

On Dynamic Capabilities and Environmental Innovations

European Society for Ecological Economics 2015: Transformations

The 11th biennial conference of the European Society for Ecological Economics

30 June-3 July 2015

University of Leeds, Leeds, UK

Summary

The literature on dynamic capabilities looks at how organizational routines generate dynamic capabilities within the organization and explores whether dynamic capabilities explain differences in performance between firms. Yet, few studies systematically examine the role of dynamic capabilities in driving environmental innovations. Environmental innovations have risen in the strategic agendas of companies due to growing pressures by external stakeholders for a reduction of the environmental impact. In the face of these shifts in the business environment, firms strive to renew their dynamic capabilities in order to meet the increasing need for environmental innovations. This paper makes a theoretical synthesis of the innovation, environmental economics and strategic management literatures and collects new survey data from UK firms. Probit regression analysis shows that technological search, market search, and learning capabilities are important in motivating different types of environmental innovations. These results provide evidence in support of the importance of dynamic capabilities for environmental innovations.

Extended abstract

Introduction

Environmental innovations have risen in the strategic agendas of companies due to growing pressures to reduce the environmental impact of the industry. Governments make environmental regulations more stringent to meet environmental targets and introduce various incentives to encourage more environmentally friendly corporate behaviour; the UK is no exception to these trends (Rumph and Bunce, 2000). In the face of these external pressures, firms are attempting to renew their dynamic capabilities in order to meet the increasing need and demand for environmental innovations. In doing so, dynamic capabilities no doubt play a very significant role even though the importance of these firm capabilities are often underestimated in the environmental economics literature. Dynamic capabilities refer to processes or routines where resources are acquired, integrated, transformed or reconfigured to create new processes or routines that generate competitive advantage for the firm (Eisenhardt and Martin, 2000; Teece, Pisano and Shuen, 1997). This paper examines the impact of dynamic capabilities upon environmental innovations based on a synthesis of the innovation, environmental economics, and strategic management literatures. In particular, in our conceptual framework we consider 4 types of dynamic capabilities¹: (1) technological search (i.e. R&D and environmental R&D), (2) market search (i.e. market research), (3) learning (i.e. training), and (4) organizational capabilities (corporate social responsibility and environmental management systems).

Literature Review

Dynamic Capabilities

In their seminal paper, Teece and Pisano (1994) defined dynamic capabilities as the ability of the management for “*appropriately adapting, integrating, and reconfiguring internal and external organizational skills, resources, and functional competences toward changing environment*” (p.538). Extending the resource-based view² (RBV) of the firm, Teece et al (1997) argued that firms need not only to develop firm-specific capabilities but to constantly renew them so as to respond to shifts in the business environment. Hence, the main rationale for the development of dynamic capabilities lies in the need of the firm to continuously renew

¹ We note that dynamic capabilities are not limited to these four as reviewed in (Teece, 2007) but we limit our analysis to these three areas which are fairly comprehensive in relation to innovation management.

² The resource-based view states that competitive advantage derives from unique, imperfectly mobile and difficult to imitate resources and capabilities (Margaret A. Peteraf, (1993), “The Cornerstones of Competitive Advantage: A Resource-Based View”, *Strategic Management Journal*, **14**, 179-88.; Jay Barney, (1991), “Firm Resources and Sustained Competitive Advantage”, *Journal of Management*, **17**, 99-120.)

its capabilities since in rapidly changing environments, characterised by shocks and Schumpeterian discontinuities, the competitive advantage that static capabilities generate is only temporary.

Environmental Innovations

Environmental innovations can be defined as “*all forms of innovations that reduce environmental impact ... throughout the lifecycle of related activities*” (OECD, 2011, p.29)³. Environmental innovations include product/service, process and organizational changes that aim to reduce the overall environmental impact of the firm (Arundel and Kemp, 2009) and create a competitive advantage to the firm. In this paper, we focus on the environmental product/service and process innovations as the most visible type of environmental innovations listed above. Most studies identify the drivers of environmental innovation at the external domain such as environmental regulations (Rehfeld et al., 2007) and environmental conscious consumers (Cleff and Rennings, 1999), while recent studies look at internal drivers (Horbach, 2008). According to Horbach (2008) internal factors such as firm’s technological capabilities and environmental management systems are important for the emergence of environmental product innovations.

