

Strategic Schemas and Corporate Environmental Performance: Theorizing, Testing, and
Enriching an Interpretive Framework

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ABSTRACT

Strategic Schemas and Corporate Environmental Performance: Theorizing, Testing, and Enriching an Interpretive Framework

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Environmental science draws public and scholarly attention to the disquieting deterioration of the global ecosystem and its impacts on human activities. Environment and management researchers have been looking at the role of business organizations in this phenomenon, both as contributors to degradation and as leaders in restoration, thus bringing forth the issue of corporate environmental performance (CEP). Research on the antecedents of CEP has examined a variety of internal and external predictors, but has surprisingly overlooked strategic schemas, which are often implied in this research and recognized as prompters for social and environmental actions. Management research needs further exploration of strategic schemas and lacks a framework that relates schemas to corporate environmental performance. The three papers in this doctoral thesis attempt to fill these gaps. The first paper proposes an interpretive framework on CEP that integrates literatures on schemas and sustainability. This framework offers an original view of schema interaction and evolution, where schema interaction models traditionally understood as discrete are shown to be interrelated. The framework also provides an explanation for business organizations' limited success in addressing global environmental issues. The second paper validates part of the framework by testing a set of relationships between schemas, organizational actions, and CEP. Combining content analysis with quantification techniques, this paper finds that although firms gather information and learn about natural environmental issues, they fail to translate their knowledge into appropriate actions. Perhaps as a result, corporate environmental initiatives correlate with a deterioration of CEP. The third paper employs cognitive mapping to examine the discourse on sustainability produced by an international trade association and four member companies over a period of eleven years. This study reveals that disclosed schemas change through two fundamental mechanisms of growth and reduction which can be used to explain all schema evolution. It also unveils the existence of two distinct types of schema content: core and peripheral content. Although schemas tend to grow incrementally, peripheral content undergoes

frequent growth and reduction, while core content grows and shapes the meaning attributed to newer content. Larger companies use the trade association as a vector to disseminate their schemas on sustainability and influence the schemas of smaller firms -and possibly of the industry as whole- by adopting and promoting new sustainability practices early. Together, these three papers provide an original and testable framework to understand CEP from a cognitive perspective, qualify the relationship between strategic schemas and CEP, and reveal underlying mechanisms of schema evolution.

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CONTRIBUTION OF AUTHORS

Although I employ the author's "we" in all three papers, I am the sole author of this thesis. My use of "we" equally reflects my discomfort with the pronoun "I" in my written productions, the theoretical and technical guidance of my thesis committee and other mentors, and my intention to enlist co-authors on the way to publication.

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THESIS OVERVIEW

General Focus: Corporate schemas, environmentalism, and environmental performance

The purpose of this thesis is to explore and explain how strategic thinking affects and constrains corporate response to environmental issues. It started with the observation that firms have been engaging in corporate environmentalism for over four decades with limited results (Whiteman, Walker, & Perego, 2013). A question followed: How could firms address environmental issues for such a long time and hardly curtail environmental degradation? Environmental degradation manifests in global indicators such as climate change, ocean acidification, ozone depletion, fresh water availability and use, biodiversity loss, and chemical pollution (Rockström et al., 2009; Steffen et al., 2015). Disaggregated at the organizational level, environmental degradation materializes in corporate environmental performance (CEP), which is “the outcome of a firm’s strategic activities that manage its impact on the natural environment” (Walls, Berrone, & Phan, 2012: 891). CEP thus consists in “these actual environmental outcomes, with their tangible and material impacts on the earth, that ultimately matter.” (Delmas, Etzion, & Nairn-Birch, 2013: 263).

Building on the assumption that firms both cause and can help mitigate environmental issues, and following the cognitive perspectives in strategy (Mintzberg, Ahlstrand, & Lampel, 2005; Narayanan, Zane, & Kemmerer, 2011) and organization theory (Walsh, 1995), this thesis investigates the links between strategic thinking, environmental initiatives, and environmental performance. In theoretical terms, this thesis examines the relationship between strategic schemas, the socially-shared cognitive maps that shape strategic actions; corporate environmentalism, the integration of environmental practices in business operations; and, corporate environmental performance.

The next section briefly reviews the theoretical background and research questions, followed by a synopsis of the thesis, and the three articles.

Theoretical Background and Research Questions

Environmental sustainability. Environmental sustainability, the conditions in which the natural environment can sustain itself indefinitely (Daly, 1990), is one of the most pressing issues of the 21st century, in that it connects to the earth’s capacity to harbor life and to crucial social and economic challenges. Environmental sustainability affects the whole planet, billions of lives, and currently “The survival of many societies, and of the biological support systems of the planet, is

at risk.” (United Nations General Assembly, 2015: 5). Environmental sustainability matters in business contexts, where the environment circumscribes the resources available to companies, which in turn employ these resources and alter surrounding ecosystems more or less intensely, affecting the environment’s capacity to renew resources. Environmental sustainability has thus become a strategic concern for many businesses, especially those who rely heavily on natural resources to create value. Environmental sustainability’s significance is critical to enterprise strategists -typically top management- who ponder and define the role of business in society (Schendel & Hofer, 1979), and to stakeholders whose ecological concerns affect corporate environmentalism and corporate environmental performance (Kassinis & Vafeas, 2006; Sharma & Henriques, 2005).

A number of factors in the organization and its environment shape CEP, although research on CEP strictly speaking -actual environmental outcomes- focuses mainly on internal predictors so far. Aspects of corporate governance like board size, board independence, board gender diversity, outside CEO representation on board, stakeholder representation on board, legal expertise on board, and shareholder activism have been linked to CEP (de Villiers, Naiker, & van Staden, 2011; Kock, Santaló, & Diestre, 2012; Walls et al., 2012). Investigations of the link from strategic planning to CEP produced uneven findings. While the level of integration of environmental issues in strategic planning was found to correlate with CEP (Judge & Douglas, 1998), some authors suggested reversed causality: performance gaps lead to the strategic integration of environmental issues (Russo & Harrison, 2005). Other studies examined resource affluence and allocation through proxies such as size, resources, and environmental innovation, and found evidence that firm size and resources predict CEP (Elsayed, 2006). In contrast, the relationship between innovation and CEP may be negative overall despite case-based evidence to the contrary (York, 2004), suggesting that most innovations do not comprise an environmental component. Innovation is complex and many elements moderate its impact on CEP, like innovation type (process or product), industry, firm size, regulatory constraints, and information sources (Pavelin & Porter, 2008). Environmental innovation can also imply trade-offs among different environmental improvements (Poesche, 1998). However, long-term patterns in the composition of local environmental innovation portfolios predict CEP (Klassen & Whybark, 1999), suggesting an overarching role for strategic vision as embedded in firms’ prevailing schemas.

Few studies investigate external predictors of CEP. They reveal that environmental management programs and environmental certifications (e.g. ISO 14001) may lead to enhanced CEP (Cordano, Marshall, & Silverman, 2010; Melo & Wolf, 2005). Nonetheless, companies seeking social legitimacy or economic performance often decouple implementation from environmental performance (Schaefer, 2007), and “decoupled” implementation is unlikely to lead to superior CEP (Aravind & Christmann, 2011). Stakeholder pressures also affect CEP, especially when they come from resourceful stakeholders and/or stakeholders with strong pro-environmental preferences (Kassinis & Vafeas, 2006). Corporate social responsibility (CSR) research offers similar insights on external predictors of social performance. It confirms that stakeholders, in particular shareholders, consumers, the media, local communities, and interest groups conduct various actions to induce firms to engage in CSR (Aguinis & Glavas, 2012). CSR research also musters some evidence of the role of regulations, standards and certifications as predictors of CSR initiatives. However, many CEP and CSR studies are not designed to explain what proportion of CEP and CSR is explained by external predictors (e.g. Buehler & Shetty, 1974; Fineman & Clarke, 1996; Melo & Wolf, 2005), while those who address this question show limited external predictor effect on CEP and CSR (e.g. Christmann & Taylor, 2006; Kassinis & Vafeas, 2006). Further, some authors suggest that standards and certifications may diminish corporate focus on substantive CSR and increase engagement in symbolic CSR, that is, minimal compliance with external requirements (Aguinis & Glavas, 2012), consistent with the above-mentioned findings on decoupling (Aravind & Christmann, 2011; Schaefer, 2007). These results suggest that internal factors exert significant influence on CSR and CEP.

In sum, research on the internal organizational predictors of CEP has produced inconclusive findings, perhaps with the exception of resource affluence, which appears to relate with CEP. In parallel, research on the external antecedents of CEP has shown a positive although limited influence from regulations and stakeholder pressure. Together, these findings call for further investigation of internal predictors that have not been considered in the past, such as corporate schemas. Although often implied in CEP studies in the form of organizational interpretations (e.g. Aravind & Christmann, 2011; Cordano et al., 2010; Schaefer, 2007) and widely recognized as predictors of CSR actions (Aguinis & Glavas, 2012; Angus-Leppan, Metcalf, & Benn, 2010; Banerjee, 2001; Bansal, 2003; Basu & Palazzo, 2008; Eberhardt-Toth &

Wasioleski, 2013; Thomas, 2005), corporate schemas have not been addressed as antecedents of CEP.

Schemas. Early discussions of schemas' role in human cognition come out in the works of 18th century German philosopher Immanuel Kant who described them as rules by which people associate abstract categories with sense perceptions (Kant, 1998). Swiss psychologist Jean Piaget received credit for introducing the term to psychology in the 1920's. Piaget (1952) theorized that children build schemas from previous experience to understand and organize subsequent experience. Closer in time, the construct of schema appears in Schutz (1962) who advances that schemas, or schemes of reference, consist in a stock of previous experiences of the world that forms the basis of all interpretation, especially in social interactions:

“When I encounter a man acting in the social world, I know that I must understand him as a human being, and this means that his actions mean something to him as well as to me, relate to his world as well as to mine, and are ultimately rooted in the interpretive scheme he has created for living his life. But this knowledge is itself taken for granted by me as well as by him; its being taken for granted by us is precisely the typification which makes intersubjectivity possible.” (1962: XXXV)

Similarly, Garfinkel describes schemas as interpretation frameworks made of standardized symbols and “a pre-established corpus of socially warranted knowledge” (Garfinkel, 1967: 56). But perhaps the theoretical significance of schemas has become more widely accepted in management, strategy, and organization research since Goffman's (1974: 21) conceptualization of cognitive frames as “schemata of interpretation”, which are loosely organized systems of “entities, postulates, and rules” that allow users to “locate, perceive, identify, and label a seemingly infinite number of concrete occurrences defined in its terms”. Since then, schemas have been used by management scholars across disciplines such as organizational behavior (e.g. Brands, Menges, & Kilduff, 2015), cognitive psychology (e.g. Dane, 2010; Fiske & Dyer, 1985), social psychology (e.g. Bartunek, 1984, 1993), organization theory (e.g. Bingham & Kahl, 2013; Labianca, Gray, & Brass, 2000), and strategy (Nadkarni & Narayanan, 2007a, 2007b). Today, strategy and organization scholars give the concept of schema a central place (Bingham & Kahl, 2013) and use it frequently to posit that interpretations shape organizational responses to a variety of issues.

In strategy, the cognitive perspective commonly assumes that corporate cognitions prompt actions. For example, Mintzberg and colleagues propose that “Strategists are largely self-taught:

they develop their knowledge structures and thinking processes mainly through direct experience. That experience shapes what they know, which in turn shapes what they do” (2005: 150). Moreover, strategy researchers have reached consensus regarding the role of schemas:

“In spite of the diversity of views in the cognitive school, on one point there is widespread agreement: an essential prerequisite for strategic cognition is the existence of mental structures to organize knowledge. These are the “frames” referred to above, although a host of other labels have been used over the years, including schema, concept, script, plan, mental model, and map.” (Mintzberg et al., 2005: 159)

Several authors draw attention to how schemas structure organizational cognitions (Bartunek, 1984; Jarzabkowski, 2008), including as regards corporate environmental initiatives (Basu & Palazzo, 2008; Hahn, Preuss, Pinkse, & Figge, 2014). These works indicate that various organizational schemas compete and interact within firms, shaping corporate interpretation and response. In particular, managers dealing with ecological issues need to reconcile intricate economic, environmental, and social concerns (Hahn et al., 2014).

Despite these developments, questions remain concerning schemas and how schemas relate to action and performance. First, most strategy research employing a cognitive perspective assumes the relationship between schemas, actions, and performance; very few studies challenge this assumption despite calls for empirical testing (e.g. Corner, Kinicki, & Keats, 1994; Daft & Weick, 1984). Second, existing research underemphasizes schema evolution and processes of mutual influence between schemas and experience. Emphasis on causality (i.e. schemas trigger actions) engenders frozen conceptualizations of schemas (for exceptions, see Bingham & Kahl, 2013; Dane, 2010), while the growing number of studies that depict schema competition within and around organizations (e.g. Kaplan, 2008; Maitlis, 2005) call for deeper knowledge on schema interaction and evolution.

Schemas and environmental performance. By examining corporate schemas and environmental performance together, this thesis contributes to filling the gaps and solving the issues described above. Because schemas are indirectly related to, and affect several antecedents of, environmental performance, they provide an alternative to oversimplified perspectives on environmental performance predictors: schemas shape corporate actions, mould organizational structure, buffer and distort outside influences (Bartunek, 1984). In other words, schemas are prone

to create a comprehensive view that accommodates internal and external CEP predictors. Further, schemas' connection to a variety of CEP predictors requires conceptual clarity, which in turn may help solve key issues. In particular, conceptual clarity demands an accurate definition and conceptualization of CEP which prevents the amalgamation between environmental actions and CEP. This distinction is fundamentally relevant since it steers sustainability research away from organization-centered accounts which often confound corporate environmental actions and performance, towards ecologically-driven narratives which emphasize actual corporate environmental performance (Bansal & Gao, 2006; Delmas et al., 2013). Schemas also provide a useful theoretical lens to understand corporate environmentalism because they allow accounting for multiple perspectives within and around corporate environmental actions and performance. As mentioned, the literature on organizational interpretation has recently stressed the co-existence of competing schemas within organizations, especially as regards ecological issues, cueing research on schema interaction and evolution. A schema perspective highlights multiple organizational ideas, reveals interaction dynamics, and sheds light on the cognitive precursors of corporate environmentalism and corporate environmental performance. In parallel, a schema perspective opens the door to questioning the assumption that schemas shape actions and performance.

Beyond providing a better understanding of schemas and the relationship between schemas, actions and performance, this thesis offers dynamic explanations of schema interaction and evolution, which shed a new light on corporate environmentalism. Indeed, this thesis contributes to the development of theory on schemas and on CEP by revealing the mechanisms that shape the outcomes of interactions between diverging schemas on CEP. The articles in this thesis contribute an innovative explanation of schema interaction mechanisms, demonstrate the explanatory power of the schema perspective as regards CEP, and illustrate the application of useful research tools for schema studies. Collectively, the papers in this thesis move toward specifying a more appropriate conceptualization of schemas as dynamic, and of corporate environmentalism as plural, even within one organization. How schema interaction might impact corporate environmentalism is the focus of the first article, leading to two research questions: 1) How do firm-level schemas interact with experience and other schemas? 2) What are the mechanisms underlying schema interaction? Whether the assumed link between corporate cognition and action can be empirically tested in the context of environmental issues sparked the second article, which asks: Does ecological interpretation reflected in corporate schemas predict

CEP? Finally, schema competition and the evolution of schemas on the natural environment inspired the third article, whose research questions are: 1) How do corporate schemas evolve over time? 2) How do powerful schema sponsors influence others' schemas?

Research Overview

The first paper is theoretical and synthesizes schema research from the cognitive perspectives in strategy (for a review, see Narayanan et al., 2011), in organization theory, and several references in social psychology (for a review, see Walsh, 1995). It also builds on research that investigates corporate sustainability from a cognitive perspective (e.g. Basu & Palazzo, 2008; Hahn et al., 2014) to describe an interpretive framework that relates strategic schemas to corporate environmental sustainability and highlights the role of schema interaction. Whereas past research has presented schema interaction patterns as separate, this article proposes that interaction patterns systematically connect. Applied to the interaction of instrumental (traditional, profit-oriented) and integrative (economically, socially, and environmentally balanced) sustainability schemas, this framework suggests that firms labor with environmental issues because they withstand schematic interaction dynamics that weaken newer strategic schemas and bolster extant ones. Schema sponsors may however employ different types of power to alter firms' schemas and/or organizational arrangements, either maintaining or disrupting schematic dynamics, and in the latter case, creating momentum for change toward corporate sustainability.

The second article empirically tests the relationship between ecological interpretation and CEP, explicating ecological interpretation as a process made of three stages: scanning, understanding, and responding to ecological issues. Independent variables come from counting environmental terms representing these three stages in the sustainability reports of 108 randomly selected firms in the Trucost environmental impact database, from 2006 to 2009. The sampled companies come from a wide range of industries and services, and are headquartered in Europe, North America, and Asia. The analysis first associates scanning, understanding, and responding with three dictionaries of words and phrases following a rigorous procedure for computer-aided text analysis (CATA) recommended by Short, Broberg, Cogliser, and Brigham (2010). The final dictionaries hold 94 words and phrases for ecological scanning, 283 for ecological understanding, and 110 for ecological responding. In parallel, a research assistant gathered sustainability reports from corporate websites, the Global Reporting Initiative's (GRI) database, and an independent online repository of corporate responsibility reports. Fewer reports were available in the earlier

years of the study and this was the main constraint on sample size. I then fed the sustainability reports into a text analysis software loaded with the three ecological interpretation dictionaries to measure the importance of each stage within the selected firms' disclosed schemas. Using Trucost's Total Environmental Damage Cost (TEDC) as my dependent variable, I then ran panel regressions to test relationships between scanning, understanding, responding, and corporate environmental performance. I used statistical controls for firm size, changes in production, industry, industry-specific pollution, and environmental regulation stringency. I also applied time lags: for example, to predict corporate environmental impact in 2009, I employed a measure of ecological responding in 2008, and of ecological scanning and understanding in 2007. In line with theory, scanning and understanding appear to be related. Contrary to expectations though, firms in the sample do not translate understanding of ecological issues into corresponding environmental actions. Perhaps more puzzling, corporate response to ecological issues seems to worsen firms' CEP. I propose interpretations of these results.

The third paper explores strategic schema evolution from 2003 to 2013 in four companies that are members of the International Council for Mining and Metals (ICMM), a trade association whose mission is to enhance environmental performance in the mining industry. Sampling was theoretical: two founding companies that continued membership over the studied period; one founding company that left in 2007; and, a newcomer as of 2009. Cognitive mapping (Axelrod, 1976; Barr, Stimpert, & Huff, 1992; Huff, 1990; Huff & Jenkins, 2002) was then applied to sustainability reports. Cognitive mapping is a content analysis technique that highlights concepts, conceptual relationships and conceptual values in texts, thus usefully exposing the three components of schemas. A research assistant and I learned the cognitive mapping procedure developed by Huff, Narapareddy, & Fletcher (1990) and made our own adaptation. We coded the sustainability reports of the five organizations over 11 years, producing 55 cognitive maps. I analyzed individual maps, compared maps over time, and across companies to characterize map content, capture the value ascribed to concepts, uncover patterns of convergence, make inferences on mutual influence among ICMM member companies, and identify schema change patterns. Through these analytical steps, I identify two fundamental mechanisms, growth and reduction, which can describe all schema evolution. I also distinguish between two types of schema content: core and peripheral. I find that schemas as a whole tend to grow incrementally, whereas peripheral content undergoes frequent growth and reduction, and core content mostly grows. Core content

also shapes the meaning attributed to newer schema content. Finally, this paper unveils how larger companies use the trade association as a vector to spread their schemas on sustainability. By adopting and promoting new sustainability practices early, they influence the schemas of smaller firms and possibly of the industry as whole.

ARTICLE 1

Why Change Toward Corporate Sustainability Is So Challenging and How Firms May Achieve It: A Strategic Schema Framework

CHANGE TOWARD CORPORATE SUSTAINABILITY

Managing changes in firms' environments is difficult (Bingham & Kahl, 2013) and managing changes in the natural environment is one of the most arduous challenges facing firms today. As reflected in the continued and accelerating deterioration of key global environmental indicators (Rockström et al., 2009; United Nations Environment Programme, 2012), firms have obtained only weak results in addressing natural environmental issues, despite over three decades of efforts (Whiteman et al., 2013). Strategy and organization studies indicate that managerial and firm-level interpretations play a crucial role in corporate response to contextual changes (Nadkarni & Narayanan, 2007a). Within firms, different interpretations may compete (Kaplan, 2008) or co-exist, possibly resulting in ambiguous responses. Managers dealing with ecological issues need to reconcile intricate economic, environmental, and social concerns, which may lead to ambivalent issue interpretation (Hahn et al., 2014). This might explain why change toward corporate sustainability is so challenging.

Organizational interpretations have served as a framework to study the emergence of green initiatives (Etzion, 2007; Howard-Grenville, 2007a; Muller & Kolk, 2010) and several authors draw attention to the structuring role of firm-level schemas in organizational interpretations (Bartunek, 1984; Jarzabkowski, 2008; Ranson, Hinings, & Greenwood, 1980). Basu and Palazzo (2008) argue that schemas shape corporate interpretations and decision-making as regards environmental concerns. They propose a view whereby managerial thinking, language, and behavioral disposition shape firms' interpretation and enactment of corporate social responsibility. Hahn et al. (2014) distinguish between two archetypal schemas and suggest that they differently impact the breadth and depth of interpretation, evaluation, and managerial responses to sustainability issues. Together, these works suggest that firms respond to ecological issues only when they interpret them as issues (Bansal, 2003; Howard-Grenville, 2007b) and that different firm-level schemas compete and interact within firms, shaping corporate interpretation and response.

Although extant research recognizes the diversity of economic, social and environmental issues facing firms and the tensions among them (Bansal, 2003; Hahn et al., 2014), it underemphasizes schema interaction and processes of mutual influence between schemas and experience (for exceptions, see Bingham & Kahl, 2013; Dane, 2010). Following the notion that schemas contribute to shaping a firms' environment (Nadkarni & Narayanan, 2007a; Weick, 1995), extant perspectives tend to propose unidirectional relationships where schemas shape firm interpretation and response to sustainability challenges, thus concealing processes of schema interaction. A more interactional understanding of schema change is thus needed to clarify the link between schemas and change toward corporate sustainability.

In this article, we review and examine the literature on schema interaction and evolution to understand how different firm-level schemas interact, shaping corporate interpretation of and response to ecological issues. We consider two research questions: 1) How do firm-level schemas interact with experience and other schemas? 2) What are the mechanisms underlying schema interaction? More precisely, we mesh research on schemas and sustainability to offer an interpretive framework linking schema interaction to corporate sustainability. This framework includes known schema interaction patterns such as bookkeeping, subtyping, replacement and relocation (Balogun & Johnson, 2004; Labianca et al., 2000), identifies original links among them, and proposes that combinations of two factors -schema discrepancy and schema support by powerful sponsors- selectively trigger these patterns. Building on French and Raven (1959), we then suggest that different power bases affect the degree and sustainment of discrepancy so as to enable superficial (first-order) or marked (second-order) schema change. Applied as a conceptual lens to the interaction of instrumental (traditional, profit-oriented) and integrative (economically, ecologically, and socially balanced) schemas, this framework suggests that firms struggle with change toward sustainability because they are subject to schema dynamics perpetuated by pervasive organizational arrangements that restrain newer schemas –like the integrative perspective– and perpetuate extant schemas like the instrumental, largely economic conception prevalent in Western societies (Banerjee, 2001; Egri and Pinfield, 1996; Key, 1999; Stormer, 2003; Stubbs and Cocklin, 2008). Remarkably, the same power-based mechanisms explain how to create change toward corporate sustainability.

This paper contributes to the literature on schemas by proposing a framework for schema evolution. This framework highlights schema interaction as central to organizational

interpretations and change. It describes previously undiscussed links between schema interaction patterns and, following Weick (1995), affirms the centrality of discrepancy avoidance in processes of organizational interpretation. Also, the description of power bases that alter the degree and sustainment of schema discrepancy sheds a new light on the mechanisms that govern schema interaction. Finally, this work contributes to the corporate sustainability literature as it explains firms' limited accomplishments in redressing natural environmental issues.

