6

The Impact of Collaboration on Green Competitive Advantage in Europe's Largest Petrochemical Cluster

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1 Introduction

A large number of studies have looked into the impact of a firm's localization in a geographical cluster. In one of the most well known, Porter (1998) explained that fierce competition within a cluster

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improves cluster firms' performance. Folta et al. (2006) looked at the impact of cluster size on cluster firms' innovation rate, alliance partners, and private investors. They found increasing individual performances until the cluster consisted of about 65 firms, after which the effect reversed. Decarolis and Deeds (1999) observed a positive link between cluster membership and the firm's financial performance. Clusters are mostly considered as fruitful environments to generate competitive advantage because they increase productivity, stimulate innovation, and attract new firms (Porter 1998, 2000; Marshall 1920). Other advantages of cluster membership are an increased likelihood that the firm internationalizes and, hence, results in higher international sales (Fernhaber et al. 2003). However, Porter (1998) indicated that a cluster needs at least ten years to establish a certain depth and create a competitive advantage, indicating that potentially not all benefits are immediately and automatically generated. Many researched positive impacts of clusters at least suggest that the cooperation of multiple firms in a geographical area stimulates some form of collaboration or synergy. Little attention, as also recently pointed out by Wassmer et al. (2014) in the context of environmental collaborations in particular, has been given to the causal effects and mediating factors of collaborations leading to green firm benefits.

Managers would however benefit from more insight into how the positive effects are generated and the processes that lead to the cluster firms' advantages. It can help to understand how to use the cluster's network to their advantage, making their firms more competitive compared to firms outside the cluster's network and supporting decisions as from membership considerations up to cluster-specific investments. Furthermore and specifically related to socioeconomic issues, such as environmental impacts, understanding the processes that lead to an increase of environmental investments which go beyond compliance, and making firms more competitive at the same time, is also valuable information for policymakers. They might become more aware of the specific stimuli that can trigger and/or reinforce a firm's (voluntary) efforts for the natural environment and may as such be more supportive of clusters or other forms of collaboration.

Wassmer et al. (2012) did an extensive literature study of all forms of environmental collaborations and discussed antecedents and consequences of these collaborations. This paper has a strong focus on inter-firm collaborations and concludes that inter-firm collaborations for environmental issues "can be seen as vehicles to realize economic value through addressing environmental problems" (Wassmer et al. 2012: 6).

The current paper builds on this and analyzes how specifically the cluster affects its firms' environmental strategies and the extent to which this results in competitive advantage. We start by looking at whether the cluster can increase the cluster firms' environmental investments and environmental performance, after which we study how these investments may lead to a competitive advantage for the cluster firms. Such a potential advantage will indeed create economic value, but at the same time may increase public benefits in such a way that these exceed the benefits firms can generate on their own.

The next section of this paper explains the underlying theoretical basis of the paper and formulates hypotheses which will be empirically tested. The third section explains the methodology used to obtain the results showed in section four. The fifth section of this paper discusses the results and formulates conclusions.

2 Theory and Hypotheses

2.1 Theoretical Framework

We build our analysis in this paper on an extension of the natural resource-based view (Verbeke et al. 2006; based on Hart 1995). The resource-based view describes how firms can obtain a sustained competitive advantage with their resources and their capabilities resulting from these resources (Barney 1991; Grant 1991). Resources are "the tangible and intangible assets a firm uses to choose and implement its strategies" (Barney 2001: 54). This definition implies that a firm does not necessarily need to own or control the resources. Therefore, we can extend the resource-based view to analyze inter-firm collaborative initiatives or systems in which the firms operate as a higher-level unit within

which resources are shared. These shared resources are termed network resources (McEvily and Zaheer 1999; Lavie 2006). McEvily and Zaheer (1999) showed empirically, by using the resource-based view as theoretical framework, that networks, such as a cluster of firms, make a valuable contribution to the development or range of competitive advantages of a firm. Network resources may as such constitute an additional source of competences. The idea of shared resources is also used in Dyer and Singh's (1998) "relational view." However, they argue that "at a fundamental level, relational rents are possible when alliance partners combine, exchange, or invest in idiosyncratic assets, knowledge, and resources/capabilities, and/or they employ effective governance mechanisms that lower transaction costs or permit the realization of rents through the synergistic combination of assets, knowledge, or capabilities" (Dyer and Singh 1998: 662). Parise and Casher (2003) introduced the idea of looking at inter-firm relations, in their case alliance relationships, as a portfolio of business partners to be managed with the goal of achieving greater business success. Wassmer and Dussauge (2011: 60) studied alliance portfolios taking a resource-based perspective. They find that "an important issue for the focal firm [is] to deal with […] the fit of a network resource with both its own resources as well as other network resources accessed from partners of other alliances." All these contributions share the idea that inter-firm relations through a network or alliance relationship could definitely increase the potential of business success or even greater competitive advantage.

Hart (1995) was the first to explicitly link environmental strategies and the resource-based view of the firm, which he termed the "natural resource-based view of the firm." He stated that firms can achieve a competitive advantage by developing competencies with their resources that foster eco-friendly activities. This hypothesis has since been empirically validated by among others (Sharma and Vredenburg 1998; Verbeke et al. 2006). We build upon the extended resource-based view (McEvily and Zaheer 1999; Lavie 2006) and the natural resource-based view (Hart 1995) and more specifically extend the Verbeke et al. (2006) approach to empirically analyze the impact of the largest European petrochemical cluster on the green competitive advantage of the cluster's firms. We argue that firms in this cluster create a joint resource base out

of which all participating organizations can tap knowledge and other necessary and useful resources for supporting environmental strategies. These resources are added to the firm's own resource base and are an additional source for the development of competencies that foster eco-friendly activities.

The type of network we will use in this study is the network in a geographical cluster. We identified several cluster theories in the existing cluster literature. The two most cited theories are from Porter (2000) and Krugman (1991) (Hoen 2001; Roh 2007). Porter (2000) regards clusters as geographically proximate organizations in the same or in related sectors, linked by vertical or horizontal relations. Krugman (1991) indicated the wider macro-oriented socioeconomic benefits clusters may have. Because Porter (2000) considered clusters from a more microeconomic perspective, as *"geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions (e.g., universities, standards agencies, trade associations) in a particular field that compete but also cooperate"* (Porter 2000: 15). Building upon Wassmer and Dussauge's (2012) work about alliance portfolios, we may argue that a geographical cluster is a portfolio of business partners and competitors. It is up to the cluster firms to utilize this portfolio to its full potential. At least, the cluster environment stimulates firms to combine network resources with both their own resources to increase their business success and to create competitive advantage.

2.2 Hypotheses

Buysse and Verbeke (2003) identified five environmental resource domains in Hart's (1995) work in which a company can invest to improve its resource base internally. By investing in these resource domains, the firm will augment its capacity for developing competencies that foster eco-friendly activities. Based on Hart's (1995) natural resource-based view, these competencies may lead to a competitive advantage. The resource domains identified are: (1) conventional green competencies related to green product and manufacturing technologies, (2) employee skills, (3) organizational competencies, (4) formal

(routine-based) management systems and procedures, at the input, process, and output sides, and (5) the reconfiguration of the strategic planning process (Buysse and Verbeke 2003).

A number of authors have described various internal organization drivers for environmental investments or environmental initiatives within the organization, i.e., drivers of investments in one or more of the five resource domains. Among the most discussed factors are the individual preferences and values of upper echelon managers, resulting in an eco-centric leadership style. Cordano and Frieze (2000) found that environmental managers' attitude toward pollution prevention is positively related to the preference for implementation of these activities. This attitude and the consequent response might be formed by the manager's individual concern, i.e., "*the degree to which [they] value the environment and the degree of discretion they possess to act on their environmental values*" (Bansal and Roth 2000). Eco-centric leadership causes "*faster diffusion and tighter integration of environmental values […] and leads to a higher degree of formalization of environmental responsibilities within the organization*" (Branzei et al. 2004: 1088). Furthermore, eco-centric leaders also succeed in finding support from others in the organization for their strategic decisions (Branzei et al. 2004). Finally, eco-centric leadership occurs more often when there is organizational slack, i.e., an excess of resources available to managers (Sharma 2000; Bansal 2003).

