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Green R&D for eco-innovation and its impact on carbon emissions and firm performance

Ki-Hoon Lee^{*}, Byung Min¹

Griffith Business School, Griffith University, Brisbane, Australia

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ABSTRACT

Over the past four decades, the results of the debates about the relationship between corporate environmental performance and corporate financial performance have remained inconclusive, due to the lack of theoretical underpinning and availability of data. This paper examines the impact of green research and development investment for eco-innovation on environmental and financial performance. The research is based on the resource-based view and the natural resource-based view, which explicitly recognize the importance of resources and capabilities. Using a sample of Japanese manufacturing firms during the period of 2001–2010, the study focuses on green research and development investment as a key proxy of eco-innovation and carbon emissions in environmental performance. Our results show the presence of a negative relationship between green research and development and carbon emissions, while green research and development is positively related to financial performance at the firm level. Our findings explicitly support that, in order for firms to adopt a proactive environmental strategy to manage their environmental and financial performance to the best advantage, they urgently need to organise unique resources and capabilities. The findings of this study provide valuable insights and basis of scientific debate on how firms to engage unique organizational resources and capabilities for superior corporate environmental and financial performance.

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1. Introduction

Global warming and its impacts on society in general leave little doubt that businesses play a major role in delivering environmental performance outcomes through production, operations, and efforts to achieve innovations of more sustainable products and practices (Hart, 1995; Porter and van der Linde, 1995; Klassen and McLaughlin, 1996; Lee, 2009; Busch and Hoffmann, 2011; Lee and Kim, 2011). Despite the importance of global warming and firm's innovation efforts, empirical studies using firm level data have been scant. This is largely due to the difficulty of obtaining data. Our research fills the gap by using firm-level data on environmental (and financial) performance and green research and development (R&D) investment. Our unique hand-collected dataset on Japanese firms enable us to investigate the association of green R&D (and R&D) with environmental (and financial) performance.

Increasing societal concerns over environmental degradation and the environmental externalities of business practices push corporate managers to reconsider their current business practices and look for ways to mitigate their firms' environmental impact (Porter and Reinhardt, 2007). Some common examples include environmental management systems, pollution prevention, reuse and recycling, energy efficiency, and carbon management. However, the fundamental question now facing corporate managers is how these activities and strategies to reduce environmental impacts affect business performance (McWilliams and Siegel, 2000; Menguc and Ozanne, 2005; Orlitzky et al., 2003; Lee and Min, 2014).

Over recent decades, debate has been ongoing as to the relationship between environmental innovation and business performance. While conventional wisdom holds that investing in environmental management increases costs without resulting in financial benefits (Palmer et al., 1995; Walley and Whitehead, 1994; Ambec and Lanoie, 2008), a new green perspective considers that early investments in environmental management offset operational costs and enhance financial returns in the long term (Porter and van der Linde, 1995; Aragón-Correa et al., 2008; Sambasivan et al., 2013). In recent years, the management literature has increasingly emphasized the idea of “win–win” environmental

^{*} Corresponding author. Tel.: +61 (0)7 5552 9181; fax: +61 (0)7 5552 9206.

E-mail addresses: ki-hoon.lee@griffith.edu.au (K.-H. Lee), b.min@griffith.edu.au (B. Min).

¹ Tel.: +61 (0)7 3735 5248; fax: +61 (0)7 3735 5249.

strategies, through which proactive environmental management will benefit environmental and economic performance. In business practice, however, developing environmentally friendly products (i.e., green products) while remaining economically and commercially competitive is a significant challenge (Lee and Ball, 2003; Lee and Kim, 2011). Meeting this challenge to create win–win strategies requires more empirical evidence that is applicable to business performance.

In many cases, manufacturing firms attempt to develop green products or production supported by increased operational and energy efficiency (Dangelico and Pujari, 2010). Environmental innovation (or eco-innovation) is a common environmental strategy that many firms adopt to achieve superior environmental and economic performance simultaneously (Dangelico and Pujari, 2010; Triguero et al., 2013). Eco-innovation is

“the production, assimilation or exploitation of a product, production process, service or management or business methods that is novel to the organization (developing or adopting it) and which results, throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resources used (including energy use) compared to relevant alternatives (Kemp and Pearson, 2008, p. 7).”

Eco-innovations are strongly related to firms' investment in research and development (R&D). Importantly, the outcomes from eco-innovation are not immediately apparent, and firms need a long-term perspective on the innovation, particularly since “innovation cannot always completely offset the cost of compliance, especially in the short term before learning can reduce the cost of innovation based solutions (Porter and van der Linde, 1995, p. 100).” In general, the debate on the link between environmental (or eco-) innovation and firm performance has been inconclusive and lacking in consensus, indicating that the debate continues (Ghisetti and Rennings, 2014). More research on the impact of eco-innovation on firm performance is needed to provide a solid foundation that will encourage and guide corporate managers on how to achieve superior environmental and financial performance simultaneously.

