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Break on through (to the other side): market innovations by environmental innovative firms

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Abstract

The identification and development of existing or new markets for environmental friendly products are essential if we are to move towards a more sustainable consumption pattern. Most research on environmental innovation has focused on the technological aspects of innovation, thereby ignoring how environmental innovative firms can enter and develop existing and/or new markets. This study draws together the literature on environmental innovation, the resource based view of the firm and signalling theory to uncover linkages between environmental innovative firms' resource profile and their ability to introduce successful market innovations. With regard to 812 environmental innovative firms, a Heckman two stage regression analysis detected that those environmental innovative firms that engaged in R&D and marketing activities or cooperated with costumers were more likely to report market innovations that improved their access to existing or new markets. However, those environmental innovative firms that cooperated with academic research institutions were found to be less likely to report market innovations that improved their access to existing and/or new markets. Implications and limitations are discussed.

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Introduction

Awareness is growing that a fundamental transformation is needed to reduce detrimental environmental impacts created by our currently unsustainable business practices (Hall et al., 2010). Governments and practitioners worldwide are encouraging firms to engage in environmentally friendly activities to mitigate environmental degradation (De Marchi, 2012). Environmental innovation relates to the development and implementation of new or modified processes or products that avoid or reduce harmful environmental impacts while ensuring firm competitive advantage (De Marchi, 2012). An emergent discourse highlights innovation as a panacea to many environmental challenges and as a conduit for bringing about structural change and sustainable development (Hall et al., 2010). However, environmental innovative firms face major challenges as consumers can be reluctant to purchase the final product due to information asymmetry issues (i.e., there is uncertainty surrounding the new technological advancement) (De Marchi, 2012). Simply supply of new products and processes does not guarantee that innovations are adopted by costumers or the market more generally. To ensure a more sustainable consumption pattern, environmental innovative firms need to enter and develop existing markets or proactively shape new markets for their technological innovations.

Information asymmetry problems can arise because the market for environmental innovations is new and because environmental innovative firms may have more knowledge of their product or process innovations than outsiders. Consumers may, for instance, lack knowledge regarding the attribute of a product (Dean and McMullen, 2007). This lack of knowledge on the part of the consumer can lead consumers to make uninformed buying decisions, often at the cost of the environment (Cohen and Winn, 2007). Accordingly, an information asymmetry barrier between the firm and the market more generally (e.g., firm owners possess superior information surrounding the quality of their product) can retard an environmental innovative firm's access to existing markets as well as its ability to enter new markets. To overcome information asymmetry problems, innovators need to convince customers and others that their technological advancements are desirable (De Clercq, 2009). It may be essential for environmental innovative firms to assemble pools of internal resources involving relevant knowledge and social capital and send quality signal to outsiders to increase their likelihood of entering and developing existing or new markets.

Despite recent research progress, prior environmental innovation studies have generally focused on the technological aspects of environmental innovation, thereby ignoring the market aspect of innovation where firms create and open up existing or new markets. For instance, studies have, by focusing on the determinants of environmental product innovations (De Marchi, 2012; Horbach, 2008) and process innovations (Aravind, 2012; Carruthers and Vanclay, 2012), generated valuable insight to how environmental friendly products and processes are first created and come into existence. However, both technological and market aspects of innovation and their interrelationships are essential for the evolution and development of industries (Schumpeter, 1934). To facilitate structural change towards sustainability, an evidence base is required that shows the types of resources that enable environmental innovative firms to successfully enter or develop existing or new markets.

The intent of this study is to bring together the streams of research on environmental innovation, the resource-based view (RBV) of the firm and signalling theory to isolate the types of resources that enable environmental innovative firms to succeed with market innovations. The following research question is in focus, the answer to which has important practitioner implications: Which resources play a central role in enabling environmental innovative firms to introduce market innovations that develop existing or new markets? Hypotheses are tested with regard to 812 environmental innovative firms. Factors associated with environmental innovative firms are explored within a Heckman two-stage procedure.

This technique enables exploration of the potential issue of selection bias relating to the profile of environmental innovative firms relative to non-environmental innovative firms.