Data Collection and Methodology

Primary data was collected through a survey of UK manufacturing firms from June to November 2010. The sample of firms used in the survey was constructed using stratified random sampling techniques, allowing for a representative presentation of small, medium and large firms from all manufacturing sectors. In total, 1695 active UK firms from 35 manufacturing sectors were contacted and after 2 mail shots and follow-up calls, we were able to collect responses from 169 firms, achieving an overall response rate of roughly 10%. The survey used a structured questionnaire based to a certain degree on the Community Innovation Survey (BIS, 2012) but also included detailed questions on the environmental innovation activities of the firms.

³ OECD (2011) emphasizes that environmental innovations do not necessarily originate from the environmental sector; instead manufacturing and service firms are increasingly taking part in the generation of environmental innovations. Moreover, the nature of environmental innovations is not always technological but extends to broader organizational innovations within the company and across the supply chain (OECD, 2011).

Since both dependent variables are binary in nature (i.e. they only take a value of 1 or 0 indicating the presence or not of the innovations in companies), we use a Probit binary response model.

Results

Our findings indicate that technological search capabilities (*R&D*) do not affect either environmental product or process innovations. By contrast, specific R&D activities tailored to environmental matters (*ECOR&D*) have a positive impact upon the probability of firms introducing both environmental product and process innovations. Early adoption and existing investments in polluting technologies can easily lead to technological lock-ins unless conscious efforts are made in order to divert firm's activities towards cleaner alternatives. Unruh (2002) argues that the majority of established firms find it hard to introduce innovations with environmental benefits because these often challenge their existing position in the market.

Our results point out that market search capabilities are important for the introduction of environmental product innovations, whilst they do not affect environmental process innovations. Environmental product innovations are in close proximity to the customer base of the firm; hence, they affect directly the green image of the company. Environmental process innovations, on the other hand, are hard to be noticed by consumers, and therefore, are less efficient in boosting company image.

Our findings show that learning capabilities are important for environmental product innovations. Learning has been found to be the main pillar of innovation in general (Nelson and Winter, 2002). Learning in relation to environmental matters, might partially require '*unlearning*' some processes that form the basis for polluting technologies. Yet, learning capabilities are not effective in driving environmental process innovations.

Finally, we find that organizational capabilities do not influence environmental innovations. The ambivalence regarding the potential effectiveness of EMS and CSR has been documented in the literature (Bansal and Hunter, 2003; Darnall, 2006; Potoski and Prakash, 2003). This is due to the fact that adoption of EMS and CSR is not sufficient for strengthening organizational capabilities; rather the quality of implementation of EMS and CSR matters the most, and this differs highly across organisations.