A second internal organization factor influencing environmental investments is the managerial interpretation of environmental issues as opportunities instead of threats. Sharma (2000) found that the greater the degree to which a manager interprets environmental issues as opportunities, the greater the likelihood of choosing for a proactive environmental strategy. On the other hand, interpreting environmental issues as threats causes a manager to rather choose for a reactive environmental strategy.

The third factor is championing by environmental managers. Championing consists of three activities: "*(1) identifying/generating an issue or idea, (2) packaging it as attractive, and (3) selling it to organizational decision makers*" (Andersson and Bateman 2000: 549). The main reason that a manager might become an environmental champion is

out of individual concerns. To be successful, it also has to be an issue in line with the organization's values, so as to be perceived as strategically important (Bansal 2003).

The last factor is supervisory behavioral support. These are all actions and behaviors from upper echelon managers that might positively influence environmental initiatives from employees. This can be in the form of a well-defined and well-communicated environmental policy, i.e., an organizational encouragement, but even more important are supervisor encouragement supporting innovation, competence building, and communication with others (Ramus and Steger 2000). Also the use of rewards and recognition and assisting in managing goals and responsibilities were found to be important supervisory behavioral support factors that can result in more investments in the five environmental resource domains. Cordano and Frieze (2000) hypothesized that more hierarchical control of environmental managers would lead to better pollution prevention results, but they could not find a significant result for this relationship. On the contrary, they found significant results in the opposite direction. This could suggest that a too strict hierarchical control, limiting the actions or innovative decisions of an environmental manager, might have a reverse effect on the environmental performance.

As the natural resource-based view suggests, investing in the five resource domains stimulates the development of eco-friendly firm-specific capabilities (Verbeke et al. 2006; Hart 1995). Sharma and Vredenburg (1998) identified three organizational capabilities emerging from environmental investments: stakeholder integration, higher-order learning, and continuous innovation. In our study, we focus on stakeholder integration and higher-order learning, because continuous innovation, as also suggested by Sharma and Vredenburg (1998) and Verbeke et al. (2006), is already integrated in or at least overlapping with the capability for higher-order learning.

Stakeholder integration "*involves the ability to establish trust-based collaborative relationships with a wide variety of stakeholders, especially those with noneconomic goals. These stakeholders may include local communities, environmental groups, regulators, non-governmental organizations (NGOs),* etc." (Sharma and Vredenburg 1998: 735). Maxwell

et al. (1997) explain that managers' decision about which strategy to pursue is dependent on market factors and non-market factors. Thus, when a manager chooses for a strategy involving collaboration, this choice might be based on economic and noneconomic motives and result in collaboration with market and non-market stakeholders (Baron 1995). Collaboration with market stakeholders intends to enhance a firm's competitive position. Related to environmental strategies, this implies the use of a green strategy to obtain a competitive advantage relative to competitors (Maxwell et al. 1997; Hart 1995; Sharma and Vredenburg 1998). Also a better financial performance (Douglas and Judge 1995; Hart and Ahuja 1996; Murphy 2002), an increased operational performance (Hart and Ahuja 1996), and higher stock prices or a higher market value of the firm (Klassen and McLaughlin 1996; Dowell et al. 2000) are market factors driving firms to proactive environmental strategies. While collaboration with market stakeholders serves to increase a firm's economic performance, collaboration with non-market stakeholders is more suited to increase a firm's overall performance (Baron 1995), including the environmental performance (Maxwell et al. 1997).

"*Higher-order learning involves the development of different interpretations of new and existing information, as a result of developing new understandings of surrounding events*" (Sharma and Vredenburg 1998: 740; Fiol 1994). It is a form of organizational learning, allowed, stimulated, and enhanced by four contextual factors: the extent to which the corporate culture is suited for enhancing learning, the extent to which it allows flexibility, the extent to which the organizational structure allows innovation, and, finally, the environment (Fiol and Lyles 1985).

The natural resource-based view (Hart 1995) further explains that when a firm develops eco-friendly capabilities due to its investments in the five resource domains, some of the capabilities might result in a sustainable competitive advantage for the firm, if they are valuable, rare, non-imitable, and non-substitutable (Barney 1991). We distinguish three dimensions of green competitive advantage: a cost advantage, a product differentiation advantage, and the reinforcement of the firm's future market position (Sharma and Vredenburg 1998; Verbeke et al. 2006). Cost reduction is aimed at lowering inputs and/or increasing

outputs. Product differentiation involves both new product development and improvements of existing products. Finally, reinforcement of the firm's future market position entails making the firm more competitive in terms of employees' learning skills, the firm's reputation, its customer satisfaction, and its market share (Verbeke et al. 2006).

Based on the extended natural resource-based view (Barney 1991; Grant 1991; Hart 1995; McEvily and Zaheer 1999; Lavie 2006), we find support that in a lot of cases, at least some of the investments in the five resource domains are stimulated, facilitated, or increased by the networks in which the firm participates, i.e., in this case the geographical cluster network. Verbeke and Vanden Bussche (2005: 127) explained that an alliance's knowledge base depends upon the synergies that result from resources of various partners through an evolutionary process. Similar to this, a cluster's resource base can be enhanced by collaboration. In other words, the cluster may stimulate the investments in the five resource domains. As these investments are determined by internal organization drivers, the cluster network may enhance the effect of the internal organization drivers, causing an increased effect on the investments in the five resource domains.

Hypothesis 1a: *The internal drivers of proactive environmental investments are reinforced by cluster collaboration*.

Hypothesis 1b: *The cluster-induced part of each internal driver of proactive environmental strategies leads to investments in the five resource domains*.

Hypothesis 2a: *Investments in the five environmental resource domains increase due to cluster collaboration*.

Consequently, the use of the extended natural resource-based model of Verbeke et al. (2006) in this paper suggests that also the development of eco-friendly firm-specific capabilities is enhanced by cluster collaboration, and that the cluster-induced part of the investments in the five resource domains also contributes to the development of eco-friendly firm-specific capabilities. Although the shared resources alone might make a significant contribution, it will also be the unique combination

of firm-specific with cluster-specific resources that will make a large contribution to the development of these capabilities.

Hypothesis 2b: *Cluster-induced investments in the five resource domains lead to the development of firm-specific capabilities.*

Hypothesis 3a: *Firm-specific capabilities can be enhanced through cluster collaboration*.

As the natural resource-based view (Hart 1995) explains, these capabilities might result in superior, sustainable firm-specific advantage. As this will in theory be the case for all the firms participating in the cluster, we could speak of a cluster-specific competitive advantage. However, due to the combination with each firm's own resources and capabilities, this advantage will be different for each firm.

Hypothesis 3b: *Cluster-induced firm-specific capabilities may lead to a firm-specific competitive advantage.*

Hypothesis 4: *Firm-specific competitive advantage can be enhanced through cluster collaboration.*

3 Method

3.1 Data and Sample

The sample for this study consists of firms in the petrochemical and chemical cluster of Antwerp and Rotterdam. Because of the geographical proximity (less than 100 km), the intense pipeline network and many (supply chain) relations between both sub-clusters, Antwerp and Rotterdam, are at least for (petro)chemicals in a global competitive context, considered as one cluster, being the most important one in Europe. Next to the (petro)chemical industry, the cluster involves related industries, as mentioned in Porter's (2000) cluster definition, such as oil refining and cracking firms, tank storage firms, transport firms, and

construction and maintenance firms. In addition to the firms active in the cluster for this paper's quantitative analysis, we have interviewed the main responsible of four cluster organizations in Antwerp and two in Rotterdam, to obtain additional qualitative information. Based on their activities and location in the cluster, we identified 161 firms. For the Antwerp part of the cluster, we selected based on a yearly publication listing all the relevant firms located in the Antwerp port area (De Lloyd 2010), 70 in total. For the cluster part in Rotterdam, we built our respondents list based on information provided by the Rotterdam Port Authority (2010) as well as Deltalinqs information, a local interest group for the Rotterdam port area, which finally resulted in 91 firms for the Rotterdam part of the cluster. We contacted all the 161 firms by phone and asked for a face-to-face semi-structured interview with the environmental manager or the plant manager on their site. This resulted in 59 in-depth interviews (response rate 36, 7%) conducted in a period of eight months from June 2010 until February 2011.