Calls have been made for more studies to focus on environmental innovation (De Marchi, 2012; Hall et al., 2010; Horbach, 2008). This study keys into emergent debates and makes the following contributions to prior environmental innovation studies. First, this study extends prior research by focusing on environmental innovative firms and market innovations. Specifically, by focusing on environmental innovative firms as the key actor and their ability to implement market innovations that develop or open up new markets for environmental friendly products, this study generates micro-level evidence about the structural change towards sustainability. There is widespread appreciation that the pools of resources available to a firm can shape firm performance (Westhead et al., 2011). Building upon the RBV of the firm and signalling theory, we extend prior research on environmental innovation. We propose that environmental innovative firms need to mobilize high-quality resources to introduce market innovations that improve the firm's access to existing markets or enable them to create new markets. In addition, this study extends current understanding by examining environmental innovative firms outside North American and European Community countries. The latter countries have provided the contexts within which the theoretical foundations of environmental innovation studies have been traditionally grounded. A country's culture and institutional context can shape people's attitudes, access to resources and behaviour with regard to opportunity exploitation. Replication and extension of previous studies in contrasting geographic and cultural contexts is needed. This study monitors market innovations among environmental innovative firms in Norway. The Norwegian Government's innovation policy is encouraging firms to increase their resource-productivity and reduce their harmful environmental impacts in order to promote economic, social and environmental sustainability.

This article is structured as follows. In the next section, the theoretical framework and hypotheses are presented. This is followed by a discussion of the research method and the data collected. Results are reported. Finally, key findings are highlighted and contributions and implications are discussed.

Theoretical insight

The resource-based view (RBV) of the firm (Barney, 1991) focuses on the heterogeneous pool of idiosyncratic resources, which must be valuable, rare, non-imitable, and non-substitutable to ensure a firm's competitive advantage. Resources may be tangible or intangible and accumulated from the internal and external environment of the firm. They relate to all assets, capabilities, organizational processes, firm attributes, information, and knowledge that make the firm capable of generating and implementing strategies that provide it with competitive advantage.

Signalling theorists focus on the credible communication of positive information to convey positive organizational attributes. A resource signal highlights the unobservable quality of the signaller to potential receivers via the observable qualities of the signal. Signal quality concerns the underlying unobservable ability of the signaller to fulfil the demands of an outsider observing the signal (Connelly et al., 2011). Application of signalling theory to the study of market innovations among environmental innovative firms suggests that firms may seek high quality resource signals to address information asymmetries perceived by outsiders (e.g., consumers), and through differentiation strategies, generate competitive advantages relative to competitors that do not have these signals to mobilize. For instance, knowledge capital resources which relates to the firm's skills, capabilities and knowledge can provide quality signals with regard to the trustworthiness of the firm's environmental innovations. Social capital resources, resources which are rooted in the firm's relationships, can provide

important sources for knowledge acquisition and learning (Hite and Hesterly, 2001), which can be leveraged to succeed in market innovations. By obtaining observable signals of firm quality environmental innovative firms may reduce information asymmetries perceived by external constituents. The firm may be able to enter wider and broader networks whose synergies can be mobilized to enable the firm with improved access to existing markets or enable the firm to enter new markets.

Derivation of hypotheses

Knowledge capital

A firm's available technical resources have been found to influence a firm's ability to develop technological environmental innovations (Horbach, 2008). Research and development (R&D) investments reflect the firm's capacity and accumulated experience to succeed in the innovation process (Clausen et al, 2012; Nelson, 1961). In addition, R&D investments may through education of the firm's employees increase the firm's ability to, not only solve forthcoming problems through innovative efforts, but also enhance the firm's ability to identify and source external knowledge. The latter may be particularly important in contexts where firms need to complement internal knowledge with external information (Lichtenthaler and Lichtenthaler, 2009), for instance, when the firm needs to develop or identify new markets for their environmental friendly products. Notably, entrepreneurial knowledge and knowledge relating to the natural environment can shape the discovery of sustainable development opportunities (Patzelt and Shepherd, 2011). R&D investments may enable the firm to identify appropriate market segments for their offering, and enable the firm to signal credibility and dependability, thus reducing information asymmetries perceived by potential consumers. In a similar vein, marketing activities can enable environmental innovative firms to engage with customers or the market more generally. Marketing activities can enable the firm to signal plausibility. Marketing activities (e.g. launch advertising or market research) can through a shift in the supply curve or by identifying a new demand curve (Cohen and Winn, 2007) enable the firm to reach existing markets through a new means or create new markets. Hence, the following hypotheses are proposed:

