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Taking risks in the face of uncertainty: An exploratory analysis of green innovation

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ABSTRACT

The relationship between uncertainty and firms' risk-taking behaviour has been a focus of investigation since early discussion of the nature of enterprise activity. Here, we focus on how firms' perceptions of environmental uncertainty and their perceptions of the risks involved impact on their willingness to undertake green innovation. Analysis is based on a cross-sectional survey of UK food companies undertaken in 2008. The results reinforce the relationship between perceived environmental uncertainty and perceived innovation risk and emphasise the importance of macro-uncertainty in shaping firms' willingness to undertake green innovation. The perceived (market-related) riskiness of innovation also positively influences the probability of innovating, suggesting either a proactive approach to stimulating market disruption or an opportunistic approach to innovation leadership.

1. Introduction

The relationship between uncertainty and firms' risk-taking behaviour has been a focus of investigation since the early work of Knight (1921) and discussion of the nature of business enterprise. For Knight, uncertainty was always immeasurable in that the distribution of potential outcomes itself was uncertain, while risk might either be measurable or immeasurable depending on the specific context. For example, a bet based on a throw of a die involves a calculable risk – the distribution of outcomes is clear; a parachute jump involves a set of predictable risks of injury but the probability attached to each risk is immeasurable. In business, incomplete information generally renders both uncertainty (Anderson and Tushman, 2001, often linked to the operating environment of an enterprise, and risk-taking immeasurable, i.e. ex ante there is no clear probability distribution of potential outcomes). This emphasises the importance for decision making of perceived rather than measured uncertainty and risk (Tidd, 2001). According to Milliken (1987) therefore, uncertainty becomes 'an individual's perceived inability to predict something accurately' while, analogously, risk-taking might be thought of as an individual's perceived inability to predict accurately the outcome of an action. In the context of innovation, this emphasises the importance for decision making of perceived environmental uncertainty (PEU) (Meijer et al., 2007; Vecchiato, 2015) and the perceived risk associated with any innovation (Dill, 1958; Meijer et al., 2010).

Theoretical perspectives, however, are ambiguous in the relationship they suggest between PEU and firms' willingness to take further risks such as those associated with innovation. Previous research (Souitaris, 2001) has shown that risk taking small firms tend to be more innovative. Strategic perspectives suggest that market turbulence may create new competitive spaces as rivals close or retrench, potentially increasing the returns to (inherently risky) innovation investment (Todd, 2010). Indeed, some firms may actively seek to create market turbulence by engaging in disruptive innovation in order to establish a position of market or technological leadership (Anthony et al., 2008; Hang et al., 2010). Russell and Russell (1992), for example, observe that in response to high levels of PEU, more entrepreneurial companies would seek to capitalise on opportunities from the environment while more conservative organisations would innovate as a means of 'strategic adaptation'. For these more conservative firms, less uncertain business conditions in which markets are predictable might provide a more conducive environment in which to undertake innovation.

Building on previous research (Dijk and Yarime, 2010; Mazzucato and Tancioni, 2008) our focus here is on the relationship between firms' perceptions of environmental uncertainty and their willingness to take risks in making environmentally-friendly innovations. Green innovation is generally associated with product, process or organisational changes which reduce the environmental burden of firms' operations, including potentially innovation related to energy saving, pollution prevention, waste recycling and reduced toxicity (Chen et al., 2006; Wang, 2015; Yang et al., 2015). The success of such innovation is important from at least three perspectives. First, green innovation plays a potentially important role in terms of sustainability (Shapira et al., 2014; Shi and Lai, 2013). In the energy sector, for example, innovation has been

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a key element of developing cost-effective wind and solar energy (Keirstead, 2007; Shum and Watanabe, 2008). Second, the increasing global emphasis on a low carbon economy is creating new markets which create opportunities for effective innovators (Marinova and Balaguer, 2009; van der Bergh, 2013). Thirdly, pioneers in green innovation may enjoy first mover advantages, maximising potential profitability in these new market spaces albeit with associated commercial risks (Chen et al., 2006).[1] One of the general lessons from developing renewables markets, however, particularly where capital costs are high, is that stability rather than uncertainty seems to play a key role in encouraging sustained entrepreneurial activity and innovation (Suurs et al., 2010). The experience of other sectors has also suggested the increasing difficulty of using past experience to shape future scenario planning in the context of changing technologies and business models (Tierney et al., 2013).

In this context, our analysis contributes to the on-going debate about the relationship between innovation risk and perceived environmental uncertainty. Also, we contribute to the growing body of research on the determinants of green innovation and its potential to address environmental issues, providing a firm-level perspective rather than the more standard macro-economic or market view (Nordhaus, 2011). Our results emphasise the link between some elements of PEU and innovation risk. Simultaneously, we reinforce the importance of both PEU and the perceived riskiness of innovation projects as stimuli for green innovation. The argument proceeds as follows. In Section 2 we briefly review previous evidence on PEU, risk and innovation and specify our hypotheses. Section 3 deals with our data and modelling approach, while Section 4 outlines the main findings. The final sections of the paper discuss the results and identify the key conclusions.