3.2 Survey Design and Measures

A survey was developed and was a basic part of and for the conducted half-structured interviews. Besides an in-depth discussion of each question, all questions were finally answered in written together with the respondents and each interview took on average about one hour and a half. The survey used in Verbeke et al. (2006) was used as a basis, but was updated with items from more recent literature and extended with relevant cluster items. Verbeke et al. (2006) survey items were based upon empirical literature contributions from 1995 to 2005. Industry experts and academic experts assessed face (content) validity of the summated scales of the survey, and the authors incorporated the experts' feedback into the survey instrument. We checked more recent literature up until 2012 and literature up until 2005 that had not been included in their list of references. A list of 101 possible new items or adaptations of existing items were composed and discussed in our team of authors. We concluded that with some minor adaptations and extensions to the existing item list, all new items were covered in our survey. Table 1 shows the list of concepts and items integrated in the survey. Items that

Table 1 Rating scales

Eco-centric leadership (Branzei et al. 2004)

1. Many of our senior managers are personally and actively involved in developing environmental protection policies for our firm
2. Many of our senior managers are personally and actively involved in monitoring the implementation of environmental protection policies for our firm
3. Our senior managers give environmental issues a high priority
4. Ideas on pollution management are shared freely among lower, middle, and upper levels within my organization
5. Most people in my organization are very aware of the need to protect the environment
6. Most people in my organization are well informed about our environmental policy

Interpretation of environmental issues as opportunities

1. Investments in environmental initiatives could translate into opportunities or benefits for the business (Bansal and Roth 2000)
2. There are more opportunities for our business arising out of the environmental agenda than threats (Sharma et al. 1999)
3. Our environmental agenda provides us with unique business opportunities that are not generated by other activities (Verbeke et al. 2006)
4. Our environmental manager regularly urges us to view our environmental agenda a as business opportunity (Sharma et al. 1999)
5. I or other managers are likely to lose rather than gaining by initiating actions to preserve the environment (Sharma 2000)
6. Any action that I or other managers may take for environmental preservation is constrained by others in the organization (Sharma 2000)
7. I am confident that I have best practice knowledge to reduce the environmental impact of company operations (Sharma 2000)

Championing of environmental managers (Cordano and Frieze 2000)

Our environmental manager thinks that:

1. Pollution prevention is the most desirable waste management goal
2. Most pollution prevention projects are worthwhile
3. Pollution prevention is an important component of a company's environmental management
4. Pollution prevention should be seen as an important component of a company's "bottom line"

Lower-level support

1. Employee suggestions have proven to be an excellent source of ideas to improve environmental performance for the company (Klassen and Whybark 1999)
2. The company has demonstrated its support to rank and file employees' new ideas (Ramus and Steger 2000)

(continued)

Table 1 (continued)

Higher-order learning (Sharma and Vredenburg 1998)
My company is able to:
1. Generate cooperation among line-staff to exchange environmental information and the integration of such information
2. Continuously expand knowledge about the business/natural environment interface
3. Look for solutions to environmental problems from fresh angles
4. Act before the rest of the industry
5. Preempt regulations
6. Experiment on the business/natural environmental domain
7. Spot opportunities amidst changes in social expectations and environmental regulations
8. Innovate and continuously improve operations while reducing environmental impact

Stakeholder integration
This item is measured differently, as explained in this paper. The four items measuring this concept in Verbeke et al. (2006) survey are dropped

Cost reduction (Sharma and Vredenburg 1998)
My company's proactive environmental practices have helped my company to be more competitive in terms of:
1. Lower material costs
2. Lower process/production costs
3. Lower costs of regulatory compliance
4. Increased productivity
5. Process innovations
6. Increased knowledge about effective ways of managing operations

Product differentiation (Sharma and Vredenburg 1998)
1. Product innovation
2. Improved product quality

Securing of the future market position (Sharma and Vredenburg 1998)
1. Organization-wide learning among employees
2. Improved employee morale
3. Overall improved company reputation or goodwill
4. Customer satisfaction
5. Market leadership

(continued)

Table 1 (continued)

Resource domain 1 (Sharma and Vredenburg 1998)
1. Implementing processes that reduce/eliminate the production of pollutants
2. Continuously improving pollution prevention results
3. Disposing of and treating hazardous/toxic wastes
4. Implementing pollution/emission control equipment
5. Recycling
6. Using waste produced as input somewhere else
7. Implementing control/alarm systems for environmental accidents
8. Observing rigorous emergency response procedures
9. Insurance planning to cover potential environmental risks
10. Carbon capture and storage

Resource domain 2
1. Training or educating employees on environmental issues (Sharma and Vredenburg 1998)

Realigning employee responsibilities to allow them adequate time to:
2. Receive environmental training (Ramus and Steger 2000)
3. Explore new environmental techniques (Ramus and Steger 2000)
4. Visit sites (Ramus and Steger 2000)

Resource domain 3
1. Coordinating the environmental efforts of various functional areas within the organization (Verbeke et al. 2006)

Improving environmental performance through greener:
2. Purchasing of production equipment (Douglas and Judge 1995; Buysse and Verbeke 2003)
3. Production (Sharma and Vredenburg 1998)
4. Distribution (wholesale and retail) (Sharma and Vredenburg 1998; Buysse and Verbeke 2003)
5. Supply chain management (Sharma and Vredenburg 1998; Buysse and Verbeke 2003)
6. R&D (Buysse and Verbeke 2003)
7. Legal and policy functions (Douglas and Judge 1995)
8. Public relations (e.g., attracting environmental conscious investors/customers) (Douglas and Judge 1995)

One item from Verbeke, Bowen, and Sellers (2006) has been dropped, i.e., "improving environmental performance through greener refining," as this is an item too specific for the oil industry, and in addition, this item is overlapping with the item "improving environmental performance through greener production"

(continued)

Table 1 (continued)

Resource domain 3

1. Coordinating the environmental efforts of various functional areas within the organization (Verbeke et al. 2006)

Improving environmental performance through greener:

2. Purchasing of production equipment (Douglas and Judge 1995; Buysse and Verbeke 2003)
3. Production (Sharma and Vredenburg 1998)
4. Distribution (wholesale and retail) (Sharma and Vredenburg 1998; Buysse and Verbeke 2003)
5. Supply chain management (Sharma and Vredenburg 1998; Buysse and Verbeke 2003)
6. R&D (Buysse and Verbeke 2003)
7. Legal and policy functions (Douglas and Judge 1995)
8. Public relations (e.g., attracting environmental conscious investors/customers) (Douglas and Judge 1995)

One item from Verbeke et al. (2006) has been dropped, i.e., "improving environmental performance through greener refining," as this is an item too specific for the oil industry, and in addition, this item is overlapping with the item "improving environmental performance through greener production"

Resource domain 4

1. Using formal procedures to review environmental concerns for all new capital investments for the company (Klassen and Whybark 1999)
2. Publishing a formal, well-defined environmental policy (Buysse and Verbeke 2003; Ramus and Steger 2000)
3. Setting specific targets for environmental performance (Ramus and Steger 2000)
4. Conducting environmental Life Cycle Assessment on major products (Sharma and Vredenburg 1998; Ramus and Steger 2000; Buysse and Verbeke 2003)
5. Implementing an Environmental Management System (Bansal and Roth 2000; Ramus and Steger 2000)
6. Publishing audit results of waste production programs annually for production areas (Sharma and Vredenburg)
7. Reviewing operating practices for their impact on the environment (Bansal and Roth 2000)
8. Publishing environmental reports (Buysse and Verbeke 2003; Ramus and Steger 2000)
9. Selection of cleaner logistics methods (González-Benito and González-Benito 2005)
10. Environmental criteria in supplier selection (González-Benito and González-Benito 2005)

(continued)

Table 1 (continued)

Resource domain 5
1. My organization has an environmental officer at the senior management level (Branzei et al. 2004)
2. Environmental managers or those chiefly responsible for environmental management in my organization have adequate authority over capital investment decisions (Branzei et al. 2004)
3. Reports of environmental performance are sent to management or directors (Buysse and Verbeke 2003)
4. Environmental reports are used actively by senior management (Buysse and Verbeke 2003)
5. Our senior managers are aware of company-specific environmental issues (Bansal and Roth 2000)
6. Our business plan includes an extensive, detailed section that describes the company's objectives for environmental performance (Klassen and Whybark 1999; Sharma 2000)
7. Reviewing environmental concerns (Klassen and Whybark 1999)
8. Environmental strategic planning (Buysse and Verbeke 2003)
9. Identifying and evaluating emerging environmental issues for their long-term (five years or more) impact on the company (Klassen and Whybark 1999)

are underlined have been adapted or added. If items were dropped from Verbeke, Bowen, and Sellers' survey, this is mentioned in the table. We extended the list of items to be measured because our survey also tries to assess the cluster impact on a list of concepts.