Hypothesis 1: *Environmental innovative firms with higher R&D investment are more likely to report that they have introduced market innovations that enabled them with improved access to existing markets or enable the firm to enter new markets.*

Hypothesis 2: *Environmental innovative firms that engage in marketing activities are more likely to report that they have introduced market innovations that enabled them with improved access to existing markets or enable the firm to enter new markets.*

Social capital

General innovations studies have underlined that firms increasingly cooperate with external constituents in the development of new products or processes (Von Hippel, 1988; Laursen and Salter, 2004; Nelson, 1993). This trend has recently been reaffirmed in environmental innovations studies. Innovation cooperations enable the firms to enter professional and social networks, thus ensuring access to scarce resources (i.e., finance, technology, knowledge, etc.) needed for technological advancement and environmental innovation (De Marchi, 2012). Deep-bonding social capital may also be important to succeed with market innovation. Cooperations with university networks or recognized research institutions can facilitate professional networks. Relational ties can create value and motivate partners to share that value (Dyer and Singh, 1998). Professional networks can thus provide a high quality signal to outsiders (Mueller et al., 2012). Cooperation with costumers can provide the firm with

valuable information that enables the firm to fulfil or create costumers demand. It can enable potential customers to understand and value the firm's technological innovations. Overall, broader and denser networks can enable the firm to complement organizational competences and resources; it can create a reputation for trustworthiness (Wong and Boh, 2010). This signal of firm quality can be sought and favourably received by consumers, enabling the firm to develop existing markets or, through proactive innovations, potential new markets. Embedded ties can enable the firm to communicate more efficiently and effectively, thus reducing communication errors and increasing speed to market. Hence, the following hypotheses are proposed:

Hypothesis 3: *Environmental innovative firms that cooperate with universities or other research institutions are more likely to report that they have introduced market innovations that enabled them with improved access to existing markets or enable the firm to enter new markets.*

Hypothesis 4: *Environmental innovative firms that cooperate with costumers are more likely to report that they have introduced market innovations that enabled them with improved access to existing markets or enable the firm to enter new markets.*

External financing

External financing provides environmental innovative firms with the necessary financial resources required for market innovations. External financing can also play a role in reducing the information asymmetries perceived by potential consumers. External financing can be used by environmental innovative firms to signal commitment, expertise and credibility (Mueller et al., 2012), thus increasing their likelihood of succeeding with market innovations. Hence, the following hypothesis is proposed:

Hypothesis 5: *Environmental innovative firms that signal the presence of external financing are more likely to report that they have introduced market innovations that enabled them with improved access to existing markets or enable the firm to enter new markets.*

Data collection and research methodology

Sample and data collection

The Norwegian Central Register of Establishments and Enterprises (CRE) list information on the population of all enterprises and establishments in Norway. In 2008, a Eurostat Community Innovation Survey (CIS) was conducted with regard to a stratified random sample of enterprises on the CRE database with regard to NACE 2-digit industrial categories and number of employees. Enterprises that employed less than 10 employees were excluded from the survey frame. A structured questionnaire was sent to the chief executive officer (CEO) or the lead R&D manager in each enterprise. In total, 4,892 responses were returned with a 95% valid response rate, suggesting that the CIS survey is representative of the population. Due to non-response on variables used in this study, the final sample includes 4655 firms (bot environmentally-friendly and not). In line with previous studies (De Marchi, 2012; Horbach, 2008), environmental innovative firms were identified by a filter question regarding the objective of the firms' innovation activity. One of the objectives firms could tick, on a scale from 0 (not relevant) to 3 (very important), was to what extent firms focused on reduction of environmental harm/effects as a key goal in their innovative activities. For the purpose of this study we focus on the 812 firms that gave the answer "very important" to this question. A total of 812 environmental innovative firms were identified.

