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The role of sources of finance on the development of wind technology

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ABSTRACT

This paper contributes to the debate on the competitiveness and maturity of wind technology by carrying out an analysis on research investments and sales of a panel of 10 wind manufacturers over the period 2002–2011, examining the extent to which public and private funding affect the competitiveness of these wind corporations. A group of major manufacturers of wind turbines with production in 2006 totaling more than 70% of the global supplied capacities is considered a representative cluster of green innovative industry for this study. Public support for research, development and demonstration (RD&D), incentives for the production of wind energy and access to credit are the three main sources of finance addressed herein. Corporate debt is the primary factor supporting both wind technology research investment and sales of wind turbines, whereas other sources of finance play a limited role. The reduction in that source of finance has important repercussions for the development of wind energy. The econometric analysis suggests that regulatory risks play a key role for the development of wind technology, even stronger than the financial risk. Thee former originate in unexpected decisions to stop subsidies (e.g. deployment ones), whereas the latter arise from restrictive access to credit.

1. Introduction

This article investigates the role of different sources of public and private finance that support the development renewable energy technology, focusing on wind energy. These sources refer to a combination of *technology push* policies, such as public research, development and demonstration (RD&D) investment, and *market pull* policies, such as deployment subsidies and feed-in tariffs. The access to credit from financial institutions, as judged by the level of corporate debt, is also considered as significant support mechanism. The weight of the latter item is expected to increase in particular for offshore wind, as the risks of the technology decrease with maturity.

Public support to technology development has been extensively researched [1–3] and proved to trigger clean energy innovation. According to the International Energy Agency statistics,[3] investment supporting research, development and demonstration activities in wind technology (RD&D) in European Union Member States have more than doubled in the last ten years, growing from € 60.11 million spent in 2001 to € 174.53 million in 2010. Many member states have intensified their support for research, seeking to support private RD&D investment, which is suboptimal in the presence of environmental and technological market failures [4]. Environmental support schemes could therefore complement and reinforce private investment, acting also as a driver of patenting [1]. Other public instruments, such as public loans, have also been demonstrated to be effective sources of financing for the deployment of renewable energy [2].

Wind energy technology has matured and has shown the potential to compete on the cost of generation with some fossil fuel technologies and most other renewable energy technologies. The presence of policy stimuli for energy production is found to be a further driver of technological progress [1]. Our intuition is that alternative sources of finance, complementing public subsidies, fundamentally support the funding of research upstream in the wind energy supply chain. According to Kalamova *et al.* [3], the companies playing a key role in the development and stabilization

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[3] International Energy Agency (IEA) RD&D Statistics, Data services, Detailed country RD&D budgets, consulted November 2012, http://wds.iea.org/WDS/Common/Login/login.aspx.

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of the clean energy market, are large multinational corporations. The companies taken into account in this study, namely *Nordex*, *Vergnet*, *Siemens*, *Vestas*, *Acciona*, *Alstom*, *Gamesa*, *Enercon*, *REpower* and *Areva*, reveal a large extent of the recent evolution of the wind industry. In 2006, seven of these companies were listed among the global top-10 wind technology manufacturers [5,6]. Due to increasing international competition, only five of them remained in the global top-10 in 2011. However, they remain important stakeholders in the wind energy industry because their research accounts for 76% of European research investment [7]. Large European wind companies register a non-negligible research investment-to-sales ratio of 2.87% [7], enjoy easier access to finance, and subsequently are expected to contribute significantly to the evolution of the wind energy industry. In the upstream of wind energy technology the term debt is here used referring to all the sources of finance other than equity, included in the current and non-current liabilities present on the balance sheet of the technology suppliers. In the downstream of wind energy sector, other types of debt such as non-recourse project debt have been identified as key sources for wind deployment. As such, [8–10] report that between 50 and 80% of the investment needs of wind deployment rely on debt (at an interest rate of approximately 6–9%) [3]. Wind projects are mainly financed through debt [11], because debt service costs tend to be lower than equity payments [12].