Most questions were measured on a seven-point Likert scale (1 = "strongly disagree" or "no importance," 7 = "strongly agree" or "strong importance"). For each measured item, we also asked whether the respondent believed that due to the effects of the cluster, there has been a positive effect on the answer given for the item. If yes, we asked whether this effect was caused by information exchange in the cluster, or whether the effect was obtained by means of a specific joint project with one or more other cluster firms. In the latter case, we also asked if the respondent's firm was the leading or one of the leading firms in the project. For all items measuring the investments in the five resource domains (except for the first six items of resource domain 5), we also asked whether the firm is investing in the item topic for at least five years to check whether it is a sustained investment. To measure the concept of stakeholder integration, we used a method already applied by several previous authors (Buysse and Verbeke 2003; Henriques and

Sadorsky 1999; Sharma and Henriques 2005; Rueda-Manzanares et al. 2008), namely:

$$\text{Stakeholder integration} = \sum\nolimits_i \mu_i \beta_i$$

where: μ_i = the interest of this stakeholder in environmental issues;

β_i = the level of attention the firm pays to this stakeholder.

We selected 19 stakeholder groups to measure stakeholder integration, i.e., (1) domestic customers, (2) international customers, (3) domestic suppliers, (4) international suppliers, (5) employees, (6) labor unions, (7) shareholders, (8) financial institutions, (9) domestic rivals, (10) international rivals, (11) international agreements, (12) ENGOs, (13) media, (14) national governments, (15) regional governments, (16) provincial governments, (17) local public agencies (e.g., municipal authority), (18) port authority, and (19) local community groups. We also measured the extent to which cluster stakeholders were taken into account by asking for the importance and active involvement in a number of local cluster organizations. These organizations were identified based on preliminary interviews with a number of cluster organizations. Finally, a number of control variables were included: plant size (measured as the natural logarithm of the number of full time equivalents), location/seaport area (Antwerp or Rotterdam), and industry (i.e., oil/chemical industry or other industry).

4 Analysis

First, we compute the scores of the pre-defined concepts based on the respondents' answers. We check for internal consistency with Cronbach's alpha. If this value is acceptable, we compute each respondent's concept score by averaging the item scores. For the items measuring investments in the resource domains, the score is reset to 1 (i.e., the investment has no importance in terms of investments made, managerial time devoted, or general commitment of the organization) if the investment is non-sustainable. In accordance with Verbeke et al. (2006), an investment is considered to be not sustained when it is not done for at least the last five years. For each concept, we compute a general score

and a cluster-induced score. For the internal organization drivers for example, we measured whether the cluster has an effect on these internal organization drivers. For example, to measure the internal organization driver "eco-centric leadership," we asked, among other questions, whether the firm's senior managers gave environmental issues a high priority. Next, we discussed with the respondent whether the cluster has contributed to this, i.e., whether their senior managers would have given a lower priority to environmental issues in the absence of the cluster. If so, we discussed with the respondent whether the effect was due to an information exchange with one or more cluster partners. Information exchange is the simplest form of cluster collaboration, in which no joint projects are done, but in which information that can help other cluster firms is exchanged. When the firm had one or more specific joint projects with other cluster firms, the intensity of cluster collaboration is larger. In our example, senior managers may have given a higher priority to environmental issues because, e.g., another firm in the joint project has highlighted the importance of the environmental topic, or just because due to the project, they became more aware of it. The strongest type of collaboration observed is collaboration in the form of projects in which the interviewed firm plays a leading role. The cluster-induced score reflects the presence of the internal organization driver and the extent to which the cluster had contributed to this presence. The score is 1 when the cluster has had no contribution (i.e., there is no cluster collaboration for this item) or when the internal organization driver is absent. On the other hand, the score is 7 when there is a very strong presence of the internal organization driver of proactive environmental strategies, and when the cluster has contributed very strongly to this presence (i.e., there are joint projects for this item, in which this firm plays a leading role). The item scores are computed by multiplying the item scores for the presence of each internal organization driver with their respective scores for the cluster contribution (0 = no cluster contribution, 1 = information exchange, 2 = joint project (no lead), and 3 = joint project as lead firm). Next, the cluster-induced concept scores are computed analogously to the concept scores. These scores are then rescaled to a scale from 1 to 7. We chose not to standardize the data, as this would efface the difference between the normal scores' averages and

the cluster-induced scores' averages. Furthermore, it would efface the difference in standard deviations. For stakeholder integration, the cluster-induced score is computed differently. We had to measure a score reflecting somehow the "cluster integration." Contrary to the regular score for stakeholder integration, we only took into account the cluster organizations as stakeholders here, as we try to measure to cluster-induced part of stakeholder integration. In other words, cluster-induced stakeholder integration measures the additional stakeholder integration due to the relations and contacts with and within the cluster organizations. We first identified the local cluster organizations in each part of the cluster (i.e., five cluster organizations for Antwerp and four for Rotterdam). We asked for the importance of each organization regarding environmental issues and the extent to which the firms are actively involved in the cluster organization. The remaining steps are analogously with the normal score for stakeholder integration.

Hypotheses 1a, 2a, 3a, and 4 are tested by means of *t*-tests. The cluster-induced variables have a score from 1 (no cluster contribution) to 7 (the variable score is very high and the cluster contribution to this high score is very strong). We test whether the score is significantly larger than 1 to determine whether the cluster has an impact. Hypotheses 1b, 2b, and 3b are tested by means of linear regression analyses.

As a number of variables are dependent on one another, we expect some correlation problems (see Table 2). However, a variable is never used in an analysis in combination with its cluster-induced variant. Furthermore, we think that the high correlation between the cluster-induced variables is due to the general effect of the cluster on a firm, i.e., the cluster effect on a firm causes a similar effect on all this firm's variables. Multicollinearity is therefore a problem when we estimate the joint effect of the independent variables on the dependent variable. However, we decided to always include the independent variables in separate models one at a time. This way, we estimate the impact of each cluster-induced internal organization driver of environmental investments on the investments in each resource domain separately. Furthermore, the effects of the cluster-induced investments in each resource domain on the development of stakeholder integration and higher-order learning are estimated. However, we also estimate the

Table 2 Descriptive statistics and correlations table

	Variable	Mean	SD	Items	α	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	Eco-centric leadership	5.59	0.86	6	.793														
2.	Managerial interpretation	4.98	0.95	7	.689	.52**													
3.	Championing of environmental managers	5.75	1.00	4	.780	.47**	.46**												
4.	Supervisory behavioral support	4.86	1.30	2	†	.25	.31*	.12											
5.	Investments in RD1	4.18	1.42	10	.844	.15	.33*	−.05	.25										
6.	Investments in RD2	3.83	1.56	4	.733	.18	.30*	−.03	.41**	.76**									
7.	Investments in RD3	3.20	1.62	8	.866	.04	.22	−.14	.18	.72**	.63**								
8.	Investments in RD4	3.75	1.71	10	.893	.01	.17	−.10	.10	.71**	.66**	.75**							
9.	Investments in RD5	5.13	1.27	9	.824	.11	.20	−.02	.19	.72**	.61**	.68**	.76**						
10.	Higher-order learning	5.02	1.03	8	.883	.65**	.67**	.42**	.34**	.39**	.37**	.29*	.19	.31*					
11.	Stakeholder integration	4.92	1.06	††	/	.22	.18	.22	.08	.11	.12	.13	.17	.26*	.31*				
12.	Lower costs	4.53	1.40	6	.884	.42**	.37**	.16	.47**	.24	.35**	.34*	.23	.02	.44**	.06			
13.	Product differentiation	4.29	1.77	2	†	.39**	.27*	.13	.39**	.19	.27*	.33*	.16	.03	.33*	.05	.66**		
14.	Securing future position	4.83	1.48	5	.933	.55**	.37**	.29*	.51**	.22	.34*	.15	.06	.13	.47**	.17	.72**	.70**	
15.	Cluster-induced eco-centric leadership	2.70	0.68	6		.57**	.41**	.22	.38**	.25	.26	.33*	.14	.16	.49**	.28*	.43**	.36**	.40**
16.	Cluster-induced managerial interpretation	2.45	0.65	7		.35**	.64**	.15	.33*	.41**	.38**	.38**	.28*	.29*	.60**	.25	.42**	.31*	.34**
17.	Cluster-induced championing	2.83	0.80	4		.16	.29*	.37**	.21	.06	.09	.17	.02	−.01	.22	.15	.29*	.29*	.24
18.	Cluster-induced supervisory behavioral support	2.25	0.71	2		.05	.14	−.11	.65**	.31*	.33*	.32*	.16	.18	.24	.05	.32*	.28*	.29*

