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Under the Tip of the Iceberg: Absorptive Capacity, Environmental Strategy, and Competitive Advantage

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Abstract

Although existing research evaluates how the adoption of proactive environmental strategies affects corporate performance, there is little understanding of the organizational mechanisms that link such strategies to competitive advantage. It is, therefore, unclear how environmental strategies relate to other management strategies that could lead to a competitive advantage. In this article, we analyze the organizational capabilities that underlie a firm's ability to generate competitive advantage from the adoption of proactive environmental strategies. We develop and test a model where absorptive capacity facilitates the development of proactive environmental strategies that result in competitive advantage. Results from a survey of 157 German chemical firms strongly support the model.

Keywords

absorptive capacity, environmental strategy, competitive advantage, chemical industry, structural equation modeling

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Introduction

Whether firms can benefit from being "green" has become an important question in the business strategy literature as exemplified by the considerable empirical research analyzing the link between beyond-compliance environmental strategy and financial performance or competitive advantage (Damania, 2001; Dowell, Hart, & Yeung, 2000; King &Lenox, 2001; Konar & Cohen, 2001; Margolis & Walsh, 2003; McWilliams & Siegel, 2000; Orlitzky, 2008; Orlitzky, Schmidt, & Rynes, 2003; Russo & Fouts, 1997; Waddock & Graves, 1997). This line of research, however, has produced mixed results. Although some studies find a positive link between environmental strategies and financial performance (Russo & Fouts, 1997), others depict an insignificant or even negative relationship once a firm has harvested low-hanging fruits (Damania, 2001; McWilliams & Siegel, 2000).

Some have argued that one reason for these mixed results might be that the question has been phrased in the wrong terms (King & Lenox, 2001; Margolis & Walsh, 2003; McWilliams & Siegel, 1999; Reinhardt, 1999; Siegel, 2009). Instead of asking whether it pays to be green, we ought to be asking about the conditions that support successful environmental strategies. Although the empirical literature on the link between environmental strategies and competitive advantage, mostly rooted in economics, emphasizes external drivers such as regulation, we still have little understanding of the organizational mechanisms that link the adoption of environmental management practices or strategies to competitive advantage (Marcus, 2005). This omission could lead to misspecified models that ignore the effect of such organizational mechanisms on both environmental strategy and competitive advantage (McWilliams & Siegel, 2000).

Practitioners within the emerging industry of socially responsible investing (SRI) provide an interesting perspective on the debate. They argue that environmental strategies not only reflect a firm's stance toward the natural environment but also represent a good proxy of a firm's management capabilities.[1] Firms that are well managed also manage their environmental strategies well. If this combination is true, are environmental strategies just the tip of the organizational iceberg? By focusing solely on environmental strategies, are we missing the essential foundations of their success? In this study, we argue that we need to look beneath the surface, under the tip of the organizational iceberg, to get a better understanding of the organizational capabilities that support the emergence of successful sustainable strategies.

Research in organizational theory has started to highlight the importance of organizational factors as predictors of the adoption of sustainable management strategies (Delmas & Toffel, 2008; Lenox & King, 2004; Sharma & Henriques, 2005). However, only a few studies have analyzed the organizational mechanisms that link the adoption of an environmentally proactive strategy to competitive advantage (Christmann, 2000; Hart, 1995; McWilliams & Siegel, 2000; Sharma & Vredenburg, 1998). Marcus (2005) recently pointed out that "though an impressive amount of work has been done, additional research is needed in understanding . . . how [an environmental competence] is created, what the capabilities upon which it is based are [and] why they might lead to competitive advantage" (p. 31). Similarly, Sharma (2005) explains that "we need research that identifies different configurations of co-specialized and complementary capabilities that generate proactive environmental approaches and competitive advantage"(p. 21)

This lack of research, however, is problematic. For management researchers, it is important to find out whether differences in environmental strategies and their consequences regarding a firm's competitiveness originate from different resource requirements and endowments. Also, for practitioners, it is important to be aware of the resource requirements for the implementation of a successful environmental strategy. Otherwise, such strategies are likely to result in adverse effects on the firm's competitive advantage.

In this article, we attempt to open the organizational black box and analyze the organizational capabilities that underlie a firm's ability to generate a competitive advantage from their environmental strategy. More specifically, we argue that a firm's absorptive capacity, defined as the "ability to recognize the value of new information, assimilate it, and apply it to commercial ends" (Cohen & Levinthal, 1990, p. 128), provides the foundations for a successful environmental strategy. We investigate how a firm's absorptive capacity can impact the adoption of beyond-compliance proactive environmental strategies such as "anticipating future regulations and social trends and designing or altering operations, processes, and products to prevent negative environmental impacts" (Aragon-Correa & Sharma, 2003, p. 73). We further investigate the relation of proactive environmental strategies to a firm's ability to generate competitive advantage (i.e., comparative cost, innovation, and reputation benefits) from such a proactive approach. From there, we propose a model that predicts a positive relationship between the level of absorptive capacity of a firm, its environmental proactivity, and competitive advantage.

To test our model, we surveyed 763 firms in the German chemical industry. Results based on responses from 157 firms—including responses from multirespondents within 54 of the firms—strongly support our hypotheses. Our results show that both the development of more proactive environmental strategies and the generation of competitive advantage from this proactivity depend on the level of absorptive capacity. We find that our model, which links absorptive capacity to environmental proactivity and competitive advantage, has a much higher predictive power than the alternative and more conventional model that only links environmental proactivity to competitive advantage. These results suggest that absorptive capacity facilitates the adoption of proactive environmental strategies that can lead to competitive advantage.

In both its theoretical and empirical domains, this article extends existing research. First and foremost, we contribute to the "pays to be green" debate by combining research on the link between environmental strategy and competitive advantage to the research seeking to explain the adoption of environmental proactivity. Our findings suggest that both environmental proactivity and competitive advantage are to some extent attributable to the same underlying general organizational capability: absorptive capacity. Our research reveals the fundamental role of organizational foundations for successful proactive environmental strategies. Second, we mutually connect two previously separated research streams. We extend the application of the concept of absorptive capacity beyond the technological and managerial to the natural environment.

The remainder of this article is organized as follows. First, we review the literature on corporate environmental strategy. Second, we develop hypotheses linking absorptive capacity, environmental proactivity, and competitive advantage. Third, we describe our methodology and results. A concluding discussion follows.

Literature Review

We define proactive environmental strategies as those that seek to reduce the environmental impacts of operations beyond regulatory requirements (Sharma, 2000) and base our argumentation on four constituting elements of environmental proactivity: (a) environmental reporting, (b) operational improvements, (c) organizational changes, and (d) regulatory proactivity. This categorization is based on Shrivastava (1995a), who outlines how environmental substrategies can be characterized comprehensively by applying a "systems view" of organizations (Katz & Kahn, 1967). First, proactive firms actively promote external and internal reporting by consultants and employees (Henriques & Sadorsky, 1999) through internal and external audits or the release of a sustainability report. Proactive firms can also design or alter products and/or organizational and operational processes to reduce or prevent negative environmental impact (Aragon-Correa & Sharma, 2003) through pollution-prevention or collaborative interactions with stakeholders (Sharma & Vredenburg, 1998). Finally, proactive firms can aim at influencing others by initiating changes and participating in the development of future regulations (Aragon-Correa, 1998; Delmas & Montes-Sancho, 2010).