FIRST-ORDER SCHEMA CHANGE AND THE STRATEGIC INTERPRETATION OF SUSTAINABILITY

Strategic schemas and models of first-order schema change

Firm constituents make sense of environmental changes through topic-specific cognitive frames called schemas (Balogun & Johnson, 2004; Bartunek, 1984, 1993; Labianca et al., 2000). Individuals routinely negotiate collective schemas that create shared meanings for organizational constituents, for an organization as a whole (Bartunek & Moch, 1987; Kaplan, 2008), or even for an industry (Bingham & Kahl, 2013). Firm-level schemas are also called strategic schemas (Nadkarni & Narayanan, 2007b). Schemas map concepts, their perceived value, and relationships among them (Bartunek, 1993). They function like socially-shared understandings of experience, its relevance, meaning and processing. They filter and structure experience, and provide norms for relevance, interpretation, and behavior (Bartunek, 1984), thus shaping how firms constituents interpret their environment (Balogun & Johnson, 2004). Schemas give experience reality by defining what is relevant and how to handle it. Reciprocally, meaning attributed to experience supports the schema that generated it (Bartunek, 1993; Giddens, 1979; Schutz, 1962).

Usually tacit and taken for granted, schemas are made explicit when firm constituents express them as values -desired goals and preferences- and interests as to the distribution and allocation of organizational resources (Ranson et al., 1980). When they do so, firm constituents deliberately or unknowingly act as schema sponsors who enact and thus support their own schemas. However, schemas often remain unnoticed because they are conveyed through inconspicuous organizational mechanisms like vocabularies, communication channels, procedures, and personnel selection (Weick, 1995). Hardly detectable, schemas pervade organizations and are difficult to change. Despite this tendency for self-preservation (Schutz, 1962: 230), schemas are dynamic and may change over time (Balogun & Johnson, 2004) as they are

constantly exposed to confirming and disconfirming schemas and experience. First, firms comprise various schemas that are rarely shared throughout the whole organization (Balogun & Johnson, 2004; Maitlis, 2005; Maitlis & Sonenshein, 2010). Second, firms continuously interact with stakeholders that carry different schemas. Third, organizations bracket information from the constant flow of experience which may disconfirm existing schemas (Labianca et al., 2000). Through these confirming and disconfirming interactions with other schemas and experience, schemas may come out reinforced, or undergo two broad types of change: first-order change consists in gradual alterations in how interpretation is made, whereas second-order change reflects a radical shift whereby organizational norms and world views are transformed (Bartunek, 1984).

Research describes two models that lead to first-order schema change (see table 1 below). The first, the *bookkeeping model*, describes the incremental modification of an extant schema by disconfirming experience (Balogun & Johnson, 2004; Rothbart, 1981; Weber & Crocker, 1983). New ideas that trigger incremental modification tend to bring refinements or extensions to existing ideas (Dane, 2010). Incremental modification may entail a few new concepts and conceptual relationships but does not disrupt existing causal chains, nor the order of collective values (Barr et al., 1992). In firms, bookkeeping was found to explain the refinement of established schemas (Balogun & Johnson, 2004), and accordingly, bookkeeping may manifest in mild operational changes, like process adaptation to better serve firm strategy (Bartunek, 1984). For example, an engineering department's assimilation of new ecological measures along other technical manufacturing procedures (Howard-Grenville, 2007b) illustrates the bookkeeping model.

The other model resulting in first-order change, *subtyping*, pictures schemas resisting change because disconfirming experience is so discrepant that extant schemas cannot process it; a sub-schema is created to account for discrepant information (Balogun & Johnson, 2004; Labianca et al., 2000; Queller, 2002; Weber & Crocker, 1983). Highly discrepant new ideas tend to be unconventional and to challenge accepted understandings (Dane, 2010). Highly discrepant schemas may involve a large number of new concepts and conceptual relationships, may go against established causal chains, and change the order of collective values (Barr et al., 1992). In subtyping, the extant schema remains perceived as generally valid and subsumes the new one, which is seen as singular. Subtypes appear because highly discrepant experience is not perceived as representative of the whole (Weber & Crocker, 1983). The subdivision of a central schema into subtypes ensures that it applies to a wider array of experience (Nicholson & Anderson, 2005) and

subsequently absorbs more experience as confirming. For example, in the 1980's, executives of the power utility Bangor Hydro held a schema centered on free enterprise. As government agencies, local communities and interest groups resisted the company's dam project on the Penobscot River (Savitz & Weber, 2006), Bangor interpreted social and ecological claims as illegitimate business restrictions, thus creating a subtype of business restrictions and making courts the primary space to resolve arguments. Over the next 15 years, even as the number and influence of its opponents grew, Bangor kept considering such demands as part of an illegitimate subtype of barriers to free market.

Table 1
Known Models of Schema Change

	Bookkeeping model	Subtyping model	Replacement model	Relocation model
Schema interaction with	Small disconfirming experiences & schemas	Salient disconfirming experiences & schemas	Small disconfirming experiences & schemas	Salient disconfirming experiences & schemas
Mechanism	Assimilation	Discrimination, isolation	Disconfirmation followed by emergence	Co-existence followed by migration
Level of change	First-order	First-order	Second-order	Second-order
Outcome	Incremental change to extant schema	Main schema and discrepant sub-schemas	Incremental change accumulating into marked change	Radical change
References	Balogun & Johnson (2004) Rothbart (1981)	Balogun & Johnson (2004) Weber & Crocker (1983)	Albert (1992) Rothbart (1981) Labianca et al. (2000) Weber & Crocker (1983)	Albert (1992) Rothbart (1981) Labianca et al. (2000) Weber & Crocker (1983)

In sum, empirical research suggests that perceived discrepancy, whether across schemas or between extant schemas and new experience, is a key condition affecting schema interaction patterns. Schema discrepancy represents the difference across schemas in terms of conceptual content, conceptual relationships, and concept values. Mild discrepancy enables assimilation while greater discrepancy may prevent it. Assimilating, the signature mechanism of the bookkeeping pattern, implies “digesting” new experience so that it is consistent with the values and conceptual relationships within extant schemas. When assimilation of new experience through dominant

collective schemas is too difficult, firm members isolate it as unrepresentative. This isolation is the signature mechanism of subtyping. Discrepancy thus acts as a track switch that directs schema interaction towards bookkeeping (low discrepancy), subtyping (high discrepancy), or reinforcement when schemas converge (discrepancy is null).

First-order schema change and the strategic interpretation of sustainability

Economics is the predominant conception of the world in Western countries and other parts of the world (Banerjee, 2001; Egri & Pinfield, 1996). It pervades both society and organizations (Ferraro, Pfeffer, & Sutton, 2005) and has inspired the dominant model of the firm (Key, 1999; Stormer, 2003; Stubbs & Cocklin, 2008). Simultaneously, the natural environment has risen as a key business concern (Banerjee, 2001; Whiteman et al., 2013). No firm-level schema harbors purely economic or ecological values. Rather, different values may be seen as orientations between which schemas continuously evolve following organizational experience (Greenwood & Hinings, 1988). In some cases, managers may see sustainability in equally ecological, economic, and social terms. Because of these multiple foci, these perspectives have been called ecocentric, integrative, or paradoxical (Gao & Bansal, 2013; Hahn et al., 2014; Shrivastava, 1995). We follow extant research and define corporate sustainability as the integration of social, environmental, and economic considerations in business (Hahn et al., 2014; van Marrewijk & Werre, 2003).

Empirical research however indicates that most Western managers interpret sustainability issues through primarily economic or sociological lenses (Boiral, Cayer, & Baron, 2009). Past studies have repeatedly found that firms implement resource efficiency and waste reduction strategies to generate above-average financial returns (Flammer, 2013), and that firms engage in greener actions in response to stakeholder pressure (e.g. Zietsma & Lawrence, 2010). These approaches explain why some firms engage in symbolic structural adaptation rather than substantive sustainability actions, that is, decoupling (Boiral, 2007; Wijen, 2014), or in misleadingly positive environmental communication, also known as greenwash (Lyon & Montgomery, 2015). More generally, economic and sociological perspectives adequately explain a range of corporate green actions ultimately meant to achieve business survival and profitability. These perspectives have been called instrumental (Aguilera, Rupp, Williams, & Ganapathi, 2007; Gao & Bansal, 2013; Margolis & Walsh, 2003), and based on the above discussion, we expect that most managers and firms interpret sustainability through instrumental schemas.

A wide range of sustainability-related experience can be interpreted through instrumental schemas. As noted, resource efficiency serves cost reduction, stakeholder engagement may prevent costly lawsuits or negative media coverage, and compliance with environmental regulations ensures avoidance of financial sanctions (for a more exhaustive list, see Basu & Palazzo, 2008: 122). From a schema-based view, experience and schemas in this line of thought may offer a small number of novel concepts and relationships, fit well in the extant chain of causality, and will not challenge the order of values, that is, the priority given to economic and sociological goals. They represent low discrepancy with instrumental schemas.

Proposition 1: In most firms, the more instrumental new sustainability-related experience or strategic schemas, the lower their discrepancy, and the higher the likelihood of first-order schema change following the bookkeeping model.

As noted however, many sustainability-related ideas draw on the integration of economic, social, and environmental concerns. Sustainability concerns may require, for example, that firm growth remains within the limits that allow for the preservation of ecological integrity (Gladwin, Kennelly, & Krause, 1995). For any firm, this may mean rejecting opportunities to generate additional revenues when ecological integrity is at risk, and such considerations have been qualified as radical or utopian (Banerjee, 2001; Egri & Pinfield, 1996). From a schema-based view, experience and schemas in this line of thought prompt the revision of numerous concepts and relationships, create new constraints in the chain of causality, and challenge the order of values by giving equal priority to economic, social, and environmental goals. They represent high discrepancy with instrumental schemas.

Proposition 2: In most firms, the more integrative new sustainability-related experience or strategic schemas, the higher their discrepancy, and the higher the likelihood of first-order schema change following the subtyping model.

SECOND-ORDER SCHEMA CHANGE AND THE STRATEGIC INTERPRETATION OF SUSTAINABILITY

Strategic schemas and models of second-order schema change

Research describes two models that lead to second-order schema change (see table 1). Extant schemas interacting with mildly discrepant experience and schemas may incrementally change over time so that collective values become altered and produce second-order change (Balogun & Johnson, 2004; Labianca et al., 2000). As the extant schema is gradually disconfirmed, a new schema gradually forms following a *replacement* pattern (Albert, 1992). *Replacement* occurs when discrepant experience disconfirms an extant schema and no clear alternative is immediately available, leading to the emergence of a new schema (Albert, 1992). In contrast, *relocation* happens when two diverging schemas momentarily co-exist and there is a migration from one to the other (Albert, 1992). Highly discrepant experience may at first be subtyped (Balogun & Johnson, 2004; Labianca et al., 2000) then lead to a shift from the dominant schema to the previously subtyped schema. When either replacement or relocation are completed, conversion has taken place (Albert, 1992, see figure 1). An example from the MacMillan Bloedel company studied by Zietsma & Lawrence (2010) illustrates both models. Up until the 1980's, this forestry company operating in British Columbia had never thought of involving stakeholders in decisions on harvesting practices. Yet, intense pressures arose against clearcutting, a technique that removes all the trees from a logging area. In the 1990's, the company held consultations with stakeholders and later tested alternative harvesting practices before adopting a technique called selective harvesting. The company's exclusive schema on harvesting methods co-existed for over a decade with the more inclusive schema conveyed by civil society until the company adopted the latter, following a *relocation* pattern. In contrast, faced with the forced abandonment of clearcutting and no clear alternative, experimenting with different methods before choosing selective harvesting exemplifies *replacement*. In general, second-order schema change deeply affects actions across organizational functions and departments, and has high-level consequences that may include shifts in resource allocation (Ranson et al., 1980), and organizational restructuring (Bartunek, 1984). In view of these descriptions, schema discrepancy alone is insufficient to predict the occurrence of first- and second-order change models. Mildly discrepant schemas and experience may lead to bookkeeping or replacement, while highly discrepant schemas and experience may result in subtyping or relocation. This raises the question of the conditions for

second-order schema change, to which the literature on schema evolution in organizations can answer.

As described in the previous section, organizational members in most firms tend to use extant schemas to assimilate new experience and schemas (bookkeeping), and isolate new schemas if assimilation fails (subtyping). Both processes result in first-order change and the reinforcement of extant schemas (Howard-Grenville, 2007b; Nicholson & Anderson, 2005). Documented occurrences of second-order schema change in firms were associated with the involvement of groups wielding power –the capacity to accomplish one’s will despite resistance (Weber, 1947)- in support of change. Indeed, Bartunek (1984) proposed an opposition-based view of second-order schema change in which groups challenge each other’s schemas. In this study and several others, Bartunek and colleagues (Bartunek, 1984, 1993) found that schema sponsors use power to influence the outcome of schema interaction and change (see also Kaplan, 2008; Kaplan & Orlikowski, 2013). Influential groups take actions that support their own schemas, test the limits of, and attempt to increase, their power. For example, in a food processing plant undergoing a Quality of Work Life (QWL) intervention, line employees were found to make requests that fit their own view of the QWL goals -better work life- as well as significantly increasing the number of requests for change, possibly in an attempt to test and push the limits of the power granted by the intervention. In parallel, corporate management took actions to ensure that the intervention would meet its own goal -productivity increase- and remain under control (Bartunek & Moch, 1987). Power is necessary for groups within firms simply to enact their own schemas and sometimes to overcome resistance to schema change. When power distribution is asymmetric, all-at-once second-order change in favor of the most influential group (i.e. relocation) is possible. When power is asymmetric but more distributed among schema sponsors, schemas interact like theses and antitheses following a dialectical pattern and gradually produce an emergent synthesis (i.e. replacement) over time (Bartunek, 1984, 1993).

Powerful sponsors need to intervene for second-order schema change to happen because it is often very difficult for persons or groups used to a given schema to accept a new one (Bartunek, 1993). Most often, such powerful sponsors are management or corporate management (e.g. Balogun & Johnson, 2004; Gioia & Chittipeddi, 1991; Labianca et al., 2000), but some studies also report decisive influence from other stakeholders such as regulatory bodies (Poole, Gioia, & Gray, 1989), or civil society (Zietsma & Lawrence, 2010). Powerful sponsors have more

opportunities to voice their schemas and participate in decision making (Bartunek & Keys, 1982), and are thus more apt to state the new schema as strongly and clearly as needed to make an impact. Further, as organizational members tend to assimilate ambiguous information through extant schemas so as to preserve them (Labianca et al., 2000), it has been observed that powerful sponsors need to hold both the old and new schemas and to serve as advocates of the new schema to effectively assist in the transition from one to the other (Bartunek, 1993; Ury, 1988).

In sum, the literature on schemas suggests that power is an essential condition for second-order schema change. Remarkably, bookkeeping was observed in experimental settings where power was absent (Weber & Crocker, 1983), but not in organizational contexts where powerful groups -like top management in a university health center (Labianca et al., 2000) and in a power utility (Balogun & Johnson, 2004)- piloted schema and organizational change. Conversely, power-devoid settings were not found to harbor second-order schema change models (Weber & Crocker, 1983). Evidence of replacement and relocation was observed only in contexts where influential sponsors, especially top management, developed a new schema and shaped organizational activities and structure (Balogun & Johnson, 2004; Labianca et al., 2000). In both cases, the end of top management's direct involvement coincided with transition from a relocation to a bookkeeping pattern (Balogun & Johnson, 2004: 544). These works indicate that the relative power of schema sponsors relates to the possibility and extent of schema change (i.e. first- or second-order). Schema reinforcement or first-order change happens when power asymmetry benefits groups supporting an extant schema. Second-order schema change occurs when power asymmetry favors groups supporting a new schema. Combining our observations on discrepancy and power, and in contrast with extant literature, we propose that schema change models are not discrete but systematically linked by these two factors -schema discrepancy and schema sponsors' power- as represented in figure 1.

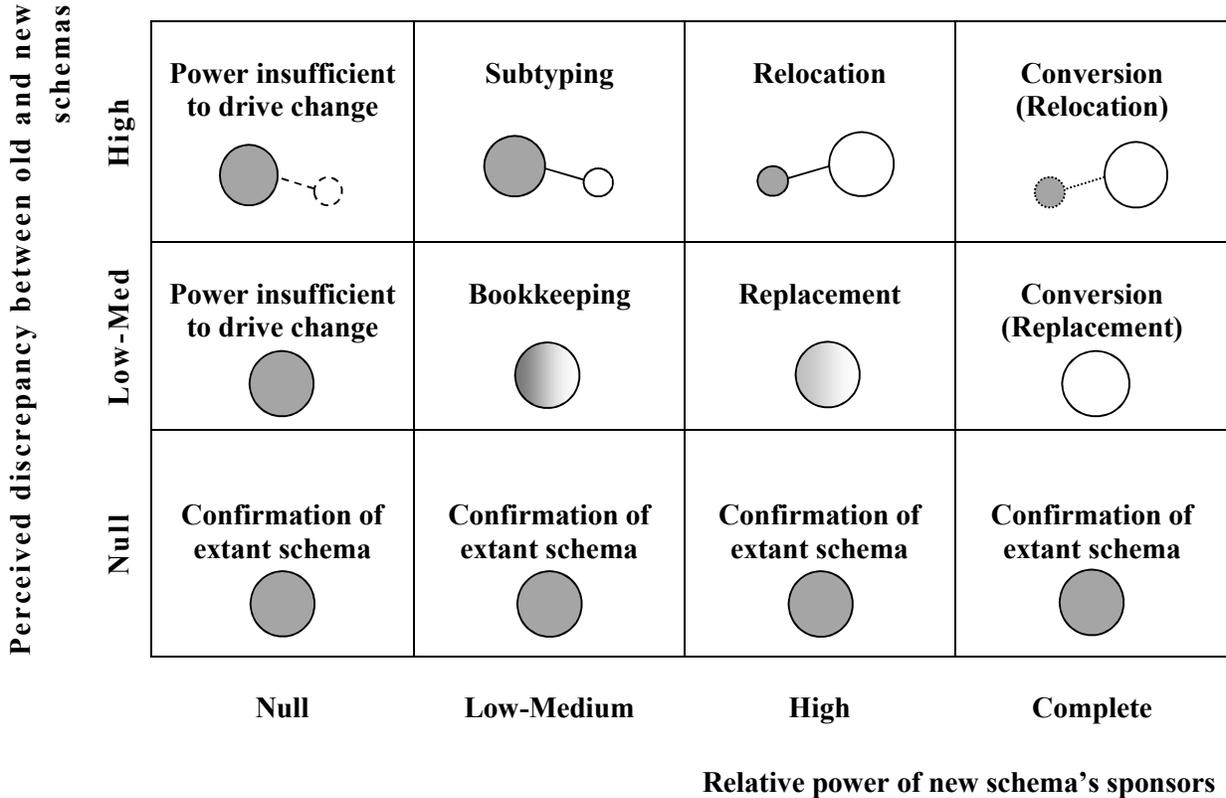
Figure 1

Models of Schema Interaction and Change, and Linking Factors

Spheres represent schemas. Small spheres represent sub-schemas.

Different colors represent different schema contents.

Dashed lines represent emerging schemas and dotted lines fading schemas.



Second-order schema change and the strategic interpretation of sustainability

The strategic interpretation of sustainability follows the same schema change patterns dependent on schema discrepancy and schema sponsor influence. Assuming as before the predominance of the instrumental view in Western settings, powerful schema sponsors in most firms try to assimilate sustainability information following extant instrumental schemas. It follows that most firms handle sustainability information following the bookkeeping or the subtyping model. As for bookkeeping, there is evidence that moderately powerful proponents of corporate sustainability obtain better results (i.e. sustainability actions) when they use the values and schemas of the more powerful groups whose behavior they are attempting to change, although such tactics reinforce extant schemas (Bansal, 2003; Howard-Grenville, 2007a). Among successful tactics used by the environmental team at the ChipCo computer chip company were,

for example, explaining sustainability challenges to engineering teams in technical terms, and presenting them as limitations on manufacturing capacity rather than as ecological issues (Howard-Grenville, 2007a: 570). This ensured minimal discrepancy with extant, technically-oriented schemas, and resulted in marginal schema change (i.e. bookkeeping). As for subtyping, higher schema discrepancy combined with the same power distribution lead to a different conclusion: discussions on the recycling of a hazardous chemical framed in terms of environmental compliance lead to the isolation of this issue. Some managers questioned the actual risk associated with the use of that chemical. Most managers held the dominant, technically-oriented schema and subtyped the issue, refusing to grant it the status of a problem in need of solving. The project was eventually dropped (Howard-Grenville, 2007a: 570).

These studies suggest that the intervention of powerful groups is needed in most firms for second-order schema change to happen in favor of integrative sustainability schemas. Powerful integrative schema sponsors need to exert some form of influence so that sustainability experience and information be collectively interpreted in integrative rather than instrumental terms. Empirical evidence of the replacement model is scarce (for an example, see Balogun & Johnson, 2004) and even more so in the sustainability literature. In their study of the Swedish firms Husqvarna and Duni, Blomquist and Sandström (2004) found that several influential schema sponsors shaped the firms' thinking and handling of sustainability: regulators, non-governmental organizations, top management, corporate environmental affairs. Perhaps because of the diversity (and likely divergent schemas) of influential groups, schema change was gradual in both firms. Little-by-little, environmental staff and managers were hired, products and production lines were adapted, structures, rules and routines were amended to include "green reminders" (2004: 370). The authors only observed evidence of first-order change but surmise that, given enough time, the two companies may find themselves with new schemas (Blomquist & Sandström, 2004: 371), which would suggest a replacement pattern.

Proposition 3: In most firms, integrative schema sponsors need to exert power so that new sustainability-related experience or schemas may trigger strategic schema change following the replacement model rather than the bookkeeping model.

Examples of relocation in empirical settings are more common. Like the MacMillan Bloedel example above, they are characterized by the concentration of power in the hands of fewer stakeholders. Typically, powerful sponsors with integrative schemas interpret sustainability-

related experience and schemas so that they radically differ from extant instrumental schemas. They enact these interpretations, taking actions and causing changes in company structure that promote second-order schema change. Taking radically innovative actions and transforming corporate structure is easier for powerful sponsors, like the late Ray Anderson, founder and CEO of Interface Inc., a US-based carpet manufacturer. After reading Paul Hawken's (1993) *The Ecology of Commerce*, Anderson decided to make sustainability his company's priority strategy. Anderson's schemas on business and sustainability shifted from instrumental to integrative, or as he put it himself, from "earth plundering" to "America's greenest" (Anderson, 2009: 2:43). Despite early managerial resistance, Anderson and his teams created working groups and elaborated strategies, guidelines and supporting programs to ensure company-wide commitment. The initial guidelines were later replaced with a more ambitious program intended to create the first large industrial firm with zero environmental impact by 2020. This led to literally hundreds of product, service and process innovations which dramatically increased environmental and economic performance (Lampikoski, 2012). From a schema-based perspective, Interface's deliberately radical greening illustrates the relocation model.

Proposition 4: In most firms, integrative schema sponsors need to exert power so that new sustainability-related experience or schemas may trigger strategic schema change following the relocation model rather than the subtyping model.

In brief, the two models that result in first-order schema change are those where firms either assimilate or isolate discrepancy, thus reducing, concealing or eliminating discrepancy. In contrast, power gives schema sponsors a voice and allows them to support integrative schemas through a variety of actions, which we examine next.

SCHEMA SPONSORS' POWER AND SCHEMA CHANGE

Power, Actions and Schema Change

The above discussion indicates that power allows schema sponsors to affect schema interactions. But how? Although powerful schema sponsors take a variety of actions that differently affect schemas (see below), we offer that the overarching principle for how actions affect schemas is discrepancy avoidance, a mechanism central to organizational interpretations (Weick, 1995). Its basic expression is that people and groups try to avoid the experience of discrepancy. We argue that firm constituents go to great lengths to avoid or reduce discrepancy,

and that they will revise the meaning of past events and actions to cope with discrepancy if needed (Garfinkel, 1967). From a schema evolution perspective, we mean that firm constituents at first try to interpret new experience through extant schemas (i.e. bookkeeping) but may disregard new experience if discrepancy is strong (i.e. subtyping), thus avoiding or at least reducing discrepancy. When discrepancy is sustained and extant schemas fail to explain ‘reality’, constituents will re-interpret experience in order to avoid discrepancy (Weick, 1995), and change their own schemas in the process, either incrementally (i.e. replacement) or drastically (i.e. relocation). In this sense, actions are primary determinants of interpretations (Garfinkel, 1967), and of schemas. Therefore, the actions of powerful schema sponsors shape firm constituents’ schemas in two ways. First, they either reinforce extant schemas or generate first-order schema change. Second, to the extent that schema sponsors can sustain firm constituents’ experience of discrepancy, they trigger the re-interpretation of past actions, and second-order schema change.

