Technological Forecasting & Social Change xxx (2013) xxx–xxx

Contents lists available at ScienceDirect

Technological Forecasting & Social Change

Signs of things to come? What patent submissions by small and medium-sized enterprises say about corporate strategies in emerging technologies

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ARTICLE INFO

Article history:
Received 11 September 2012
Received in revised form 15 July 2013
Accepted 8 September 2013
Available online xxxx

Keywords:
Nanotechnology
Small and medium-sized enterprises
Intellectual property
Competitive intelligence
Patents
Corporate strategies

ABSTRACT

The management of intellectual property (IP) – particularly in the form of patents – has become of increasing importance to technology-oriented small and mid-sized businesses. Such companies adopt diverse strategies to develop and exploit knowledge as they move along innovation pathways from research and development (R&D) to technology commercialization. This investigation examines IP submissions through recent patents in the field of nanotechnology to better understand those strategies and focuses on how indicators of R&D activity, collaborations, funding and firm characteristics can be used to garner strategic and competitive intelligence about the orientations and IP strategies of technology-based firms. Our analysis of data from the Georgia Tech's Global Nanotechnology Database and other sources and illustrative case studies of U.S. small and medium-sized enterprises in nanotechnology shows that there are at least two different strategic approaches to enter this field and distinctive roles along the innovation pathway. A longer-term strategy is associated with nanotechnology research and discovery and possibly use of nanotechnologies to enhance properties of products. Another strategy is associated with a newer generation of firms with a strong focus on novel nanotechnology product development and commercialization and more intensive patenting activity.

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1. Introduction

The management of intellectual property (IP) – particularly in the form of patents – has become of increasing importance to small and mid-sized technology-oriented businesses. Firms seek a strategic approach to their own IP to maximize returns to their investments in research, new technologies and innovative products, processes and services, as well as to protect their competitive positions. There is also much strategic insight to be gained from understanding firms' IP approaches and through tracking IP patterns by sectors and technologies. Such comparative and aggregated analyses of IP used as a management tool can provide strategic and competitive intelligence that is of particular value in fast-developing technology sectors.

This paper presents a framework and methodology to probe what efforts to acquire intellectual property can tell us – particularly when coupled with other sources of information – about corporate strategies to engage in and develop emerging technologies. This includes characterizing new technology-based firms in terms of their emphasis towards knowledge discovery and exploitation, the relationship of public innovation funding and patenting, and the role of external knowledge sources and collaborations. We also explore size, industry sector, and generational differences among nanotechnology firms in patenting.

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0040-1625/$ – see front matter © 2013 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.techfore.2013.09.006

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The paper is organized as follows. The next part (Section 2) discusses recent developments in IP and corporate strategies, sets the context of this research, and puts forward two propositions that offer explanations to patentable outputs and commercialization in emerging technologies in terms of firm-level factors. We then (in Section 3) describe our methodological approach, model and nanotechnology data. Findings are then presented (in Section 4) about corporate strategies in nanotechnology, drawing on statistical modeling and mini case studies. Section 5 discusses those findings and elaborates on their corporate and policy implications. The final part of the paper (Section 6) considers overall conclusions and discusses future steps for research.

2. IP and corporate strategies

In growing technology-oriented sectors, corporate activities to develop and exploit knowledge may adopt diverse forms as they move along innovation pathways from research and initial development to commercialization of technologies. Prior work has classified new technology-based firms into either science-based – that is, firms that seek to develop applications based on research and discoveries of new concepts, materials, or techniques – or engineering-based—that is, firms that seek to expand and refine existing applications [1]. Firms in either category can pursue the development and protection of IP. This suggests a variety of plausible IP and technology strategies that firms may follow to engage in an emerging field. For example, firms can combine, to a different extent, own IP advancement with a series of additional knowledge-related activities including scientific publication and research cooperation with research institutions and other firms. Alternatively, firms may focus on the development of broader or narrower technology portfolios and, hence, more or less intensive patenting activity.