The literature has identified several opportunities for proactive environmental strategies to benefit shareholders directly (McWilliams & Siegel, 2001; Siegel, 2009). These include cost savings achieved by preventing pollution, value creation strategies achieved through the development of greener products (Klassen & Whybark, 1999; Reinhardt, 1998), or benefits resulting from non-market strategies to influence government regulation so that their rivals are at a disadvantage (Shrivastava, 1995). However, we argue that—as with any strategy within a firm—the success of these proactive environmental strategies will depend on the firm's organizational capabilities that determine corporate success more generally. For example, given the conceptual similarity between pollution-prevention and total quality management, it may be possible to accelerate the accumulation of resources in the former by integrating it into the latter (Roome, 1992). In firms that do not have well-developed quality-management processes, there could be barriers to implementing pollution-prevention because the strategy requires the voluntary involvement of large numbers of people, especially line employees, in continuous-improvement efforts. Surprisingly, very few studies have looked at the relation between organizational capabilities, environmental proactivity, and competitive advantage. As McWilliams and Siegel pointed out, this omission could lead to model misspecification. Using the case of R&D, they argue that because environmental proactivity and competitive advantage are strongly correlated to R&D, researchers should disentangle these various effects rather than testing the effect of environmental proactivity on competitive advantage alone (McWilliams & Siegel, 2000).

Although research has examined the drivers for the adoption of proactive environmental strategies, most studies have focused on the influence of external stakeholders such as regulators, customers, or environmental nongovernmental organizations, rather than on firm organizational capabilities. These studies have investigated how the adoption of proactive environmental strategies is influenced by environmental legislation and regulations (Carraro, Galeotti, &Gallo, 1996; Delmas, 2002; Delmas & Montes-Sancho, 2010; Delmas & Montiel, 2008; Delmas, Russo, & Montes-Sancho, 2007; Majumdar & Marcus, 2001; Rugman & Verbeke, 1998; Russo, 1992), customers (Christmann & Taylor, 2001; Delmas & Montiel, 2009), and the desire to improve or maintain relations with their communities (Florida & Davison, 2001; Henriques & Sadorsky, 1996). Others have shown that managerial perceptions of the importance of various stakeholder pressures were associated with a more proactive environmental stance (Delmas, 2001; Henriques & Sadorsky, 1999; Sharma & Henriques, 2005). However, there is comparatively less empirical evidence on whether organizational capabilities enable firms to adopt such strategies. Cordano and Frieze (2000) focus on managers' attitudes about pollution-prevention as an important antecedent to pollution-prevention activity. Darnall and Edwards (2006) show how firms' capabilities, resources, and ownership structure impact the cost of the adoption of an environmental management system. Delmas and Toffel (2008) identify both institutional pressures and organizational characteristics as predictors for the choice of a firm's environmental strategy. Lenox and King (2004) analyze how absorptive capacity facilitates the adoption of pollution-prevention practices among manufacturing facilities within the information and communications technology industry. Empirical research investigating the underlying capabilities that enable firms to develop a competitively valuable environmental strategy is even scarcer. One exception is the work by Christmann (2000) that shows the importance of complementary assets to gain cost competitive advantage.

There is a need to further understand the capabilities that form the basis for environmental proactivity (Sharma, 2005). Although such capabilities can take many forms, the ability to absorb and transform knowledge is particularly relevant to processes and products related to the environment, which span multiple fields of expertise and are typically found outside of the firm's boundaries (Hart, 1995; Russo & Fouts, 1997). In addition, this knowledge is often complex, tacit, new to the firm, and implies profound changes in business processes (Hart, 1995; Russo & Fouts, 1997). As such, firms not only need to acquire knowledge on environmentally proactive technologies, they also need to learn how to build up processes that enable them to absorb relevant environmental knowledge.

We argue that absorptive capacity can help firms design or alter operations, processes, and products to reduce or prevent negative environmental impact. Absorptive capacity can be conceptualized as an integrated system in which several individual elements jointly allow a firm to learn from external sources (Jansen, van den Bosch, & Volberda, 2005). An important insight from the literature on absorptive capacity is that prior knowledge allows the uptake and integration of new knowledge (Cohen & Levinthal, 1990). Todorova and Durisin (2007) detail four main related steps that define absorptive capacity: Knowledge acquisition, knowledge assimilation, knowledge transformation, and knowledge exploitation. Knowledge acquisition triggers the uptake of new external knowledge, knowledge assimilation refers to the ability to integrate new knowledge, and knowledge transformation refers to the ability to derive new insights and consequences from the combination of existing and newly acquired knowledge (Todorova & Durisin, 2007). Although assimilation simply adds new knowledge to the existing knowledge base, transformation creates new knowledge from a novel combination of new and existing knowledge. Finally, knowledge exploitation represents the ability to apply and commercialize acquired, assimilated, and potentially transformed knowledge by creating new operations, products, or services, or by altering existing ones. Although R&D is central to the development of absorptive capacity, the two terms represent different concepts (Cohen & Levinthal, 1990). Investments in R&D represent knowledge acquisition and may favor knowledge assimilation, knowledge transformation, and knowledge exploitation. However, other factors such as training or manufacturing can impact knowledge assimilation, transformation, and exploitation.

Although previous literature has shown the importance of absorptive capacity to turn previously external knowledge into a commercial outcome in high-technology environments (Lane, Koka, & Pathak, 2006; Lane, Salk, & Lyles, 2001), it has not yet attempted to link absorptive capacity to the absorption of external knowledge in the environmental domain, which is marked by strong social and regulatory pressures. The only exception is the work of Lenox and King (2004) that shows how the distribution of knowledge within the firm, and the role that managers play in administering information to organizational subunits, can facilitate the adoption of pollution-prevention practice. However, although King and Lenox did demonstrate the importance of management support in conjunction with absorptive capacity to facilitate the adoption of pollution practices, they did not investigate the effect of absorptive capacity on competitive advantage.

In this article, we expand this previous literature by demonstrating how absorptive capacity can not only facilitate the acquisition, assimilation, transformation, and exploitation of knowledge related to the natural environment through proactive environmental strategies but can also lead firms to gain competitive advantage. We argue that absorptive capacity facilitates the adoption of successful environmental strategies because environmental strategies require the combination of knowledge from various sources that are often outside of the firm. Managing environmental problems is complex and cuts across accepted organizational, functional, and disciplinary boundaries (Kemp, 1997). The interdisciplinarity of environmental issues require access to different competencies that exist mostly outside of the firm. Furthermore, the nature of environmental issues requires the firm to understand not only consumer but also social demands in a proactive way.

Hypotheses

Absorptive Capacity and Environmental Proactivity

Research has shown that knowledge in one field can ease the absorption of new knowledge in related fields (Cohen & Levinthal, 1990). Firms that have developed organizational capabilities to acquire new knowledge in their field will be better able to acquire knowledge related to environmental practices and technologies than firms that have not developed such capabilities (Marcus & Geffen, 1998). For example, firms that have developed capabilities in establishing research partnerships can build on these capabilities to launch new partnerships focused on emerging environmental technologies. Expertise in building partnerships will lower the cost of establishing new partnerships. Managers of such firms might also feel more comfortable with the idea of engaging in collaborations outside their immediate set of expertise than managers who have never established external partnerships. In addition, high levels of absorptive capacity, especially in the form of knowledge assimilation and transformation capabilities, will ensure the adequate understanding and application of external knowledge. Such absorptive capacity is not simply the sum of the individual capacities within the firm. The way in which knowledge is distributed within the organization and the structure of communications are just as significant (Lenox & King, 2004). Because environmental processes span across multiple fields of expertise, firms with good intraorganizational communication will be more likely to assimilate and transform external knowledge related to the environment than firms with weaker organizational communication (Pinkse, Kuss, & Hoffmann, 2010). It will be easier, for example, to conduct a product life cycle assessment for a firm where information flows easily across departments and the supply chain. This relative ease is because to implement a life cycle assessment, a company needs to obtain information regarding the environmental impact of a product throughout the life of the product and of its various components. Finally, knowledge exploitation capabilities allow the firm to reap commercial benefits from environmental proactive strategies. This gain can be achieved, for example, through participation in the design of best available techniques that will be chosen by regulatory agencies as the industry standard.