Relatedly, the schema literature suggests that actions leading to second-order change need to be consistent and sustained over time (Labianca et al., 2000; Poole et al., 1989) so that constituents do not revert to previous schemas. We acknowledge that one way to ensure consistency is to purposely design organizational arrangements – structure, reward systems, measurement techniques, etc. – to convey specific schemas. “By changing material organizational conditions and practices”, organizational arrangements bring schemas to reality (Ferraro et al., 2005: 9). We therefore argue that the sustained experience of the schemas ingrained in organizational arrangements is necessary to enable second-order change.

Using French and Raven’s (1959) notion of power bases -reward, coercion, reference, expertise, and legitimacy- we offer that different power bases grant schema sponsors access to different actions with distinct effects on firm-level schemas. Remarkably, French and Raven’s (1959) typology of power bases distinguishes between perceived and realized power (Kim, Pinkley, & Fragale, 2005): while power bases rest on others’ perception of the ability to reward, coerce, etc. (i.e. perceived power), power is defined as influence on others’ behavior and cognitions (i.e. realized power). This cause-effect conceptualization is conducive to the theorization of schema change in that it explicitly addresses the effects of power on cognitive change and specifies the influence-mechanisms underlying different power bases. We propose, then, that different power bases allow for actions that distinctly affect the degree and sustainment of discrepancy that firm constituents experience. In response, firm constituents use available

strategies to avoid discrepancy, preferably bookkeeping or subtyping, else replacement or relocation, and their schemas evolve accordingly in a first- or second-order pattern. We now take a closer look at power bases to assess whether they might allow schema sponsors (1) to modify firm constituents' perceived degree of discrepancy and (2) to sustain firm constituents' experience of discrepancy so as to generate second-order schema change toward sustainability. We propose that all power bases can be used to alter perceived discrepancy, while only legitimate power can alter organizational arrangements and sustain firm constituents' experience of discrepancy. Table 2 summarizes our propositions.

Reward Power

Definition. French and Raven (1959) define reward power as based on the perceived ability to reward prescribed ideas and behaviors. In organizational settings, typical groups with reward power are management, executives, shareholders (e.g. through the board of directors and market value), the media (e.g. through positive coverage), civil society (e.g. through endorsements, awards), and regulators (e.g. through alleviated compliance requirements). For example, it is not unusual for firms to implement compensation mechanisms based on environmental performance (e.g. Russo & Harrison, 2005).

Degree of discrepancy. Reward power associates positive valence (attractiveness) to prescribed ideas and behaviors (French & Raven, 1959) and can thereby affect the perceived degree of discrepancy. Reward magnitude exceeding firm constituents' expectations signals that the prescribed behavior is more valuable (less discrepant from firm values) than perceived, while rewards below expectations suggest that this behavior is less valuable than perceived. The difference between expected and actual reward magnitude relates to change in perceived discrepancy. Thus, influential schema sponsors with reward power can affect firm constituents' perceived degree of discrepancy. In theoretical terms, they can induce switches among schema change patterns between bookkeeping and subtyping, and between replacement and relocation, along the y-axis of Figure 1. We have proposed that more integrative sustainability schemas have higher discrepancy and a higher likelihood of first-order schema change following subtyping in most firms. Accordingly, no or low rewards are expected for integrative sustainability ideas and actions, but offering rewards for these ideas and actions can reduce their degree of discrepancy.

Proposition 5a: By offering rewards for integrative sustainability ideas and actions, schema sponsors with reward power can reduce the perceived degree of

discrepancy of integrative sustainability schemas so that they trigger collective schema change following the bookkeeping model instead of the subtyping model.

Sustainment of discrepancy. Reward power leads to “dependent” change (French & Raven, 1959: 152) because the probability of reward for conformity depends on the influential group that mediates the rewards and on the observability of the prescribed behavior. In turn, whether the prescribed behavior can be observed depends on a number of factors (e.g. number of employees, employees’ geographic dispersion) so that it can be difficult for schema sponsors to monitor prescribed behaviors. Schema sponsors with reward power only cannot change organizational arrangements to systematically monitor prescribed behaviors and dispense rewards, and the probability of reward for conformity therefore varies. Consequently, the ability of schema sponsors with reward power only to consistently sustain firm constituents’ experience of discrepancy is limited. Indeed, research suggests that clear rewards are a necessary but insufficient element of systems fostering the achievement of sustainability-oriented goals (Wijen, 2014).

Proposition 5b: Integrative schema sponsors with reward power only are unlikely to sustain firm constituents’ experience of discrepancy with integrative schemas so as to trigger collective schema change following a second-order change model.

Coercive Power

Definition. French and Raven (1959) define coercive power as based on the perceived ability to punish undesired ideas and behaviors. In organizational settings, typical groups with coercion power are management, executives, shareholders (e.g. through the board of directors and market value), the media (e.g. through negative coverage), civil society (e.g. through negative public campaigns, or legal action), and regulators (e.g. through non-compliance fines). For example, research indicates that external pressure on firms for environmentally-friendly behavior has drastically increased in the last three decades and has intensified financial market punishment for eco-harmful behavior (Flammer, 2013).

Degree of discrepancy. Coercive power associates negative valence to prescribed ideas and behaviors so that certain “regions” of behavior become laden with negative valence (French & Raven, 1959: 152). Coercive power can thereby affect the perceived degree of discrepancy. Punishment magnitude exceeding expectations signals that the prescribed behavior is more undesirable than perceived (more discrepant from firm values), while punishment below expectations suggests that this behavior is less undesirable than perceived. The difference between

expected and actual punishment magnitude relates to change in perceived discrepancy. Thus, influential schema sponsors with coercive power can affect firm constituents' perceived degree of discrepancy. In theory, they can induce switches among schema change patterns between bookkeeping and subtyping, and between replacement and relocation, along the y-axis of Figure 1. We have proposed that more instrumental sustainability schemas have lesser discrepancy and a higher likelihood of first-order schema change following bookkeeping in most firms. Accordingly, no punishment is expected for instrumental sustainability ideas and actions, but threatening punishment can increase the perceived degree of discrepancy associated with them.

Proposition 6a: By threatening/administering punishment for instrumental sustainability ideas and actions, schema sponsors with coercive power can increase the degree of discrepancy of instrumental sustainability schemas so that they trigger collective schema change following the subtyping model instead of the bookkeeping model.

Sustainment of discrepancy. Like reward power, coercive power leads to “dependent” change (French & Raven, 1959: 152) because the probability of punishment for non-conformity depends on the influential group that mediates the punishment and on the observability of the undesired behavior. Whether the undesired behavior can be observed depends on a number of factors (see reward power) so that it can be difficult for schema sponsors to monitor undesired behaviors. Schema sponsors with coercive power only cannot change organizational arrangements to systematically monitor undesired behaviors and dispense punishments, and the probability of punishment for non-conformity is therefore uncertain. As a result, the ability of schema sponsors with coercive power only to consistently sustain firm constituents' experience of discrepancy is limited. This is in line with research suggesting that strict rule enforcement is insufficient to foster the achievement of sustainability-oriented goals (Wijen, 2014).

Proposition 6b: Integrative schema sponsors with coercive power only are unlikely to generate and sustain firm constituents' experience of discrepancy with instrumental schemas so as to trigger collective schema change following a second-order change model.

Referent Power

Definition. French and Raven (1959) define referent power as based on identification with a person or group, a feeling of oneness, or a desire for a similar identity. In organizational settings,

groups with referent power may be management (e.g. charismatic leaders), thought leaders (e.g. gurus, bloggers, writers, journalists, public figures, etc.), trade associations (e.g. as they set common rules for an industry), and civil society (e.g. civil organizations with popular ideas). For example, Paul Hawken's (1993) ideas on sustainability inspired Ray Anderson's strategic re-orientation of Interface Inc. towards corporate environmentalism (Anderson, 2009).

Degree of discrepancy. Referent power brings firm constituents discomfort for non-conformity or satisfaction for conformity based on identification, in particular with actions and ideas (French & Raven, 1959: 155). Referent power can thereby affect the perceived degree of discrepancy. The referent's actions and ideas conform to firm constituents' expectations indicate congruence, while non-conformity with expectations signals discrepancy. The difference between expected and displayed actions and ideas relates to change in perceived discrepancy. Thus, influential schema sponsors with referent power can affect firm constituents' perceived degree of discrepancy. From a schema perspective, they may induce switches among schema change patterns between bookkeeping and subtyping, and between replacement and relocation, along the y-axis of Figure 1. We have proposed that more integrative sustainability schemas have higher discrepancy and a higher likelihood of first-order schema change following subtyping in most firms. Accordingly, firm constituents expect referents to exhibit little integrative sustainability actions and ideas, but referents displaying such actions and ideas can reduce their degree of discrepancy in the eyes of firm constituents.

Proposition 7a: By exhibiting integrative sustainability ideas and actions, schema sponsors with referent power can decrease the degree of discrepancy of integrative sustainability schemas so that they trigger collective schema change following the bookkeeping model instead of the subtyping model.

Sustainment of discrepancy. Referent power may lead to "dependent" or "independent" change and the degree of dependence does not depend on the observability of desired actions and ideas. In fact, people are often unaware that they are subject to referent power (French & Raven, 1959: 155). Reciprocally, referents may be unaware that they have referent power over particular individuals or groups. Although schema sponsors with referent power may act as role models, they do not know which firm constituents regard them as referents. Further, extant research acknowledges the transitory nature of referent power. In the case of business gurus, for example, observers have noted: "Guru today, gone tomorrow" (Nicholson & Anderson, 2005: 167). Schema

sponsors with referent power only cannot change organizational arrangements to systematically expose firm constituents to their actions and ideas. Consequently, the ability of schema sponsors with referent power only to consistently sustain firm constituents' experience of discrepancy is limited.

Proposition 7b: Integrative schema sponsors with referent power only are unlikely to sustain firm constituents' experience of discrepancy with integrative schemas so as to trigger collective schema change following a second-order change model.

Expert Power

Definition. French and Raven (1959) define expert power as based on perceived knowledge in a given area. They distinguish expert power, which depends on the expert's credibility and relationship with firm constituents, from informational influence. The latter is an impersonal form of power which varies with informational content, and more precisely, the fit of conveyed information with firm constituents' cognitive structure (i.e. their schemas). In organizational settings, typical groups with expert power are management and colleagues (e.g. seasoned co-workers), academics (e.g. through teaching, research and outreach activities), the media (e.g. through coverage of new or advanced topics), and subject matter specialists (e.g. consultants, lawyers, professional trainers). For example, when Ray Anderson decided to strategically re-orient his firm towards corporate environmentalism, he assembled a team of sustainability specialists, the "Eco Dream Team", who helped craft Interface's new environmental strategy and provided advice on environmental topics (Lampikoski, 2012: 6).

Degree of discrepancy. Expert power primarily results in social influence on firm constituents' cognitive structure, that is, acceptance of the validity of the information conveyed by the expert (French & Raven, 1959). Expert power can thereby affect the perceived degree of discrepancy. Expert advice aligned with expectations signals low discrepancy with firm constituents' existing cognitive structure. More or less discrepant expert advice challenges firm constituents' cognitive structure and signals a corresponding degree of discrepancy. The (mis)alignment of expert advice and existing cognitive structure relates to change in perceived discrepancy. Thus, influential schema sponsors with expert power can affect firm constituents' perceived degree of discrepancy. In theoretical terms, they can induce switches among schema change patterns between bookkeeping and subtyping, and between replacement and relocation, along the y-axis of Figure 1. We have proposed that more integrative sustainability schemas have

higher discrepancy and a higher likelihood of first-order schema change following subtyping in most firms. Accordingly, expert advice is expected to align with instrumental sustainability ideas and actions, but expert advice supporting integrative ideas and actions can decrease their degree of discrepancy.

Proposition 8a: By advising in favor of integrative sustainability ideas and actions, schema sponsors with expert power can decrease the degree of discrepancy of integrative sustainability schemas so that they trigger collective schema change following the bookkeeping model instead of the subtyping model.

Sustainment of discrepancy. Expert power leads to “dependent” change in that the new cognitive structure depends on the relationship with the expert, although it may become more independent with time. The dependence of change following expert advice varies. Expert advice combined with informational influence produces “more independent” structures (French & Raven, 1959: 156) so that advice aligned with existing cognitive structures is more likely to generate independent change. Further, it has been shown that recipients’ beliefs may vary over time depending on the amicable nature of the relationship with the expert (French & Raven, 1959). Schema sponsors with expert power only cannot change organizational arrangements to systematically expose firm constituents to their expertise. Therefore, the ability of schema sponsors with expert power only to consistently sustain firm constituents’ experience of discrepancy is limited.

Proposition 8b: Integrative schema sponsors with expert power only are unlikely to sustain firm constituents’ experience of discrepancy with integrative schemas so as to trigger collective schema change following a second-order change model.

Legitimate Power

Definition. French and Raven (1959) define legitimate power as based on internalized values which guide people’s evaluation of certain behaviors, attitudes, beliefs as more or less legitimate. Legitimate power can be based on cultural values, acceptance of social structure, and/or designation by a legitimizing agent. Cultural values and acceptance of social structure give people with certain characteristics or hierarchical authority the right to prescribe behavior for others. For example, “a foreman should assign work [and] it is the management’s prerogative to make certain decisions.” (French & Raven, 1959: 154). Designation by a legitimizing agent means that one or more persons receive the legitimacy to perform certain tasks from a legitimate source. In

organizational settings, typical groups with legitimate power are management and shareholders (e.g. majority equity holders) each in their own area of authority.

Degree of discrepancy. Legitimate power comes from a value-induced feeling of moral obligation to follow the leader's prescriptions and can therefore affect firm constituents' perception of discrepancy. Leaders' support for ideas and actions aligned with expectations signals no discrepancy. Dissuasion, mild or marked, from the same ideas and actions indicates a corresponding degree of discrepancy. The (mis)alignment of legitimate support and dissuasion with existing cognitive structures relates to change in perceived discrepancy. Influential schema sponsors with legitimate power can thus affect firm constituents' perceived degree of discrepancy. From a schema perspective, they can induce switches among schema change patterns between bookkeeping and subtyping, and between replacement and relocation, along the y-axis of Figure 1. We have proposed that more integrative sustainability schemas have higher discrepancy and a higher likelihood of first-order schema change following subtyping in most firms. Accordingly, legitimate prescriptions are expected to align with an instrumental view, but legitimate prescriptions supporting integrative ideas and actions can decrease their degree of discrepancy.

Proposition 9a: By prescribing integrative sustainability ideas and actions, schema sponsors with legitimate power can decrease the degree of discrepancy of integrative sustainability schemas so that they trigger collective schema change following the bookkeeping model instead of the subtyping model.

Sustainment of discrepancy. Legitimate power leads to "highly dependent" change in that the application of the prescription depends on the relationship with the leader and firm constituents' perception of her legitimacy (French & Raven, 1959: 154). Change induced by legitimate power can become less dependent to the extent that the leader's influence "serves to activate the values and to relate them to the system which is influenced, but thereafter the new state of the system may become directly dependent on the values" (French & Raven, 1959: 154). Firm values are heterogeneous however and the leader's prescriptions are bound to go against the values of some firm constituents, triggering resistance. The ability of schema sponsors to consistently sustain firm constituents' experience of discrepancy through legitimate power thus seems limited. The difference with other bases of power, though, is that schema sponsors with legitimate power can change organizational arrangements to systematically expose firm constituents to prescribed actions and ideas. Depending on their area of influence, schema sponsors

with legitimate power – such as managers – can change company strategy, resource allocation, structure, policies, procedures, and actions in a way that aligns with the schemas they sponsor (Ferraro et al., 2005). As firm constituents interact with these changes, they repeatedly experience discrepancy (or congruence), and provided these changes are consistent (Labianca et al., 2000), their schemas evolve (or are confirmed) over time.

Proposition 9b: Integrative schema sponsors with legitimate power only can sustain firm constituents' experience of discrepancy with integrative schemas so as to trigger collective schema change following a second-order change model.

Table 2

Schema Sponsors' Power Base, Discrepancy and the Range of Schema Change

Power base	Can impact the degree of discrepancy	Can impact the duration of discrepancy	Change Range
Reward	Yes	No	First-order only
Coercion	Yes	No	First-order only
Reference	Yes	No	First-order only
Expertise	Yes	No	First-order only
Legitimacy	Yes	Yes	First- and second-order

DISCUSSION

The purpose of this article is to deepen our understanding of strategic schema interaction in firms so as to characterize the mutual influence of instrumental and integrative schemas and explain why firms obtain faint results when it comes to solving natural environmental issues. We have proposed that the predominance of instrumental schemas combined with power-induced mechanisms of schema perpetuation explains firms' weak results with regards to natural environmental issues. Specifically, we have argued that instrumental and integrative schemas co-exist in firms but mostly interact in patterns that foster the dominance of extant instrumental schemas. The enactment of instrumental schemas engenders organizational structure and action unfit to support change toward corporate sustainability. This is unless powerful sponsors actively promote integrative schemas and enable second-order schema change patterns, leading to organizational change over time.

Why firms obtain faint environmental results. The primary contribution of this paper is to the organizational sustainability literature. The predominance of instrumentality in firm-level schemas since the 1950's has shaped the structure and actions of Western firms in ways that made them fit for profit maximization, but less so for effective solutions to contemporary ecological issues. Schemas tend to self-protect and self-perpetuate by absorbing or isolating other schemas and experience. With time, instrumental schemas have brought about arrangements –language, norms, measurement and reward systems- that have further entrenched the economic conception in society and business organizations (Ferraro et al., 2005). We argue that unless powerful groups in- and out-side firms promote integrative schemas consistently over an extended period, the cognitive, structural and behavioral changes needed for corporate sustainability are unlikely to happen.

Progress toward corporate sustainability occurs in a context of social interdependencies in which actors -individuals, groups, and organizations alike- are unlikely to realize green plans as intended, but rather, as the hardly foreseeable product of multiple diverging influences (Newton, 2002). If greening projects are more likely to be successful when “there is strong agreement between the key actors involved” (Newton, 2002: 532), long-term schema change toward sustainability in firms requires evolution not only in organizational structure and arrangements, but also in societal systems that perpetuate the instrumental perspective, such as business education (Ferraro et al., 2005) and business law (Newton, 2002: 530).

Schema evolution framework. This paper contributes to research on organizational schemas by proposing a framework for schema evolution. First, our framework suggests that specific combinations of two factors –schema discrepancy and support by powerful schema sponsors- selectively trigger schema evolution patterns, as depicted in figure 1. Inquiry into these two factors suggests that the degree of discrepancy shapes the primary reaction of firm constituents, either assimilation or rejection, while power bases delimit schema sponsors' ability to generate first-order or second-order schema change.

Second, although extant research considers schema interaction models as discrete, this conceptualization draws systematic relationships among them, answering the puzzling question of high schema discrepancy leading both to the subtyping model (first-order change), and to the relocation model (second-order change). As noted, the degree of discrepancy switches the schema interaction pattern from assimilation (bookkeeping/replacement) to rejection

(subtyping/relocation). Then the sustainment of discrepancy, depending on schema sponsors' interventions, moves the schema interaction pattern from first- to second-order. In this light, the replacement model constitutes the second-order extension of the bookkeeping model, and the relocation model forms the second-order extension of the subtyping model.

Third, we argue that discrepancy avoidance is the overarching mechanism that guides and explains schema interactions. Firm constituents prefer to interpret new information through existing schemas (bookkeeping) because consonant experience does not challenge their cognitive structure. When new information is highly discrepant, firm constituents tend to reject it (subtyping) to avoid exposure to discrepancy and the revision of existing schemas. Only when these two coping strategies fail do firm constituents have no other way to avoid discrepancy than to modify their own schemas. Depending on circumstances, this happens gradually (replacement) or over a short time span (relocation). This explanation of schema interaction reasserts the centrality of discrepancy avoidance in interpretation processes (Weick, 1995), in contrast with recent theorizations (e.g. Basu & Palazzo, 2008; Hahn et al., 2014).

Finally, this paper also discusses how schema sponsors with different power bases affect the degree and sustainment of discrepancy. All power bases have the potential to impact the degree of discrepancy of targeted ideas and actions. However, only legitimate power allows for the alignment of sponsored schemas with organizational arrangements such as firm structure, control systems, and routines. Therefore, only schema sponsors with legitimate power –typically but not only management– can sustain firm constituents' experience of discrepancy so as to generate second-order schema change.

Implications for Research and Practice

Implications for Research on Sustainability. This paper offers several implications for scholars who feel that management researchers have “societal leadership responsibilities” whereby we are not only to anticipate but also to shape the future (Corley & Gioia, 2011: 28). First, researchers are in a unique position to recognize schemas and their alternatives. By training, we are exposed to a number of theoretical lenses and thus tend to have heightened awareness of alternative perspectives (Allison, 1971). Our practice also encourages us to reflect on extant theories, question them, refine them or develop new ones (Corley & Gioia, 2011) that might inspire businesses on the path to sustainability. Second, sustainability scholars have intensively studied the “business case for sustainability”, which underlines how green initiatives can enhance

economic performance (Bondy, Moon, & Matten, 2012) and the “social license to operate”, which depicts firms implementing sustainable initiatives to obtain social legitimacy (Aguilera et al., 2007). As noted, these interpretations center on profit, draw from and reinforce instrumental conceptions, whereas global ecological indicators indicate a need for alternative perspectives. Ecological economics, for example, proposes that the interdependence of environmental and economic concerns exists at the level of human survival and well-being (Jackson, 2010; Stiglitz, Sen, & Fitoussi, 2010). Few management papers follow such approaches (for exceptions, see Whiteman & Cooper, 2011; Whiteman et al., 2013), despite their potential for promoting long-term economic, social *and* environmental sustainability.

Implications for Research on Schemas. The management literature on strategic schemas is characterized by a relative scarcity of studies on schema change in organizations. As this paper argues that schema discrepancy and the relative power of schema sponsors are key determinants of schema change patterns, several related questions need to be empirically explored: do higher degrees of discrepancy consistently prompt greater subtyping isolation (e.g. Beelitz & Merkl-Davies, 2012)? Extreme experiential discrepancy has been shown to temporarily disable interpretation (e.g. Weick, 1993) but what happens when extreme discrepancy is sustained? What is the threshold beyond which the sustainment of discrepancy triggers second-order change? Does the frequency of discrepant experience also affect schema interaction and how? Precision is also needed regarding the extent to which power predicts the speed or extent of cognitive assimilation by firm constituents. These questions are open to a wide range of approaches and methodologies that identify and track schema content and evolution over time.

Implications for Management. Firms routinely develop green agendas and implement green initiatives (Banerjee, 2001; Bondy et al., 2012). This paper suggests that businesses can engage in two types of actions to achieve corporate sustainability. *Within* firms, managers are influential schema sponsors and can affect interpretations over time by adopting and promoting integrative schemas so that organizational structure and actions evolve accordingly. Ferraro et al. (2005) highlight the use of language, norms, and design to this end. As for *language*, “An important implication of sensemaking is that, to change a group, one must change what it says and what its words mean. [...] Language transformation can be a pathway to behavioral transformation” (Weick, 1995: 108–109). Firms can use the language of sustainability to change the substance of interpretations and frame issues so as to give ecological, social and economic

concerns equal priority. *Norms* circumscribe the range of socially-acceptable behaviors in the firm and significantly shape organizational actions (Howard-Grenville, 2007b). Management can create norms aligned with integrative schemas to reinforce these schemas and mold actions accordingly. In particular, firms can socially construct norms by ensuring long-term consistency between integrative schemas, organizational discourse (e.g. policies, rules, reports), and actions (e.g. practices, routines). Finally, so far as organizational *design* and managerial practices constitute the enactment of schemas, they create the conditions that make schemas come ‘true’ over time. For instance, “What organizations do in terms of reward practices comes to determine what people want and expect from their jobs, [...] creating a cycle of behavior” (Ferraro et al., 2005: 20). Firms can thus implement environmentally-aligned arrangements such as selection policies, reward and measurement systems to encourage sustainable behavior. As the perceived consonance of organizational actions with extant and new schemas seems decisive in the prevalence of one schema over another (Labianca et al., 2000), firms willing to migrate to integrative schemas need to take actions consistently.