2. Literature and hypotheses

2.1. Innovation risk

Behavioural models of innovation suggest that firms' willingness to engage in innovation will be positively related to anticipated post-innovation returns and negatively related to the perceived riskiness of the project (Calantone et al., 2010; Mechlin and Berg, 1980). There are several conceptualisations of innovation depending on the dimensions considered (see Abernathy and Clark, 1985; Henderson and Clark, 1985, for two characteristic examples). The perceived riskiness of an innovation project will itself reflect the technological complexity of the project as well as commercial concerns about sales, profitability and potential competition (Cabrales et al., 2008; Keizer and Halman, 2007; Roper et al., 2008). Radical drug discovery projects, for example, are inherently more risky than more incremental innovations, and project risks may either be exacerbated or offset by a firm's prior experience of undertaking similar projects and their ability to manage elements of innovation risk during the development process using techniques such as real options (Malik, 2011).[2] The technological and market related elements of innovation risk are not independent, however, as Keizer and Halman (2007) suggest: 'Radical innovation life cycles are longer, more unpredictable, have more stops and starts, are more context-dependent in that strategic considerations can accelerate, retard or terminate progress, and more often include cross-functional and or cross-unit teamwork. Incremental projects are more linear and predictable, with fewer resource uncertainties, including simpler collaboration relationships' (p.30).[3] Iyer et al. (2006) also stress the impact of market context, arguing that in some situations such as that in developing countries incremental innovation might represent a more appropriate strategy than radical innovation (Hang et al., 2010). Other studies have suggested that while market turbulence itself may not influence the nature of innovation activity, technological turbulence can have an effect on innovation returns (Calantone et al., 2010). This suggests the possibility that firms embracing technological risks, particularly in the context of environmental uncertainties, may benefit by gaining first mover advantages or market leadership (Leenders and Voermans, 2007).

Technological innovation risks are associated primarily with the potential failure of development projects to achieve the desired technological or performance outcomes, an inability to develop a solution which is cost-effective to manufacture/deliver (Astebro and Michela, 2005), or issues around project development time (Menon et al., 2002; Von Stamm, 2003, p. 308–309). Each may have implications for the subsequent market success or viability of an innovation. In terms of development time, for example, it has been suggested that compressed development time may necessitate overly rapid decision making, reducing innovation quality (Zhang et al., 2007) with potentially negative effects on post-innovation returns (Bower and Hout, 1988). Market-related innovation risks have a commercial dimension linked directly to the demand for the innovation but may also involve issues around rivalry or appropriability conditions. Astebro and Michela (2005), for example, emphasise demand instability as one of three main factors linked to reduced innovation survival in their analysis of 37 innovations supported by the Canadian Inventors Assistance Programme.[4] In newly evolving industries, in particular, demand can play a key role in stimulating innovation (Klepper and Malerba, 2010). Studies of a range of environmental technologies, for example, have emphasised the role of the contemporaneous development of supply-side capability and market demand, often supported by public policy (Dijk and Yarime, 2010; Norberg-Bohm, 2000; Taylor, 2008). In domestic markets for photovoltaics, for example, feed-in tariffs and other fiscal incentives have been used successfully to encourage demand in some countries (Germany, Spain) in the hope of stimulating innovation and market development (Frondel et al., 2008). Market rivalry and competitors' responses may also play a critical role in shaping market-related innovation risks. Rivals' new product announcements may reduce future returns (Fosfuri and Giarratana, 2009), for example, while appropriability conditions may shape firms' ability to benefit from new innovations and therefore shape their market strategy (Leiponen and Byma, 2009). We argue therefore that:

Hypothesis 1. The probability of green innovation will be negatively related to perceived innovation risk.

Beyond the specific innovation project, firms' assessment of the likely returns to any innovation might be said to depend on their perceptions of environmental uncertainty.

2.2. Perceived environmental uncertainty (PEU)

Some studies have considered PEU as a single construct, for example, related to technology (Taminau, 2006), economic conditions (Koetse et al., 2006), or ex ante measures of profit and loss (Ballantine et al., 1993). Other studies have used a single construct for PEU but included a range of different sources of uncertainty. For example, Miles and Snow (1978) examine PEU in terms of financial markets, trade unions, government and regulatory bodies for the macro-external environment and customers, suppliers and competitors for the micro-external environment. Similarly, Ruth et al. (2000), following Daft et al., (1988) and Sawyer (1993), consider both macro-external PEU factors such as technological and political uncertainty, alongside micro-external PEU factors such as customers, markets and resources. The majority of most recent studies have, however, emphasised the multi-dimensional or multi-level aspect of PEU. Miller (1992), for example, writing in the international business tradition, examines macro-level uncertainty

[1] See Kim and Lee (2011) for an exploration of the advantages and commercial risks implicit in first mover and early-entrant strategies.

[2] Incremental innovation might be said to involve 'product line extensions or adding modifications to existing products or platforms (Iyer et al., 2006). Radical innovations are usually said to differ in at least one of two ways reflecting significant changes in product or process technologies and/or a firm's business model (Wuyts et al., 2004)

[3] See also Leifer et al. (2000).

[4] The other predictors of innovation survival identified by Astebro and Michela (2005) are 'technical product maturity' and 'entry cost and price'.