References

- Acur, N., Kandemir, D., De Weerd-Nederhof, P. C., & Song, M. 2010. "Exploring the Impact of Technological Competence Development on Speed and NPD Program Performance." *Journal of Product Innovation Management* 27(6): 915-929.
- Agarwal, S., Erramilli, M. K., & Dev, C. S. 2003. "Market orientation and performance in service firms: role of innovation." *Journal of Services Marketing* 17(1): 68 - 82.
- Aggeri, F. 1999. "Environmental policies and innovation: A knowledge-based perspective on cooperative approaches." *Research Policy* 28(7): 699-717.s
- Arimura, T. H., Hibiki, A., & Katayama, H. 2008. "Is a voluntary approach an effective environmental policy instrument?: A case for environmental management systems." *Journal of Environmental Economics and Management* 55(3): 281-295.
- Arundel, A., & Kemp, R. 2009. "Measuring eco-innovation" UNI-Merit Working Paper Series.
- Ashford, N.A. 1994. "Government strategies and policies for cleaner production." United Nations Environment Programme: Industry and Environment.
- Assink, M. 2006. "Inhibitors of disruptive innovation capability: a conceptual model." *European Journal of Innovation Management* 9(2): 215-233.
- Baker, W. E. & Sinkula, J. M. 2005. "Market Orientation and New Product Paradox." *Journal of Product Innovation Management* 22 (6): 483-502.
- Bansal, P., & Hunter, T. 2003. "Strategic Explanations for the Early Adoption of ISO 14001." *Journal of Business Ethics* 46(3): 289-299.
- BIS, 2012. The Community Innovation Survey, available at: <http://www.bis.gov.uk/policies/science/science-innovation-analysis/cis>.
- Boiral, O. 2007. "Corporate greening through ISO 14001: a rational myth?" *Organization Science* 18(1): 127-126.
- Brunnermeier, S. B., & Cohen, M. A. 2003. "Determinants of environmental innovation in US manufacturing industries." *Journal of Environmental Economics and Management* 45(2): 278-293.
- Carrillo-Hermosilla, J., 2006. "A policy approach to the environmental impacts of technological lock-in." *Ecological Economics* 58(4): 717-742.
- Cleff, T., & Rennings, K. 1999. "Determinants of environmental product and process innovation." *European Environment* 9(5): 191-201.
- Cockburn, I. M., & Henderson, R. M. 1998. "Absorptive Capacity, Coauthoring Behavior, and the Organization of Research in Drug Discovery." *The Journal of Industrial Economic*, 46(2): 157-182.
- Cohen, W. M., & Levinthal, D. A. 1989. "Innovation and Learning: The Two Faces of R & D." *The Economic Journal* 99(397): 569-596.
- Cohen, W. M., & Levinthal, D. A. 1990. "Absorptive Capacity: A New Perspective on Learning and Innovation" *Administrative Science Quarterly* 35(1): 128-152.
- Cronin, J., Smith, J., Gleim, M., Ramirez, E., & Martinez, J. 2010. "Green marketing strategies: an examination of stakeholders and the opportunities they present." *Journal of the Academy of Marketing Science* 39(1): 158-174.
- Dahlmann, F. and Brammer, S. 2011. "Exploring and explaining patterns of adaptation and selection in corporate environmental strategy in the USA." *Organization Studies* 32 (4): 527-553.

- Darnall, N., 2006. "Why firms mandate ISO 14001 certification." *Business & Society* 45 (3): 354–381.
- Day, G. S. 1994. "The Capabilities of Market-Driven Organizations." *The Journal of Marketing* 58(4): 37-52.
- Demirel, P., & Kesidou, E. (2011). "Stimulating different types of eco-innovation in the UK: Government policies and firm motivations." *Ecological Economics* 70(8): 1546-1557.
- De Luca, L.M., Verona, G., Vicari, S. 2010. "Market Orientation and R&D Effectiveness in High-Technology Firms: An Empirical Investigation in the Biotechnology Industry." *Journal of Product Innovation Management* 27(3): 299–320.
- Freeman, C., & Soete, L. (1997). *The Economics of Industrial Innovation*. Cambridge: MIT Press.
- Frondel, M., Horbach, J., & Rennings, K. 2008. "What triggers environmental management and innovation? Empirical evidence for Germany." *Ecological Economics* 66(1): 153-160.
- Gilg, A., Barr, S., & Ford, N. 2005. "Green consumption or sustainable lifestyles? Identifying the sustainable consumer." *Futures* 37(6): 481-504.
- Green, K., McMeekin, A., & Irwin, A. 1994. "Technological trajectories and R&D for environmental innovation in UK firms" *Futures* 26(10): 1047-1059.
- Hagedoorn, J., Duysters, G. 2002. "External Sources of Innovative Capabilities: The Preferences for Strategic Alliances or Mergers and Acquisitions." *Journal of Management Studies* 39(2): 167–188.
- Hall, J. (2000). "Environmental supply chain dynamics." *Journal of Cleaner Production* 8(6): 455-471.
- Harhoff, D., Scherer, F. M., & Vopel, K. 2003. "Citations, family size, opposition and the value of patent rights." *Research Policy* 32(8): 1343-1363.
- Harvey, F. 2011. "Nick Clegg unveils long awaited details of green investment bank." *Guardian*, 23 May 2011, available at: <http://www.guardian.co.uk/environment/2011/may/23/clegg-unveils-green-investment-bank>.
- Helfat, C. E. 1997. "Know-how and asset complementarity and dynamic capability accumulation: the case of R&D." *Strategic Management Journal* 18(5): 339-360.
- Henderson, R. M., & Clark, K. B. 1990. "Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms." *Administrative Science Quarterly* 35(1): 9-30.
- Heusinkveld, S., Benders, J., & van den Berg, R.-J. 2009. "From market sensing to new concept development in consultancies: The role of information processing and organizational capabilities." *Technovation* 29(8): 509-516.
- Hillary, R. 2004. "Environmental management systems and the smaller enterprise." *Journal of Cleaner Production* 12(6): 561-569.
- Horbach, J. 2008. "Determinants of environmental innovation: New evidence from German panel data sources." *Research Policy* 37(1): 163-173.
- Hughes, A., 2001. "Innovation and business performance: small entrepreneurial firms in the UK and the EU." *New Economy* 8 (3): 157–163.
- Hull, C.E., Covin, J.G. 2010. "Learning Capability, Technological Parity, and Innovation Mode Use." *Journal of Product Innovation Management* 27 (1): 97–114.
- Iatridis, K., 2009. "International certifiable management standards as manifestations of business legitimacy: evidence from Greece." In: Paper Presented at the BAM 2009 Conference.