Outside their boundaries, firms can contribute to the realization of their green agenda on a broader scale by promoting integrative schemas with suppliers, industry associations, educational institutions, governments, and civil society. In the manner of institutional entrepreneurs (Hardy & Maguire, 2008), firms can endeavor to shape societal institutions by creating institutional arrangements needed to disseminate integrative schemas among a variety of stakeholders, a key to the success of green initiatives.

CONCLUSION

We have argued that strategic schemas are key to corporate sustainability. More precisely, we have proposed a framework that relates firm-level schemas, organizational arrangements, and corporate sustainability. We have also shed a new light on the operation of schema change and suggested that it is driven by firm constituents’ avoidance of discrepancy, following two factors that shape the degree and sustainment of discrepancy. This framework helps discuss the interaction between integrative and instrumental schemas and why firms obtain limited results in solving environmental issues. Businesses are often caught in societal and organizational arrangements that protect and perpetuate existing instrumental schemas. However, firms can also transform these

arrangements in- and outside their boundaries so as to achieve corporate sustainability and contribute to solving global sustainability issues.

ARTICLE 2

Ecological Interpretation and Corporate Environmental Performance: Do Communicative Firms Pollute Less?

CORPORATE INTERPRETATION AND ENVIRONMENTAL PERFORMANCE

Strategic management research has long recognized that organizational interpretation –“the process of translating data into knowledge and understanding” (Thomas & McDaniel, 1990)- shapes corporate action. Researchers have described how interpretive assessments predict the occurrence and nature of organizational response to contextual changes (Dutton & Duncan, 1987), how the categorization of issues as opportunities or threats may affect organizational involvement in the response to these issues (Dutton & Jackson, 1987), and how managerial interpretation is used to create momentum for strategic change (Gioia & Chittipeddi, 1991). More recently, researchers have shown that managers faced with ambiguous strategic decisions engage in interpretation to reconcile competing views or impose one so as to prompt desired patterns of organizational action (Kaplan, 2008; Kaplan & Orlikowski, 2013). Further, firms enacting interpretations shape aspects of the strategic environment, including industry velocity (Nadkarni & Narayanan, 2007b), the resource environment (Baker & Nelson, 2005), strategically-relevant knowledge (Nag & Gioia, 2012), and the development of strategic capabilities (Eggers & Kaplan, 2013). Yet, despite these works’ inherent links to strategic outcomes, few studies have looked at the relationship between organizational interpretations and firm performance (for an exception, see Thomas, Clark, & Gioia, 1993).

Similarly, researchers have studied organizational interpretations as predictors of corporate environmental actions (Etzion, 2007; Howard-Grenville, 2007a; Muller & Kolk, 2010). Basu and Palazzo (2008) have proposed that firms’ interpretation process consists of interactions between thinking, language, and actions that shape their understanding of, and response to, natural environmental issues. Hahn, Preuss, Pinkse, & Figge, (2014) theorize that cognitive frames, also known as schemas (Bartunek, 1984; Nadkarni & Narayanan, 2007b), influence how broadly and deeply firms interpret and respond to environmental issues. However, although research has investigated various internal and external predictors of environmental outcomes (Aguinis & Glavas, 2012), very few studies have looked at organizational interpretations as predictors of corporate environmental performance (CEP).

In addition, much research investigating corporate environmental performance confounds CEP and corporate environmentalism; it treats as identical the corporate impact on the natural environment (Walls et al., 2012) and the degree to which firms integrate environmental practices in their operations (Van Marrewijk & Werre, 2003). At a time when the global business community, government officials, academics, and international/civil society organizations consistently place environmental issues among the top five global business risks (World Economic Forum, 2014, 2015), while scientific research offers a darkening portrait of the global ecosystem (Field, Barros, Mach, & Mastrandrea, 2014), there is a need for research on antecedents of CEP that distinguishes CEP from corporate environmentalism, and addresses both.

We intend to start filling these gaps by answering the following research question: Does ecological interpretation expressed in disclosed corporate schemas predict CEP? In this study, we assumed that ecological interpretation, defined as the translation of data into knowledge and understanding about the natural environment, takes place in three consecutive stages: scanning, understanding, and responding (Daft & Weick, 1984; Hahn et al., 2014; Thomas et al., 1993). We used computer-aided text analysis (Short et al., 2010) to capture elements of ecological interpretation in the disclosed corporate schemas (sustainability reports) of 108 companies from 2005 to 2008. We tested whether relationships exist between our selected elements of interpretation –scanning, positive/negative labelling of ecological issues, understanding, responding- and corporate environmental impact.

The purpose of this article is to investigate the relationship between ecological interpretation and CEP. More broadly, by applying a schema perspective to the study of corporate environmental performance, we attempt to examine the links between cognitions, actions, and performance within the context of corporate sustainability. We also shed light on the working assumption that there is significant overlap between corporate schemas, i.e. firm-level cognitive maps, and disclosed schemas, the carefully crafted maps that companies communicate in publicly-available reports.

In the next section, we draw on Daft and Weick's (1984) model of organizations as interpretation systems to describe ecological interpretation, the three-stage process through which firms scan for, understand, and respond to ecological issues. We then describe our methods and findings. In the discussion section, we explain why our results contradict a rational model of organizational interpretation, and why corporate environmental response might paradoxically

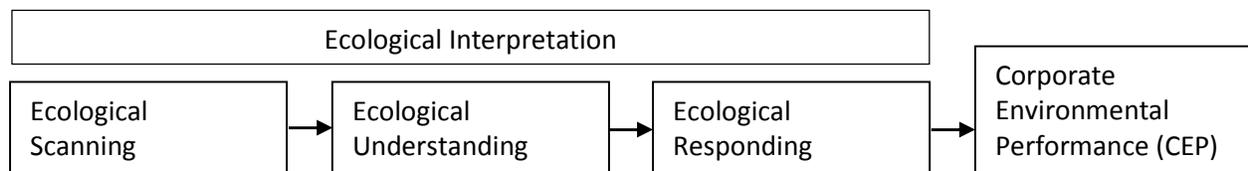
worsen environmental performance. We describe the theoretical contributions and methodological limitations of our study and conclude with implications for research and practice.

ECOLOGICAL INTERPRETATION: SCANNING, UNDERSTANDING, RESPONDING

Among the models that explain how organizations give meaning to experience and enact these meanings, Daft and Weick (1984), emulated by others (Milliken, 1990; Thomas et al., 1993), proposed a representation of organizational interpretation whereby it is shaped mainly by top managers and composed of three stages: scanning, understanding, and responding. Recently, similar models have been proposed to describe managerial and organizational response to social and natural environmental issues (Basu & Palazzo, 2008), and Hahn et al. (2014) have explicitly used Daft and Weick’s (1984) model to theorize how managers with different schemas address sustainability issues. These works provide useful insights on the interpretation process and the nature of organizational response, but they do not deal with their outcomes. Building on Thomas et al.’s (1993) reasoning, we offer an empirical application of Daft & Weick’s (1984) model to the interpretation of sustainability issues, which we call ecological interpretation. Our operational model therefore includes three stages of ecological interpretation as well as a link to CEP as shown in Graph 1.

Graph 1

Operational Model of Ecological Interpretation and Environmental Performance



Ecological Scanning

Daft and Weick (1984) define scanning as monitoring the environment and gathering data for managers. Accordingly, we propose that ecological scanning consists of monitoring the internal and external corporate environment, and gathering data that pertain to the natural environment. Managers are subject to a wide range of cognitive and resource limitations. For example, individual mental and physical capacities, values, conceptions, and knowledge limit the rationality of organizational decision-making (Simon, 1945). Managers thus need to be selective because they generally access more information than they can process (Bansal, 2003; Daft & Weick, 1984;

Thomas et al., 1993). As a result, they do not systematically include ecological scanning in their scanning activities.

How managers select areas for scanning depends on the relevance they assign to various topics on the basis of their schemas (Hahn et al., 2014; Hambrick, 1982; Pfeffer & Salancik, 1978). Managers tend to pursue information that is congruent with organizational schemas while they are prone to ignore information that contradicts them (Bartunek, 1984; Das & Teng, 1999; Hahn et al., 2014; Schutz, 1962). Whether a firm deliberately scans its internal and external environments for thematic information therefore indicates the type of issues which managers view as strategically relevant (Dutton & Duncan, 1987).

Managers with schemas centered on the economic side of business attend less to environmental and social issues, unless the latter are advanced by stakeholders that directly bear on business (Hahn et al., 2014). As a result, firms tend not to recognize numerous sustainability issues that arise in their organizational setting, and to focus on few sustainability topics which relate to financial outcomes. As a result, certain sustainability issues which require scanning non-conventional sources, such as biodiversity, may go unnoticed (Hahn et al., 2014). In contrast, managers with schemas emphasizing environmental issues tend to pay attention to a wide range of environmental issues (Hahn et al., 2014). They are likely to use a variety of tools and techniques that monitor information of an ecological nature and gather data on their own environmental impact. In turn, the amount of information that managers gather on an issue influences their interpretation of this issue. Managers who use much information are better able to deal with ambiguity and uncertainty (Milliken, 1990; Thomas et al., 1993). Further, they are likely to emphasize the positive aspects of an issue; managers with high-capacity information systems tend to label strategic issues positively (Thomas & McDaniel, 1990). Accordingly, we expect managers who know and use more environmental data gathering tools to interpret ecological issues positively.

Hypothesis 1a: Ecological scanning is positively related to firm-level interpretation of environmental issues in positive terms.

Extant research considers scanning as a predictor of interpretation (Daft & Weick, 1984; Hambrick, 1982). For instance, many firms actively monitor their markets to better understand their environment, and design fitting strategies (Nadkarni & Narayanan, 2007a). Managers with different schemas value and collect different types of information, and are thus likely to differ in

their interpretations and actions (Dutton & Duncan, 1987; Thomas et al., 1993). Managers with schemas that underline the natural environment heed a number of environmental issues and, for any given sustainability issue, notice various aspects of it (Hahn et al., 2014). As they gather information and become more knowledgeable, their schemas become larger and more complex, containing more components, and more relationships among components (Dane, 2010). Managers who collect large amounts of ecological information are therefore more capable of attributing meaning to, and establishing connections among, a wide array of environmental issues. In other terms, they are more likely to gain a deeper understanding of environmental issues.

Hypothesis 1b: Ecological scanning is positively related to firm-level ecological understanding.

Ecological Understanding

Daft and Weick (1984) define understanding as developing shared comprehension of events and building joint schema content. Accordingly, we propose that ecological understanding means attributing shared meaning to experience, events, and data that pertain to the natural environment, and developing firm-level schemas. Meaning is attributed by applying existing structures for understanding, schemas, or developing new ones (Thomas et al., 1993). Schemas thus guide understanding, as well as issue handling and response (Bartunek, 1984, 1993) and research has shown that understanding is a predictor and determinant of strategic action (Bartunek, 1984; Dutton, Fahey, & Narayanan, 1983; Gioia & Chittipeddi, 1991; Kaplan, 2008; Thomas et al., 1993).

Daft and Weick (1984) envisioned interpretation mainly at the strategic level of management. In particular, whereas scanning can be performed by various organizational members, a small group of top managers has primary influence on understanding and responding for the firm as whole (Bartunek, 1984; Hambrick & Mason, 1984, Thomas et al., 1993). Meaning attribution to strategic issues often stems from managers' categorizations which themselves originate in their schemas. Categorization sorts objects, events, etc. into cognitive groups with similar perceived attributes (Dutton & Jackson, 1987; Thomas et al., 1993). Two commonly used categories are opportunities and threats (Anderson & Nichols, 2007; Barr & Glynn, 2004; Dutton & Duncan, 1987), respectively associated with positive and negative valence (Jackson & Dutton, 1988; Thomas et al., 1993). Indeed, one of the simplest and most used distinctions in strategic interpretation is between positive and negative understanding of an issue (Hahn et al., 2014).

Understandings guide actions in specific directions: issue participants are more likely to increase their engagement in problem-solving when they understand an issue positively, as an opportunity, rather than negatively, as a threat (Dutton et al., 1983). Positive understandings also lead to more open search for issue resolution than negative ones (Sharma, 2000). As regards sustainability issues, Sharma found that the likelihood of proactive strategic environmental action, “ranging from pollution prevention to habitat preservation, voluntary restoration, reduction in the use of unsustainable materials and fossil fuels, [...] increased use of environmentally friendly technologies [...] creative problem solving, [...] adoption of innovative technologies [...] and collaborative interactions with stakeholders” (Sharma, 2000: 683), increases with positive managerial understanding of environmental issues.

Hypothesis 2a: Firm-level interpretation of environmental issues in positive terms is positively related to ecological responding.

Understanding involves attributing explicit meaning to experience; it serves as a prompter for action (Weick, Sutcliffe, & Obstfeld, 2005). From a schema perspective, understanding manifests in increased, more complex schema content, that is, a greater number of concepts and relationships among them (Dane, 2010). In particular, understandings of an issue “relate various events or concepts together in a causal manner” so that issue participants can devise a chain of actions thought to resolve the issue (Dutton et al., 1983: 315). Consequently, managers with low understanding of an issue may have little or no idea of the causal mechanisms that lead to issue resolution. On the other hand, people with deeper understanding of an issue, such as subject matter experts, tend to solve problems in a more forward-oriented and effective manner (Dane, 2010). Further, deep understanding of strategic situations allows managers to escape “the bounding qualities of information, beliefs, and values which restrict [...] potential actions” and to elaborate alternative courses of actions (Dutton et al., 1983: 309). Managers’ understanding of an issue therefore relates to the spectrum of possible actions they can consider and take regarding that particular issue. Sustainability issues are no exception: once managers have given meaning to sustainability issues following their schemas, they will respond on that basis (Hahn et al., 2014). We thus expect that firms whose managers have a deeper understanding of ecological issues use a greater number and variety of environmental actions.

Hypothesis 2b: Ecological understanding is positively related to firm-level ecological responding.

Ecological Responding

Understanding leads to action: as new understandings of causal relationships emerge, they translate into action. In this sense, action is the enactment of extant and new understandings (Daft & Weick, 1984), which we call responding (Hahn et al., 2014). Consequently, we define ecological responding as firm-level action in response to natural environmental issues.

“The link between effective action and successful performance is a fundamental presumption in the strategic management literature.” (Thomas et al., 1993: 245) and empirical research supports the notion that the number of responses is related to firm performance. For example, Smith, Grimm, Gannon, and Chen (1991) observed that high counts of responses by domestic airlines were related to profitability. More recently, Patel, Kohtamäki, Parida, and Wincent (2015) found that firms which have higher variability in their innovation portfolios achieve better performance, especially when they develop deeper understanding of issues at hand.

Extant research also suggests variance in the ecological impact of different environmental practices and strategies (Klassen & Whybark, 1999; Rodrigue, Magnan, & Cho, 2013; Walls et al., 2012) and we therefore expect to find links between ecological responding and corporate environmental performance (CEP). More precisely, we argue that the magnitude of corporate response relates to CEP; this can be attributed to several factors such as the amount of resources allocated to corporate environmental response (Elsayed, 2006), the degree of integration of environmental actions in strategic planning (Judge & Douglas, 1998), and the long-term coherence of environmental innovation portfolios (Klassen & Whybark, 1999), among others. As noted, corporate environmental performance should not be confounded with ecological responding. CEP is “the outcome of a firm’s strategic activities that manage (or not) its impact on the natural environment” (Walls et al., 2012: 891). CEP is therefore concerned with tangible and material impacts on the natural environment (Delmas et al., 2013). In other words, high CEP signifies low environmental impact.

Hypothesis 3: Ecological responding is negatively related to environmental impact.

METHODS AND ANALYSIS

Sample

To test these hypotheses, we randomly selected companies listed in the Trucost database, a leading data provider which tracks the environmental impacts of over 4200 publicly traded

companies from various industries and countries, including all Standard and Poor 500 firms. Our initial sample included 68 companies in 2003, 106 in 2004, 128 in 2005, 148 in 2006, 171 in 2007, and 182 in 2008. Since Trucost holds environmental performance data on thousands of firms, sample size limitation primarily came from our ability to obtain and analyze the sustainability reports needed to measure our independent variables. We gathered sustainability reports mostly from corporate websites, but also from the Global Reporting Initiative's (GRI) database, and from CorporateRegister.com, an online directory of corporate responsibility reports. Fewer reports were available in the earlier years covered by this study, as fewer companies published sustainability reports then, and fewer cared to make these reports available online for more than a couple of years. This explains why the number of companies in our initial sample increases over time. Because we use time lags, we needed measures of our independent variables in the two years preceding the dependent variable; to predict corporate environmental impact in 2009, we employed a measure of ecological responding in 2008, and of ecological scanning and understanding in 2007. These constraints guided the construction of our final sample, a balanced panel of 108 firms with data on environmental impact from 2006 to 2009. These companies come from a wide range of industries including automobiles and parts, banks, basic resources, chemicals, construction and materials, financial services, food and beverage, healthcare, industrial goods and services, insurance, media, oil and gas, personal and household goods, real estate, retail, technology, telecommunications, travel and leisure, and utilities. Their headquarters are located in 25 European, North American, and Asian countries.

Dependent Variable

Our dependent variable is the log-transformed¹ Total Environmental Damage Cost (TEDC) associated with firm activity, drawn from the Trucost database. Trucost calculates and expresses corporate environmental impact in financial terms (i.e. U.S. dollar value) based on corporate sustainability reports, publicly available environmental data, and proprietary economic modelling using governmental, industry, and national economic accounts data. Trucost's economic

¹ In order to ensure the validity of p-values in our t-tests, we selected every variable transformation in this paper based on a search for the closest fit to a normal distribution. We used a function of our statistical package (Stata) that searches the ladder of powers (Tukey, 1977) running chi-squared tests to determine whether transformations are consistent with a normal distribution. The transformations with the smallest chi-squared value are the closest fit to a normal distribution.

modelling methods are validated by independent academic experts. In addition, Trucost submits its variables to studied companies for verification. Variables encompass both *direct* company impacts such as landfill waste, recycling, and boiler, car fleet, and manufacturing emissions; and *indirect*, supply chain impacts like energy use, water consumption, raw materials, and logistics. By accounting for direct and supply chain impacts, Trucost covers outsourced and de-merged polluting activities, and allows for the comparison of vertically integrated and non-vertically integrated companies. TEDC aggregates the costs of about 700 different types of resource use and emissions in four categories: greenhouse gas (GHG) emissions, water use, acid rain precursor (ARP) emission, and solid waste disposal.

Independent Variables

Data Sources. Following previous research, we use written discourse as a representation of schemas (Barr et al., 1992; Bingham & Kahl, 2013; Tsoukas, 2009). Specifically, we examine disclosed schemas as presented in sustainability reports. One key working assumption in this research is therefore that disclosed schemas reasonably overlap with corporate schemas. As mentioned however, corporate schemas are cognitive maps shared at the firm level, while disclosed schemas are thoughtfully designed messages that firms choose to convey in public documents. Sustainability reports, and public corporate communications more broadly, thus have several limitations as representations of schemas. First, it is likely that firms cannot completely express their schemas, even for themselves, and they may deliberately hide their schemas from external stakeholders. Consequently, disclosed schemas represent the portion of corporate schemas that firms are willing and able to reveal (Narayanan & Fahey, 1990). Second, many firms resort to public relations and communication companies to write sustainability reports so that the terminology used in these reports may not fully be that of the issuing firm, and the description of environmental activities may be unduly favorable. Third, and relatedly, company reports often contain greenwash –overly positive emphasis on corporate environmental achievements- intended for shareholders, the media or the general public (Delmas & Burbano, 2011).

On the other hand, sustainability reports are valuable sources of information on corporate environmental actions. In many countries including the United States, companies are not legally required to publicize environmental initiatives, and environmental disclosure in these reports therefore conveys strategic intention along with information on corporate environmental management (Philippe & Durand, 2011). As well, research suggests that top management

participates in the framing and editing of company reports (Barr et al., 1992; Nadkarni & Narayanan, 2007b; Schwenk, 1989), which implies that sustainability reports convey managerial schemas. Further, noting the central role of environmental units in dealing with corporate environmental issues (Bansal, 2003), we believe that sustainability reports (and most types of social and environmental reports) also convey the schemas of corporate departments responsible for environmental affairs. Finally, while we agree that companies willing to enhance their legitimacy and reputation embellish environmental actions in public reports, we assume that embellishment is limited. While firms may show insincere interest in the natural environment, they can only report on environmental initiatives which they actually conducted, and they are legally liable for the accuracy of environmental information that stakeholders use, among others, for financial risk assessment. We also think that firms engaging in greenwash pay special attention to their public image and are concerned with possible market retaliation if greenwash is revealed, a likely event in times of public and media scrutiny (Bowen & Aragon-Correa, 2014). As a result, firms must keep greenwash credible and therefore limited. Based on this discussion, we assume that disclosed and corporate schemas reasonably overlap, so that disclosed schemas inform us about corporate schemas and courses of action.

Measuring ecological interpretation. Following Hahn et al. (2014) we used Daft and Weick's (1984) three-dimensional conceptualization of organizational interpretation and distinguished three stages of ecological interpretation: ecological scanning, understanding, and responding. To identify manifestations of each stage in sustainability reports, we first associated each stage with a list of words and phrases, which we called a dictionary. We built the three dictionaries following a procedure for computer-aided text analysis (CATA) recommended by Short, Broberg, Cogliser, and Brigham (2010). We first created lists deductively from existing glossaries in academic books, regulatory agencies, business associations, non-governmental organizations, and international organizations. We then inductively generated words by scanning 30 randomly selected reports in our sample with the CATScanner software (McKenny, Short, & Newman, 2012), manually retaining relevant terms and sorting them into the appropriate dictionary. We combined the deductive and inductive lists and trimmed all repeated terms to avoid double counts. For example, we crossed out "air pollutant" because "pollutant" was also listed. As well, all terms that might refer to non-environmental concepts were removed to prevent false positives. For example, "atmosphere" was deleted because it may relate to the gases around the

earth or to a general feeling or mood. We validated the dictionary with a panel of 3 faculty members from the Academy of Management's Organization and the Natural Environment (ONE) Division. Each panel member received a spreadsheet containing the three dictionaries and was asked to validate every word and phrase according to instructions and definitions provided in Appendix 1 & Table 1 respectively. We also asked our panel members to add missing terms and reinstate deleted ones as they deemed necessary. The final dictionaries hold 94 words and phrases for ecological scanning, 283 for ecological understanding, and 110 for ecological responding, totalling 487 terms reflecting stages of ecological interpretation.

Exhibit 1

Instructions to panel members for construct validation

Ecological Interpretation

Thank you for your willingness to help us develop a computer-aided text analytic (content analysis) dictionary for ecological interpretation.

Corporate interpretation occurs as a sequence of three core steps: scanning, understanding, and responding (Daft & Weick, 1984; Hahn et al., 2014; Thomas et al., 1993). We propose that ecological interpretation is composed of the same three steps: ecological scanning, understanding, and responding.

As an expert judge, you will be helping us to identify whether words, identified using the process outlined by Short, Broberg, Cogliser, and Brigham (2010), are representative of the identified construct based on the definition provided. Specifically, in evaluating the presented words, we would like you to respond to the following prompt:

Would this word be representative of the construct if it was present in an annual or sustainability report?

When you believe that a word reflects the construct, please place an "x" in column F, labeled "The Word Fits This Definition". When a word does not reflect the construct, please leave column F blank.

Each dimension of the construct is represented as a green tab below for your evaluation. After you have completed each word list, if you feel that we have omitted a word that should be associated with the construct, we would appreciate your input. We have provided an orange tab below, "Missing Words", where you can communicate these additions to us.

Thank you very much for your generosity in helping us develop this measure of ecological interpretation. We will send you the final word list upon completion for your use and will send the citation and proof of our manuscript upon acceptance for publication.