In conclusion, we argue that absorptive capacity in the form of knowledge acquisition, assimilation, transformation, and exploitation is crucial to facilitate the development of proactive environmental strategies. This requirement is particularly true in the chemical industry, where technological, environmental, and general management issues are often closely related. In such a case, prior knowledge in one area is also applicable in another and therefore fosters the firm's absorptive capacity across these different domains. From here, we derive our first hypothesis:

> *Hypothesis 1*: The higher the level of absorptive capacity, the greater the environmental proactivity of the firm.

Absorptive Capacity and Competitive Advantage

As outlined in the previous section, we see absorptive capacity as an enabler for firms to develop environmental proactivity. In addition, we see absorptive capacity as facilitating the generation of competitive advantage from environmental proactivity. In doing so, we use an approach that considers environmental proactivity from a strategic perspective (Reinhardt, 1999; Siegel, 2009). We base our investigation on three strategies that outline the possible strategic spectrum to reconcile competitiveness and environmental proactivity: Comparative cost reduction, value creation strategies aiming at innovation and product differentiation, and improved reputation.

Empirical evidence shows that environmentally proactive firms can realize significant savings in production costs by preventing pollution compared to reactive firms (Christmann, 2000; Hart & Ahuja, 1996; Klassen & Whybark, 1999). Pollution prevention may save not only the cost of installing and operating end-of-pipe pollution-control devices, it also may increase productivity and efficiency (Porter & van der Linde, 1995; Shrivastava, 1995; Smart, 1992). Less waste means better utilization of inputs, resulting in lower costs for raw materials and waste disposal. Moreover, environmental proactivity might help firms reduce the probability or the cost of uncertain but adverse outcomes such as environmental accidents that could lead to business interruptions, liability, punitive regulation, or damage to corporate reputations (Hart & Milstein, 2003).

We argue that absorptive capacity can leverage comparative cost advantages from proactive environmental strategies. Firms with highly developed absorptive capacity are likely to leverage cost advantages when implementing environmental changes because of their improved access to a wider variety of technologies and resulting flexibility in capability deployment (Zahra & George, 2002). Moreover, absorptive capacity can help to better assess the benefits of new technologies with respect to their ability to reduce potential liability costs, legal fees, or product take-back costs, or to leverage production efficiencies and waste reduction. Knowledge exploitation ensures the smooth implementation of these new technologies. The higher the level of absorptive capacity, the more easily and the more widely a firm will generate cost benefits from environmental proactivity.

Besides objectives of comparative cost reduction, firms can pursue value-creation strategies by aiming at innovation and product-differentiation benefits (Christmann, 2000; Delmas et al., 2007; Hart, 1995; McWilliams & Siegel, 2001; Porter & van der Linde, 1995) or by seeking an improved image and reputation based on environmental proactivity (Menon & Menon, 1997; Reinhardt, 1998; Shrivastava, 1995). Firms can also aim at imposing a cost on their competitors through more stringent regulations if they have already invested in technologies required by forthcoming regulation (Shrivastava, 1995; Vogel, 1995). Absorptive capacity can enable firms to realize differentiation and reputation advantages through proactive environmental strategies (Shrivastava, 1995). However, to realize these benefits, a firm needs to value, acquire, and assimilate knowledge to understand market trends. Furthermore, the firm has to use its transformation and exploitation capability to draw conclusions from these market trends and to develop or alter processes, products, or services that eventually result in a competitive advantage.

Finally, whether the firm is able to generate competitive advantage depends on the extent to which competitors are able to replicate such a strategy. Because both absorptive capacity and environmental proactivity depend on processes that are complex and often tacit (Hart, 1995; Szulanski, 1996), they are difficult to imitate (McEvily & Chakravarthy, 2002). In addition, in strong regimes of appropriability, a firm can protect its innovation derived from absorptive capacity through patents (Cohen & Levinthal, 1990). Then, the cost for knowledge replication is increased for rivals, leading to performance differences across firms (Zahra & George, 2002). Christmann outlines how such strong conditions of appropriability exist in innovation-driven regimes, for example, where firms are environmentally proactive. She explains that firms are able to create proprietary solutions and to benefit from them (Christmann, 2000).

Summing up, a high level of absorptive capacity enables a firm to turn environmental opportunities into competitive advantage, especially comparative cost, innovation, and reputation advantages. From there, state our second hypothesis:

> *Hypothesis 2*: The higher the level of absorptive capacity, the greater the competitive advantage generated from environmental proactive strategies.

Figure 1 illustrates our hypotheses. This figure shows that a firm's absorptive capacity explains both the adoption of environmental proactive strategies (Hypothesis 1) and competitive advantage derived from these strategies (Hypothesis 2). We therefore do not anticipate the relationship between environmental proactivity and competitive advantage to be direct but rather inferred from absorptive capacity.

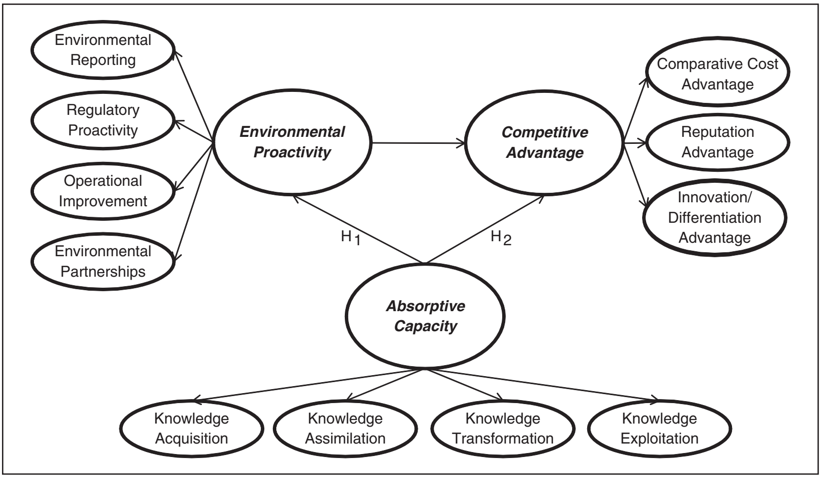

Figure 1. Absorptive capacity, environmental strategies, and competitive advantage

Method

Industry Choice

To limit variance and increase comparability, we focus our empirical analysis on one industry in one country: the German chemical industry. This industry was chosen because of the salience of environmental concerns and because of the importance of research and innovation for competitiveness. The chemical industry has a high environmental impact due to, for example, the industry's toxic emissions (Christmann, 2000, 2004; Hoffman, 1999; King & Lenox, 2000; Nehrt, 1996). The German chemical industry is affected by environmental regulation such as the new European chemicals policy EC/2006/1907 on the registration, evaluation, authorization, and restriction of chemicals (REACH). With an average R&D budget of 5.5% of sales, the chemical industry is also one of the most research-intensive industries in Germany (VCI, 2007), which points towards the importance of knowledge management and absorptive capacity. In addition, in 2006 the German chemical industry was the world's leading exporter of chemical products for the 4th year in a row, with exports valuing 119.6 billion Euros (VCI, 2007), which highlights a strong national and international competitive edge. Finally, with roughly 3,500 companies and total sales of about 162.2 billion Euros (VCI, 2007), the population of firms in the industry is sufficiently large for empirical analysis.