In this research, carbon emissions serve as a proxy for environmental performance and green R&D as a proxy for eco-innovative R&D investment. The main objective of this study is to examine the relationship between green R&D investment and carbon emissions and the relationship between green R&D investment and firm's financial performance.

The remainder of this paper is organized as follows. First, a review of the literature on eco-innovation and its impact on firm performance within the resource-based view and the natural resource-based view establishes a foundation for hypothesis development. Next, description of the data and model to test the hypothesis is followed by presentation of the results and further analysis and subsequent discussion on the effects on financial performance. The final section offers conclusions and implications of the study's findings.

2. Theoretical foundation and hypothesis development

The resource-based view (RBV) and natural resource-based view (NRBV) provide an appropriate theoretical basis for discussing the contribution of resources and capabilities to the performance of eco-innovation (Menguc and Ozanne, 2005; Dangelico and Pujari, 2010; Lee and Kim, 2011). In particular, these theories shed light on the relationships among resources, capabilities, and performance, which constitute the basis for eco-innovation in a holistic view.

The RBV and NRBV essentially hold that the competitive advantage of a firm lies in heterogeneous resources that have the

distinctive characteristics of being valuable, costly to imitate, and non-substitutable (Barney, 1991; Hart, 1995). Recognition that its resources by themselves are insufficient to create a competitive advantage raises the strategic importance of a firm's specific efforts or ability to exploit its resources to its own advantage. However, the RBV has been criticized as being unable to explain how to deploy resources to achieve a competitive advantage within a changing external environment (DeSarbo et al., 2005; Hart, 1995). In light of the currently changing institutional regulations, market pressure, and stakeholder influence related to the natural environment, the RBV has obvious limitations in explaining how to improve business performance relating to the natural environment. Furthermore, management theory, including the RBV, has ignored the constraints imposed by the natural environment, and “given the growing magnitude of ecological problems..... this omission has rendered existing theory inadequate as a basis for identifying important emerging sources of competitive advantage (Hart, 1995, p. 987).”

With the increasing environmental pressures from the government and marketplace, firms face sustainability challenges to fostering effective eco-innovation capabilities (Dangelico and Pujari, 2010; Cheng et al., 2014). Building on the concept of the RBV, Hart (1995, 2005) developed the NRBV by including natural environmentally caused constraints and opportunities and arguing that a sustainable competitive advantage can be achieved through valuable, rare, costly-to-copy, and immovable firm resources and capabilities of the firm. According to the NRBV, to respond to the natural environment and achieve long-term success, firms need to accumulate resources and manage capabilities with a longer-term focus rather than a short-term focus on profits at the expense of the environment. An ability to envision sustainable technologies and products can lead to a firm's competitive advantage in the market. Further elaboration of the NRBV highlighted the links between environmental strategies, green capabilities, and competitiveness at a firm level (Hart, 2005; Hart and Dowell, 2011).

As a part of a sustainable development strategy, eco-innovation can be viewed as the cultivation of distinctive, long-term focused green capabilities, buttressed by top management support, eco technologies, and R&D investment. External eco-innovation includes all green external activities of the firm, particularly those involving suppliers, government agencies, and market. Internal eco-innovation includes business practices for efficient and effective management of eco-innovation processes, particularly new product development (Cheng et al., 2014; Ghisetti and Rennings, 2014). While eco-innovation can be further defined in terms of products, processes, and organizations (Pujari et al., 2004; Lee and Kim, 2011; Triguero et al., 2013), this research adopts the definition of eco-innovation from Kemp and Pearson (2008), which highlights both the operational and organizational efforts of a firm to reduce negative environmental impacts. As a firm engages in eco-innovation and makes substantial efforts to reduce the negative effects of activities on the natural environment, many aspects of existing production, processes, and product development need to be reconsidered (Hart, 1995; Gonzalez-Benito and Gonzalez-Benito, 2005).

As a result of adopting eco-innovation, a firm's environmental performance may improve. A study of environmental management and environmental performance described environmental performance at the firm level as a measurement of how successful a firm is in reducing its negative impact on the natural environment (Klassen and McLaughlin, 1996; Gutowski et al., 2005). Environmental performance includes efficient use of resources, reduction of wastes and energy consumption, and reduction of environmental risks (Aragón-Correa et al., 2008). To improve environmental performance using eco-innovation, firms need to invest in new environmental technologies to reduce pollution and carbon emissions. Eco-innovation can help to identify inefficiencies in production and

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