Adapted from:

McKenny (2015) Resources for CAT Scanner: A Computer-Aided Text Analysis Tool

<http://www.amckenny.com/CATScanner/resources.php>

Table 1

Definitions accompanying instructions to panel members for dictionary validation

Ecological interpretation	Ecological interpretation in organizations occurs as a sequence of three core stages: scanning, understanding, and responding (Daft & Weick, 1984; Hahn et al., 2014; Thomas et al., 1993)
Ecological scanning	The words in the list below refer to tools, activities, measures and systems for the monitoring/measurement of environmental impact.
Ecological understanding	The words in the list below refer to (1) natural phenomena and processes, as well as (2) aspects of natural environmental impacts and their causes.
Ecological responding	The words in the list below refer to tools, activities, and principles that mitigate/prevent environmental degradation or restore the natural environment.
Missing words	Are we missing words on one or more of the lists? Please indicate these words in the appropriate lists below.
Rejected words	Words we considered & rejected because they may refer to non-environmental topics or to both positive and negative environmental impacts.

Still following Short et al. (2010), we assessed interrater reliability using Holsti's (1969) coefficient, which is the ratio of coding agreements to the total number of coding decisions: $IRC = 2M / (N_1 + N_2)$, where IRC is the interrater reliability coefficient, M is the number of coding decisions on which the 2 judges are in agreement, and N_1 and N_2 are the numbers of coding decisions made by judge 1 and 2 respectively. Content analysts suggest that IRCs of 0.80 and above (Krippendorff, 2004; Riffe, Lacy, & Fico, 2005), or 0.75 and above (Ellis, 1994) reflect high reliability. We interpret our IRCs, ranging from 0.71 to 0.93 (see Table 2 for detailed IRC report), as indicative of acceptable consistency among our raters.

Table 2

Interrater reliability coefficients (IRC) of the ecological interpretation dictionaries

Dictionary / IRC	Judges 1&2	Judges 2&3	Judges 1&3
Ecological scanning	.76	.82	.71
Ecological understanding	.80	.93	.78
Ecological responding	.91	.91	.87

To measure ecological scanning, understanding, and responding in sustainability reports, we assumed that the frequency of concepts in texts indicates their importance (Knoke & Kuklinski, 1982; Nadkarni & Narayanan, 2007b). We loaded our three dictionaries into the Linguistic Inquiry and Word Count (LIWC) software which returns the ratio of dictionary words to the total word count in documents (Pennebaker, Booth, & Francis, 2007). We used the square-root transformations of the ratios for scanning, understanding, and responding as our measures.

As noted, research suggests that organizational interpretation is composed of three dimensions: scanning, understanding, and responding. We therefore tested the multidimensionality of our construct: ecological interpretation. One important assumption for the measurement of multidimensional constructs is that each dimension differs from, and simultaneously relates to, the others (Short et al., 2010). Researchers who use content analysis can observe results from several dictionaries and determine multidimensionality by visual inspection of the correlation matrix comparing dictionaries: dimensions should be correlated, although not too highly, that is, below 0.8 (Hair, Anderson, Tatham, & Black, 1998), and if possible, below 0.5 (Short et al., 2010). The correlations for the dimensions of ecological interpretation are presented in Table 3. They range from 0.19 to 0.49 with the highest p-value at 0.0001, providing evidence that ecological interpretation is a multidimensional construct.

Table 3
Correlations of ecological interpretation dimensions

Dimensions	Scanning	Understanding	Responding
Scanning (p-value)	1		
Understanding (p-value)	.4870 (.0000)	1	
Responding (p-value)	.1908 (.0001)	.3862 (.0000)	1

Positive-negative interpretation of environmental issues. We used LIWC's built-in dictionary of positive and negative emotions to assess the overall valence of sustainability reports. LIWC's authors have established the internal and external validity of this dictionary (Pennebaker, Boyd, Jordan, & Blackburn, 2015) and management researchers have successfully used this method to evaluate the positive-negative nature of media coverage (Bednar, 2012; Pfarrer, Pollock, & Rindova, 2010; Zavyalova, Pfarrer, Reger, & Shapiro, 2012). For each report, we computed a ratio of positive affective content to total affective content (Pfarrer et al., 2010). We used the cubic transformation of this ratio as our variable representing the positive-negative interpretation of environmental issues.

Control Variables

We included other variables to control for effects on corporate environmental performance. We estimated *firm size* with log-transformed firm sales available in the Trucost database. We calculated the variation of sales divided by total sales, also from Trucost, to account for *changes in production*. Following Berrone, Cruz, Gomez-Mejia, and Larraza-Kintana (2010), we controlled for industry air pollution, computing the log-transformation of industry specific CO₂-equivalent emissions from 22 member-countries of the Organisation for Economic Co-operation and Development (OECD). These data are available online in the OECD's Environmental Data Compendium. Because every industry has a particular air pollution profile, this variable allowed us to control for industry pollution and industry simultaneously. Finally, drawing on Russo and Harrison (2005), as well as Berrone et al. (2010), we assessed country-level *stringency of environmental regulations* using the log-transformation of CO₂-equivalent emissions per thousand dollars of national gross domestic product (GDP), and the inverse square root transformation ($1/\sqrt{x}$) of energy consumption (kg of oil equivalent) per thousand dollars of GDP. Our CO₂-

equivalent emissions and energy consumption data comes from the United Nations Statistics Division, and our GDP data, from the World Bank DataBank.

Statistical Methods

Our final sample is a panel data set containing cross-sectional and time-series information on 108 firms over 4 years for a total of 432 observations. Although ordinary multiple regression models can be used on panel data, they are prone to a number of issues related to unobserved and time-invariant variables that may generate correlation in error terms and spurious regression results, and thus need to be controlled (Barnett & Salomon, 2012; Hausman & Taylor, 1981; Hsiao, 2003). One convenient way to control for these unwanted effects is to use panel regression models. We tested our hypotheses using fixed effects and random effects panel regressions. A fixed effects model controls for unobserved variables that are constant over time and vary across entities (firms). A random effects model assumes the presence of both unobserved variables that are constant over time and vary across cases, *and* unobserved variables that vary over time and remain constant across cases. Breusch-Pagan Lagrange multiplier tests indicated that random effects regressions were more appropriate than ordinary least squares regressions in all cases. We used a Hausman test (Hausman, 1978) to decide between fixed and random effects for each hypothesis (see Table 4). As well, Wald tests showed when time-fixed effects were needed in our (entity-)fixed effects models, and we included year dummy variables in our models to account for time-fixed effects accordingly (see Tables 7 & 8).

Table 4
Hausman tests for each hypothesis

Hypothesis	Hausman test's chi-squared value	Hausman test's p-value	Regression model indicated by test
1a - Scanning & positive interpretation	0.29	0.59	Random effects
1b - Scanning & understanding	5.90	0.02	Fixed effects
2a - Positive interpretation & responding	1.87	0.17	Random effects
2b - Understanding & responding	24.57	0.0000	Fixed effects
3 - Responding & environmental impact	41.07	0.0000	Fixed effects
3 - Reversed causality	10.66	0.0011	Fixed effects

Note: low p-values indicate that the unique errors in the model are correlated with the regressors and point to the fixed effects model. In contrast, high p-values point to the random effects model.

Finally, due to the presence of heteroskedasticity, we performed regressions with robust standard errors using Huber-White estimators (see Tables 7 & 8).

RESULTS

Tables 5 and 6 respectively provide descriptive statistics and pairwise correlations for our variables of interest. Table 7 shows the results of our fixed effects, random effects, and robust standard errors regressions for hypotheses 1a, 1b, 2a, and 2b. Table 8 presents our regression results for hypothesis 3. In Table 7 and 8, we highlighted in grey the models we selected after running Hausman, Wald, and heteroskedasticity tests.

Table 5
Descriptive statistics

Variable	Mean	Standard deviation	Minimum	Maximum
Environmental impact ^{L+2}	5.76575	1.810926	1.210699	9.714928
Ecological responding ^{S+1}	0.4937938	0.2412959	0	1.24499
Ecological understanding ^S	0.6249746	0.2567137	0	1.506652
Interpretation of env. issues ^C	0.5899597	0.1123481	0	1
Ecological scanning ^S	0.2160867	0.1138692	0	0.6855655
Sales turnover ^{L+1}	9.390193	1.374572	4.963124	13.03541
Sales variation ⁺¹	0.0996018	0.2131863	-0.5837362	1.40144
Country-level energy intensity ^{1/S+1}	0.0926733	0.0116611	0.0691714	0.1259882
Country-level carbon intensity ^{L+1}	-1.294253	0.4222819	-2.496174	0.2116811
Industry carbon intensity ^{L08}	17.16581	1.921872	13.71886	21.20501

^L Log-transformed; ^S Square-root-transformed; ^C Cubic-transformed;
^{1/S} 1/Square-root-transformed; ⁺² lagged 2 years; ⁺¹ lagged 1 year; ⁰⁸ fixed year: 2008.

Table 6
Pairwise correlations

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Environmental impact	1.0000													
2. Ecological responding	0.1646 (0.0006)	1.0000												
3. Ecological understanding	0.4302 (0.0000)	0.4347 (0.0000)	1.0000											
4. Interpretation of env. issues	-0.0469 (0.3311)	0.1126 (0.0193)	0.0009 (0.9847)	1.0000										
5. Ecological scanning	0.3673 (0.0000)	0.2640 (0.0000)	0.5958 (0.0000)	0.0249 (0.6060)	1.0000									
6. Sales turnover	0.6768 (0.0000)	0.1546 (0.0013)	0.1576 (0.0010)	-0.0191 (0.6930)	0.1993 (0.0000)	1.0000								
7. Sales variation	0.0425 (0.3782)	-0.0015 (0.9748)	0.0213 (0.6595)	0.1073 (0.0258)	-0.0068 (0.8883)	0.0208 (0.6666)	1.0000							
8. Country-level energy intensity	-0.1182 (0.0140)	-0.0872 (0.0702)	-0.2281 (0.0000)	-0.1291 (0.0072)	-0.1825 (0.0001)	-0.1082 (0.0245)	0.0744 (0.1227)	1.0000						
9. Country-level carbon intensity	0.0574 (0.2335)	0.1447 (0.0026)	0.1401 (0.0035)	0.1806 (0.0002)	0.1390 (0.0038)	-0.0216 (0.6540)	0.0324 (0.5017)	-0.6512 (0.0000)	1.0000					
10. Industry carbon intensity	0.4393 (0.0000)	-0.0950 (0.0484)	0.3206 (0.0000)	-0.0999 (0.0379)	0.2638 (0.0000)	-0.0487 (0.3129)	0.0925 (0.0546)	0.0536 (0.2659)	0.0206 (0.6694)	1.0000				
11. Year 2005	-0.0137 (0.7761)	-0.0245 (0.6115)	-0.0183 (0.7052)	0.0398 (0.4090)	0.0037 (0.9387)	-0.0650 (0.1773)	-0.0865 (0.0725)	-0.1001 (0.0375)	0.1242 (0.0097)	-0.0020 (0.9674)	1.0000			
12. Year 2006	0.0140 (0.7722)	0.0304 (0.5287)	-0.0595 (0.2173)	-0.0268 (0.5785)	-0.0367 (0.4463)	-0.0169 (0.7261)	-0.1155 (0.0163)	-0.0292 (0.5450)	0.0746 (0.1215)	-0.0024 (0.9604)	-0.3333 (0.0000)	1.0000		
13. Year 2007	-0.0115 (0.8119)	0.0228 (0.6360)	0.0610 (0.2061)	-0.0221 (0.6472)	0.0226 (0.6395)	0.0357 (0.4591)	0.1271 (0.0082)	0.0467 (0.3326)	-0.0414 (0.3911)	-0.0073 (0.8795)	-0.3333 (0.0000)	-0.3333 (0.0000)	1.0000	
14. Year 2008	0.0112 (0.8158)	-0.0287 (0.5515)	0.0168 (0.7282)	0.0091 (0.8510)	0.0104 (0.8289)	0.0462 (0.3379)	-0.1560 (0.0011)	0.0826 (0.0863)	-0.1575 (0.0010)	0.0117 (0.8087)	-0.3333 (0.0000)	-0.3333 (0.0000)	-0.3333 (0.0000)	1.0000

Note: p-values are between parentheses.

Table 7
Ecological scanning, understanding, responding, and positive interpretation of environmental issues: Results of fixed and random effects regressions

Dependent variable	Interpretation of environmental issues (Hyp 1a)			Ecological understanding (Hyp 1b)			
	Fixed	Random	Random (1)	Fixed	Random	Fixed (1)	Fixed (1) (2)
Ecological scanning	0.0791 (0.0656) {0.228}	0.0531 (0.0526) {0.313}	0.0531 (0.0694) {0.444}	0.6845 (0.1029) {0.000}	0.9240 (0.0898) {0.000}	0.6845 (0.1837) {0.000}	0.6641 (0.1849) {0.000}
Year 2006							-0.0130 (0.0155) {0.403}
Year 2007							0.0327 (0.0168) {0.054}
Year 2008							0.0147 (0.0169) {0.386}
Constant	0.5729 (0.0147) {0.000}	0.5785 (0.0143) {0.000}	0.5785 (0.0182) {0.000}	0.4771 (0.0230) {0.000}	0.4253 (0.0258) {0.000}	0.4771 (0.0397) {0.000}	0.4729 (0.0408) {0.000}

Dependent variable	Ecological responding (Hyp 2a)			Ecological responding (Hyp 2b)			
	Fixed	Random	Random (1)	Fixed	Random	Fixed (1)	Fixed (1) (2)
Interpretation of env. issues	-0.0434 (0.0782) {0.579}	0.0007 (0.0744) {0.993}	0.0007 (0.1040) {0.995}				
Ecological understanding				0.0494 (0.0467) {0.291}	0.1628 (0.4139) {0.000}	0.0494 (0.0426) {0.248}	0.0526 (0.0443) {0.238}
Year 2006							0.0239 (0.0132) {0.073}
Year 2007							0.0179 (0.0174) {0.307}
Year 2008							-0.0026 (0.0175) {0.883}
Constant	0.5194 (0.0464) {0.000}	0.4934 (0.0488) {0.000}	0.4934 (0.0638) {0.000}	0.4629 (0.0297) {0.000}	0.3920 (0.0320) {0.000}	0.4629 (0.0266) {0.000}	0.4511 (0.0265) {0.000}

Notes: Standard errors are between parentheses. p-values are between brackets. (1) Robust standard errors. (2) Entity (firm) and time (year) fixed effect model. Models selected following Hausman, Wald, and heteroskedasticity tests are highlighted in grey.

Table 8
Regression models of corporate environmental impact

Dependent variable Model	Corporate environmental impact			
	Fixed	Random	Fixed (1)	Fixed (2)
Ecological responding	0.3322 (0.1974) {0.093}	0.4424 (0.1861) {0.017}	0.3322 (0.1979) {0.096}	0.3327 (0.1983) {0.094}
Sales turnover	-0.0209 (0.1600) {0.896}	0.7501 (0.0637) {0.000}	-0.0209 (0.1099) {0.850}	-0.021 (0.1770) {0.905}
Sales variation	0.1474 (0.1184) {0.214}	-0.1646 (0.1057) {0.120}	0.1474 (0.1204) {0.224}	0.1619 (0.1255) {0.198}
Country-level energy intensity	16.2434 (17.2802) {0.348}	-7.3710 (9.0924) {0.418}	16.2434 (15.0797) {0.284}	15.5286 (22.9212) {0.499}
Country-level carbon intensity	0.1185 (0.2612) {0.650}	0.3371 (0.1941) {0.082}	0.1185 (0.1907) {0.536}	0.1531 (0.2708) {0.572}
Industry carbon intensity	0.2297 (0.0729) {0.002}	0.3822 (0.042) {0.000}	0.2297 (0.0197) {0.000}	0.2206 (0.0733) {0.003}
Year 2006				0.0531 (0.0629) {0.399}
Year 2007				-0.0308 (0.0885) {0.728}
Year 2008				0.0528 (0.1044) {0.614}
Constant	0.4884 (1.9874) {0.806}	-6.9213 (1.1678) {0.000}	0.4884 (1.1092) {0.661}	0.7360 (2.8475) {0.796}

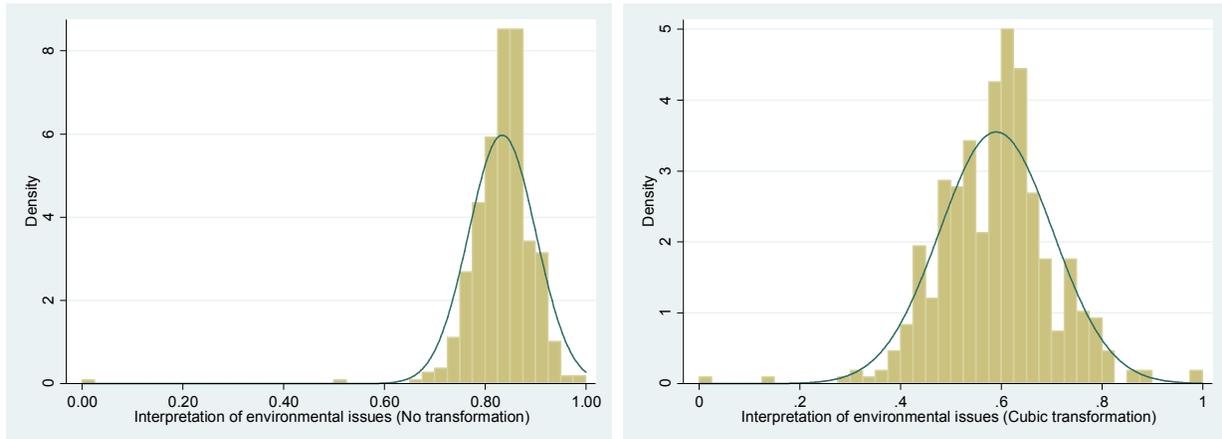
Notes: Standard errors are between parentheses. p-values are between brackets. (1) Robust standard errors. (2) Entity (firm) and time (year) fixed effect model. The model selected following Hausman, Wald, and heteroskedasticity tests is highlighted in grey.

Ecological Scanning

Results show a weak and non-significant relationship between ecological scanning and the positive interpretation of environmental issues ($\beta = 0.0531$, $p = 0.444$), providing no support to hypothesis 1a. The limited variance in the interpretation of environmental issues may explain this result. As shown in Graph 2, nearly all firms in our panel present environmental issues very positively; only 2 out of 432 observations show positive interpretation ratios below 0.6. The absence of support to hypothesis 1a suggests that a vast majority of firms consistently chooses to address environmental issues under a positive light in sustainability reports notwithstanding how deeply they monitor ecological data.

Graph 2

Frequency distribution of the interpretation of environmental issues



Note: the normal distribution line is superimposed on the variable's distribution histogram.

In contrast, results indicate a strong, positive, and significant relationship between ecological scanning and ecological understanding ($\beta = 0.6641$, $p = 0.000$), supporting hypothesis 1b.

Ecological Understanding

Our results show no evidence of a relationship between firm-level interpretation of environmental issues in positive terms and ecological responding ($\beta = 0.0007$, $p = 0.995$), offering no support to hypothesis 2a. Again, the absence of a relationship here may be attributable to the limited variance in the interpretation of environmental issues. Further, results do not point out a relationship between ecological understanding and ecological responding ($\beta = 0.0494$, $p = 0.248$), giving no support to hypothesis 2b. This suggests that firms' responses to environmental issues are incommensurate to ecological understanding expressed in disclosed schemas. Stated differently, the degree of firm-level understanding of environmental issues does not systematically translate into the extent of corporate environmental response.

Ecological Responding

Our results suggest that there exists a positive, marginally significant relationship between ecological responding and corporate environmental impact ($\beta = 0.3322$, $p = 0.096$). This result goes against hypothesis 3, which predicted a negative relationship between the two. Rather, it indicates that the more firms deal with ecological response in disclosed schemas, the higher their environmental impact one year later. This result raises several questions which we address next.

Complementary Analysis

How come that the more firms address ecological responding in their disclosed schemas, the more they pollute later on? We found two possible explanations. First, if schemas and disclosed schemas reasonably overlap as we have assumed so far, it means that firms engage in inappropriate responses that do not affect or worsen environmental issues rather than mitigate them. This interpretation is supported by our other finding that firms' responses to environmental issues are incommensurate to ecological understanding expressed in disclosed schemas. The disconnection between firms' understanding of environmental issues and corporate environmental response can explain the inadequacy of the latter. Second, if our working assumption is not met, the presence of ecological responding in disclosed schemas is greenwash rather than a reflection of firms' actual pattern of meanings and actions. This alternative explanation is supported by our observation that a vast majority of firms associate environmental issues with positive wording in sustainability reports. In this perspective, firms use sustainability reports to project favorable images of themselves and impress stakeholders. This can lead to exaggerating the importance of ecological responding in disclosed schemas, particularly when corporate environmental performance is low.

Despite our argument that schemas prompt action and eventually influence performance, we therefore need to consider the possibility that environmental performance informs disclosed schemas, that is, reversed causality. We used the same panel to test for reversed causality, and we lagged our dependent variable, ecological responding, by one year. Because we did not collect ecological responding data for 2009, we had to drop one year of observations. Our final panel to test for reversed causality included dependent variable data on 108 firms from 2006 to 2008, for a total of 324 observations. Like before, we used a Hausman test (see Table 4) to choose between fixed and random effects, and a Wald test to detect heteroskedasticity. These tests pointed to a fixed effects model with robust standard errors. The results of the robust fixed effects regression show a significant, negative coefficient ($\beta = -0.1124$, $p = 0.009$) indicating that the more firms pollute, the less they address ecological responding in disclosed schemas.

We further divided our panel into three groups based on observed environmental impact and conducted independent group t-tests (see Table 9). These tests indicate that the difference of means in ecological responding differs between low-impact and medium-impact firms, as well as between low-impact and high-impact firms. However, there was no statistically significant difference of means in ecological responding between medium-impact and high-impact firms.

Actually, the mean statistic for ecological responding was lower for high-impact firms than for medium-impact firms. Additional panel regressions within low-, medium-, and hi-impact groups (see Table 10) showed marginal evidence that the more low-impact firms pollute, the more they address ecological responding in disclosed schemas ($\beta = 0.0642$, $p = 0.094$). No significant relationship was found for medium-impact or high-impact firms.

Table 9
Independent group t-tests on mean ecological responding

Group	Mean responding	Standard error	Standard deviation	Low impact	Medium impact
Low-impact firms	0.4499	0.0214	0.2225	n/a	
Medium-impact Firms	0.5230	0.0219	0.2275	t = -2.3867 p = 0.0179 group means differ	n/a
High-impact firms	0.5187	0.0251	0.2607	t = -2.0857 p = 0.0382 group means differ	t = 0.1291 p = 0.8974 group means do not differ

Table 10
Within-group panel regressions

Dependent variable	Responding in low-impact firms		Responding in medium-impact firms		Responding in high-impact firms	
	Without controls	With control variables	Without controls	With control variables	Without controls	With control variables
Environmental impact	-0.1018 (0.0725) {0.168}	0.0642 (0.0384) {0.094}	0.0070 (0.0439) {0.873}	0.0289 (0.0496) {0.559}	-0.0402 (0.0319) {0.207}	0.1123 (0.0788) {0.162}
Sales turnover		-0.0506 (0.0322) {0.115}		0.0111 (0.0418) {0.791}		-0.4634 (0.2478) {0.069}
Sales variation		-0.0627 (0.0475) {0.187}		-0.0506 (0.0616) {0.411}		0.0122 (0.1199) {0.919}
Country-level energy intensity		-2.5231 (2.9522) {0.393}		0.4201 (3.2891) {0.898}		37.7837 (20.7393) {0.076}
Country-level carbon intensity		0.0606 (0.0511) {0.236}		0.1849 (0.0937) {0.049}		0.3926 (0.4409) {0.379}
Industry carbon intensity		-0.0188 (0.0197) {0.340}		0.0084 (0.0286) {0.768}		Omitted
Constant	0.8219 (0.2648) {0.004}	1.2573 (0.4652) {0.007}	0.4753 (0.2574) {0.065}	0.2824 (0.8120) {0.728}	0.8203 (0.2555) {0.001}	1.4984 (2.0944) {0.479}

DISCUSSION

Contributions and Future Research

Contrary to previous research which found evidence of a positive relationship between scanning and the positive interpretation of strategic issues (Thomas et al., 1993), our results show no support for a relationship between ecological scanning and the positive interpretation of environmental issues. Further, we find no evidence of a link between the positive interpretation of environmental issues and ecological responding. We explain the absence of these expected relationships with the limited variance in the interpretation of environmental issues: all but two observations in our panel demonstrate that firms interpret environmental issues in very positive terms. In turn, we surmise that the desire to appear under a positive light in public documents leads firms to associate environmental issues with positive terminology in sustainability reports, independently from ecological scanning efforts, and from subsequent environmental actions.