Measures

As archival data was not available in our industry context to proxy absorptive capacity, proactive environmental strategies, and competitive advantage, we opted for a survey approach with a multi-item scheme and multirespondents for each firm. This alternative has proved useful in previous research exposed to the same challenge (Aragon-Correa, 1998; Christmann, 2000; Delmas & Toffel, 2008; Jansen et al., 2005; Sharma, 2000).

As we describe below in greater detail, each of three main variables, that is , absorptive capacity, environmental proactivity, and competitive advantage through environmental proactivity, was developed based on constructs developed by scholars in similar contexts. We asked eight industry experts to check the validity of each of these constructs in our setting. We used an iterative process where we interviewed a set of experts, took into account their suggestions in a revised questionnaire, and presented the new version to the next set of experts until we had integrated the views of all eight of the experts. We measured each item with a 7-point Likert-type scale (all items are presented in Appendix A).

Measurement of absorptive capacity. Researchers measured absorptive capacity using various indicators. For example, Cohen and Levinthal (1990) chose R&D intensity as their proxy. Others used a survey approach involving a five-item scale measuring absorptive capacity (Lane & Lubatkin, 1998; Szulanzki, 1996). Because absorptive capacity consists of several subcapabilities, we decided to measure these individually. We therefore combined the constructs from Jansen et al. (2005) with a measure from Jaworski and Kohli (1993). As such, we included 14 items to describe our four separate constructs for knowledge acquisition (four items), assimilation (three items), transformation (four items), and exploitation (three items).

Measurement of environmental proactivity. Sharma and Vredenburg developed a comprehensive set of constructs to measure the proactivity of an environmental strategy in their study of the oil and gas industry (Sharma, 2000; Sharma & Vredenburg, 1998). We built on their constructs and complemented these with an additional construct to reflect the firm's regulatory proactivity, based on Khanna, Koss, Jones, and Ervin (2007). The items were adapted to the chemical industry setting by using industry experts as outlined above. The procedure resulted in 15 items for four constructs: environmental reporting (three items), regulatory proactivity (three items), improvement of operations (four items), and environmental partnerships (five items).

Measurement of competitive advantage through environmental proactivity. Constructs for estimating the competitive advantage gained from an environmental strategy have been used in a variety of studies (Christmann, 2000; Darnall

& Edwards, 2006; Delmas, 2001; Russo & Fouts, 1997). Because we included both private and publicly traded firms, we could not use accounting measures. Instead, we used constructs for innovation and comparative cost advantages from Christmann (2000) that are based on a multi-item scheme, and complemented these with items for innovation and reputation from the Sharma and Vredenburg (1998) study. The constructs were also adapted to the chemical industry setting using industry experts as outlined above. During this process, we dropped and modified a number of items. The procedure resulted in ten items for three main constructs: comparative cost benefits (four items), innovation and differentiation (three items), and reputation and customer relations (three items).

Controls

Firm size. Firm size has been hypothesized to influence both environmental and business performance of firms (Aragon-Correa, 1998; Orlitzky, 2001). We controlled for company size using the logarithm of annual sales.

Management support. Researchers have shown the roles of gatekeeper and boundary spanner, both inside and outside the firm and between different entities within the firm, as drivers of a firm's absorptive capacity (Lenox & King, 2004). Management support has also been found to influence environmental activities and has been thoroughly addressed in strategic management research both theoretically and empirically in case study research (Henriques & Sadorsky, 1999; Hunt & Auster, 1990; Roome, 1992; Wartick & Cochran, 1985). In our case, our construct builds on the study conducted in the policy domain by Khanna et al. (2007).

Sample Selection and Response Rate

For our empirical analysis, we chose member firms of the chemical industry association of Germany, the Verband der Chemischen Industrie (VCI), with research and production operations based in Germany: A total of 1,143 member firms at the time of the evaluation (July 2007).[2] This membership represents roughly a third of all chemical companies in Germany, and close to 90% of all employees in the German chemical companies. Thus, members of the German chemical industry association tend to include the largest chemical companies in Germany.

In the following step, we identified the mail addresses and telephone numbers of the companies listed in the directory. To obtain a number of independent knowledge sources, we contacted the 1,143 companies by phone and requested contact information for the most knowledgeable person in the areas of firm competitiveness, environmental strategy, and knowledge management. Typically, the contacts were the CEO for firm strategy, the R&D director for knowledge management, and the director of the environmental department for the firm's environmental strategy.

We eliminated 30 firms because the respondents stated that an assessment of the actual state of the overall company was not feasible due to a recent merger or larger restructuring processes. Finally, we removed 350 firms that stated that they had an internal policy not to participate in any voluntary survey. These actions reduced the sample to 763 firms.

Subsequently, we administered a personalized questionnaire survey to collect firm information for the dependent and independent variables from independent knowledge sources. As such, most firms received three individual letters: One to the CEO, one to the director of R&D, and one to the director of the environmental department. For each letter, the set of questions depended on the contact person's position and included either the constructs that assessed competitive advantage, environmental proactivity and management support, or absorptive capacity. In cases where we could identify a single contact person only, for example, in smaller companies where the CEO was responsible for all areas, we sent a survey questionnaire containing all sets of questions to the identified single respondent. Each package held a cover letter, the survey, and an addressed and stamped return envelope. In addition, the cover letter offered the options to fill in the survey by fax, online, or via phone.[3] Four weeks later, we conducted a second round of phone calls as a first reminder. Finally, an additional 4 weeks later, we sent a last reminder via email.

A total of 271 firms delivered at least one part of the questionnaire (i.e., competitive strategy, knowledge management, or environment), which represents a response rate of 35.5%, whereas 157 firms delivered all parts of the questionnaire, which represents a response rate of 20.6%. This result represents a satisfactory response rate (Delmas & Toffel, 2008; Hoskisson, Cannella, Tihanyi, & Faraci, 2004; McEvily & Chakravarthy, 2002). Out of these 157 firms, 33 firms had two or three respondents (21%) who responded to different parts of the questionnaire. In such cases, we aggregated the responses so that each firm represented one observation in the database. We tested sample representativeness in several ways. First, we searched for differences in the compositions of the original and responding sample. To test if some 22 subsectors of the VCI within our sample were more likely to respond, we performed a binary logistic regression with the dummy variable for response or nonresponse as dependent variable. The results show no significant bias regarding any of the investigated subsectors. To test whether greener firms were more likely to participate in our questionnaire, we used the same methodology to test for the representativeness of firms participating in the Responsible Care initiative of the chemical industry, a special initiative to reduce environmental impact. The results also show no significant bias related to participation in Responsible Care.[4] Finally, we compared the size distribution of the respondents in our sample to the German chemical industry and found a higher representation of larger companies. This skew is explained by our sample being based on members of the German chemical industry association, which includes the largest German chemical firms. We assigned each firm to a predefined size group and performed a paired *t*-test, which revealed differences at a significance level of $p = 0.043$.

