by the latest grant, helped identify the above risks in some aspects of the technological platform and have provided a rigorous validation of other ongoing activities. This process continues to minimise commercial litigation risks, in relation to both large incumbent players and emerging new entrants within Company A's dynamic technological sector and target markets. Company A achieved these successes in fluid cooperation with long-standing IPR and grants advisory partners, with whom it plans to continue working for its future R&D.

An overview of Company A's innovation journey is shown in Figure 1.

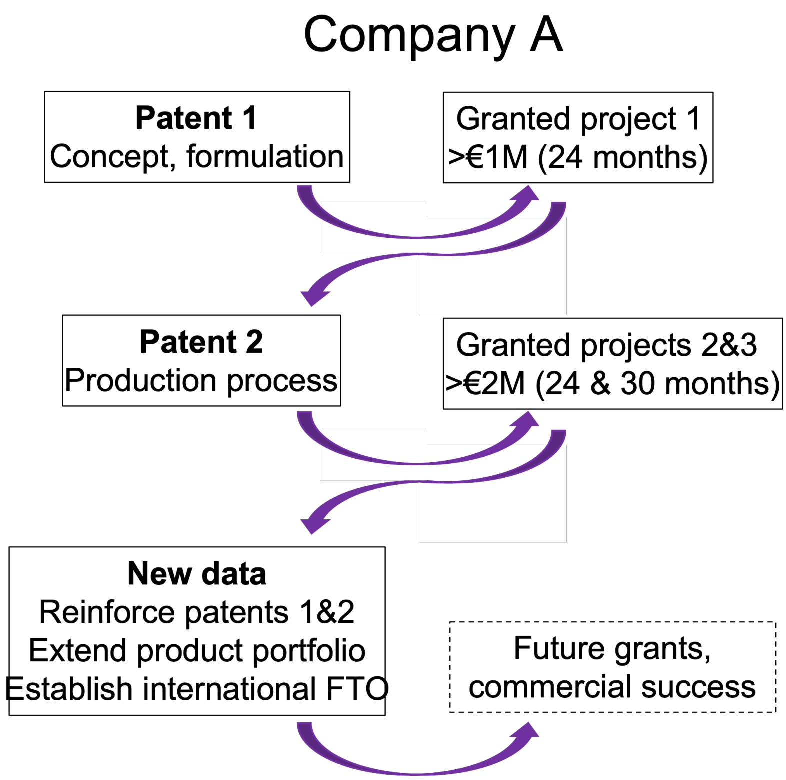

Figure 1. Company A IPR activities and granted R&D innovation projects.

Looking at a separate example, an innovative Spanish start-up, Company B, designed a technically novel (1-A), water- and grease-proof nanocoating for glass substrates. This comprised a chemical formulation and synthesis route that bypassed the standard use of fluorine moieties (2-B – inventive step), widespread in current standard processes but being phased out due to toxicity and environmental harm of residues shed from the coating over time. The novel nanocoating promised to provide a valuable anti-fouling function with multiple application areas including optical lenses and solar panel renewable energy production efficiency (3-C). Armed with a detailed analysis of the global state-of-the-art and patent landscape (4-D, establishing likely FTO) but no filed patent up to that time, Company B formed a collaboration with another, more-established, Spanish hi-tech SME, Company C. Company C brought a novel proprietary platform to the collaboration for effective nanocoating deposition on various solid substrates as, due to its complex 3-dimensional nanostructure, the coating had to be applied within a high-vacuum (2B, technical difficulty). At the time of establishing the collaboration, Company C had filed 4 patents around its technological platform, at least one of which was directly relevant to the anticipated process of choice to apply Company B's novel nanocoating on glass. Companies B and C teamed up with a European grant funding consultancy, with which they together obtained a single shared EU grant of €50,000. This funding was allocated to assess the technological and commercial feasibility of the new integrated technology over a 6-month period. During the study, Company B oversaw a professional patentability and FTO study by legal professionals. This showed that the new coating was not in fact patentable, but that there was FTO to commercially exploit the technology. Company B continued developing the nanocoating for market, keeping its formula as a closely guarded industrial secret. In this case, a relatively small grant was conducive of IPR management activities supporting technology exploitation. This is reminiscent of the observed effect of collaborative health-tech R&D projects promoting positive innovation and R&D performance outputs irrespective of the size of the grant obtained (Zhang et al., 2018). In both the above example projects, positive effects enabling subsequent commercial exploitation were observed, even without further hard IP protection downstream of the publicly funded project.