Our results provide evidence of a relationship between ecological scanning and understanding. This is coherent with the theoretical model of organizations as interpretation

systems underlying this paper: data acquisition allows managers to give meaning to experience (Daft & Weick, 1984). However, opposite to Daft and Weick's (1984) model, and a fundamental assumption of Western rationalist thinking, our results show that understanding does not translate into proportionate action (i.e. responding). Following the model's logic and terminology, we might say that firms in our sample failed to "learn" (1984: 286). This result also goes against Thomas et al.'s (1993) conclusion that scanning and understanding ease strategic action. However, Daft and Weick (1984) issued a caveat stating that the three-stage model of scanning, understanding, and responding oversimplifies processes involving beliefs, politics, and perceptions. Thomas et al. (Thomas et al., 1993) also noted that oversimplifications of interpretation-performance relationships do not properly reflect the complex processes occurring in organizational settings. Accordingly, recent research has proposed that managers whose schemas encompass a wide array of business and ecological issues are more likely to interpret sustainability issues ambivalently (Hahn et al., 2014). Relatedly, it has been argued that firms with business-centred approaches to sustainable initiatives are ill-equipped for environmental sustainability (Pain, 2015). Future research could investigate how ambivalence, trade-offs, and contradictions as regards the importance and centrality of sustainability in firm-level schemas explains the apparent disconnection between ecological understanding and responding.

Despite our expectations, the testing of our last hypothesis produced some evidence of a positive relationship between ecological responding and corporate environmental impact. We envisioned two explanations for this result. First, assuming overlap between schemas and disclosed schemas, we speculated that firms implement inappropriate responses that either do not affect or worsen environmental issues. Second, assuming limited overlap between schemas and disclosed schemas, we offered that firms might exaggerate ecological responding when corporate environmental performance (CEP) is low. Additional testing refuted the latter explanation, showing a significant negative relationship between corporate environmental impact and ecological responding the following year. With this complementary analysis, our results suggest that firms' ecological responding is inappropriate for the challenges at hand. The inappropriateness of ecological responding may in turn be attributable to various factors ranging from changing corporate goals, lack of resources, competing priorities, ambivalence, or as hinted by our other results, the observed disconnection between ecological understanding and ecological responding.

Altogether, these results provide weak support for a deterministic perspective on the model of organizations as interpretation systems, and in particular, for the schema-action-performance relationship. In sum, while firms' data gathering seems to be related to their comprehension of environmental issues, companies neither convert comprehension into commensurate actions, nor actions into reduced environmental impact. This resonates with Daft and Weick's (1984), and Thomas et al.'s (1993) caveat against oversimplification. Research has documented elaborate debates between sponsors of eco-centric and business-driven schemas within firms (Bansal, 2003; Howard-Grenville, 2007a) engaging in framing contests (Kaplan, 2008) to influence organizational actions. Building on this literature, the examination of how corporate sustainability debates impact ecological responding and CEP constitutes a complementary research avenue.

Beyond ecological interpretation, this paper has also shed light on our working assumption that disclosed schemas overlap schemas (Narayanan & Fahey, 1990). Testing for reversed causality, we were able to rule out the possibility that firms with high environmental impact systematically enhance ecological responding in sustainability reports. Instead, we found that these firms systematically reduce ecological responding in sustainability reports, suggesting an intention to underemphasize ecological responding. Given the strategic nature of sustainability reports (Philippe & Durand, 2011), it is unlikely that firms publicly express the scarcity of their responses to ecological challenges. Rather, our interpretation is that high-impact firms deliberately adopt a low profile to avoid being perceived as dishonest and risking societal and market sanction. This is coherent with recent research proposing that it is not always in the best interest of firms to greenwash under conditions of public scrutiny (Lyon & Maxwell, 2011). Following events or periods of high corporate environmental impact, firms remain strategically modest or even silent in corporate sustainability disclosure so as to prevent criticism (Bowen, 2014; Carlos & Lewis, 2015; Eun-Hee & Lyon, 2015). This interpretation supports our assumption that, while sustainability reports are carefully crafted tools for strategic communication, firms cautiously keep their discourse credible in reaction to increasing public skepticism toward corporate sustainability claims.

Limitations

We wish to acknowledge several limitations to this study. First, this paper has described the creation and validation of three dictionaries of ecological terms. This self-developed measure for the identification of ecological interpretation needs further validation. While we have followed

rigorous procedures to enhance content and discriminant validity (Short et al., 2010), we need to test our tool with various samples to demonstrate external validity. Analyzing different types of corporate communications such as annual reports, 10-K forms, press releases and executive interviews might produce insights as to the generalizability of findings across settings. Further testing will also be needed to establish nomological validity, our tool's capacity to predict separate but theoretically linked concepts, such as corporate environmentalism (Van Marrewijk & Werre, 2003) and environmental orientation (Banerjee, 2001), for instance. Used with text analysis software, our dictionaries can identify terms and phrases related to environmental monitoring, environmental phenomena and impacts, and environmental restoration. They can inform future research by capturing the salience of the natural environment in various types of textual sources reflecting, among others, organizational interpretation, strategy, and discourse.

Second, our proxies for ecological scanning, understanding, and responding are built on the analysis of disclosed schemas in public documents. As discussed, disclosed schemas represent only what firms are willing and able to communicate, and are subject to embellishment and undue modesty. Although there exist alternative documentary sources, some of which are listed above, we expect that social desirability affects all firm-issued documents in a similar manner. Qualitative research methods (e.g. case study, ethnography) could allow for a more transparent depiction of ecological scanning, understanding, and responding, perhaps closer to firm-level schemas. By design however, researchers employing qualitative techniques will need to make a trade-off between the depth of analysis and the number of firms studied. Working with publicly-available documents, we have conducted a longitudinal study of a relatively large number of firms.

Third, we recognize that corporate reporting has evolved since the period covered by our data: 2006-2009. The 2008 financial crisis triggered by the American mortgage market has ended; public awareness and scrutiny have increased; reporting standards and practices have changed. Although we have controlled for time-varying unobserved variables by using random effects regression models when needed, future research could investigate more recent periods. In addition to accounting for changes in the social, economic, and technical context of corporate sustainability reporting, coverage of later periods should permit studies on larger samples because of the greater availability of corporate reports in recent years.

Fourth, our measure of corporate environmental impact, Trucost's TEDC, is partially based on self-reported firm data and thus subject to the same social desirability bias. We have argued,

however, that firms are legally liable for false declarations in public documents. Further, companies face public scrutiny on corporate environmental actions and the threat of corrective market reactions if irresponsible behavior toward the environment is revealed (Flammer, 2013). On another note, TEDC contains estimates of unavailable data, leaving room for approximation. We have found that Trucost uses established environmental economics methodologies approved by independent experts, and validates estimations with the studied firms. Indeed, some sustainability researchers consider TEDC one of “the most significant measures of environmental performance” in the literature (Delmas et al., 2013: 259). Finally, TEDC aggregates impact types (e.g. waste, volatile organic compounds, etc.) that differ importantly within and across companies, and thus offers a coarse-grained picture of corporate environmental impact. We have preferred TEDC to finer-grained data also available in the Trucost database because TEDC weights environmental impact types through dollar valuation before it aggregates them, thus allowing for comparison across companies with different resources use and emissions. In sum, we find that TEDC offers acceptable credibility and valuable practicality.

IMPLICATIONS AND CONCLUSION

This paper opened with the statement that strategic management research has long recognized the shaping influence of organizational interpretation on corporate action (Daft & Weick, 1984; Thomas et al., 1993; Thomas & McDaniel, 1990). Our study’s main contribution is the qualification of relationships between stages of firm-level interpretation: scanning, understanding, responding (i.e. action), and corporate environmental performance. We have shown that organizational interpretation does not always clearly mould firms’ actions. In the case of ecological interpretation -the interpretation of ecological issues and phenomena- we have found no relationship between the depth of corporate understanding and the extent of corporate actions. It seems that the scanning-understanding-responding interpretation sequence is disrupted so that responding does not take place in a commensurate fashion. We suggested that hidden interpretation mechanisms involving divergent, undisclosed schemas might be the cause. Our results also indicate that disclosed corporate environmental actions positively relate to corporate environmental impact, and we inferred that firms’ environmental actions tend to be ecologically inadequate.

As well, this paper contributes to the management literature on sustainability. Together, our findings hint that firms can hardly reduce their environmental impact unless they become able to translate their understanding of ecological issues into adequate, proportionate corporate actions. Firm-level understanding of sustainability issues is not always straightforward however (Hahn et al., 2014), and competing schemas often lead to business-driven, ineffective responses to ecological issues (Pain, 2015). In addition, this paper provides a dictionary to measure ecological interpretation with computer-aided text analysis software, for further validation and use in future research.

More broadly, this paper is anchored in a stream of research that examines the relationships between strategic cognitions, actions, and their consequences (Narayanan et al., 2011). As such, it sheds some light on the link between organizational interpretation and performance. Recently, research has given much attention to the interaction of divergent schemas and their cognitive outcomes (Hahn et al., 2014) and to the competition between divergent schema sponsors who attempt to affect strategic choice and action (Kaplan, 2008). Yet, there has been little emphasis on the performance outcomes of such struggles. Further, our results indicate that there are feedback mechanisms linking past performance and corporate actions. Recent works have examined how organizational members reconcile events of the past with present and upcoming stakes (Kaplan & Orlikowski, 2013) and future research in that area could provide insights on the linkages between “temporal work” (2013: 965) and performance outcomes, and reciprocally.

Future research might also integrate additional organizational factors that interact with schemas and shape performance. Firm structure is an apparent starting point, schema evolution being associated with structural change (Bartunek, 1984; Ranson et al., 1980). Congruence between firm-level schemas, structure and actions would be expected to produce better performance outcomes, including as regards environmental performance (Russo & Harrison, 2005). Then, the question arises whether schemas, structure, and actions can simultaneously be made congruent for multiple types and contexts of performance. As scholars address these and other emerging questions, they will heed previous calls for cautiousness (Daft & Weick, 1984; Thomas et al., 1993) by providing a more adequate depiction of the complex relationships between interpretation, action, and performance in organizational settings.

ARTICLE 3

Different yet the same:

The evolution of disclosed strategic schemas on sustainability

STRATEGIC SCHEMAS AND SUSTAINABILITY

Scholarly interest for corporate sustainability keeps growing and researchers have inquired into the cognitive settings that favor corporate environmentalism (Aguinis & Glavas, 2012). Many studies mention schemas and related concepts explicitly or tacitly as key antecedents of organizational change and actions toward sustainability (Angus-Leppan et al., 2010; Banerjee, 2001; Basu & Palazzo, 2008; Eberhardt-Toth & Wasieleski, 2013; Thomas, 2005). Built on values and fundamental assumptions about causal relationships (Weick, 1995), schemas are defined as socially-shared cognitive templates used to interpret experience on a given topic or domain (Bartunek, 1993). Schemas filter and structure organizational experience, and guide the attribution of meaning to experience as well as the enactment of attributed meaning (i.e. corporate action). Schemas determine both what is relevant in the flow of organizational experience, how it should be treated, and acted upon (Bartunek, 1984). In brief, schemas form the basis for firm sensemaking (Weick, 1995) and action (Nadkarni & Barr, 2008; Nadkarni & Narayanan, 2007a; Weick et al., 2005).

Research has looked at schemas and organizational structure (Bartunek, 1984), schemas and organizational actions (Bartunek, 1993; Weick et al., 2005), or schema attributes like size and complexity (Dane, 2010). But although studies of schemas in organizational settings reveal the need for more research on schema change patterns, that is, on the ways schemas affect each other leading to stasis or change (Balogun & Johnson, 2004; Labianca et al., 2000), extant research remains essentially silent on this topic (for an exception, see Bingham & Kahl, 2013).

Past efforts in management and organization studies provide cues about factors that impact schematic change dynamics. In particular, studies in organizational settings hint that the relative power of groups that support new schemas influences which schema change patterns unfold (Balogun & Johnson, 2004; Labianca et al., 2000). Similarly, the sustainability literature proposes that firm experience is filtered through dominant schemas. When these devalue natural environmental concerns, it takes great skill from green champions to convey the importance of sustainable action and convince powerful organizational actors to take pro-environmental action

(Bansal, 2003; Howard-Grenville, 2007a). These works draw attention to power asymmetry across groups that convey divergent schemas (Balogun & Johnson, 2004; Gioia & Chittipeddi, 1991; Labianca et al., 2000; Maitlis, 2005). Some of these authors (Balogun & Johnson, 2004; Labianca et al., 2000) have observed that groups promoting new schemas achieve various schema change patterns: bookkeeping (incremental schema change), subtyping (isolation of a new schema), replacement (emergence of a new schema), and relocation (shift between two existing schemas). These studies, however, do not emphasize the possible relationship between group power and schema change patterns. Beyond power, extant research does not investigate other factors that might trigger different schema change patterns.

We propose to fill this void by exploring two research questions: 1) How do corporate schemas evolve over time? 2) How do powerful schema sponsors influence others' schemas? In particular, we observe how firm-level schemas evolve as they interact with other schemas within the mining industry. We use cause mapping (Axelrod, 1976; Barr et al., 1992; Huff, 1990; Huff & Jenkins, 2002) to describe disclosed schemas on sustainability at the International Council for Mining and Metals (ICMM) and four ICMM member companies from 2003 to 2013. Our findings deepen our understanding of schema change by highlighting that schemas tend to grow incrementally over time while obeying enduring corporate values, thus becoming different yet the same. Our findings also reveal how powerful actors influence others' schemas and actions by anticipating future trends and experimenting with new sustainability practices, promoting adoption by less proactive industry members.

In the next sections, we briefly review extant research before we describe our data and methods. We then present our findings. In the last section, we discuss the contributions of this paper and implications for research and practice.

STRATEGIC SCHEMA EVOLUTION

Research in management and organization studies has shed light on schema content and structure. Studies on organizational schemas suggest that schema content includes information on concepts along with causal links among concepts inside the schema (Bartunek, 1993; Bartunek & Moch, 1987), consistent with earlier work in social psychology (Fiske & Dyer, 1985). As well, constituent concepts are given meaning and value (Bartunek, 1993; Bingham & Kahl, 2013), which implies that there exists a hierarchy of concepts reflecting firm values within schemas. Some

authors have characterized schema structure as focused -schema structure revolves around a limited number of concepts with few relations- to complex -structure encompasses a large number of concepts with multiple relations (Nadkarni & Narayanan, 2007b). Little work describes how schema content and structure evolve over time, and more research is needed in that direction (Bingham and Kahl, 2013).

Schema evolution has been found to follow certain patterns, by which old schemas evolve as firms either “digest” new schemas or adopt them (Balogun & Johnson, 2004; Labianca et al., 2000; Rothbart, 1981; Weber & Crocker, 1983). Four patterns have been identified: (1) bookkeeping characterizes gradual change from old to new schemas. Given schemas tend to endure and resist gradual change, a bookkeeping pattern may result in the absorption of the new by the old; (2) subtyping happens when a new schema is created as a sub-schema (of lesser value) under an old schema as a result of its marked discrepancy; (3) relocation represents a migration from an old schema to a concurrent new one; (4) replacement describes the disconfirmation of an old schema accompanied by, and possibly causing, the emergence of a new one (Albert, 1992; Balogun & Johnson, 2004; Labianca et al., 2000). However, most research on schema interaction patterns does not examine the relationships that might exist among them, nor the factors associated with the occurrence of one schema interaction pattern over others. In brief, there exists no framework that integrates schema interaction patterns and presents the conditions and processes through which these patterns unfold.

Much attention has been given to the ways in which management may deliberately or not impact internal groups’ schemas (Bartunek, 1984; Gioia & Chittipeddi, 1991; Poole et al., 1989). More generally, scholars have studied how organizational groups –managerial or not- negotiate the meaning attributed to firm experience and attempt to modify or replace other groups’ schemas (Bartunek, 1993; Kaplan, 2008; Kaplan & Orlikowski, 2013). In particular, the sustainability literature portrays environmental champions “selling” green initiatives and employing an array of techniques to this end (Bansal, 2003; Howard-Grenville, 2007a, 2007b). Yet, this literature is not explicit about the effects of meaning negotiation on schema content and structure. For instance, although sustainability champions best succeed at changing behaviors when they borrow schemas from the groups they try to influence, it seems that schema borrowing reinforces old schemas and marginalizes new ones (Howard-Grenville, 2007a). Answers to these questions require further inquiry about schema interaction dynamics.

DATA AND METHODS

Research Design

We observe strategic schema evolution in several member companies of a large industry association, the International Council for Mining and Metals (ICMM) whose mission is to enhance environmental performance in the mining industry. Schema evolution is the transformation of schemas as a result of their exposure to other schemas and experience. ICMM member companies are exposed to ICMM's schemas because they voluntarily affiliate with and fund ICMM knowing that its purpose is to enhance sustainability practice and performance in the industry. Further, members must commit to enhanced corporate environmental performance and adhere to ICMM sustainability policies. Finally, ICMM's strategic decisions are sanctioned by member companies' executives, which ensures corporate commitment at the highest hierarchical level. Simultaneously, member companies' and ICMM's schemas on climate change diverge due to local priorities and circumstances. Further, while members actively contribute to produce ICMM's sustainable development positions and actions through their participation in various ICMM work groups, the outcomes of the work groups are beyond the control of any individual member company. ICMM also employs about 20 directors, managers and program officers whose administration affects the direction and results of work groups' activities. We therefore expect that, while they are fully aware of ICMM's positions, individual ICMM members have varied positions on sustainable development and climate change. Further, it is our understanding that those members who convey divergent strategic orientations in their official discourse do so knowingly.

Schemas are cognitive structures that guide firms' interpretations; corporate discourse draws on schemas to convey carefully crafted messages to selected audiences. To capture firms' schema evolution, we look for changes in the concepts, conceptual values, and conceptual relationships that constitute schemas (Bartunek, 1993), using cause mapping (Axelrod, 1976; Barr et al., 1992; Huff, 1990; Huff & Jenkins, 2002). Doing so, we assume that the production of discourse with meaning (i.e. ICMM's annual reports and policies, members' sustainability reports) is an act of interpretation and enactment that exposes strategic schemas. As such, consecutive reports reveal schema evolution, as discussed in more detail below.

Analyzing Sustainability Reports

This study looks at annual reviews from ICMM and sustainability reports from its corporate members. As a firm's public discourse contains elements of reflection which decision makers

select for disclosure with specific stakeholders in mind (Narayanan & Fahey, 1990; Philippe & Durand, 2011), the question arises whether these reports accurately represent the studied firms' schemas. One side of the question is whether sustainability reports can be taken to represent firm-level schemas. A number of studies show that corporate documents intended for public disclosure tend to be jointly prepared by various individuals and departments, for instance, top executives and public relations departments (e.g. Barr et al., 1992). They are therefore more likely to represent a collective or corporate point of view, and have been specifically used to this end in management research, including to study firms' environmental strategies (Philippe & Durand, 2011; Sharma & Henriques, 2005).

Another aspect of the question is whether sustainability reports are accurate representations of schemas. We propose that representations of corporate interpretations in public documents are fractional because (1) firms may not be able to fully articulate their positions, even for themselves, and (2) firms may decide to strategically withhold part of their positions from external stakeholders (see below). Sustainability reports thus convey selected parts of the schemas that firms are able to express (Narayanan & Fahey, 1990), which we call "disclosed schemas". In addition, sustainability reports are expected to feature overstatement of sustainability priorities and embellishment of green accomplishments, known as "greenwash" (Lyon & Montgomery, 2015). Again, we follow Narayanan and Fahey (1990) in stating that the correlation between corporate discourse and corporate schemas depends on the context in which public discourse happens. We argue that the current context characterized by public scrutiny of firms' environmental performance deters greenwash and enhances the likelihood that sustainability reports correctly communicate corporate achievements. This claim is supported by a growing body of research showing that it is not always in a firm's best interests to exaggerate environmental accomplishments. Economic modelling suggests that firms which are publicly expected to perform well and have limited information about their own environmental performance are better off not disclosing anything than greenwashing, while firms which are publicly expected to perform poorly and have accurate information about their own environmental performance are better off fully disclosing than greenwashing (Lyon & Maxwell, 2011). Recent research also shows that firms are less likely to make sustainability claims and to announce environmental certifications when their recent activities are in contradiction with such claims (Carlos & Lewis, 2015). These studies suggest that there can be significant penalty for greenwash, of which firms are acutely aware especially at times of active monitoring by the

media and civil society (Bowen & Aragon-Correa, 2014). Notably, ICMM represents an industrial sector where companies need a ‘social licence to operate’ (Aguilera, Rupp, Williams, & Ganapathi, 2007) and are thus under enhanced scrutiny by local communities, environmental groups, and governments. Finally, all firms are legally liable for false representation in their sustainability reports to the extent that financial stakeholders feed sustainability information into risk assessments. Together, these points represent powerful constraints on the public discourse of the companies we have studied. This context suggests acceptable overlap between the studied sustainability reports and our sample organizations’ strategic schemas.

Using Cognitive Mapping to Capture Schema Evolution

Cognitive mapping, or cause mapping, is a content analysis technique that highlights conceptual relationships, including causal assertions, in texts (Axelrod, 1976; Huff, 1990; Huff & Jenkins, 2002). In this study, we take sustainability reports to represent revealed parts of collective schemas (Narayanan & Fahey, 1990) and we use cognitive mapping to identify concepts and relationships among them (Axelrod, 1976; Barr et al., 1992) within sustainability reports. We thus capture conceptual relationships in the schemas disclosed in sustainability reports. As we do so, we acknowledge that these maps do not offer a perfect representation of strategic thought, but we take the position that cognitive maps capture part of the strategic knowledge that studied companies use (Huff, 1990: 14).

Cognitive mapping graphically represents concepts as boxes and the relationships between them as arrows. Each arrow is associated with a letter code that characterizes the type of relationship depicted. Two coders, the first author and a research assistant, learned the coding procedure developed by Tucker Wrightson for Axelrod (Tucker Wrightson, 1976: 291–332) and later modified by Huff, Narapareddy, & Fletcher (1990). We developed our own adaptation of these procedures as shown in Table 1. By representing each relationship separately, cognitive mapping clarifies the concepts and conceptual relationships contained in texts.