We were also able to dispel concerns of common method bias in our data. Common method bias occurs when the instruments the researcher employs enter into or affect the score or measures that are being gathered. First, 21% of our data includes two or three different respondents, which means that there is no common method bias in this subsample of our respondents.[5] Second, we did not find common bias in the remaining 80% of the data. For this test, we calculated single-factor scores for the main variables absorptive capacity, environmental proactivity, and competitive advantage and performed a regression between pairs of them. So for example, we would use competitive advantage as a dependent variable and absorptive capacity, environmental proactivity, number of respondents, and sales as independent variables. If common method bias was present, the variable "number of respondents" would be significant (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003; Spector, 2006). The variable number of respondents was not significant in any of the models. We were therefore able to dismiss concerns of common method bias.[6]

Structural model. We employed structural equation modeling (SEM, AMOS Version 7, via maximum likelihood estimates) because of the ability of this technique to analyze models based on several latent variables that are more complex than multiple regression models (Hardy & Bryman, 2004). Structural modeling addresses structural and measurement issues frequently found in survey-designed research and is increasingly being used in strategic-management research (Capron, 1999; Cordano & Frieze, 2000; Delmas & Toffel, 2008; Sharma, 2000; Shook, Ketchen, Hult, & Kacmar, 2004; Simonin, 1999).[7]

The construction of each latent variable can be depicted by a set of linear equations of the form:

$$Y_i = \beta_0 + X_{i1}\beta_1 + \ldots + X_{ip}\beta_p + \varepsilon_i$$

Similarly, the relation between the different latent variables can be described with a set of linear equations of the same form. The equations system is solved under the side condition to minimize the overall variance error. Often, different letters are used to distinguish between the latent and observable variables. For simplicity and as we focus on the relation between the latent variables only, we use a single notation.

As such, in our case the equations system between the three main variables can be described as:

$$CA = \beta_{CA} + X_{CA,ACAP}\beta_{EP,ACAP} + X_{CA,EP}\beta_{CA,Ep} + \varepsilon_{EP}$$
$$EP = \beta_{EP} + X_{EP,ACAP}\beta_{EP,ACAP} + \varepsilon_{EP}$$

Where *CA* reflects the overall level of competitive advantage, β_{CA} reflects a potential systematic deviation from the neutral level, $\beta_{CA,ACAP}$ reflects the effect size of absorptive capacity on *CA*, $\beta_{CA,EP}$ reflects the effect size of environmental proactivity controlled for the effects of absorptive capacity, and finally ε_{CA} depicts the error in the variance that cannot be explained by any of the variables.

Structural diagnostics. Based on a number of tests, we found a good overall fit of the model. For example, the model has a χ^2/df ratio of 1108/796 = 1.44, which is lower than 2 and therefore implies a good fit of the model (Marsh & Hocevar, 1985). We find that the χ^2 is statistically significant (p = .000), which could suggest some misspecification of the model although it is well recognized that this statistic is sensitive to sample size (Arbuckle & Wothke, 1999). We considered other structural diagnostics for the overall fit of the model that are not sensitive to sample size (Bentler, 1990). We calculated the root mean squared error of approximation (RMSEA), an estimate of the discrepancy between the original and reproduced covariance matrices in the population (Steiger, 1990). In our model, the RMSEA of 0.05 is within an acceptable range (Cudeck & Browne, 1983). Likewise, we found an incremental fit index (IFI; Bollen, 1989) of 0.91, a Tucker Lewis index (TLI; Tucker & Lewis, 1973) of 0.90, and a comparative fit index (CFI; Bentler & Bonett, 1980) of 0.91. Each of these indices is above the common threshold of 0.90 that designates an acceptable fit. In sum, these structural diagnostics indicate a very good relative fit of the theoretical model to the underlying data.

Measurement Model

The measurement model describes the construction of the latent variables from the observed variables. We constructed 12 latent variables from a set of 41 items (see Appendix A). We performed a confirmatory factor analysis using principal component analysis with Varimax rotation, as well as calculating Cronbach's

Table 1. Measurement Paths

Measurement paths	Unstandardized regression weight	Standard error	Critical ratio	Standardized regression weight	p value
Absorptive capacity					
Knowledge acquisition	1 (fixed)			0.58	
Knowledge assimilation	2.6	0.7	3.7	0.77	***
Knowledge transformation	3.7	1.0	3.9	0.98	***
Knowledge exploitation	3.3	0.9	3.7	0.95	***
Environmental proactivity					
Environmental reporting	1.7	0.2	7.0	0.90	***
Regulatory proactivity	1 (fixed)			0.75	***
Operational improvement	1.1	0.2	5.4	0.77	***
Environmental partnerships	1.2	0.2	6.3	0.82	***
Competitive advantage					
Cost	1 (fixed)			0.50	***
Reputation	1.0	0.2	4.6	0.84	***
Innovation/ differentiation	1.2	0.2	4.8	0.83	***

***$p < .001$.

alpha to confirm the loading of our items on the latent variables (details provided in Appendix A). Our three main latent variables (absorptive capacity, competitive advantage, and proactive strategies) were derived from 11 of these latent variables as shown in Table 1 below. The remaining 12th latent variable is management support.

Results

Table 2 presents the results for the hypothesized relations between the main variables. We find that absorptive capacity has a positive and significant impact

Table 2. Results of the Structural Model

Antecedent variable → Consequent variable	Regression weight	Standard error	Critical ratio	*p* value	Standardized regression weight
Hypothesized relations					
Absorptive capacity → Environmental proactivity	0.50	0.25	2.0	.043	0.15
Absorptive capacity → Competitive advantage	0.68	0.29	2.3	.020	0.32
Control relationships					
Environmental proactivity → Competitive advantage	0.22	0.09	5.6	.011	0.35
Absorptive capacity → Management support	1.96	0.71	2.8	.005	0.31
Management support → Environmental proactivity	0.37	0.06	6.6	***	0.70
Company size → Absorptive capacity	0.05	0.03	1.8	.067	0.17
Company size → Management support	0.51	0.15	3.4	***	0.26
Company size → Environmental proactivity	0.26	0.07	4.0	***	0.25
Company size → Competitive advantage	–0.04	0.06	–0.6	.529	–0.06

***$p < .001$; company size in logarithm of sales

on environmental proactivity and competitive advantage, and that environmental proactivity has a significant and positive impact on competitive advantage. In addition, we find two mediation effects: Environmental proactivity mediates the relation between absorptive capacity and competitive advantage, and management support mediates the relationship between absorptive capacity and environmental proactivity.

Hypothesis 1. The results for the main relations provided in Table 2 confirm Hypothesis 1 that predicted a positive effect from absorptive capacity on the generation of environmental proactivity. The path between absorptive capacity and environmental proactivity is positive and significant ($\beta = 0.15, p = .043$). Based on the standardized coefficient, a one standard deviation increase in absorptive capacity is associated with a 0.15 increase in environmental proactivity. However, a closer look infers a mediating role of management support. In fact, variations in levels of the independent variable, absorptive capacity, account significantly for variations in the management support mediator ($\beta = 0.31$, $p = .005$). Furthermore, variations in the mediator significantly account for a variation in the dependent variable, environmental proactivity ($\beta = 0.70$, $p < .001$). The total standardized effect of absorptive capacity on environmental proactivity increases ($\beta = 0.36$) when taking into account the indirect effect of absorptive capacity on environmental proactivity via management support. Moreover, to function as a mediator, the direct relation between the independent and the dependent variable needs to weaken substantially when including the mediating variable (Baron & Kenny, 1986). We confirmed this condition in a separate model that assessed the influence of absorptive capacity on a firm's environmental proactivity after removing the variable management support. Although all structural diagnostics remain similar, the significance of the relation between absorptive capacity and environmental proactivity increases ($\beta = 0.36$, $p = .004$). Thus, we find strong support for Hypothesis 1 yet mediated by management support.