Taking a final example, Company D is a UK SME that has developed disruptive oral medicinal food formulations for the diagnosis of food allergies. The company was founded in 2013 as a University spin-out to build on results obtained in a large collaborative European research project. Part of the company's IP was quickly protected by 2 patent applications. The company was successful in closing £6.4Mn in private investment to develop its first product formulation, manufacturing plant, and initial regulatory approvals for peanut allergy diagnosis in adults. Recently, the company secured a positive technical evaluation for a new R&D project supported by a large national public grant. The proposal was prepared in collaboration with external specialists in granted public innovation projects. The provisional technical approval of the project strongly benefited from the company's well-developed IP protection strategy, including the initial patents supplemented by a solid trade secret strategy around scaled manufacturing and pharmaceutical-grade quality control recently developed by the company. The grant substantially de-risks the development of a new range of pediatric formulations for multiple different trigger foods. It will stimulate the company to accelerate and broaden this area of its operations to meet an urgent and growing medical need in a vulnerable patient group. The company expects to generate new patentable foreground IP from the project.

5 Conclusions and Future Directions

The present study considers a conceptual framework and real industrial R&D examples to rationalise the observed correlation in the literature between public R&D innovation grants, formal IPR management including patenting and FTO studies, and subsequent commercial exploitation of novel technologies, particularly by SMEs. A key observation is that high-tech SMEs with existing patents already meet some requirements to secure grants covering future R&D innovation work. This comes with the proviso that SMEs are a highly heterogeneous group with variable requirements and specialties. The level of patenting activity and strength of appropriability conveyed by patents varies by technology type, with the above examples focused mainly on chemistry and advanced materials where patents tend to play a relatively important role (Al Aali and Teece, 2013, p10). In addition, formal IPR rights are granted *ex ante* before the exact value of an innovation is known, which is one of several perceived tensions between formal IPR protection and economic benefits associated with free market competition (Ganslandt, 2013, p15). From a public policy and grant body perspective, a solid IPR position may therefore be a necessary element, but only form part of the larger picture for a successful public funding application.

Beyond the link from IPR to public subsidies, granted projects feed future IPR activities. Best innovation practice in publicly funded project design and implementation includes further data generation, patentability assessments, hard IP protection (where possible and desired) and ongoing FTO analyses consolidating the firm's IPR and knowledge base. This reciprocal cyclic relationship is depicted in Figure 2 below. Patenting (1-3 on left panel) has similar requirements to successful grant funding applications (A-C), as presented in Section 2 above. FTO analyses generate data that bolster competitor research and business plan development (4-D), which in turn supports grant approval. Successfully implementing the project potentially supports formal IPR activity and generates data supporting further IP applications. This propagates the cycle, which was a consistent feature of public R&D innovation grants across the EU and wider Europe, including Denmark and the UK.

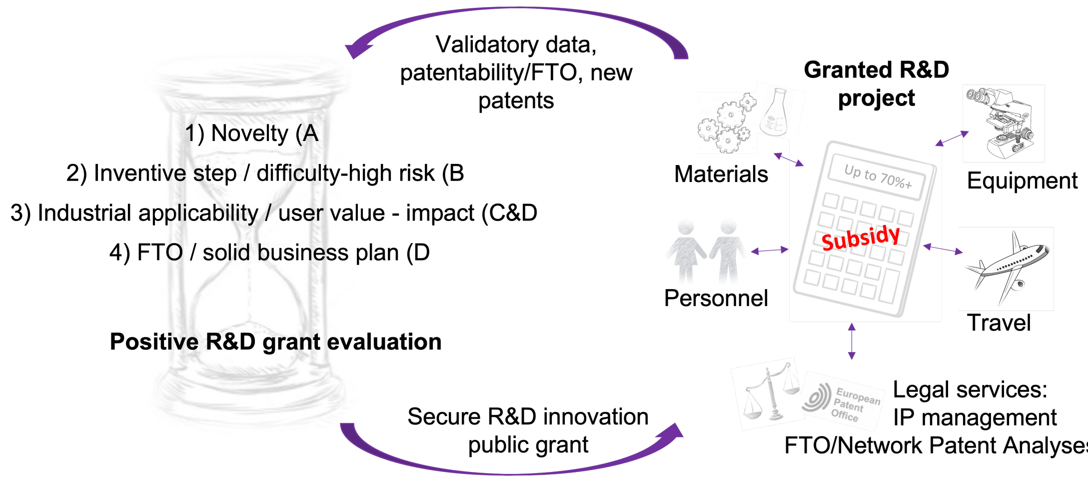

Figure 2. Cyclical relationship between new formal IPR assets (left panel) and implementing publicly funded R&D innovation projects (right).