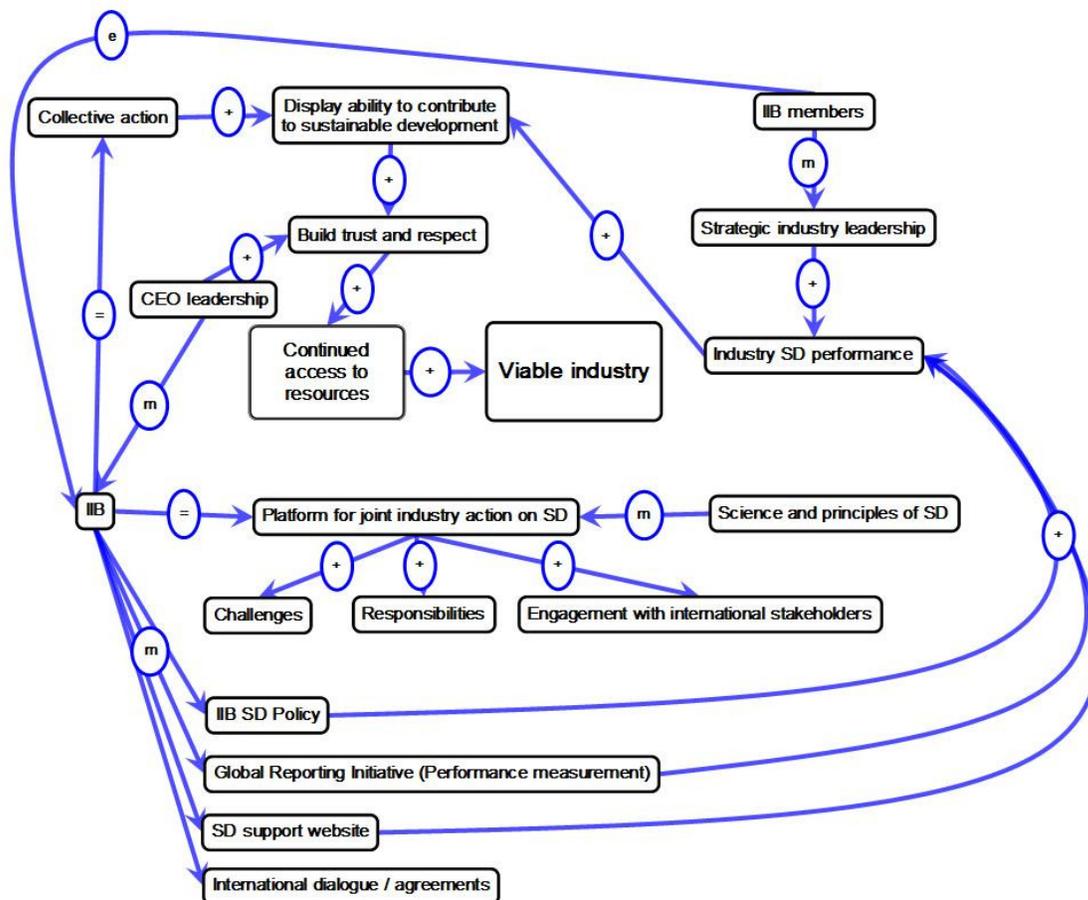
Table 1
Coding Categories (adapted from Axelrod, 1976 and Barr et al., 1992)

Symbol	Definition
+	Positively affects
-	Negatively affects
c+	Is positively correlated to
c-	Is negatively correlated to
a	May or may not be related to, affects indeterminably
m	Affects in some nonzero way
o	Does not matter for, has no effect on, has no relation to
p	Produces, generates, creates
=	Is equivalent to, is defined as
e	Is an example of, is one member of

Cognitive mapping further allows for the identification of values attached to concepts. Cognitive mapping plainly represents links between concepts and therefore depicts concepts along with associated rationales and values. Consider the following excerpt mapped in figure 1: “ICMM members believe that the mining, minerals and metals industry acting collectively can best ensure its continued access to land, capital and markets as well as build trust and respect by demonstrating its ability to contribute successfully to sustainable development” (ICMM, 2003). Here, cognitive mapping clarifies the link between the mining industry and the need to demonstrate its ability to contribute to sustainable development. By spelling out that collective action serves to enhance the industry’s ability to demonstrate its contribution to sustainable development, which in turn is instrumental to stakeholder trust and continued access to resources, cognitive mapping reveals how the studied organization hierarchize the values attached to collective action, sustainable development, stakeholder trust, and access to resources. In sum, cognitive mapping usefully exposes the three components of schemas: concepts, conceptual relationships, and conceptual values (Bartunek, 1993).

Figure 1

Graphic Representation of ICMM's Disclosed Schema on Sustainable Development in 2003



To capture schema evolution patterns, we compare maps and look at schema components in consecutive years, focusing on the addition and subtraction of concepts, new or changed conceptual relationships, and the values attributed to concepts (Barr et al., 1992). For more on the analysis of schema change, see the data analysis section below.

Research Setting

This study looks at various materials from ICMM and four of its member firms: Anglo American (AA), Freeport McMoran (FM), Alcoa (AL), and African Rainbow Minerals (ARM). ICMM is a large industry association comprising about 50 international members (firms and industry associations) and its mission is to channel industry efforts to address sustainability challenges. It seeks to improve environmental performance through stakeholder engagement,

member sensitization, capacity building, performance measurement, sustainability reporting, outreach activities, and involvement in policy making. Since ICMM's action addresses various sustainability-related issues, we chose to focus on environmental issues and more precisely climate change, which has been an area of heightened focus for ICMM, its members, and their stakeholders in the last decade.

Based on the theoretical understanding that interaction among discrepant schemas is a determinant in the occurrence of schema change (Pain, 2015), we attempted to capture schema discrepancy and ensuing patterns of schema evolution by looking at different ICMM member profiles: newcomer, longstanding members, and recently disengaged member. Since ICMM members must publicly commit to sustainable development (SD), we expected schema change in newcomers following their enrollment due to exposure to ICMM's SD discourse and requirements. Likewise, we anticipated schema change in disengaged members after their withdrawal and likely dissociation from ICMM's ideas. Further, we foresaw schema change in long-time members as their schemas interact with ICMM's. In order to theoretically and purposefully sample these three profiles, we selected four ICMM members as the focal firms for this study: two founding companies that continued membership over the studied period (Anglo American and Freeport-McMoran), one founding company that left in 2007 (Alcoa), and a newcomer as of 2009 (African Rainbow Minerals).

Anglo American is a multinational company with headquarters in London, United Kingdom, and revenues of \$33.06bn in 2013. AA's operations are located on all continents and encompass iron ore, manganese, coal, copper, nickel, platinum, and diamonds. Alcoa is a multinational company with headquarters in Pittsburg, U.S.A., and revenues of \$23.03bn in 2013. AL specializes in bauxite mining, alumina, aluminium, and aluminium products and has operations in Australia, Brazil, Jamaica, Suriname, Guinea, and Saudi Arabia. Freeport-McMoran is a multinational company with headquarters in Phoenix, U.S.A., and revenues of \$20.92bn in 2013. FM operates copper, gold, molybdenum, and cobalt mines, as well as oil and gas extraction sites located in Chile, the Democratic Republic of Congo, Indonesia, Peru, and the U.S.A. African Rainbow Minerals is a multinational company with headquarters in Johannesburg, South Africa, and revenues of \$2.01bn in 2013. ARM mines iron, manganese, chrome, coal, copper, nickel, and platinum in the Democratic Republic of Congo, Malaysia, South Africa, and Zambia.

Although the mining industry is not currently at the center of public debate, it is known as a sector of activity with high environmental footprint that needs some level of social legitimacy to operate. As such, the mining industry generates continuous communication on environmental issues between ICMM, its members, and local and global stakeholders. Further, ICMM's role is explicitly to generate and channel collective action as an industry platform for joint corporate action on environmental issues (ICMM, 2003). This lively communication context makes ICMM and its members ideal cases for cognitive mapping.

Data Sources and Data Analysis

We used ICMM's annual reports and policy statements as found on ICMM's website. Member companies' sustainability reports come from their websites. In order to show change, we examined three types of documents produced by ICMM and its members over a period of 11 consecutive years, from 2003 to 2013. ICMM's *annual reviews* explain ICMM's strategic orientations and provide some assessment of goal achievement. Members' *annual sustainability reports* highlight corporate environmental strategies and performance. Finally, we cross-checked and complemented information from the sustainability reports with data from the members' *annual reports*.

In the first stage of analysis, we converted all the reports into corresponding maps using cognitive mapping as described above. Every map consists of concepts and relationships among them. We first drew the 11 cognitive maps representing ICMM's schemas on sustainability and climate change from 2003 to 2013. While annual reviews and sustainability reports address numerous issues such as shareholder value, health and occupational safety, and human rights, schemas are topic-specific (Bartunek, 1993). Accordingly, we focused mapping on strategy, sustainability, the natural environment, and climate change. Using the same technique, we graphically represented the disclosed schemas of the four selected member companies, producing 44 additional cognitive maps, a total of 55 maps (see figure 1 for a sample map). We then assessed the size of schemas represented in the maps, counting the number of concepts in each map and adding the number of relationships (Calori, Johnson, & Sarnin, 1994; Eden, Ackermann, & Cropper, 1992). Each map contains between 63 and 430 concepts and relationships. We further obtained member companies' revenues data from their annual sustainability reports, environmental impact data from the Trucost database (for AA, FM, AL, 2003-2010), and ICMM membership details from ICMM annual reviews. We present compiled information on schema

size, ICMM membership, and members' revenues and environmental impact in Table 2. The evolution of corporate schema sizes over the studied period is represented in Graph 1.

Table 2
Compiled Organizational Data

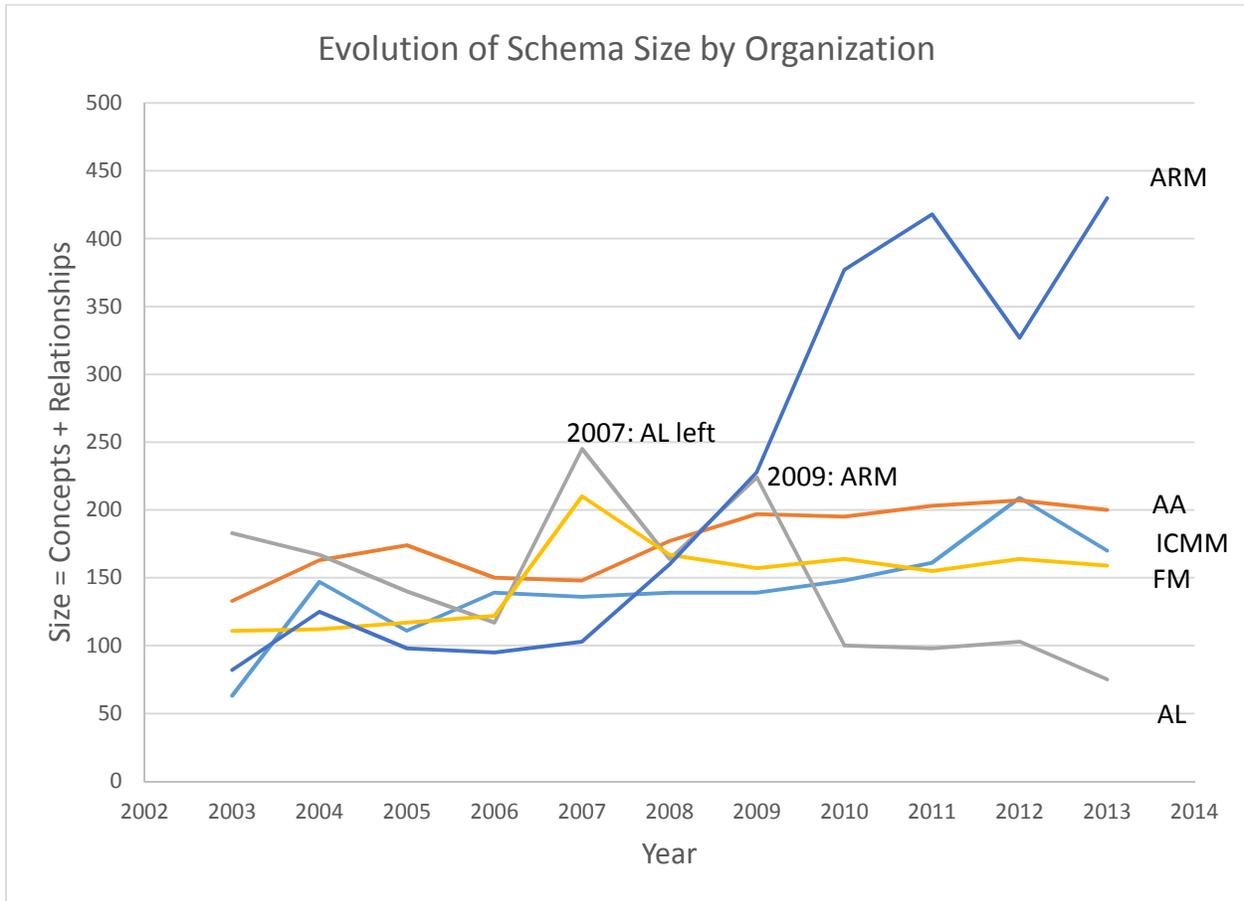
		2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
ICMM	Members*	15/27	16/23	15/24	15/24	16/28	17/30	19/30	18/30	21/31	22/34	21/33
	Concepts (C)	30	70	54	71	66	67	70	74	80	103	83
	Relations (R)	33	77	57	68	70	72	69	74	81	106	87
	Size (C+R)	63	147	111	139	136	139	139	148	161	209	170
AA	Sales (\$bn)	24.9	31.94	34.47	24.99	25.47	26.31	20.86	27.96	30.58	32.79	33.06
Founder	TEDC (\$mn)	6863.99	5369.65	5623.89	6178.31	5325.41	4605.27	5251.51	5075.69	n/c	n/c	n/c
Still in	TEDC/\$ sales	0.27566	0.16812	0.16315	0.24723	0.20909	0.17504	0.25175	0.18153	n/c	n/c	n/c
	Concepts (C)	64	77	89	74	72	79	95	89	89	92	95
	Relations (R)	69	86	85	76	76	98	102	106	114	115	105
	Size (C+R)	133	163	174	150	148	177	197	195	203	207	200
AL	Sales (\$bn)	21.09	23.48	25.57	30.38	29.28	26.90	18.44	21.01	24.95	23.7	23.03
Founder	TEDC (\$mn)	4740.81	4728.29	4477.97	4676.76	4492.58	5568.79	5822.48	6353.99	n/c	n/c	n/c
Left in 2007	TEDC/\$ sales	0.22479	0.20138	0.17513	0.15394	0.15344	0.20702	0.31575	0.30243	n/c	n/c	n/c
	Concepts (C)	88	80	68	56	116	80	101	47	46	48	34
	Relations (R)	95	87	72	61	129	84	123	53	52	55	41
	Size (C+R)	183	167	140	117	245	164	224	100	98	103	75

* Corporate members/Regional and commodity associations

Compiled Organizational Data – Continued

		2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
FM	Sales (\$bn)	2.21	2.37	4.18	5.79	16.94	17.8	15.04	18.98	20.88	18.01	20.92
Founder	TEDC (\$mn)	724.79	393.34	414.56	391.96	1260.3	1830.42	1444.64	1564.22	n/c	n/c	n/c
Still in	TEDC/\$ sales	0.32796	0.16597	0.09918	0.06770	0.0744	0.10283	0.09605	0.08241	n/c	n/c	n/c
	Concepts (C)	53	56	55	58	100	84	72	77	75	79	76
	Relations (R)	58	56	62	64	110	83	85	87	80	85	83
	Size (C+R)	111	112	117	122	210	167	157	164	155	164	159
ARM	Sales (\$bn)	0.63	0.63	0.82	0.64	0.87	1.61	1.30	1.45	2.20	2.14	2.01
New as of 2009	TEDC (\$mn)	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
	Concepts (C)	42	64	48	47	50	73	106	181	202	162	196
	Relations (R)	40	61	50	48	53	87	122	196	216	165	234
	Size (C+R)	82	125	98	95	103	160	228	377	418	327	430

Graph 1
Evolution of Schema Complexity



In the second stage of analysis, we coded map content to capture the meaning and structure of schemas on sustainable development, and in particular, the strategic reasoning underpinning corporate SD initiatives. This stage was intended to facilitate further analysis by clustering map content under comparable categories since our maps cover a variety of topics that do not always lend themselves to comparison. Adopting an inductive and interpretive approach, we identified emerging categories describing sustainability strategies and their components, then clustered map content under these categories. Using terms and phrases employed by the studied organizations, we labeled these categories as follows: strategic objectives, credibility, stakeholder management, leadership, commitment, sustainability performance, and sustainability practices.

Table 3 summarizes how these categories were identified. In addition, we reviewed the cognitive maps built in the first stage of analysis, highlighting the nature of relationships among concepts within the studied schemas. From a schema perspective, by characterizing relationships among concepts and clustering concepts into categories, we reveal the value ascribed to categories, thus fully depicting schema components: concepts (categories), relationships, and values (Bartunek, 1993). In broader terms, we explain how the studied organizations relate and value components of sustainability strategies.

In the third stage of analysis, we looked for similarities and differences between ICMM and member companies' schemas along the considered period, focusing on actions taken. We first identified a set of actions suitable for cross-organizational comparison. It is useful here to note that the activities of the studied companies, although mining-related, differ in nature and scale. Thus, corporate actions linked to technology and production, such as energy supply and consumption, water management, emissions reductions, equipment and operations optimization are hardly comparable across companies in our sample. Instead, we examined sustainability and stakeholder management practices applicable to all the studied companies, including internal control systems, risk management, stakeholder outreach, environmental certifications, dissemination of best practices, and policy implementation. Among these practices is the application of the reporting guidelines developed by the Global Reporting Initiative (GRI), an independent international organization that provides tools for businesses, governments and others to communicate the impact of business on sustainability issues through rigorous sustainability reporting (Global Reporting Initiative, 2017). We chose to showcase the adoption of GRI guidelines because the details of implementation (e.g. audit, level of reporting) and evolution (i.e. GRI G2 in 2002, G3 in 2006, and G4 in 2013) provide multiple points of comparison across companies and over time. We then built an event history database (Maguire & Hardy, 2013; van de Ven & Poole, 1990) to systematically document the sequence of events related to the adoption of GRI guidelines. In this part of the analysis, we used two additional data sources: ICMM *annual reviews* which report members' GRI application levels as of 2009, and the *GRI online database* which discloses companies' GRI compliance and application levels. Cross-organizational comparison over time uncovered patterns of convergence, allowing inferences on mutual influence among ICMM member companies.

Table 3
Categories Describing Sustainability Strategies and Their Components

Categories	Description of Data Coded	Example
Strategic objectives	Conceptual relationships associated with strategy, objectives, goal setting, targets, corporate future, orientation, approaches, priorities, focus, values, vision, and mandate.	The likelihood of operating in a carbon constrained future has been built into our strategic thinking (AA, 2006).
Credibility	Conceptual relationships associated with credibility, confidence, trust, reputation, respect, transparency, accountability, compliance, awards, third-party certification, and audits.	ARM is committed to working smartly, responsibly and efficiently to effectively integrate economic, environmental and social needs as a basis for continuously improving performance and ensuring trust (ARM, 2004).
Stakeholder management	Conceptual relationships associated with stakeholders, partnerships, participations, associations, collaborations, cooperation, joint work, communication, and dialogue.	FM’s engagement with suppliers on the issue of fuel efficiency and GHG emissions helps improve FM’s sustainability performance (FM, 2010).
Leadership	Conceptual relationships associated with leadership, leading, being a leader/catalyst for change/example/role model/partner of choice, pioneering, and providing advice/guidance.	It is through the member companies’ leadership in these critical areas, united by a set of common core values, that we can serve as an example for the mining and metals industry globally (ICMM, 2008).
Commitment	Conceptual relationships associated with commitment, being committed, engagement, moral obligation, doing “what is right”, duty, and responsibility.	As we search for stable and long-term energy supplies, we are committed to decreasing our reliance on fossil fuels by increasing [...] our use of natural, renewable energy sources that help us lower our carbon dioxide emissions (AL, 2003).
Sustainability performance	Conceptual relationships associated with improved environmental performance, reduced environmental footprint/impact, social and environmental outcomes, and contribution to sustainable development.	Working toward sustainable development through our operations and programs helps ensure a healthy environment and communities in our area of operation, which is vital to our future success (FM, 2003).
Sustainability practices	Conceptual relationships associated with the management of sustainability issues, actions taken, efforts made, investments, programs, practices, policies, social and environmental management systems, and performance monitoring.	[We implement] best-practice programmes in enterprise development, local procurement, local capacity building, education and training, and community social investment (AA, 2013)

In the fourth and final stage of analysis, we compared organizational schemas over consecutive years to identify patterns of schema evolution, and underlying processes of change. We used schema change patterns identified in previous research to characterize schema change in the studied sample. Bookkeeping and subtyping are first-order schema change (Bartunek, 1984) patterns, associated with stability in the most valued concepts. Bookkeeping happens through incremental modifications due to minor experiential discrepancy (Balogun & Johnson, 2004; Rothbart, 1981; Weber & Crocker, 1983). Subtyping involves the creation of a subtype or sub-schema to discriminate and isolate strongly discrepant new schemas or experience (Balogun & Johnson, 2004; Labianca et al., 2000; Weber & Crocker, 1983). Replacement and relocation are second-order schema change (Bartunek, 1984) patterns, associated with change in the most valued concepts (Balogun & Johnson, 2004; Labianca et al., 2000; Rothbart, 1981). Replacement occurs through the gradual emergence of a new schema, while relocation starts with the momentary co-existence of two schemas and unfolds with a shift from one to the other (Albert, 1992). We have explained above that the nature of *relationships* among *concepts* also reveals the third component of schemas: *values*. We therefore heeded the nature of new relationships as concepts added to extant schemas in order to capture the value of new concepts. With existing patterns in mind, we attempted to unveil change processes, new schema change patterns, and sequences in patterns.

RESULTS

We present four sets of findings: observations on the studied organizations' schemas, ICMM membership, and environmental performance; a description of schema content and articulation; a cross-organizational comparison of schemas illustrated by the adoption of GRI reporting guidelines; and an analysis of the evolution of corporate members' schemas.

Observations on Schemas, ICMM Membership, and Environmental Performance

In this section, we make general observations on the evolution of the studied organizations' disclosed schemas over time, how they coincide with ICMM membership, with improving environmental efficiency, and in two cases, with net environmental impact reduction.

Schema growth over time. Overall, we observed an augmentation in the size of disclosed schemas over the studied period, as presented in detail in Table 2 and Graph 1. From 2003 to 2013, schema size rose from 63 to 170 for ICMM, 133 to 200 for AA, 111 to 159 for FM, and 82 to 430 for ARM. At AL, the only company to leave ICMM during the period of study, schema size notably

dropped from 183 to 75 in the same period. Except for AL, member companies' schemas increased in size over time, slowly for founding members AA and FM, and rapidly for the new member, ARM. Overall, the size of ICMM's schemas tends to be below that of its members. These observations are coherent with extant research proposing that schemas become more complex with new concepts and relationships as knowledge is acquired (Dane, 2010). Implied is the idea that new concepts and relationships are added and therefore that schemas have a tendency to grow over time. In this sense, increasing schema size in the organizations we studied reflects increasing expertise on the topic of sustainable development.

ICMM membership and schema growth. In addition, our observations suggest that ICMM membership relates to disclosed schemas' size. ARM's schema size, which had been mostly below ICMM's, rose significantly above ICMM's and other members' schema size after it joined ICMM in 2009. In 2013, ARM's disclosed schemas had about 225 more concepts and relationships than ICMM's. Reversely, AL's schema size, which had been above ICMM's during its membership, dropped below ICMM's after its membership ended in 2007. In the final year of the study, AL's disclosed schemas had 100 concepts and relationships less than ICMM's. In contrast, the schema size of founding members AA and FM remained relatively close to ICMM's along the studied period.

Improving environmental efficiency over time. Looking at revenue and environmental impact data, our findings suggest that studied companies improve their environmental efficiency (environmental impact to revenue ratio) over time and build larger schemas on sustainable development. In the studied organizations, environmental impact per dollar of revenue decreases over ICMM membership time, while it increases over non-membership time. From 2003 to 2010, the environmental impact to revenue ratio decreased from 0.28 to 0.18 at AA, and from 0.33 to 0.08 at FM. At AL, it decreased from 0.22 to 0.15 over the period 2003-2007. After AL left ICMM in 2007, its impact to revenue ratio went from 0.15 to 0.30. Where environmental impact data is available (i.e. studied member companies except ARM), schema size coincides with environmental efficiency.