Measures

Dependent variable

The CIS 2008 survey gathered self-reported information relating to the perceived effect of the market innovations introduced between 2006 and 2008. The market innovation effects variable was operationalized as a summated factor score of three statements. Respondents were asked, on a scale from 0 (not relevant) to 3 (very important), to rate how important the effects of the market innovations were in relation to: increased or maintained market share; new customer groups; and new geographic markets (MarketIEffects). The construct yielded a Cronbach's alpha coefficient of .78, which implies satisfactory reliability.

Independent variables

With regard to information held on the CIS 2008 survey, R&D investment is measured as the firms' expenditures on intramural research and development in 1000 NOK (R&D). The variable is log transformed to conform to normality assumptions.

Marketing activities is measured as a binary variable. Firms that reported that they had invested in activities with regard to market introduction of their new or significantly improved goods or services, including market research and launch advertising, between 2006 and 2008 were allocated a value of '1' and '0' otherwise (MarketingA)

Cooperation with universities and/ or research institutes is measured as a binary variable where firms that reported innovation cooperation with universities and / or research institutes between 2006 and 2008 were allocated a value of '1' and '0' otherwise (ResearchCoop)

Cooperation with customers is measured as a binary variable where firms that reported innovation cooperation with customers between 2006 and 2008 were allocated a value of '1' and '0' otherwise (CustomerCoop).

External financing is measured as the amount of financing in 1000 NOK the firm received from public sources (Financing).

Control variables

Larger firms have a higher propensity to innovate (Acs & Audretsch 2003). Firm size is measured as the logarithm of number of employees (Size). Industry environments differ regarding entry costs, average performance, reinvestment intensity and sunk costs, which can shape individual firm performance. Industry-dummies is entered and controlled for using the NACE 2 level. Regulation is a promoter of environmental innovation (Porter and Van der Linde, 1995), and is a selection variable for the Heckman analysis. Regulation was measured as the extent to which the firm, from a scale from 0 (not relevant) to 3 (very important), developed product or process innovations to comply with new standards or regulations.

Data analysis

Summary statistics are reported in table 1. A correlation matrix of the control and independent variables is presented in Table 2. The variance inflation factor (VIF) scores range between 1.06 and 2.57 and suggest no evidence of multicollinearity. The presented regression models should therefore not be distorted by this problem.

The propensity to be environmental innovative may be based on both observable and unobservable variables. If unobservable variables are correlated with environmental innovative firms' ability to successfully implement market innovation this could potentially bias the interpretation. A Heckman two-stage approach is conducted to assess the potential issue of sample selection bias (i.e., whether the unobservable variables associated with

successful market innovation are associated with the unobservable variables associated with environmental innovation). This approach identifies both a method of testing for selection effects between environmental innovative firms and non-environmental innovative firms, and for consistent estimation if selection effects are shown to be statistically significant (Heckman, 1979).

[Table 1 and 2 about here]

Results

The first step of the Heckman test explores the issue of selection bias relating to the profiles of environmental innovative firms. With regard to the total sample of environmental innovative and non-environmental innovative firms (4,655 firms), a probit regression analysis was estimated relating to the propensity to be environmental innovative or not. The variables (observables) included in step 1 need to be different from those included in step 2 (i.e. relating to the market innovation dependent variable). At least one independent variable has to be included in step 1 but not step 2, which is theoretically associated with the propensity to be environmental innovative but not to introduce successful market innovations (Robson et al., 2012). There is growing acknowledgement that regulation promotes environmental innovative firm behaviour (Porter and Van der Linde, 1995). Regulation is included in the step 1 model.