- Jaw, C., Lo, J.-Y., & Lin, Y.-H. 2010. "The determinants of new service development: Service characteristics, market orientation, and actualizing innovation effort." *Technovation* 30(4): 265-277.
- Jiménez-Jimenez, D., Valle, R. S., & Hernandez-Espallardo, M. 2008. "Fostering innovation: The role of market orientation and organizational learning." *European Journal of Innovation Management* 11(3): 389 - 412.
- Johnson, J. L., Lee, R. P.-W., Saini, A., & Grohmann, B. 2003. "Market-Focused Strategic Flexibility: Conceptual Advances and an Integrative Model." *Journal of the Academy of Marketing Science* 31(1): 74-89.
- Kesidou, E., & Demirel, P. 2012. "On the drivers of eco-innovations: Empirical evidence from the UK." *Research Policy* 41(5): 862-870.
- Keskin, H. 2006. "Market orientation, learning orientation, and innovation capabilities in SMEs: An extended model." *European Journal of Innovation Management* 9(4): 396 - 417.
- Könnölä, T., & Unruh, G. C. 2007. "Really changing the course: the limitations of environmental management systems for innovation." *Business Strategy and the Environment* 16(8): 525-537.
- Laforet, S. 2009. "Effects of size, market and strategic orientation on innovation in non-high-tech manufacturing SMEs." *European Journal of Marketing* 43(1/2): 188 - 212.
- Lanjouw, J. O., & Mody, A. 1996. "Innovation and the international diffusion of environmentally responsive technology." *Research Policy* 25(4): 549-571.
- Lee, J., Lee, J., & Lee, H. 2003. "Exploration and Exploitation in the Presence of Network Externalities." *Management Science* 49(4): 553-570.
- Levinthal, D. A., & March, J. G. 1993. "The myopia of learning." *Strategic Management Journal* 14(2): 95-112.
- Lewin, A.Y., Massini, S., & Peeters, C. 2011. "Microfoundations of internal and external absorptive capacity routines." *Organization Science* 22(1): 81-98.
- Lichtenthaler, U., Ernst, H. 2012. "The Performance Implications of Dynamic Capabilities: The Case of Product Innovation." *Journal of Product Innovation Management* DOI: 10.1111/j.1540-5885.2012.00957.x
- Lim, K. 2009. "The many faces of absorptive capacity: spillovers of copper interconnect technology for semiconductor chips." *Industrial and Corporate Change* 18(6): 1249-1284.
- Lukas, B., & Ferrell, O. 2000. "The effect of market orientation on product innovation." *Journal of the Academy of Marketing Science* 28(2): 239-247.
- Lundvall B. A., 1988. Innovation as an interactive process: from user-producer interaction to the national system of innovation. In Dosi G.et al. (Eds), *Technical Change and Economic Theory*. London: Frances Pinter, (pp. 349-369).
- Magat, W. A. 1979. "The Effects of Environmental Regulation on Innovation." *Law and Contemporary Problems* 43(1): 4-25.
- Malueg, D. A. 1989. "Emission credit trading and the incentive to adopt new pollution abatement technology." *Journal of Environmental Economics and Management* 16(1): 52-57.
- March, J. G. 1991. "Exploration and exploitation in organizational learning." *Organization Science* 2(1): 71-87.
- March, J. G., & Simon, H. A. 1958. *Organizations*. Oxford, England: Wiley.