Examples of Norwegian, Spanish and UK SMEs undertaking publicly subsidised projects demonstrated clear elements of the above cyclical innovation engine. These included serial innovator SMEs having successfully undertaken several rounds of formal IP protection and publicly subsidised project implementation. Examples of both large and smaller grants feeding the IPR – granted project cycle were discussed. The outcomes were consistent with sustained positive R&D innovation effects of small collaborative grants relative to larger subsidies. Over time, a feed-forward, mutually propagating relationship between IPR management and grant success was observed for some SMEs. Whether grant writing capacity is internal or outsourced, grants are often awarded to propel the most innovative companies, who are often single or multiple patent holders, as much as to support specific outstanding innovation projects. In the outsourced grant expertise model, grant proposal preparation and granted project management services becomes increasingly cost-effective, and the consultant's professional radar for relevant upcoming themed grant calls more valuable, over time. Part of the value in the external support model in today's highly competitive grants ecosystem may be in the transfer of innovation best practices between companies. As Bessant and Rush (1995, p.109) put it, consultants act "rather like bees, cross-pollinating between firms, carrying experiences and ideas from one location or context into another".

Observations with respect to FTO of the example SMEs in this study suggest that the strong connection between public grants and IP management may extend beyond grant recipients own foreground/background IP with direct implications for the firm's market competitiveness. Cross-referencing international databases that seek to quantify SME commercial and innovation performance supports this notion. The Global Entrepreneurship Index (GEI) provides an international comparative index of success indicators for business start-ups. The GEI's 'Competition' ability criterium measures start-ups' capacity to make and market new products. The top 10 highest performing European countries in the EIS-2019 score an average of 82% for the 'Competition' ability criterium in the GEI-2018 index, compared to the pan-European average of 49%. This suggests that companies with strong innovation capacity, including good IPR assets (as defined in the EIS), are competitive (as defined in the GEI). Professional FTO studies contribute to this by ensuring that new market entrants can undertake commercial activity without weakening their unique value proposition to the customer and/or running undue litigation risks. This, in turn, may have a positive effect on the GEI Competition criterium, which is based on several parameters indicative of the national capacity for start-ups to create novel products within the context of their regional, national, and international competitive landscape, and to successfully enter the market with those products.

Based on the observations and framework presented in this paper, future research may consider the relative importance of a company's formal IP position for attracting public funding across various regions, grant bodies and technological sectors. It may also be interesting to further analyse the type of activities undertaken in publicly subsidised projects and their contribution to further IP activities and other positive indicators of R&D output and commercial exploitation. Such analyses may be undertaken for serial innovators versus single grant recipients, or across various sizes of granted projects. Does the size of the budget dedicated to formal IPR management services in the publicly funded project significantly influence the patent output and other commercial exploitation indicators? Should R&D innovation output measures focused on IP-related activities consider other factors beyond patenting, such as informal IP protection measures and FTO? What is the relative importance of attracting private or public grant funding in the decision to patent across different technological sectors? How does this interplay with other strategic factors influencing formal IPR management, such as long product development times versus the level of market competition in the pharmaceutical industry? If previous patents support successful grant applications, better understanding these factors may usefully inform grant proposal evaluation systems. It may also help dissect how subsidised R&D innovation project outputs relate to commercial success for the hi-tech enterprises involved in these projects. From a management perspective, there is scope for R&D-intensive SMEs to better understand the role of their background IPR status in attracting public funding, and to evaluate the suitability of in-house or external professional support strategies to promote success in securing and undertaking publicly subsidised R&D innovation projects. Purveyors of professional R&D innovation grant consultancy and legal IPR-associated services may stop to consider potential synergies between their offerings to deliver additional value to their clients.

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Potential Conflict of Interest

The author operates in a commercial capacity delivering grant acquisition services for PNO Consultants UK, who offer grant acquisition and project management services for approved R&D innovation projects mainly to British SMEs. The wider PNO Group delivers similar services across Europe, notably including the European Framework and European Innovation Council Programmes.

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