Model 1 is the step 1 Heckman model relating to the control, selection and independent variables, focusing on the propensity to be environmental innovative or not. As expected, regulation is significant and positive related to the propensity to be environmental innovative. Similarly, firm size and cooperation with academic research institutions are significant and positive related to the propensity to be environmental innovative. A generalized residual variable, the inverse Mills ratio, which is a function of the correlation between the disturbances of the probit model, was considered during step 2, which relates to an ordinary least squares (OLS) regression analysis focusing upon the effects of the environmental innovative firm's market innovations. In step 2 the independent and control variables and the inverse Mills ratio, but not the regulation variable, were included as regressors. Model 2 shows that the inverse Mills-ratio variable is significant and negative, indicating that the sample of firms included in the step 2 of the Heckman approach – environmental innovative firms– have unobservables that are negatively related to the successful implementation of market innovations. The insertion of the inverse Mills ratio controls for selection bias and ensures consistent estimation (Heckman, 1979).

The proposed hypotheses are explored in Model 2, which relates to step 2 in the Heckman two stage approach ($\chi^2 = 169^{***}$)

Hypothesis 1 stated that environmental innovative firms with higher R&D investment would be more likely to report market innovations that enabled them with improved access to existing markets or enable the firm to enter new markets. The R&D variable is positive and significant related MarketIEffect ($p < 0.01$). Hypothesis 1 is supported.

Hypothesis 2 stated that environmental innovative firms that engaged in marketing activities would be more likely to report market innovations that enabled them with improved access to existing markets or enable the firm to enter new markets. The MarketingA variable is positive and significant related MarketIEffect ($p < 0.01$). Hypothesis 2 is supported.

Hypothesis 3 and 4 suggested that environmental innovative firms that engaged in innovation cooperation would be more likely to report market innovations that enabled them with improved access to existing markets or enable the firm to enter new markets. The ReserachCoop variable is negative and significant ($p < 0.01$), whilst the CostumerCoop variable is positive and significant ($p < 0.01$). Hypothesis 3 is not supported, whilst hypothesis 4 is supported.

Hypothesis 5 stated that environmental innovative firms that signalled the presence of external financing would be more likely to report market innovations that enabled them with improved access to existing markets or enable the firm to enter new markets. The Financing variable is positive but not significant. Hypothesis 5 is not supported.

[Table 3 about here]

Conclusions and implications

This study explores the external validity of theoretical perspectives generated in North American and European Community contexts with reference to private firm behaviour in Norway. We extend previous research on environmental innovation by focusing on the market aspects of environmental innovation. The identification and development of existing or new markets for environmental friendly products is essential if we are to move towards a more sustainable consumption pattern. Uncovering linkages between an environmental innovative firm resource profile (i.e., signals) and its ability to introduce successful market innovations is therefore of considerable theoretical and practical relevance.

In this study, we integrate insight from environmental innovation studies, the RBV of the firm and signalling theory to identify the resources that enable environmental innovative firms to introduce market innovations that enable the firm with improved access to existing markets or enabled to firm to enter new markets. Environmental innovation studies focus upon the development and implementation of new processes or products that avoid or reduce harmful environmental impacts, whilst the RBV of the firm focuses on the pools of internal resources that enable the firm with competitive advantage. Signalling theory focuses on the credible communication of positive information to convey positive organizational attributes. Notably, we advance environmental innovation studies by proposing that environmental innovative firms may need to mobilize high-quality resources to successfully introduce market innovations. Specifically, we suggest that environmental innovative firms benefit from mobilizing high quality resource signals to address information asymmetries perceived by outsiders (e.g., consumers). As such, this study extend prior research on the signalling benefits of quality resources (Mueller et al., 2012; Reuer et al., 2012) by showing that environmental innovative firms that send positive signals relating to the quality of their resources are more likely to report successful market innovations.

The study provides fresh insight surrounding the types of resources that promote successful market innovations among environmental innovative firms. Two-stage Heckman regression analysis detects that those environmental innovative firms that invested in R&D and marketing activities or cooperated with costumers were more likely to report market innovations that improved their access to existing and/or new markets. Those environmental innovative firms that had cooperated with universities and research institutions were, however, found to be less likely to report market innovations that improved their access to existing and/or new markets. Given the central importance given by policy to build and support university- industry links (Bruneel et al., 2010), this finding point to a serious hindrance towards effective collaboration which need to be considered in future research. The benefits of external financing relating to market innovation need to be monitored over longer time-periods of evaluation.