(continued)

Table 2 (continued)

	Variable	Mean	SD	Items	α	1	2	3	4	5	6	7	8	9	10	11	12	13	14
19.	Cluster-induced investments in RD1	2.61	0.91	10		.28*	.30*	−.04	.25	.65**	.54**	.66**	.50**	.44**	.39**	.09	.41**	.41**	.30*
20.	Cluster-induced investments in RD2	2.27	0.90	4		.15	.25	−.01	.26*	.54**	.71**	.57**	.48**	.43**	.24	−.08	.24	.29*	.30*
21.	Cluster-induced investments in RD3	2.24	0.75	8		.14	.14	−.04	.11	.40**	.37**	.67**	.47**	.46**	.17	.23	.31*	.39**	.32*
22.	Cluster-induced investments in RD4	2.18	0.77	10		−.03	.04	−.12	.06	.50**	.48**	.54**	.75**	.54**	.07	.09	.18	.20	.15
23.	Cluster-induced investments in RD5	2.57	1.21	9		.06	.09	−.11	.22	.43**	.32*	.44**	.30*	.30*	.21	.11	.17	.22	.12
24.	Cluster-induced higher-order learning	2.71	0.92	8		.42**	.44**	.01	.33*	.45**	.39**	.45**	.33*	.39**	.65**	.16	.46**	.37**	.36**
25.	Cluster-induced stakeholder integration			††		.19	.19	−.09	.20	.40**	.34**	.26*	.39**	.38**	.32*	.38**	.20	.03	.22
26.	Cluster-induced lower costs	2.40	0.89	6		.29*	.34*	.16	.35**	.27*	.26*	.44**	.29*	.17	.40**	.05	.76**	.50**	.50**
27.	Cluster-induced product differentiation	2.22	1.02	2		.14	.28*	−.09	.26	.24	.24	.33*	.19	−.02	.30*	.13	.49**	.74**	.44**
28.	Cluster-induced securing of future position	2.30	0.76	5		.47**	.48**	.21	.46**	.33*	.36**	.36**	.19	.19	.56**	.27*	.65**	.62**	.73**
29.	Plant size	4.46	1.70			.02	−.10	−.12	.05	.26*	.24	.14	.25	.25	.03	−.09	.08	−.03	−.03
30.	Seaport	0.59				.12	.18	.08	.15	.15	.11	.13	−.03	.01	.13	.14	.27*	.19	.28*
31.	Activity in oil or chemical industry	0.47				.02	.06	−.11	.16	.43**	.36**	.43**	.61**	.47**	.04	.09	.20	.08	.01

(continued)

Table 2 (continued)

	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
…																
16.	.69**															
17.	.52**	.57**														
18.	.55**	.55**	.33*													
19.	.58**	.65**	.41**	.44**												
20.	.39**	.53**	.38**	.41**	.69**											
21.	.39**	.42**	.48**	.24	.71**	.54**										
22.	.18	.33*	.34**	.20	.60**	.56**	.68**									
23.	.53**	.43**	.33*	.45**	.48**	.39**	.35**	.35**								
24.	.55**	.74**	.33*	.53**	.70**	.45**	.45**	.35**	.31*							
25.	.32*	.41**	0.12	.35**	.45**	0.12	.27*	.35**	.39**	.45**						
26.	.59**	.59**	.45**	.44**	.58**	.35**	.52**	.32*	.32*	.60**	.20					
27.	.44**	.48**	.32*	.46**	.48**	.29*	.37**	.24	.30*	.46**	.27*	.55**				
28.	.64**	.68**	.44**	.55**	.58**	.45**	.50**	.29*	.31*	.67**	.34*	.72**	.66**			
29.	−.10	.02	−.27*	.00	.13	.13	−.09	.08	−.05	.15	.15	.02	−.21	−.14		
30.	.15	.15	.08	.11	.25	.18	.17	−.09	.18	.26	.01	.28*	.16	.37**	.12	
31.	.14	.24	.00	.19	.42**	.27*	.30*	.42**	.24	.23	.35**	.29*	.13	.12	.23	.10

*Correlation is significant at the 0.05 level (2-tailed)

**Correlation is significant at the 0.01 level (2-tailed)

†These constructs only contain two items, so Cronbach's alpha is not computed. For Supervisory behavioral support, $r=0.273$, $p=0.040$. For product differentiation, $r=0.752$, $p=0.000$

††Stakeholder integration is measured differently

impact of simultaneous investments in the five resource domains on the development of these capabilities, but these results have to be interpreted more carefully due to the problem of multicollinearity. Finally, we estimate the impact of the cluster-induced capabilities for stakeholder integration and for higher-order learning on each dimension of competitive advantage. Again, the simultaneous as well as the separate impact is estimated. In each analysis, we have to be aware that the separate models are much more trustworthy because here the independents are not impacted by multicollinearity. Therefore, conclusions will be based on the separate models. Next, as the dependent and independent variables are measured by the same instrument, there is a possibility for common method bias. Also consistency bias, occurring when respondents try to avoid contradictory attitudes, perceptions, or attributions in their self-reported responses, could have impacted our data (Staw 1975). However, we believe that due to the fact that the surveys were completed by means of face-to-face interviews conducted by one person only, namely the first author, we believe that the impact of this type of bias was minimized. The same is valid for acquiescence bias, the tendency to always agree with the questions. When the interviewer detected acquiescence bias, more background information about the questions was asked to check whether the respondents were answering in accordance with their real opinions, attitudes, or perceptions. Finally, we tried to limit social desirability bias, the tendency to give socially acceptable answers, by guaranteeing that the answers are confidential, and that no individual results are communicated or published.

5 Results

Hypotheses 1a, 2a, 3a, and 4 are tested by means of one-tailed *t*-tests. The variables, calculated with observed scores, are scored from 1 (no cluster contribution) to 7 (the variable score is very high, and the cluster contribution to this high score is very strong). In other words, we have to test whether the scores are significantly larger than 1.

The results are shown in Table 3. Hypothesis 1a tests whether the cluster-induced internal drivers of proactive environmental strategies,

Table 3 One-tailed *t*-tests to test for cluster contribution (test value = 1)

Variable	Mean	SD	*t*	*p*-value
Cluster-induced eco-centric leadership	1.87	0.76	8.78	.000
Cluster-induced managerial interpretation of environmental issues as opportunities	1.73	0.69	8.08	.000
Cluster-induced championing by environmental managers	2.00	0.96	7.87	.000
Cluster-induced supervisory behavioral support	1.50	0.74	5.20	.000
Cluster-induced investments in RD1	1.98	0.95	7.91	.000
Cluster-induced investments in RD2	1.75	0.89	6.47	.000
Cluster-induced investments in RD3	1.66	0.69	7.20	.000
Cluster-induced investments in RD4	1.56	0.67	6.41	.000
Cluster-induced investments in RD5	1.55	0.56	7.64	.000
Cluster-induced higher-order learning	1.97	0.83	9.01	.000
Cluster-induced stakeholder integration[a]	2.43	1.13	9.77	.000
Cluster-induced cost reduction	1.79	0.87	6.81	.000
Cluster-induced product differentiation	1.63	1.00	4.63	.000
Cluster-induced securing of the future market position	1.58	0.73	6.00	.000

[a]The score for cluster-induced stakeholder integration is computed differently from the other cluster-induced concept scores

i.e., eco-centric leadership, managerial interpretation of environmental issues as opportunities, championing by environmental managers and supervisory behavioral support, do exist. All four cluster-induced internal drivers are significantly larger than 1, so hypothesis 1a is supported. Hypothesis 2a tests whether the investments in the five resource domains are enhanced by the cluster. This is the case for all five resource domains, so also hypothesis 2a is supported. Hypothesis 3a tests whether the cluster-induced capabilities developed from the investments in the five resource domains, i.e., stakeholder integration and higher-order learning, exist. Both capabilities have scores significantly larger than 1, so the analysis supports hypothesis 3a. Finally, hypothesis 4 tests whether there is a cluster contribution to the development of sustainable competitive advantage. All three dimensions of cluster-induced competitive advantage are significantly larger than 1, so also hypothesis 4 is supported.