- Milliman, S. R., & Prince, R. 1989. "Firm incentives to promote technological change in pollution control." *Journal of Environmental Economics and Management* 17(3): 247-265.
- MIT, 2011. *Sustainability: The 'Embracers' Seize Advantage*. MIT Sloan Management Review. Massachusetts.
- Mowery, D. C., Oxley, J. E., & Silverman, B. S. 1998. "Technological overlap and interfirm cooperation: implications for the resource-based view of the firm." *Research Policy* 27(5): 507-523.
- Narver, J.C., Slater, S.F., MacLachlan, D.L. 2004. "Responsive and Proactive Market Orientation and New-Product Success." *Journal of Product Innovation Management* 21(5): 334-347.
- NESTA, 2010. "Demand and innovation: How customer preferences shape the innovation process." NESTA/The Work Foundation Working Paper: March 2010.
- OECD. (2009). *Eco-Innovation in Industry: Enabling Green Growth*: OECD Publishing.
- OECD. (2011). *Better Policies to Support Eco-innovation*, OECD Studies on Environmental Innovation: OECD Publishing.
- Palazzo, G., & Scherer, A. 2006. "Corporate Legitimacy as Deliberation: A Communicative Framework." *Journal of Business Ethics* 66(1): 71-88.
- Pavitt, K. 1984. "Sectoral patterns of technical change: Towards a taxonomy and a theory." *Research Policy* 13(6): 343-373.
- Popp, D. 2006. "International innovation and diffusion of air pollution control technologies: the effect if NOx and SO2 regulation in the US, Japan and Germany." *Journal of Environmental Economics and Management* 51: 46-71.
- Porter, M.E., 1991. "America's green strategy." *Scientific American* 264 (4).
- Porter, M. E., & Linde, C. v. d. 1995. "Toward a New Conception of the Environment-Competitiveness Relationship." *The Journal of Economic Perspective* 9(4): 97-118.
- Potoski, M., & Prakash, A. 2005. "Green Clubs and Voluntary Governance: ISO 14001 and Firms' Regulatory Compliance." *American Journal of Political Science* 49(2): 235-248.
- Rehfeld, K.-M., Rennings, K., & Ziegler, A. 2007. "Integrated product policy and environmental product innovations: An empirical analysis." *Ecological Economics* 61(1): 91-100.
- Renko, M., Carsrud, A., & Brännback, M. 2009. "The Effect of a Market Orientation, Entrepreneurial Orientation, and Technological Capability on Innovativeness: A Study of Young Biotechnology Ventures in the United States and in Scandinavia." *Journal of Small Business Management* 47(3): 331-369.
- Rennings, K., Ziegler, A., Ankele, K., & Hoffmann, E. 2006. "The influence of different characteristics of the EU environmental management and auditing scheme on technical environmental innovations and economic performance." *Ecological Economics* 57(1): 45-59.
- Romijn, H. 1999. *Acquisition of Technological Capability in Small Firms in Developing Countries*, London: Macmillan Press.
- Rondinelli, D., & Vastag, G. 2000. "Panacea, common sense, or just a label?: The value of ISO 14001 environmental management systems." *European Management Journal* 18(5): 499-510.