The context in which we examine our topic is that of the development of IP, or more specifically, patenting activities, in the domain of nanotechnology. Nanotechnology is an emerging technology through which materials, devices and systems can be enabled with novel properties resulting from the engineering and assembly of matter at extremely small scales. At the nanoscale, scientific discoveries have unveiled new properties that offer the potential for innovative applications in a wide array of market segments such as energy, pharmaceuticals, and semiconductors. With a wide range of potential applications, nanotechnology is anticipated to have significant business and economic impacts in future years. The nature of those impacts will depend to a substantial extent on corporate activities undertaken now and in earlier periods.

There are different perspectives as to how the field of nanotechnology is evolving and whether the field is entering a phase of more intense commercialization and corporate activities. One of these perspectives proposes that there is an accelerating growth curve in patenting activity as nanotechnology moves from research to commercialization. Previous research has shown that the balance of corporate activity between publications and patent applications has shifted more towards the latter in recent years, which suggests that a shift in corporate emphasis from discovery to commercialization in nanotechnology is underway [2]. Other works suggest similar general trends but with some twists such as, for example, different waves of growth driven by periods of research discovery, knowledge absorption, and then commercially oriented growth [3].

Efforts to better understand strategies in an emerging field such as nanotechnology can benefit from insights coming from other developed fields and research on enterprise behavior. Rather than changes in firm strategies or new foci of R&D activities, there may be more profound, structural changes resulting from the creation of new firms that enter the field with new, radically different strategies to those implemented by pre-existing firms. For example, previous research found a new generation of small and medium-sized enterprises (SMEs) in the semiconductor industry in the 1990s that focused on specific design and IP creation rather than on integrated chip production [4]. When entering a new technological domain, new SMEs may also be significantly different from incumbent firms in their performance and nature. Scholars have found, for example, that newer firms can produce better quality innovations as measured by the innovation's market value [5] and that new firms may directly develop as born global firms rather than following the path of incumbent firms that become traditional exporters or flexible specialists [6].

This paper focuses on the individual corporate strategies of SMEs in the emerging nanotechnology domain. While many scientific discoveries have been made in this filed, nanotechnology has sluggishly moved from labs to concrete industrial applications. In part, this may be due to nanotechnology's multidisciplinary, wide-ranging and potentially disruptive features, posing a decision-making challenge to design the most appropriate corporate strategies and organizational structures to adopt and exploit nano-related innovations [7]. In this context, the identification of formal strategies or emerging patterns of corporate behavior is likely to present some difficulties. Certainly, different research approaches can be applied to this with varying results. In particular, this paper focuses on the examination of technology patent submissions by SMEs to add further understanding about choices in corporate strategies in this emerging domain and, more generally, better understand the future evolution of the field of nanotechnology.

There are a number of dimensions of the study of corporate strategies that are of interest of this research. R&D funding is one of those key dimensions. Fast growing technology-oriented firms generally draw on venture capital and other sources of funding such as procurement contracts and research grants to fund early R&D phases in product development. Previous research has shown that firms that are awarded research grants, for example, grow faster and are more likely to succeed in subsequent stages of fundraising and development toward commercialization [8,9]. Other scholars have also emphasized the importance of external and internal knowledge sources for innovation [10–12] and described how companies, in the pursuit of an open innovation approach, increasingly rely on external knowledge sources to be able to successfully achieve innovations and profit from new technologies [13]. Hence, R&D activities and R&D collaborations are important aspects to understand corporate strategies as they become instances of knowledge creation and sourcing/dissemination, respectively. Other more general factors are likely to affect corporate strategies. Company size, market segment, and whether the company is a newcomer or an experienced firm, for example, may explain differences in strategic decisions

Please cite this article as: L. Kay, et al., Signs of things to come? What patent submissions by small and medium-sized enterprises say about corporate..., Technol. Forecast. Soc. Change (2013), http://dx.doi.org/10.1016/j.techfore.2013.09.006

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