Hypotheses 1b, 2b, and 3b are tested by means of linear regression analyses. Hypothesis 1b tests whether the cluster-induced part

of internal drivers of proactive environmental strategies (i.e., cluster-induced eco-centric leadership, cluster-induced managerial interpretation of environmental issues as opportunities, cluster-induced championing by environmental managers, and cluster-induced supervisory behavioral support) leads to investments in the five resource domains. This hypothesis is tested for each resource domain. The results are shown in Table 4.

In model 1, only the control variables are added to the model. Model 2 adds the independent variables. The independent testing variables have correlations ranging between .33 and .69. However, as explained above we base our conclusions on the models 3–6. Table 4, resource domain 1, shows that the investments in conventional green competencies related to green product and manufacturing technologies, i.e., resource domain 1, are positively influenced by the cluster-induced impact of eco-centric leadership and by the cluster-induced impact of the managerial interpretation of environmental issues as opportunities. The other two internal organization drivers of environmental proactivity do not have an effect on the investments resource domain 1. For resource domain 2, i.e., investments in employee skills, Table 6.4 shows that we can make an identical conclusion: cluster-induced eco-centric leadership and cluster-induced managerial interpretation of environmental issues as opportunities have a positive impact on the investments in employee skills, while the other two internal organization drivers of environmental investments have not. The results for the impact of the internal organization drivers of environmental proactivity on the investments in resource domain 3, the organizational competencies, are also shown in Table 4. Models 3 to 6 show that all four internal organization drivers of environmental proactivity have a significantly positive impact on the investments in organizational competencies. However, as shown in Table 4, investments in resource domain 4, i.e., in formal (routine-based) management systems and procedures, at the input, process, and output sides, are not influenced by the cluster-induced internal organization drivers of environmental proactivity. This last conclusion is also valid for investments in resource domain 5, the reconfiguration of the strategic planning process. In sum, hypothesis 1b is partly supported.

Table 4 Results of the linear regression analyses for hypothesis 1b

Independent variables	Dependent variable		Resource domain 1						Resource domain 2					
	Description	Model	1	2	3	4	5	6	1	2	3	4	5	6
PS	Plant size		.099	.112	.162	.104	.101	.113	.222	.258	.294†	.227	.224	.234
SP	Seaport		.433	.334	.312	.353	.422	.393	.205	.078	.065	.130	.191	.169
OCH	Activity in oil or chemicals		.924*	.610†	.805*	.670†	.910*	.852**	.830*	.540	.693†	.594	.814†	.766†
ECO	Cluster-induced eco-centric leadership			.071	.413†					.244	.476†			
OPP	Cluster-induced managerial interpretation of environmental issues as opportunities			.877*		.690**				.701		.643*		
CHA	Cluster-induced championing by environmental managers			−.247			.135			−.199			.163	
SUP	Cluster-induced supervisory behavioral support			−.021				.346		−.086				.309
Constant			3.088**	2.113*	2.136*	2.044**	2.824**	2.554**	2.278**	1.176	1.181	1.305	1.962*	1.801*
R^2			.193*	.317**	.240**	.299**	.202*	.228**	.151*	.235†	.199*	.222*	.161†	.173*
p of R^2			.010	.007	.007	.001	.019	.009	.035	.061	.021	.011	.057	.043
ΔR^2 (model 1)				.124†	.046†	.106**	.009	.035		.083	.047†	.071*	.010	.021
p of ΔR^2				.086	.085	.008	.450	.137		.281	.089	.036	.438	.258

Independent variables	Resource domain 3						Resource domain 4						Resource domain 5					
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
PS	.344*	.442**	.460**	.339*	.339*	.355*	.327*	.359*	.374*	.329*	.328*	.332*	.150	.152	.174	.153	.150	.153
SP	.267	.038	.022	.182	.234	.205	−.361	−.451	−.452	−.404	−.369	−.377	.019	−.027	−.027	−.019	.019	.012
OCH	.956*	.688†	.715†	.690†	.917*	.845*	1.723**	1.553**	1.633**	1.588**	1.713**	1.694**	.878**	.704*	.832**	.759*	.877**	.865**
ECO		.685†	.833**					.239	.313					.047	.158			
OPP		.138		.723*				.378		.367				.585		.323		
CHA		.022			.381†			−.114			.101			−.206			.005	
SUP		.079				.535*		−.126				.141		−.163				.061
Constant	1.048	−.906	−.871	−.045	.307	.222	1.621*	.916	.900	1.065	1.424†	1.402†	4.077**	3.737**	3.713**	3.589**	4.067**	3.983**
R^2	.241**	.384**	.380**	.327**	.294**	.302**	.398**	.425**	.416**	.418**	.401**	.402**	.211**	.267*	.220*	.243**	.211*	.213*
p of R^2	.002	.001	.000	.000	.001	.001	.000	.000	.000	.000	.000	.000	.006	.029	.012	.006	.015	.014
ΔR^2 (model 1)		.143	.139**	.086*	.053†	.061*		.027	.018	.020	.003	.004		.056	.009	.032	.000	.001
p of ΔR^2		.037	.001	.014	.056	.039		.687	.218	.188	.592	.567		.466	.439	.150	.972	.760

*p<.05
**p<.01
†p<.10

Hypothesis 2b states that the cluster-induced investments in the five resource domains lead to the development of firm-specific capabilities, i.e., a capability for stakeholder integration and a capability for higher-order learning. The analysis is repeated for each capability. The results are shown in Table 5. Correlations between the independent testing variables range between .35 and .71, causing multicollinearity in the models 2 in Table 5. In addition, the total number of variables in the analysis is rather large for our data set. Therefore, our conclusions are based on models 3–7, in which the individual impact of the cluster-induced investments in each resource domain is tested for its impact on the development of a capability for stakeholder integration and for higher-order learning.

Table 5 shows that the cluster-induced investments in the five resource domains do not have an effect on the development of a capability for stakeholder integration. On the other hand, a capability for higher-order learning is developed due to the cluster-induced investments in resource domains 1 and 2. The cluster-induced investments in the resource domains 3–5 have no effect on the development of this capability, either. Hypothesis 2b is partly supported.

Finally, hypothesis 3b states that the cluster-induced firm-specific capabilities may lead to a firm-specific competitive advantage. The analyses are shown in Table 6.

Correlation between the variables cluster-induced stakeholder integration and cluster-induced higher-order learning is .45. However, we decided again to base our conclusions on the models 3 and 4. Table 6 shows the results of the regressions estimating the impact of the cluster-induced development of the two capabilities on cost reduction. The results show that cluster-induced higher-order learning indeed leads to cost reduction, while the cluster-induced capability for stakeholder integration does not. Also product differentiation is positively impacted by a cluster-induced capability for higher-order learning, but not by cluster-induced stakeholder integration, as shown in Table 6. Finally, Table 6 shows that cluster-induced higher-order learning is not adequate for the securing of the firm's future position. Here, the cluster-induced capability for stakeholder integration has a significant impact on this dimension of competitive advantage. In sum, each dimension of competitive advantage is enforced by one of the cluster-induced capabilities, so hypothesis 3b is supported.

An outline of the results is visualized in Fig. 1.