As expected, Size and Regulation were positively and significantly related to a firm's propensity to be environmental innovative. Also innovation cooperation with academic research institutions, such as universities and research institutes, were found to be positively and significantly related to a firm's propensity to be environmental innovative.

Our findings have implications for policy makers and practitioners. This study suggests that environmental innovative firms need to address several obstacles to ensure that

their environmental friendly initiatives are adopted by costumers and the market more generally. Policy makers may have a role in facilitating local networks that enable environmental innovative firms to internally assemble and manage resource bases that signal credible quality and plausibility to outsiders. Also, they could encourage more environmental innovative firms to engage with costumers and the market more generally by covering the full or partial costs associated with R&D and marketing activities. However, the onus is on the entrepreneur to assemble the relevant knowledge, networks and quality resources in order to be sought and favourable perceived by existing and/or new markets.

Inevitably this study is associated with limitations which provide fruitful avenues for future research. This study was limited to Norwegian firms. Presented findings can be generalized to the Norwegian context, and potentially to other contexts with similar cultural, economic and political conditions. To examine the generalizability of our findings (i.e., external validity), additional studies are warranted in other cultural, national, locational and industrial settings (Halme et al., 2009).

Key-informant managers can provide reliable information about firm characteristics and the issues faced. However, doubt may be cast on the wider validity of self-report measures. To reduce the problem of common method bias and to improve construct validity, studies need to complement information from key informants from secondary sources (Mueller et al., 2012). We failed to explore whether the innovation related to incremental or radical innovations. Future longitudinal studies need to monitor the benefits effects of market innovations with reference to a broader array of innovation outcomes. Contrasting ‘types’ of entrepreneurs and firms have been detected with regard to their internal resource pools (Westhead et al., 2011).

Collaboration experience can be a critical determinant of the success or failure of subsequent alliances (Bruneel et al., 2010). Experienced entrepreneurs could also be more likely to recognize the benefits of signalling legitimacy, and be more effective at using a wider range of symbols to enhance firm development (Clarke, 2011). As such, future studies would benefit from considering finer measures of the extent and nature of prior entrepreneurial experience and knowledge with regard to archival and survey data.

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Tables

Table 1. Descriptive statistics (based on firms included in the second stage Heckman)

	Mean	Std. Dev.	Min	Max
MarketIEffect	2.34	3.54	0	9
Size	4.09	1.22	2.30	9.68
R&D	3.15	4.13	0	13.72
MarketingA	.12	.32	0	1
ResearchCoop	.22	.41	0	1
CostumerCoop	.17	.38	0	1
Financing	.20	.40	0	1

Notes: N=812

Table 2. Correlation matrix (based on sample included in the second stage Heckman)

	(1)	(2)	(3)	(4)	(5)	(6)
1. CostumerCoop	1					
2. Financing	0.30*	1				
3. ResearchCoop	0.54*	0.46*	1			
4. Size	0.22*	0.08*	0.24*	1		
5. R&D	0.46*	0.65*	0.61*	0.32*	1	
6. MarketingA	0.27*	0.21*	0.17*	0.06	0.25*	1

*Sig at the 0.05 level (or better) – two tailed.

Table 3. Heckman regression modes

	Model 1	Model 2
<i>Dependent variable</i>	Step 1	Step 2
	Environmental innovative	MarketIEffect
<i>Control variables</i>		
Size	.069***	-.075
Industry dummies	Included	Included
Regulation	.762***	
<i>Independent variables</i>		
R&D	-.009	.148***
MarketingA	.056	1.982***
ResearchCoop	.383***	-1.17***
CostumerCoop	.085	1.016***
Financing	.077	.176
Constant	-2.449***	2.078***
Inverse Mills Ratio	-	-.807***
Observations	4655	4655
Censored observations	-	3843
Uncensored observations	-	812
χ^2		169***
R ²		0.18

Notes; * p < 0.1; ** p < 0.05; *** p < 0.01 (two-tailed)