Hypothesis 2. The results confirm the predicted relationship that absorptive capacity has a positive effect on the generation of competitive advantage from a proactive environmental strategy. The path between absorptive capacity and competitive advantage is positive and significant ($\beta = 0.32$, $p = .020$). Based on the standardized coefficient, a one standard deviation increase in absorptive capacity is associated with a 0.32 increase in competitive advantage.

Although we find that the direct effects of environmental proactivity and absorptive capacity on competitive advantage are both significant, we wanted to test how these two effects worked together. We therefore calculated the indirect effect of absorptive capacity on competitive advantage via environmental proactivity ($\beta = 0.05$) and the total effect including the direct and indirect effects ($\beta = 0.38$). These results show that the total effect is superior to the direct effect, implying a partial mediating role for environmental proactivity. We also evaluated the existence of the mediating role of the firm's environmental proactivity on competitive advantage by removing the variable environmental proactivity from the model, and found an increased significance of the relation between absorptive capacity and competitive advantage ($\beta = 0.44$, $p = .006$), confirming the mediating role of the firm's environmental proactivity (Baron & Kenny, 1986).

Overall, our results indicate that a significant share of the firm's environmental proactivity is attributable to the firm's absorptive capacity, and that environmental proactivity is not the only determinant of competitive advantage.

The combination of both environmental proactivity and absorptive capacity allows a firm to benefit from its environmental stance.

To compare our model to a more classic test of the effect of environmental strategies on competitive advantage, we developed a second alternative model in which we omit absorptive capacity. In this model, the significance of the *direct* relationship between environmental strategies and competitive advantage increases ($\beta = 0.540$, $p < .001$). However, this alternative model yields worse fit statistics than our original model. In sum, our original model adds significant explanatory power to a more traditional approach.

Robustness. To ensure the robustness of our data, we validated the findings using a number of alternative approaches. First, we wanted to confirm that the result would hold for the population of 271 firms. For this confirmation, we repeated the different analyses with the larger data sample, considering all responses from the 271 firms by taking advantage of AMOS' full information maximum likelihood (FIML) estimation routine to handle missing data, which allows taking into account all information observed. The model yielded better fit indices than the conservative model with 157 firms and supported the two hypotheses even more strongly. Although the relationship between environmental proactivity and competitive advantage decreases in significance, the relationships between absorptive capacity and environmental proactivity as well as competitive advantage become even more significant. As such, this model also highlights the role of absorptive capacity to generate value through environmental proactivity.[8]

Second, we wanted to test whether the results were driven by specific elements of environmental proactivity, absorptive capacity, or competitive advantage. To gain a better insight into the details of the first hypothesized relation, we used the factor scores of the different subvariables of competitive advantage, environmental proactivity, and absorptive capacity and conducted two multivariate analyses (MANCOVA). First, we used the four different individual elements of absorptive capacity as well as the interaction term of these elements as independent variables and the measures for environmental proactivity as dependent variables. In addition, we conducted another MANCOVA exploring the different subconstructs of absorptive capacity and competitive advantage. We controlled for the number of respondents and company size. Table 3 displays the results.

The MANCOVA results reflect the findings from the structural equation model but allow a more detailed view of the mode of action of absorptive capacity. Each individual element does not contribute a specific share to the value of absorptive capacity. Instead, the value of absorptive capacity seems

Table 3. MANCOVA Absorptive Capacity—Environmental Proactivity/Competitive Advantage

	Environmental proactivity						Competitive advantage					
		Multivariate tests[a]	Tests of between-subject effects					Multivariate tests[a]	Tests of between-subject effects			
Independent variables	Dependent variables	F (Significance)	B^c	F	Partial η^2	Significance	Dependent variables	F (Significance)	B^c	F	Partial η^2	Significance
Corrected model												
	Environmental reporting			8.46	0.389	.000	Comp. cost			5.37	0.260	.000
	Regulatory proactivity			6.00	0.311	.000	Reputation			4.21	0.216	.000
	Operational improvement			6.70	0.335	.000	Innovation			3.95	0.205	.001
	Environmental partnerships			5.11	0.278	.000						
Intercept		6.06 (.000)						0.62 (.603)				
	Environmental reporting		–0.91	19.30	0.172	.000	Comp. cost		–0.30	1.71	0.016	.193
	Regulatory proactivity		–0.96	17.16	0.156	.000	Reputation		0.00	0.00	0.000	.985
	Operational improvement		–0.55	6.23	0.063	.014	Innovation		–0.01	0.00	0.000	.977
	Environmental partnerships		–0.69	8.20	0.081	.005						
Knowledge acquisition		0.41 (.800)						2.31 (.080)				

(continued)

Table 3. (continued)

	Environmental proactivity						Competitive advantage					
		Multivariate tests[a]	Tests of between-subject effects					Multivariate tests[a]	Tests of between-subject effects			
Independent variables	Dependent variables	F (Significance)	B^c	F	Partial η^2	Significance	Dependent variables	F (Significance)	B^c	F	Partial η^2	Significance
	Environmental reporting		0.07	0.49	0.005	.484	Comp. cost		0.22	4.32	0.039	.040
	Regulatory proactivity		0.08	0.53	0.006	.470	Reputation		0.22	3.83	0.035	.053
	Operational improvement		–0.01	0.01	0.000	.926	Innovation		0.08	0.48	0.004	.492
	Environmental partnerships		0.13	1.16	0.012	.285						
Knowledge assimilation		1.54 (.198)						1.58 (.198)				
	Environmental reporting		0.11	1.03	0.011	.313	Comp. cost		–0.13	1.08	0.010	.301
	Regulatory proactivity		0.05	0.15	0.002	.700	Reputation		0.15	1.30	0.012	.256
	Operational improvement		0.23	3.79	0.039	.055	Innovation		0.20	2.18	0.020	.143
	Environmental partnerships		0.26	3.79	0.039	.054						
Knowledge transformation		1.13 (.350)						3.25 (.025)				
	Environmental reporting		0.01	0.00	0.000	.955	Comp. cost		0.40	7.75	0.068	.006
	Regulatory proactivity		–0.02	0.01	0.000	.917	Reputation		0.05	0.12	0.001	.735

(continued)

Table 3. (continued)

	Environmental proactivity						Competitive advantage					
		Multivariate tests[a]	Tests of between-subject effects					Multivariate tests[a]	Tests of between-subject effects			
Independent variables	Dependent variables	F (Significance)	B^c	F	Partial η^2	Significance	Dependent variables	F (Significance)	B^c	F	Partial η^2	Significance
	Operational improvement		0.27	3.09	0.032	.082	Innovation		0.25	2.53	0.023	.115
	Environmental partnerships		–0.01	0.01	0.000	.932						
Knowledge exploitation		2.07 (.091)						1.54 (.209)				
	Environmental reporting		0.23	3.70	0.038	.057	Comp. cost		–0.13	1.12	0.010	.293
	Regulatory proactivity		0.13	1.00	0.011	.320	Reputation		0.14	1.24	0.011	.268
	Operational improvement		–0.10	0.67	0.007	.416	Innovation		–0.05	0.13	0.001	.719
	Environmental partnerships		0.08	0.35	0.004	.555						
ACAP interaction[b]		3.08 (.020)						4.00 (.010)				
	Environmental reporting		0.04	2.79	0.029	.098	Comp. cost		0.05	5.63	0.050	.019
	Regulatory proactivity		0.08	7.27	0.073	.008	Reputation		0.07	9.82	0.084	.002
	Operational improvement		0.08	8.33	0.082	*.005*	Innovation		0.04	3.25	0.029	.074
	Environmental partnerships		0.06	4.22	0.043	.043						