Table 5 Results of the linear regression analyses for hypothesis 2b

Independent variables	Dependent variable		Stakeholder integration							Higher-order learning						
	Description	Model	1	2	3	4	5	6	7	1	2	3	4	5	6	7
PS	Plant size		−.070	.000	−.066	−.034	−.090	−.079	−.075	−.063	−.075	−.100	−.106	−.093	−.079	−.067
SP	Seaport		.328	.268	.345	.405	.273	.338	.305	.203	−.036	.067	.113	.118	.219	.180
OCH	Activity in oil or chemicals		.209	.200	.243	.259	.153	.188	.145	.186	−.033	−.088	.127	.100	.147	.124
CRD1	Cluster-induced investments in RD 1			−.052	−.053						.432†	.427**				
CRD2	Cluster-induced investments in RD 2			−.463†		−.261					.048		.306†			
CRD3	Cluster-induced investments in RD 3			.441			.220				.150			.336		
CRD4	Cluster-induced investments in RD 4			−.384				.068			−.353				.123	
CRD5	Cluster-induced investments in RD 5			.596					.277		.018					.263
Constant			4.957**	4.497**	5.014**	5.163**	4.746**	4.900**	4.592**	5.154**	4.780**	4.694**	4.912**	4.833**	5.050**	4.807**
R^2			.034	.173	.036	.073	.051	.035	.054	.020	.170	.151†	.080	.065	.025	.040
p of R^2			.601	.289	.746	.406	.593	.751	.571	.780	.303	.070	.352	.468	.856	.706
ΔR^2 (model 1)				.139	.002	.039	.017	.001	.019		.150	.131**	.060†	.045	.005	.020
p of ΔR^2				.175	.760	.148	.338	.797	.307		.145	.007	.072	.120	.622	.305

*$p < .05$
**$p < .01$
†$p < .10$

Table 6 Results of the linear regression analyses for hypothesis 3b

Independent variables	Dependent variable	Cost reduction				Product differentiation				Securing future market position			
	Description Model	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
PS	Plant size	−.069	−.062	−.070	−.061	−.047	−.021	−.047	−.031	−.127	−.126	−.130	−.122
SP	Seaport	.748†	.556	.748†	.548	.670	.435	.670	.466	.889*	.798†	.888*	.744†
OCH	Activity in oil or chemicals	.535	.325	.398	.345	.246	.156	.268	.038	.052	−.223	−.189	−.085
CSI	Cluster-induced stakeholder integration		.037	.181			−.243	−.006			.250	.317†	
CHL	Cluster-induced higher-order learning		.475†		.496*		.710*		.565†		.222		.358
Constant		4.151**	3.301**	3.782**	3.344**	3.983**	3.238**	3.995**	3.020**	4.890**	4.020**	4.244**	4.307**
R^2		.106	.186†	.125	.185*	.041	.124	.041	.106	.089	.152	.140†	.125
p of R^2		.111	.056	.131	.029	.549	.258	.718	.229	.174	.125	.092	.132
$\triangle R^2$ (model 1)			.079†	.019	.079*		.083	.000	.065†		.063	.051†	.036
p of $\triangle R^2$			.094	.294	.029		.115	.980	.064		.161	.084	.147

*$p < .05$
**$p < .01$
†$p < .10$

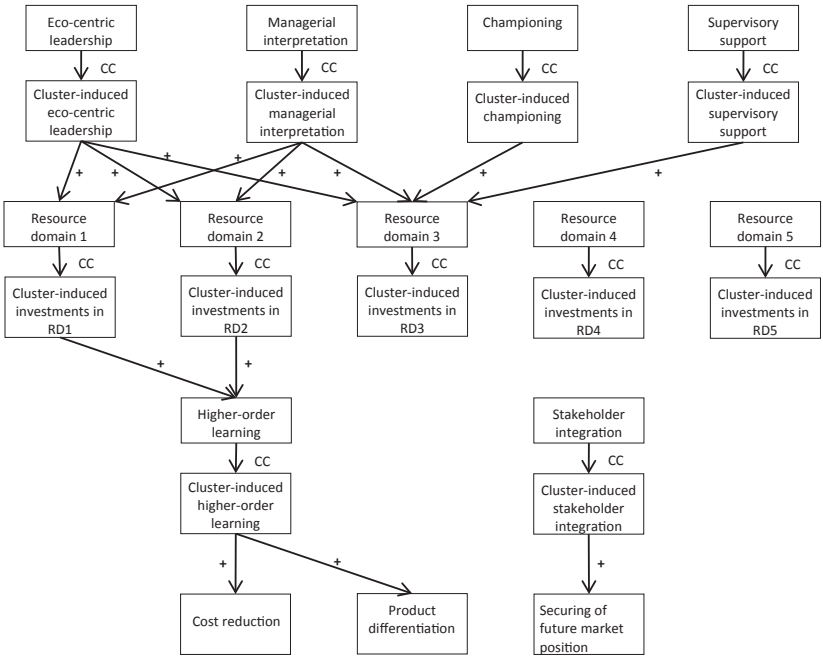

Fig. 1 Visualization of the analytical results (cc: Cluster collaboration; this step lifts out the part of the variable that is due to cluster collaboration. This step is only performed when we have statistically determined that the cluster-induced part exists)

6 Discussion and Conclusion

Our results show that the largest European petrochemical cluster contributes positively to the presence of internal organization drivers of proactive environmental strategies, i.e., to eco-centric leadership, to a managerial interpretation of environmental issues as opportunities, to championing by environmental managers, and to supervisory behavioral support. Thus, we can conclude that a specific part of the internal drivers of environmental investments exists due to explicit collaborative actions and initiatives from the cluster members.

We find that cluster-induced eco-centric leadership increases the investments in the resource domains 1, 2, and 3, but not in the resource domains 4 and 5. This is only partly in line with our expectations based on previous literature (Noda and Bower 1996; Bansal and Roth 2000; Cordano and Frieze 2000; Sharma 2000; Bansal 2003; Branzei et al. 2004; Verbeke et al. 2006). We could assume that eco-centric leadership which finds its origin in the cluster has the same effect as when coming from other origins. This study confirms this assumption: Cluster-induced eco-centric leadership positively impacts the investments in conventional green competencies related to green product and manufacturing technologies, investments in employee skills, and investments in organizational competencies. However, we did not find that eco-centric leadership that finds its origin in the cluster drives investments in formal (routine-based) management systems and procedures nor that it drives investments in the reconfiguration of the strategic planning process. We believe that this might be due to the fact that our sample consisted mainly of large subsidiaries, but no or few headquarters of (petro) chemical firms. Subsidiaries do not always have the responsibility to decide upon the management systems and procedures or strategic planning processes. Furthermore, we find that the cluster-induced managerial interpretation of environmental issues as opportunities has a similar effect as the cluster-induced eco-centric leadership driver, i.e., it increases the investments in the resource domains 1, 2, and 3, but we do not find an effect on the resource domains 4 and 5. In the literature, the managerial interpretation of environmental issues as opportunities has been identified as a driver of investments in the environmental resource domains (Sharma 2000; Verbeke et al. 2006). We found a positive effect of cluster-induced managerial interpretation of environmental issues as opportunities on the investments in conventional green competencies related to green product and manufacturing technologies, investments in employee skills, and investments in organizational competencies, but did not find this effect on the investments in formal (routine-based) management systems and procedures or in the reconfiguration of the strategic planning process. Again, we believe these last two resource domains are mainly determined by the headquarters, whereas the first three are predominantly the responsibility of