- Rosenkopf, L., & Nerkar, A. 2001. "Beyond local search: boundary-spanning, exploration, and impact in the optical disk industry." *Strategic Management Journal* 22(4): 287-306.
- Rumph, K., & Bunce, J.-M. 2010. *UK Elections and Cleantech. Blue, Red or Yellow, but all Green.* London.
- Russo, M.V., Harrison, N.S. 2005. "Organizational design and environmental performance: clues from the electronics industry." *Academy of Management Journal* 48 (4): 582–593.
- Sagar, A. D., & van der Zwaan, B. 2006. "Technological innovation in the energy sector: R&D, deployment, and learning-by-doing." *Energy Policy* 34(17): 2601-2608.
- Sarkis, J. 2003. "A strategic decision framework for green supply chain management." *Journal of Cleaner Production* 11(4): 397-409.
- Scott, J. 2003. "Absorptive Capacity and the Efficiency of Research Partnerships." *Technology Analysis & Strategic Management* 15(2): 247-253.
- Seuring, S., & Müller, M. 2008. "From a literature review to a conceptual framework for sustainable supply chain management." *Journal of Cleaner Production* 16(15): 1699-1710.
- Srivastava, R. K., Fahey, L., & Christensen, H. K. 2001. "The resource-based view and marketing: The role of market-based assets in gaining competitive advantage." *Journal of Management* 27(6): 777-802.
- Srivastava, S. K. 2007. "Green supply-chain management: A state-of-the-art literature review." *International Journal of Management Reviews* 9(1): 53-80.
- Sroufe, R. 2003. "Effects of environmental management systems on environmental management practices and operations." *Production and Operations Management* 12(3): 416-431.
- Suchman, M. 1995. "Managing Legitimacy: Strategic and Institutional Approaches" *Academy of Management Review* 20 (3): 571-610.
- Teece, D., & Pisano, G. 1994. "The Dynamic Capabilities of Firms: an Introduction." *Industrial and Corporate Change* 3(3): 537-556.
- Teece, D. J. 2007. "Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance." *Strategic Management Journal* 28(13): 1319-1350.
- Teece, D. J. 2006. "Reflections on "Profiting from Innovation." *Research Policy* 35(8): 1131-1146.
- Theyel, G. 2000. "Management practices for environmental innovation and performance." *International Journal of Operations & Production Management* 20(2): 249 – 266.
- Unruh, G. C. 2002. "Escaping carbon lock-in." *Energy Policy* 30(4): 317-325.
- von Hippel, E. 1987. "Cooperation between rivals: Informal know-how trading." *Research Policy* 16(6): 291-302.
- Van Echtelt, F.E.A., Wynstra, F., Van Weele, A.J., Duysters, G. 2008. "Managing Supplier Involvement in New Product Development: A Multiple-Case Study." *Journal of Product Innovation Management* 25(2): 180–201.
- Vorhies, D. W., & Harker, M. 2000. "The Capabilities and Performance Advantages of Market-Driven Firms: An Empirical Investigation." *Australian Journal of Management* 25(2): 145-171.
- Wagner, M., 2007. "On the relationship between environmental management, environmental innovation and patenting: evidence from German manufacturing firms." *Research Policy* 36(10): 1587–1602.

- Walker, H., Di Sisto, L., & McBain, D. 2008. "Drivers and barriers to environmental supply chain management practices: Lessons from the public and private sectors." *Journal of Purchasing and Supply Management* 14(1): 69-85.
- Weerawardena, J. 2003. "The role of marketing capability in innovation-based competitive strategy" *Journal of Strategic Marketing* 11(1): 15-35.
- Williamson, D., Lynch-Wood, G., & Ramsay, J. 2006. "Drivers of Environmental Behaviour in Manufacturing SMEs and the Implications for CSR." *Journal of Business Ethics* 67(3): 317-330.
- Winter, S. G. 2003. "Understanding dynamic capabilities." *Strategic Management Journal* 24(10): 991-995.
- Wright, P. M., Dunford, B. B., & Snell, S. A. 2001. "Human resources and the resource based view of the firm." *Journal of Management* 27(6): 701-721.
- Yannopoulos, P., Auh, S., & Menguc, B. 2012. "Achieving Fit between Learning and Market Orientation: Implications for New Product Performance." *Journal of Product Innovation Management* 29(4): 531-545.
- Zahra, S., & George, G. 2002. "Absorptive capacity: A review, reconceptualization, and extension." *Academy of Management Review* 27(2): 185-203.
- Zhu, Q., & Sarkis, J. 2006. "An inter-sectoral comparison of green supply chain management in China: Drivers and practices." *Journal of Cleaner Production* 14(5): 472-486.