(continued)

Table 3. (continued)

	Environmental proactivity						Competitive advantage					
		Multivariate tests[a]	Tests of between-subject effects					Multivariate tests[a]	Tests of between-subject effects			
Independent variables	Dependent variables	F (Significance)	B^c	F	Partial η^2	Significance	Dependent variables	F (Significance)	B^c	F	Partial η^2	Significance
Logarithm of annual sales		7.04 (.000)						3.40 (.021)				
	Environmental reporting		0.42	22.67	0.196	.000	Comp. cost		0.22	6.47	0.057	.012
	Regulatory proactivity		0.42	18.00	0.162	.000	Reputation		–0.03	0.13	0.001	.721
	Operational improvement		0.29	9.85	0.096	.002	Innovation		0.12	1.72	0.016	.192
	Environmental partnerships		0.25	6.29	0.063	.014						
Number of respondents		0.92 (.456)						0.6 (.613)				
	Environmental reporting		0.09	0.55	0.006	.458	Comp. cost		–0.11	0.64	0.006	.426
	Regulatory proactivity		0.18	1.74	0.018	.190	Reputation		–0.03	0.04	0.000	.839
	Operational improvement		–0.07	0.27	0.003	.606	Innovation		–0.15	1.13	0.010	.290
	Environmental partnerships		0.18	1.63	0.017	.204						

a. Multivariate tests: Pillai's trace, Wilks's Lambda, Hotellings's Trace, Roy's Largest Root (all values converged).
b. (Acquisition × Assimilation × Transformation × Exploration).
c. Parameter estimate.

to result from the combined effect of all elements. As such, we find that absorptive capacity is able to unfold only when all four elements are present.

These results further confirm the finding drawn from the structural model. We find that the combined effect of all elements turns absorptive capacity into a valuable capacity. Interestingly, we also find that some of the elements taken individually might be costly to the firms but that their combined interaction might not. For example, the construct "exploitation" has a negative and significant effect on cost reduction, but the effect becomes positive when "exploitation" is combined with the other elements of absorptive capacity.

Third, because we used cross-sectional data that we gathered contemporaneously, we tested whether our results were robust to the inclusion of reverse path. In the original model, we include paths extending from absorptive capacity to environmental proactivity and competitive advantage. We developed an alternative model that included paths from the subconstructs of competitive advantage and environmental proactivity to the main construct of absorptive capacity and to the main construct of environmental proactivity. Neither of the new reverse paths was statistically significant and the results of this model yielded nearly identical estimates of the original hypothesized relationships.

Fourth, another potential concern derives from heterogeneity within our sample that is not controlled for in our structural equation model. Specifically, because our sample includes facilities from several subindustries and structural equation modeling techniques do not allow for industry dummies, it is possible that unobserved differences between these industries may account for some of our results. To test whether our results were sensitive to unobserved industry differences, we estimated regression equations corresponding to the paths of the structural equations. In these regression analyses, we included additional control variables such as firm size (measured as logarithm of annual sales), R&D budget (in share of sales), subindustry (as dummy variables for, for example, pharmaceuticals, coatings, and so on), and environmental budget. All control variables had no impact on the findings. The results of these regression analyses confirmed the findings of the structural model. All hypothesized relationships remain statistically significant ($p < .001$) with the predicted sign.

Discussion and Conclusions, and Future Research

We started by asking what constitutes the basis for successful proactive environmental strategies. We argued that by studying the link between proactive environmental strategies and competitive advantage independently from the firms' more general organizational capabilities, researchers might just be looking at the tip of the iceberg and missing the most fundamental element of the success of proactive environmental strategies. To investigate the less visible organizational drivers of the development of successful environmental strategies, we developed a model to investigate the relationship between absorptive capacity, environmental proactivity, and competitive advantage. Our findings show that the adoption of proactive environmental strategies depends on the firm's level of absorptive capacity, mediated by management support. Similarly, the generation of competitive advantage from such a proactive approach seems largely fueled by the firm's absorptive capacity. These results hold contributions for both theory and practice.

First, we contribute to the "pays to be green" debate by combining research on the link between environmental strategies and competitive advantage with the research seeking to explain the rationale for the adoption of environmental proactivity. To some extent, the results also suggest spuriousness regarding the relation between environmental proactivity and competitive advantage, because both variables rely on organizational capability. Previous research had ignored that environmental proactivity provides the foundation for such proactive strategies. Because absorptive capacity was not included in previous models, it is possible that the effect of environmental proactivity on competitive advantage was artificially inflated.

In addition, widen the context of application of the absorptive capacity concept. Although many scholars have made use of absorptive capacity in a technological context, little research has extended the application of the concept beyond this domain (Lane et al., 2006; Lenox & King, 2004; Zahra & George, 2002). Here, we apply the concept of absorptive capacity beyond a purely technological or managerial domain to an external and complex area that simultaneously requires the consideration of social, regulatory, technological, and managerial issues. Whereas the core of the literature on absorptive capacity emphasizes the processes of building up technological knowledge within and outside the firm, our work stresses that absorptive capacity can facilitate the acquisition of external expertise in the social and regulatory domain. In addition, we find that absorptive capacity is only realized when upper management is driving the process. This finding confirms that when examining the development of new strategies it is important to consider the political processes within an organization, such as decisions of power holders upon courses of strategic action (Child, 1972; Lenox & King, 2004; Rosenkopf & Nerkar, 2001; Todorova & Durisin, 2007).

Our third contribution is of a practical nature, as the findings give strategic guidance for firms. Those firms that aim at strengthening their environmental competencies without forfeiting their competitiveness should not initially invest in environmental measures but rather in their absorptive capacity. Having a strong stand in acquiring, assimilating, transforming, and exploiting knowledge seems a valuable precondition to realizing benefits from a proactive environmental strategy. The applicability of our approach is further supported by the fact that the different elements of absorptive capacity relate to distinct knowledge management tools. For example, knowledge acquisition refers to access to knowledge networks such as universities, participation in research alliances, or direct knowledge acquisitions, for example, firm or patent acquisitions. Moreover, the concept of absorptive capacity suggests that knowledge contributes best to a firm's competitive advantage if the respective processes are fully integrated within the firm. Conversely, an isolated environmental division is unlikely to transfer knowledge to other units. Our work can also provide practical guidance to investors who are seeking to understand the link between environmental and competitive advantage. Our results confirm socially responsible investors' intuition that environmental proactivity rests on solid managerial foundations.