the subsidiaries. Next, we found that cluster-induced championing by environmental managers contributes positively to investments in organizational competencies, i.e., resource domain 3. This resource domain determines the extent to which the environmental goals of the various functional areas in the organization are aligned and the extent to which these functional divisions participate in achieving the broader environmental strategy goals of the company. This coordination task is the specific responsibility of the environmental manager. If the environmental manager is an environmental champion, he or she has to negociate and convince others in the organisation, more than focusing on investments in resource domain 3. We might expect that the same is true for the resource domains 1 and 2, but the results do not confirm these expectations. We did not find a significant contribution of championing by the environmental manager on the investments in conventional green competencies related to green product and manufacturing technologies and in employee skills. An explanation might be that contrary to resource domain 3, which is almost exclusively the responsibility of the environmental manager, the investments in resource domain 1 are often to be approved by the management team, and not just the environmental manager. Some firms in our sample even needed the approval of their headquarters for these investments. An environmental manager that is an environmental champion has to negotiate and convince others in the organization more than in the case of investments in resource domain 3. The same might be true for the investments in employee skills, i.e., resource domain 2. However, an additional factor that might play is that employee training is often given during other training sessions, where environmental issues are just mentioned. Training sessions specifically for environmental matters are extremely rare. Therefore, the direct impact that the environmental champion might have on the investments in employee skills is low. He/she might impact the quality of the environmental trainings, but probably not the quantity or the exclusive attention for environmental matters. Again, due to the nature of our sample, we do not find a significant impact of championing activities by the environmental manager on the investments in the resource domains 4 and 5. Confirming what was found in the literature (Cordano and Frieze 2000; Ramus and Steger 2000; Verbeke

et al. 2006) also supervisory behavioral support contributes positively to the investments in the five environmental resource domains. Although supervisory, behavioral support is impacted by the cluster, this only happens to a limited extent. In most companies, this is a purely internal matter. We only find a significant result for the investments in organizational competencies. The supervisory support, mainly aimed at involving lower echelons in generating ideas for environmental improvement, seems to be adequate for improving the coordination of environmental efforts among the various functional areas in the organization. However, supervisory behavioral support originating from the cluster collaboration is not sufficiently large (see Table 3) to have a significant impact on the investments in conventional green competencies related to green product and manufacturing technologies and in employee skills. We do not find a significant effect on the investments in the resource domains 4 and 5 either because of the nature of our sample. However, also the small effect of the cluster on supervisory behavioral support might be the cause of the absence of a significant impact.

Furthermore, our results showed that the investments in the environmental resource domains were enhanced by the cluster via information exchange or via joint projects in the cluster. Based on the extended natural resource-based view of the firm (Hart 1995; McEvily and Zaheer 1999; Lavie 2006), we expected that these enhanced investments would lead to the development of a capability for stakeholder integration and a capability for higher-order learning (Verbeke et al. 2006). However, although we find that stakeholder integration is enhanced by the cluster, we do not find evidence that this effect is due to the cluster-enhanced investments in the environmental resource domains. There may be another influencing factor which we did not include in our model, which is a weakness of our study.

Based on our research, we can state that explicit cluster collaboration increases the number of contacts between the cluster firms. Managers will come more into contact with other firms in the cluster (suppliers, customers, and competitors) as well as with noneconomic organizations such as environmental NGOs or port authorities, as these are drawn to or created for the cluster due to the geographical concentration of firms. As the number of contacts increases, also the level of stakeholder

integration might increase. This might explain that we do find an impact of the cluster on stakeholder integration, but this effect does not take place via the cluster-induced investments in the environmental resource domains.

The development of a capability for higher-order learning, on the contrary, is enhanced by cluster-induced investments in resource domains 1 and 2, i.e., by cluster-induced investments in conventional green competencies related to green product and manufacturing technologies and in employee skills. These investments bring along a significant effect on the development of organizational learning related to environmental issues. However, we do not find a significant effect of cluster-induced investments in organizational competencies, in formal (routine-based) management systems and procedures and in the reconfiguration of the strategic planning process on the capability for higher-order learning. For resource domain 3, we believe that this might be due to the fact that the environmental investments in organizational competencies, i.e., the coordination of environmental goals of the various functional divisions of the organization, is mainly a responsibility of the environmental manager, so there is an insufficient impact on the "general" higher-order learning of the organization. For resource domains 4 and 5, as explained before, we believe that due to the nature of the petrochemical and chemical industry, the investment decisions are made predominantly by the headquarters. Finally, we also tested whether the cluster increases the competitive advantage of the cluster firms. We found evidence that all three dimensions of competitive advantage, i.e., cost reduction, product differentiation, and the securing of the future market position, were enhanced by the cluster. According to the extended natural resource-based view of the firm (Hart 1995; McEvily and Zaheer 1999; Lavie 2006), competitive advantage is enhanced by the cluster-induced development of stakeholder integration and higher-order learning. We find that this is indeed the case, but each dimension of competitive advantage is only supported by one of the capabilities. Cost reduction and product differentiation are enhanced by the cluster-induced development of higher-order learning, while the securing of the future market position is enhanced by the cluster-induced development of stakeholder integration. In other words, the cluster-induced capability for higher-order learning leads to a rather

direct impact on the firm's performance by means of reducing the costs and broadening and improving the range of products of the firm. On the other hand, the cluster-induced capability for stakeholder integration has a more long-term impact, as it can maintain the firm's license to operate and secure the existence of the firm in the market. Thus, both cluster-induced capabilities combined result in shorter-term and longer-term competitive advantages for the firm.

Our results show that the internal drivers of environmental investments, the investments themselves, a capability for stakeholder integration and for higher-order learning, and competitive advantage are enhanced by the cluster network. We found that the investments in the resource domains 1–3 are positively influenced by the effect of the cluster on eco-centric leadership and on the managerial interpretation of environmental issues as opportunities. In addition, resource domain 3 is also enhanced by the effect of the cluster on championing of environmental managers and on supervisory behavioral support for environmental initiatives. Next, we found that the increased investments through the cluster contribute significantly to the development of a capability for higher-order learning. Finally, the results show that the effect of the cluster on stakeholder integration contributes to the securing of the future market position, and that the cluster's effect on higher-order learning reduces costs and increases product differentiation. In other words, the cluster-induced capabilities lead to a reinforcement of the firm's competitive advantage.

If the firm's top management is aware of the cluster effects and how these can contribute to better firm performance on several domains, they might be able to further strengthen this effect. A manager might, for example, search more actively opportunities for information exchange or joint projects with other cluster firms. This way, the cluster-induced effect on eco-centric leadership, on the managerial interpretation of environmental issues as opportunities, on championing by environmental managers, and on supervisory behavioral support can be larger. As our study shows, this should result in more investments in conventional green competencies related to green product and manufacturing technologies, in employee skills, and in organizational competencies. Furthermore, the cluster also contributes to the development of a capability for stakeholder integration, although this is not a result of

the increased investments in the environmental resource domains. The additional development of the capability for stakeholder integration also results in an increased competitive advantage, i.e., a more secured future market position. This is a long-term benefit that will result in increased customer satisfaction and better employee morale. Furthermore, it will increase the company's reputation and goodwill. Thus, managers should seek to get involved in the cluster and involve stakeholders in their decision-making processes in order to maximize the cluster's contribution to the competitive position of the firm.

Also cluster organizations can benefit from the results of our study. As they are now more aware of the processes that lead to a better competitive position for the cluster firms, they might try to stimulate information exchange and joint projects further. They might especially focus on enforcing the internal organization drivers of environmental investments, as these are the basis for the cluster contribution to reduced costs and increased product differentiation. In other words, they should further stimulate eco-centric leadership, they should demonstrate that the environmental topic is an opportunity for a firm and not a threat, they should help the firms' environmental managers with their championing behavior, and they should try to stimulate the involvement of lower echelons in generating ideas that can benefit the firms' environmental goals and performances. To this end, the cluster organizations can stimulate collaboration and its effects by organizing meetings, seminars, and events for top managers focused on stimulating these internal organization drivers. The main goal is to create or improve the managers' vision and attitude toward environmental leadership and show the beneficial effects that this may have on the firms' competitive position.

Finally, policymakers also have a responsibility in enforcing the effect of a geographical cluster on its firms. They may intervene in and stimulate the effect of existing cluster organizations or enhance cluster collaboration via government-dependent cluster organizations such as port authorities in port clusters. We only studied mature clusters in which collaboration was already well developed. However, we believe that government subsidies for collaborative initiatives might be especially helpful in young clusters that have yet to discover the full beneficial effect of the cluster. Nonetheless, policymakers have to be aware that the cluster

can help to drive firms toward a more proactive approach of their dealings with the environment, whereas the traditional law-making approach, focusing on setting targets, is mainly based on reactive behavior of the firms. Thus, we recommend that policymakers shift their attention toward stimulating proactive behavior. One way to do this is by seeking methods to stimulate the cluster collaboration, because, as shown is this study, this will lead to more environmental investments and a better competitive position at the same time.

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