Third-party finance availability is a function of the uncertainty with regard to the market potential of the technology, which is influenced by the (perceived) maturity of the technology [13]. The more mature the technology, the lower the level of financial risk associated with that technology will be. Moreover, uncertainty regarding the market potential of wind energy technology depends on the design of the public intervention. For example, a strong environmental governmental policy targeting the increased deployment of wind technology indirectly reduces the financial risk associated with wind technology [14] and results in higher availability of cheaper debt for the more established (mature) technologies. Thus, these interdependencies between public intervention and private finance affect the cost of financing wind technology. Finally, risks associated with wind technology which can arise from technology maturity, public intervention or the level of private finance available mark out the level of diffusion of the technology [15] and the level of RD&D investments in wind technology.

To distinguish the types of risk associated with wind technology, a panel analysis from 2002 to 2011 has been conducted. Recent econometric studies on innovation processes in renewable energy [1,16] make use of panel analysis at the country level, exploring the relationship between innovation patterns and financial resources. Moreover, country level studies [17] explore the presence of environmental policy spillovers upon innovation patterns. Building on this stream of literature, this analysis focuses instead on a firm-level perspective. The adoption of such a level of analysis is an element of originality that fits the purpose of investigating the contribution of financial and institutional (domestic and foreign) players as key determinants of the performance of multinational economic entities. The paper examines the role of three different sources of finance, as determinants of the innovation and production activities of wind turbine manufacturers: (i) the private research investment; (ii) reimbursable private loans to private entities (banks or other creditors) and (iii) non reimbursable public subsidies (e.g. for RD&D) and energy and climate change deployment policies (e.g. financial incentives for electricity production).

The paper is organized as follows. Section 2 reviews the main sources of finance that accompany each stage of the wind technology life cycle. Section 3 presents the data and Section 4 provides an overview of the research activities and sales of European wind turbine manufacturers. Section 5 estimates the contribution of the three sources of finance to the research and sales of wind technology. Section 6 presents the consequences of reduced finance availability and discusses the risks emerging from these limitations. Finally, Section 7 concludes the paper.

2. Review of sources of finance by technology life cycle

The mobilization of private funds in the early stages of a technology life cycle is challenged by the uncertainty related to the market potential of the new technology [18]. Accordingly, private funding is lower in the early stages and increases in the final stages of the innovation process, when the technology is closer to market. Complementary public funding is therefore needed, and varying along the life cycle of the wind technology.

Public funding represents an important driver of the early stages of the innovation process [19,20] and accompanies private initiatives through the demonstration stage, also called the “valley of death”. National or laboratory funding and additional grants are set in place to address the high risk of the level of future revenue from these innovative activities, which discourages private R&D initiatives. Among the variety of policy instruments, subsidies specifically aimed at research, development and demonstration act as primary support for renewable energy patenting [1]. In addition to subsidies, public loans, equity investment, prizes and tax credits stimulate innovation processes [2]. In the later stage of market diffusion, public policy instruments, such as feed-in tariffs act as drivers of innovation and diffusion processes for wind technology [21,22]. Deployment subsidies are more abundant than public RD&D support for wind technology. Based on conservative estimates, Laleman and Albrecht [23] point out that for every Euro spent on future technologies RD&D additional €35–41 are spent on the deployment of existing technologies. This imbalance is estimated to increase three fold by 2020 if current RD&D budgets remain unchanged [23]. The amount/type of public intervention should be carefully weighted, as an over stimulation of a specific technology potentially limits the development of other renewable technologies, as public money availability is limited. Additionally, public support for innovation should complement rather than replace private investments; publicly-conducted innovation reveals to be cost inefficient compared to privately conducted innovation which turns out to register a higher rate of success [2].

In the early stage of the innovation process, **private research investments** focus on market needs, such as those triggered by globalization and the expansion in new markets [19]. Accordingly, companies introduce products and process innovations rather than new technologies, which, in most of cases, constitute customer-driven market development [19,20]. However, the more mature a wind technology is, the smaller the risk associated with it, the smaller the uncertainty related to market revenues from its exploitation, and the greater the research commitment in further developing the technology will be (see Fig. 1).

The proportion of revenues that can be invested in a technology, which is approximately 2% [23], determines the slope of the learning curve [24] and consequently the diffusion of the technology. Through learning effects, wind turbine manufacturers can reduce the cost of energy to ensure that wind technology can be competitive with traditional sources of energy [6]. As a result, they also get involved in the validation of the technology which constitutes early-stage research. Such a commitment would enhance the limited role that has been attributed by earlier studies [19] to private funding in the early stages of the innovation process.

As the level of uncertainty decreases, the financial institutions increase their investment in wind technology research.