Our research is not without limitations. One should consider a more dynamic model where the development of competencies in the firm's environmental strategy—which is an outcome of the firm's absorptive capacity—increases the firm's absorptive capacity through extending the firm's knowledge base. Therefore, the existence of feedback loops as part of a longer process needs further investigation. Although cross-sectional survey data offers advantages over archival publicly available data to investigate firms' organizational capabilities, longitudinal data would allow a more dynamic investigation if it were available. Moreover, although the chemical industry provided an excellent context because of the salience of environmental concerns, future research should test how our model holds for other industrial contexts where environmental issues are less significant. Finally, we focused on a single national context. It would be interesting to analyze the effect of differing national regulatory settings on the relations between absorptive capacity and successful proactive environmental strategies.

Appendix A

Latent variables items	*M*	*SD*	Number of items	Cronbach's alpha	Variance explained	Standardized regression weight	Significance
Absorptive capacity							
Knowledge acquisition			*4*	*0.77*	*59.1%*		
1. Business units and functional groups strongly interact with upper levels to acquire new knowledge	4.6	1.3				0.80	***
2. Different departments (business units/ functional groups such as procurement, legal, different R&D) strongly interact with each other to acquire new knowledge	4.7	1.3				0.96	***
3. The company collects industry information through informal means (e.g., lunch with industry friends, talks with trade partners)	5.1	1.3				0.38	*fixed*
4. The company regularly organizes special meetings with third parties (customers, consultants, and so on) to acquire new knowledge	4.9	1.5				0.45	***
Knowledge assimilation			*3*	*0.86*	*77.6%*		
5. We quickly recognize shifts in our market (e.g., competition, regulation, demography)	5.2	1.2				0.79	*fixed*
6. New opportunities to serve our clients are quickly understood.	5.5	1.1				0.87	***

***$p<.001$

(continued)

Appendix A. (continued)

Latent variables items	*M*	*SD*	Number of items	Cronbach's alpha	Variance explained	Standardized regression weight	Significance
7. Consequences of technological progress are quickly understood.	5.1	1.1				0.79	***
Knowledge transformation			*4*	*0.83*	*66.6%*		
8. The company regularly considers the impact of changing market demands for the portfolio of products and services (e.g., employees full-time dedicated as part of product management, regular meetings, and so on.)	4.5	1.5				0.64	***
9. The meetings held regarding new operations and products are highly effective (meeting goals are set and achieved, and so on).	4.5	1.2				0.68	***
10. Newly acquired knowledge is documented and shared within the whole company.	4.4	1.5				0.83	***
11. The applicability of new knowledge to existing knowledge is quickly recognized.	4.6	1.2				0.88	*fixed*
Knowledge exploitation			*3*	*0.67*	*60.1%*		
12. The processes (e.g., procedures, and so on) for all kinds of activities are clearly known (e.g., face-gate-process, standard operating procedures, and so on).	5.0	1.5				0.65	*fixed*
13. We experience difficulties in implementing client requests (e.g., product modifications, and so on.)—inverted—	5.0	1.2				0.53	***

***$p<.001$

(continued)

Appendix A. (continued)

Latent variables items	*M*	*SD*	Number of items	Cronbach's alpha	Variance explained	Standardized regression weight	Significance
14. We constantly consider how to better exploit knowledge (e.g., lessons learned processes).	4.2	1.4				0.70	***
Management support			3	0.89	*82.0%*		
15. . . . provide incentives and assistance for environmentally friendly practices and technologies?	3.4	1.8				0.84	***
16. . . . encourage facilities to participate in voluntary environmental programs? (e.g., with other departments, other companies, and so on.)	3.3	1.8				0.97	*fixed*
17. . . . allow facilities to make environmental investments to go beyond legal compliance?	3.4	1.7				0.75	***
Environmental proactivity							
Environmental reporting			*3*	*0.81*	*73.2%*		
18. Internal assessment of the environmental impact of operations	4.1	2.1				0.87	*fixed*
19. Comprehensive external environmental audit	3.5	2.4				0.86	***
20. Do you release a public environmental or sustainability report (yes/no)	0.2	0.4				0.60	***
Regulatory proactivity			*3*	*0.73*	*65.9%*		
21. Adopted comprehensive product life cycle analysis	2.5	1.6				0.47	***

***$p<.001$

(continued)

Appendix A. (continued)

Latent variables items	*M*	*SD*	Number of items	Cronbach's alpha	Variance explained	Standardized regression weight	Significance
22. . . . participate in the development of new environmental regulation?	2.1	1.7				0.73	*fixed*
23. . . . contribute to the design of new best available techniques?	2.6	1.8				0.95	***
Operational improvement			*4*	*0.76*	*57.8%*		
24. Investment in additional pollution/emission control equipment	3.8	2.1				0.64	*fixed*
25. Closed-loop waste use within the organization	3.8	2.0				0.72	***
26. Closed-loop waste use with other organizations	2.7	1.8				0.60	***
27. Implementation of other processes/ technologies to reduce waste	4.0	1.8				0.70	***
Environmental partnerships			*5*	*0.88*	*67.4%*		
28. With companies within the chemical industry	2.3	1.7				0.77	*fixed*
29. With companies outside the chemical industry	2.1	1.5				0.66	***
30. With suppliers and distributors	2.8	1.7				0.79	***
31. With industry associations	2.8	1.9				0.84	***
32. With government/local communities	2.3	1.7				0.76	***

***$p < .001$

(continued)

Appendix A. (continued)

Latent variables items	*M*	*SD*	Number of items	Cronbach's alpha	Variance explained	Standardized regression weight	Significance
Competitive advantage through environmental proactivity							
Cost			3	0.87	79.1%		
33. We incur lower compliance costs with regulations of environmental issues relative to our domestic competitors.	3.5	1.3				0.88	fixed
34. Overall, our environmental strategy improves our relative cost position to domestic competitors.	3.5	1.3				0.90	***
35. Overall, our environmental strategy improves our relative cost position to foreign competitors.	3.0	1.4				0.72	***
Reputation			3	0.83	74.9%		
36. Overall company reputation or goodwill	5.0	1.0				0.70	fixed
37. Loyalty of existing customers	4.5	0.9				0.83	***
38. Attraction of new customers	4.7	1.0				0.84	***
Innovation/differentiation			3	0.86	77.5%		
39. Development of new technologies	4.7	1.0				0.84	fixed
40. Development of new or improvement of existing processes and operations	4.8	1.0				0.80	***
41. Development of new or improvement of existing products	4.8	1.1				0.80	***

***$p<.001$

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Notes

1. According to Innovest Strategic Value advisors, leaders in Socially Responsible Investing research, "Companies' ability to handle political, environmental, labor, and human rights risks are powerful proxies and leading indicators for their overall management quality—or the lack thereof." (http://www.innovestgroup.com/index.php?option=com_content&task=view&id=34&Itemid=32).
2. Verband der Chemischen Industrie www.vci.de
3. 62% of the respondents answered by postal mail or by fax and 38% responded by filing the online questionnaire.
4. Results available upon request from the authors (Appendix B, Table B1). Appendix B is too long to publish and contains considerable statistical data organized into tables. Specific tables in that appendix are referred in notes to this article.
5. Our data originate from a varying number of independent sources (respondents). 24.0% of the data (40 responses) used to assess the relation between absorptive capacity and environmental proactivity, 19.1% of the data (31 responses) used to assess the relation between absorptive capacity and competitive advantage, and 20.2% of the data (33 responses) used to assess the relations between environmental proactivity and competitive advantage stem from independent sources, the rest stem from a single respondent.
6. Results available from the authors (Appendix B ,Table B2).
7. The structural model is available from the authors upon request (Appendix B, Figure B1).
8. Results available from the authors (Appendix B, Tables B3 and B4).

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