Cases of net environmental impact reduction over time. Importantly, improving impact to revenue ratios do not reflect net environmental impact reduction. Most companies present explicit growth plans in SD reports and insist that long-term net environmental impact reduction should not be expected since environmental impact correlates with operations' growth. This is the

main reason why companies focus on efficiency rather than net impact reduction. One Alcoa report mentions:

“Although the total amount of waste generated in our metals process area has increased as a result of the growth of Alcoa, our processes are generally among the most efficient in the world, with several benchmark plants in terms of process efficiencies and low emissions.” (Alcoa, 2003)

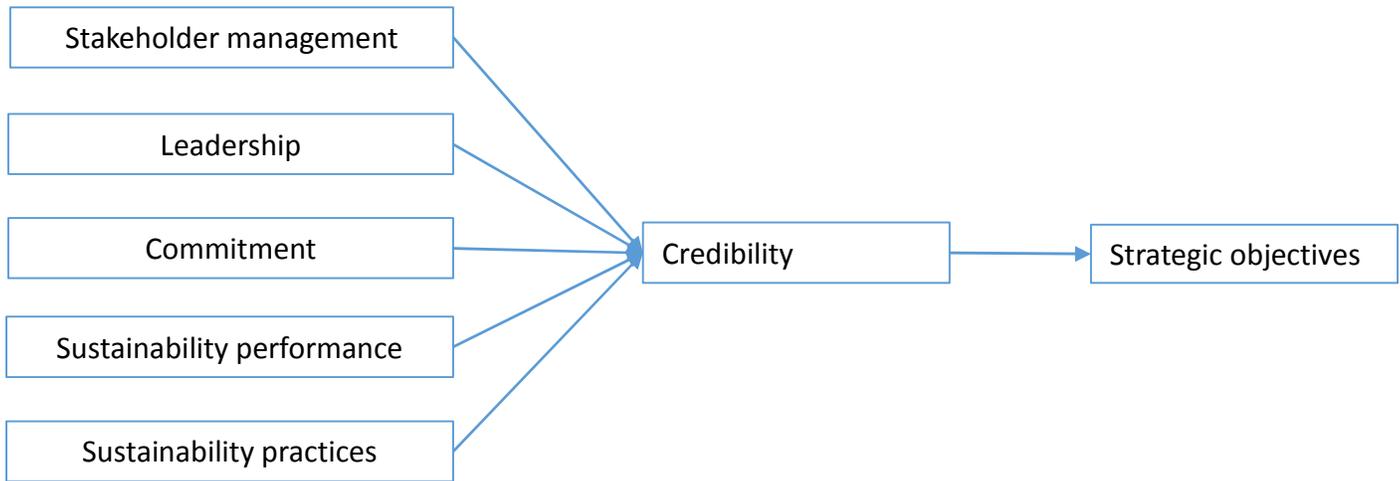
It is therefore remarkable that one company increased efficiency faster than operations, achieving net environmental impact reduction. Anglo American’s environmental impact -measured in dollars of environmental damage cost- declined from \$6.9bn to \$5.1bn in the period 2003-2010. Also notable is Alcoa’s environmental impact down from \$4.7bn to \$4.5bn between 2003 and 2007. After it left ICMM, Alcoa’s environmental impact rose from \$5.6bn to \$6.4bn from 2008 to 2010. Finally, Freeport McMoran’s environmental impact doubled from 2003 to 2010, while its revenues increased tenfold, illustrating the effect of operations’ growth on environmental impact despite best-in-class environmental efficiency.

Schema Content and Articulation

In this section, we describe the seven categories that emerged from coding map content to capture the strategies and strategic components underpinning corporate sustainability initiatives, as explained in Table 3. Building on the conceptual relationships highlighted by cognitive mapping, Figure 2 reveals how these categories relate within the studied schemas. Remarkably, the path diagram in Figure 2 applies to all organizations and endures, indicating similar schemas and shared values across organizations over time. In a nutshell, Figure 2 clarifies that firms leverage sustainability strategies to gain credibility and achieve strategic goals. We unfold this finding in the outline of the seven categories below. Each outline starts with a definition derived from the studied schemas, followed by its location within schemas, and an overview of its content. Finally, we explain how each category connects to the others and to corporate sustainability.

Figure 2

Articulation of Strategic Components Underpinning Corporate Sustainability



Strategic objectives are the most valued goals stated by the studied organizations. They guide organizational actions in the long term and spell out how the other components of strategy connect. Strategic objectives are presented in disclosed schemas as part of the corporate mission, vision, strategy, and policies. Table 4 illustrates that the content of strategic objectives in the studied schemas is centered on the viability and long-term growth of mining operations. Emphasis is placed on continued access to land, capital, markets, and other resources such as a skilled workforce. All other goals connect with strategic objectives following an instrumental logic. In this context, sustainability is primarily understood as business sustainability: “sustainability is defined as using our values to build financial success, environmental excellence, and social responsibility” (AL, 2003-2009); “ensure that we remain a vibrant, sustainable business entity” (FM, 2012); “ensuring the sustainability of our business” (ARM, 2013). Sustainability’s place among other strategic targets depends on its contribution to economic and financial performance.

Credibility represents the mining companies’ ability to make their discourse on sustainability believable by relevant stakeholders (defined below). Credibility amounts to stakeholder trust and is instrumental for mining companies to achieve their stated strategic objectives of access to land, capital, markets and other resources. For example, government trust facilitates the release of mining permits, that is, access to land. Credibility is addressed in disclosed schemas together with content on stakeholders, social capital, reputation, and trust. Table 5 shows that credibility-related content in the studied schemas emphasizes maintaining company and

industry reputation, establishing credibility and building trust, communicating with stakeholders, keeping commitments, and meeting society's expectations. Credibility connects to strategic goals as a means to an end. In turn, all other components of strategy identified in the maps are intended to build, establish, and maintain credibility. Sustainability is no exception: "If resources are not extracted responsibly and in accordance with the needs and standards of society, we will lose the trust of stakeholders." (FM, 2009).

Stakeholder management consists in establishing and maintaining productive communication and collaboration with relevant stakeholders. Relevant stakeholders are those controlling the resources, the access to which is considered a strategic objective. These include investors whose trust affects the financial resources available for operations and growth (access to capital); governments that issue exploration and mining permits (access to land); local communities whose cooperation can make or break a mining operation (access to land); civil society organizations with the influence to enhance or damage a company's reputation (access to all resources); employees whose skills and behavior affects performance outcomes (access to workforce); and other mining companies acting as competitors and partners (access to markets). Disclosed schemas tend to group stakeholder management with content on credibility, market intelligence, and local operations. Table 6 indicates that content on stakeholder management encompasses trend monitoring, change anticipation, crisis prevention, industry promotion, public relations, technological innovation, and market entry. Stakeholder management connects to credibility in a mutually influential relationship: credibility eases stakeholder management, while stakeholder management strengthens credibility. All other components of strategy identified in the maps feed into stakeholder management and credibility. In this sense, perceived sustainability contributes to peaceful and constructive stakeholder relations.

Table 4
Strategic Objectives

Organization	Examples
ICMM	[We] recognise that only by continually demonstrating its ability to contribute to sustainable development, can the industry build the trust and respect necessary to ensure its continued access to land, capital and markets. (ICMM, 2003)
Anglo American	These distinctive challenges mean we must manage a wide range of increasingly salient social and political risks. These issues are fundamental to our continuing access to land and resources and to our ability to attract investors and the best talent. (AA, 2006)
Alcoa	At Alcoa, sustainability is defined as using our values to build financial success, environmental excellence, and social responsibility in partnership with all stakeholders in order to deliver net long-term benefits to our shareowners, employees, customers, suppliers, and the communities in which we operate. (AL, 2003-2009)
Freeport-McMoran	To supply essential metals to current and future generations, we are guided by our stated business objectives, principles and policies, and we continuously improve our sustainable development programs. Our approach has three core elements. Economic: Leverage our operating and financial expertise, technologies and supply chain to ensure that we remain a vibrant, sustainable business entity. Social: Operate safely, and uphold and promote human rights. Engage openly and transparently with internal and external stakeholders and keep our commitments to build trust. This enhances our ability to obtain permits to operate, ensures we have a dedicated workforce and affords us business opportunities. Environmental: Evaluate environmental aspects continuously throughout a project's life cycle to minimize adverse impacts and promote opportunities. (FM, 2012)
African Rainbow Minerals	In order to meet our commitment to preserving and enhancing shareholder value, ensuring the sustainability of our business and achieving long-term growth, ARM: works responsibly; has a governance structure in place; is respectful of all our stakeholders; provides an environment which encourages our employees; maintains a non-discriminatory workplace; invests in the health and wellbeing; employs a devolved management structure; aims for operational excellence; improves the living conditions; and, adds shareholder value. (ARM, 2013)

Table 5
Credibility

Organization	Examples
ICMM	Trust and respect [are] necessary to ensure [the industry's] continued access to land, capital and markets. (ICMM, 2003) The sector was facing a number of significant challenges, notably: maintaining the industry's reputation; sustaining profits; accessing new assets; and preserving investor and employee confidence. (ICMM, 2007)
Anglo American	How can trust be built between companies, NGOs and the public at large? One way is through very open reporting on standardised indicators such as those developed by the Global Reporting Initiative (GRI). (AA, 2005) To turn a stakeholder into a business partner, we need to demonstrate that we can be trusted to do the right things all the time. (AA, 2013)
Alcoa	Alcoa is at its best when we keep open lines of communication to all of our stakeholders, and respond decisively when they raise legitimate concerns. (AL, 2007) The key message we received from panel members is that they want to know how we think. They are looking for assurances of a carefully considered thought process within our company that leads to the programs and actions we undertake. (AL, 2007)
Freeport-McMoran	Our fundamental challenge is to find the most efficient production methods that will enable us to meet demand for our products in a cost-effective manner while minimizing negative impacts. If resources are not extracted responsibly and in accordance with the needs and standards of society, we will lose the trust of stakeholders. (FM, 2009) [Our approach is to] engage openly and transparently with internal and external stakeholders and keep our commitments in order to build trust. This enhances our ability to obtain permits to operate and ensures we have a dedicated workforce (FM, 2010-2013)
African Rainbow Minerals	At [African Rainbow Minerals] we are committed to: [...] working smartly, responsibly and efficiently to effectively integrate economic, environmental and social needs as a basis for continuously improving performance and ensuring trust. (ARM, 2004) I have no doubt that the South African Government is aware of these mining success stories and recognises the crucial importance of maintaining the confidence and trust of the investment community. (ARM, 2012)

Table 6
Stakeholder Management

Organization	Examples
ICMM	<p>Objectives: [...]</p> <p>2. To listen to others, identify public concerns and anticipate change so members can better understand evolving societal values, proactively address risks, avoid crises and serve in a leadership position in addressing issues of public concern.</p> <p>3. To identify and communicate the nature of the contribution of the mining, minerals and metals industry to sustainable development.</p> <p>4. To build and maintain effective relationships with those important for ensuring the industry's licence to operate. (ICMM, 2009-2013)</p>
Anglo American	<p>We are committed to working to extract and transform the natural resource capital wisely: creating jobs, building skills, contributing to social and physical infrastructure. We continue to work to conserve biodiversity and minimise pollution, waste and resource consumption for the benefit of our shareholders, our employees and the communities and countries in which we operate. (AA, 2004)</p>
Alcoa	<p>Alcoa's vision is to be the best company in the world. To achieve this, we need to engage our stakeholders, set short- and long-term goals, implement initiatives to reach those goals, and be the best company in the communities in which we operate. (AL, 2004)</p>
Freeport-McMoran	<p>The foundation of our plans for production growth and resource expansions includes our commitment to join with stakeholders in working toward sustainable development. (FM, 2013)</p>
African Rainbow Minerals	<p>An integral part of ARM's business is the forging of partnerships with key players in the commodity sectors to ensure that ARM is at the forefront of technological development and global practices and has access to key markets and to value-generating growth opportunities. (ARM, 2006-2010)</p>

Leadership is mining organizations' ability to influence relevant stakeholders and is primarily directed at other mining companies and associations, investors, and local communities. Firms claim leadership to disseminate their ideas and positively impress stakeholders. Leadership in disclosed schemas is thus often associated with self-promotion. Table 7 shows that the studied organizations assert leadership in varied areas such as size, assets, mining, operational performance, health, safety, environmental and materials stewardship, socio-economic development, sustainability, and technology. Leadership directly connects to stakeholder management through stakeholder influence, and to credibility as perceived leadership enhances organizational credibility. It connects to commitment, sustainability performance, and sustainability practices to the extent that leadership is seen as a result from genuine commitment and effective sustainability practices, and can be demonstrated through sustainability performance. Although leadership based on size, assets, and operational performance might not fit the definition of environmental sustainability, it suits the studied organizations' understanding of sustainability as business continuation. In this perspective, sustainability leadership equates business leadership.

Commitment represents the studied organizations' adherence to sustainability principles and engagement in related activities. Most often commitment stands for organizational intentions with regards to sustainability. In disclosed schemas, commitment is addressed within corporate approaches, policies, and programs, as well as within references to membership in industry associations, partnerships with stakeholders, and compliance with regulation. Table 8 exemplifies commitment's association with socially desirable features and activities such as transparency, dialogue, collaboration, health and safety, and environmental, social, and economic benefits. Commitment connects to credibility as a declaration of intention to "do the right thing", and to sustainability practices as an assumed trigger. Further, stakeholders assess the authenticity of corporate commitment to sustainability through enacted sustainability practices and demonstrated sustainability performance. Sustainability here is therefore both an intermediate goal serving strategic objectives and an indicator of good faith.

Table 7
Leadership

Organization	Examples
ICMM	It is through the member companies' leadership in these critical areas [health, safety, environmental and materials stewardship, socio-economic development], united by a set of common core values, that we can serve as an example for the mining and metals industry globally. (ICMM, 2008)
Anglo American	Anglo American has long had a reputation for being a sustainability leader. [...] Major mining companies can and should be considered development partners while at the same time continuing to be successful businesses. My ambition is for all our host communities, and our wider stakeholder base, to feel their lives are better for Anglo American's presence. (AA, 2013)
Alcoa	[We] believe that this upgraded technology can be used by others to increase hydro efficiency worldwide. (AL, 2003) In many instances, we are performing beyond compliance and leading the establishment of new, higher standards. (AL, 2003) We were included in the Dow Jones Sustainability Indexes for the twelfth consecutive year and again recognized as the global sustainability leader for the aluminum industry. (AL, 2013)
Freeport-McMoran	On March 19, 2007, Freeport-McMoRan Copper & Gold Inc. completed its acquisition of Phelps Dodge Corporation, creating the world's largest publicly traded copper company. The new Freeport-McMoRan Copper & Gold Inc. will be an international mining industry leader with its corporate headquarters in North America (FM, 2006) Getting [sustainable development] wrong would jeopardize our position as a leading international mining company. (FM, 2011)
African Rainbow Minerals	ARM is a leading South African diversified mining and minerals company with world-class long-life, low-cost assets in key commodities. An integral part of ARM's business is the forging of partnerships with major players in the resource sector. (ARM, 2010) [ARM] aims for operational excellence and continuous quality improvement, which includes employing a leading practice sustainable framework to fulfil our aim of achieving leading environmental and health performance and a safe, injury-free workplace. (ARM, 2013)

Table 8
Commitment

Organization	Examples
ICMM	<p>Our members are committed to improving their sustainable development performance and to producing responsibly the mineral and metal resources society needs. (ICMM, 2004)</p> <p>There are few short cuts to trust building. It relies on industry to commit to continuous disclosure, information sharing, openness to engagement and dialogue. (ICMM, 2012)</p>
Anglo American	<p>A major challenge for the extractive sector is to ensure that we work in harmony with local communities and that our operations are acknowledged as good neighbours. This requires regular engagement with local people and a commitment to maximising the social and economic contribution which we make during the lifetime of our operations so that they contribute to sustainable development. (AA, 2003)</p> <p>Today, businesses that operate sustainably are likely to prosper. For Anglo American it means meeting our commitments to stakeholders and seeking to operate to the highest possible standards of safety, health, environmental and community development practices. (AA, 2013)</p>
Alcoa	<p>Our commitment to sustainability has a long history and is evident everyday — from the way we live our Values to the following strategic framework for sustainability supported by measurable objectives for guiding our operations. (AL, 2003)</p> <p>By staying true to that commitment, we made significant strides toward our strategic sustainability targets in 2012 despite significant global economic volatility. (AL, 2012)</p>
Freeport-McMoran	<p>Demonstrating the strength of our commitment, we spent a total of \$93 million on sustainable development programs in the area of our mining operations during 2003, including \$52 million on environmental management and \$41 million on social development. (FM, 2003)</p> <p>The foundation of our plans for production growth and resource expansions includes our commitment to join with stakeholders in working toward sustainable development. (FM, 2012-2013)</p>
African Rainbow Minerals	<p>At [ARM] we are committed to embedding sustainable development as an integral part of the business (ARM, 2003-2005)</p> <p>We are committed to conduct our business safely and responsibly, as we seek to forge partnerships that increase our access to markets and value-generating growth opportunities. (ARM, 2010)</p>

Sustainability performance describes the impacts of corporate programs, practices, and products in the economic, social, and environmental domains. Mining companies use sustainability performance to demonstrate commitment and progress. Sustainability performance is disclosed in introductions, executive addresses, and general and topic-specific performance reviews on climate change, materials stewardship, health and safety, etc. Table 9 evidences that the content of sustainability performance centers on economic, social, and environmental benefits. Sustainability performance connects to commitment, leadership, and sustainability practices respectively as a proof of authenticity, progress, and effectiveness. Ultimately, it facilitates stakeholder management and enhances organizational credibility. Again here, environmental sustainability is an intermediate goal serving strategic objectives and an indicator of good faith.

Sustainability practices are organizational actions meant to enhance business viability through positive impacts in the economic, social, and environmental domains. Like with sustainability performance, mining companies use sustainability practices to demonstrate commitment and progress. Indeed, firms frequently confound practices and performance, so that sustainability practices stand as contributions to sustainability whose positive impact is presumed rather than shown: “Although anecdotal evidence points to member practices creating significant sustainable development-related improvements, for example, objective documentation and assessment of overall progress remains elusive.” (ICMM, 2009: 7). Within disclosed schemas, sustainability practices are presented in general and topic-specific performance reviews, and detailed in case studies. Table 10 attests that the content of sustainability practices revolves around economic, social, and environmental benefits. Sustainability practices connect to commitment and leadership respectively as evidence of authenticity and progress. Further, when substantiated by sustainability performance, sustainability practices fuel stakeholder management and enhance credibility.

Table 9
Sustainability Performance

Organization	Examples
ICMM	<p>ICMM members offer strategic industry leadership towards achieving continuous improvements in sustainable development performance in the mining, minerals and metals industry. (ICMM, 2003)</p> <p>ICMM makes a vital contribution to strengthening mining and metals' contribution to sustainable development (ICMM, 2013)</p>
Anglo American	<p>Improved energy efficiency impacts both business performance and environmental benefits, and a wide range of initiatives are in various stages of development across the Group. The progress of these projects is being closely monitored to ensure maximum financial and developmental leverage is obtained to complete these projects successfully. (AA, 2005)</p>
Alcoa	<p>Through their light weight, high strength, durability, and recyclability, our products are inherently sustainable and improve the sustainability of our customers' products. (AL, 2012)</p> <p>Between 2005 and 2013, we reduced the GHG emission intensity of our Global Primary Products business by 25.5%. We reduced our absolute GHG emissions by 3.1 million metric tons from 2012 to 2013, and our total 2013 GHG emissions (CO2 equivalents) equaled 43.4 million metric tons. (AL, 2013)</p>
Freeport-McMoran	<p>Working toward sustainable development through our operations and programs helps ensure a healthy environment and communities in our area of operation, which is vital to our future success. (FM, 2003)</p> <p>We develop infrastructure, support health, safety and education efforts, and provide local employment and business development opportunities. The metals we produce are critical for a sustainable, healthy, energy-efficient society. (FM, 2011-2013)</p>
African Rainbow Minerals	<p>[Our] sustainable development initiatives continue to contribute meaningfully to the social and economic landscape in South Africa. (ARM, 2003)</p> <p>As long as environmental, social and governance-related challenges associated with mining are adequately managed through sound risk management-based practices, mining is a promising sector for investment and an important vehicle for development and poverty alleviation. (ARM, 2010)</p>

Table 10
Sustainability Practices

Organization	Examples
ICMM	ICMM members launched a pilot third party assurance procedure to report on their performance [...] Independent assurance is not only critical to the credibility of the Framework, it is also proof that [...] ICMM’s member companies are prepared to both stand by these commitments and be openly and independently judged against them. (ICMM, 2006)
Anglo American	Besides the potential cost savings of using wind power where grid power is expensive, wind energy reduces the burning of fossil fuels for conventional power generation. The carbon credits that will accrue to sustainable power generation will play an important role in our ability to secure environmental permits for our new mining operations. (AA, 2003)
Alcoa	We eliminate waste every day, reducing our costs and capital requirements. (AL, 2003) In 2009, we piloted a “design for sustainability” product strategy for consumer electronics and conducted product pilots for a laptop and a cell phone. We expanded our product pilots in 2010, including significantly increasing furniture’s recyclable material content and reducing its end-of-life landfilling by nearly 75% and weight by 50%. (AL, 2010)
Freeport-McMoran	PT Freeport Indonesia was one of the first mining operations in Indonesia to achieve this recognition when we were awarded ISO 14001 certification in December 2001 for our mining and ore processing operations. This significant achievement demonstrates our strong commitment to providing effective environmental management at our operations. (FM, 2004) Our Environmental Policy is based on our objective to be compliant with laws and regulations and to minimize environmental impacts using risk management strategies based on valid data and sound science. It requires that we [...] conduct the design, development, operation and closure of each facility in a manner that optimizes the economic use of resources while reducing adverse environmental effects. (FM, 2011)
African Rainbow Minerals	A number of short-term measures have been put in place at an operational level to deal with reduced energy consumption constraints [...] such as: Replacing incandescent lights with fluorescent lights, and the distribution of low-energy bulbs; Improved control of geysers; Introducing new ventilation start-up procedures and reviewing ventilation requirements; Optimisation of compressed air usage [...]. (ARM, 2008)

Cross-Organizational Comparison: The Adoption of the GRI Guidelines

In this section, we describe when and how each of the studied organizations adopted the GRI guidelines, updates, and related practices (e.g. GRI application level assurance) with a view to infer influence from certain ICMM members on others' schemas and actions. Although our review of organizational schemas indicates that many sustainability-related actions follow a similar pattern of adoption as that of the GRI guidelines, we present the latter to illustrate characteristics of adoption shared across sustainability-related actions. We start with individual chronologies of adoption of GRI guidelines, summarized in Table 11, followed by a comparison of GRI adoption timelines in the studied companies.

Chronologies of adoption. The GRI released the 2002 Sustainability Reporting Guidelines (G2) in an effort to enhance the quality and rigour of its first set of guidelines (G1) tested in 1999 and published in 2000. As early as 2003, the ICMM signed an agreement with the GRI to work on a Mining and Metals sector supplement to the G2, completed in 2004 and published in 2007. The ICMM also participated in the development of the 2006 GRI G3 and 2013 GRI G4 guidelines, along with a large and diverse group of companies, unions, non-governmental organizations, and research institutions. In 2005, the ICMM formally committed its corporate members to report in accordance with the GRI guidelines and tested a procedure for independent third-party assurance of sustainability reports in 2006. The assurance procedure was approved in 2008, formally committing ICMM corporate members to independent external assurance as regards ICMM sustainability principles and the GRI (G3) guidelines.

AA issued its first report in accordance with GRI (G1) guidelines in 2001. AA's reports complied with G2 from 2003 to 2006, and with G3 from 2007 to 2013, when AA transitioned to the G4. AA participated in the review of the G3 in 2005, started reporting the highest level of application of GRI guidelines (i.e. A+) immediately after it adopted the G3 in 2007, and maintained that level consistently until 2013. In 2003, AA was the first among the studied companies to provide independent third-party assurance of its sustainability reports, and of its GRI application levels in 2007, entrusting these tasks to two of the big four accounting and assurance firms, KPMG and PricewaterhouseCoopers. Finally, AA was one of the first two companies to make a GRI compliance table (called a GRI index) publicly available every year to demonstrate their reports' conformity with GRI guidelines.

Table 11
Chronology of GRI Guidelines Adoption

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
ICMM corporate members officially commit to report in accordance with GRI G2 (2002) guidelines											
	n*	n*	y	y	y	n	n	n	n	n	n
ICMM corporate members officially commit to report in accordance with GRI G3 (2006) guidelines											
	n	n	n	n	n	y	y	y	y	y	y
ICMM corporate members officially comply with GRI G2 (2002) guidelines											
AA	y	y	y	y	n	n	n	n	n	n	n
AL	y	y	y	n	n	n	n	n	n	n	n
FM	n	n	n	y	y	n	n	n	n	n	n
ARM	n	n	n	y	n	n	n	n	n	n	n
ICMM corporate members officially comply with GRI G3 (2006) guidelines											
AA	n/a	n/a	n/a**	n**	y	y	y	y	y	y	y**
AL	n/a	n/a	n/a	n	y	y	y	y	y	y	y**
FM	n/a	n/a	n/a	n	n	y***	y	y	y	y	y
ARM	n/a	n/a	n/a	n	n	y	y	y	y	y	y
GRI G3 application level											
AA	n/a	n/a	n/a	n	A+	A+	A+	A+	A+	A+	A+ **
AL	n/a	n/a	n/a	n	Undeclared	Undeclared	Undeclared	A+	A+	B	n/a **
FM	n/a	n/a	n/a	n	Undeclared	Undeclared	A+	A+	A+	A+	A+
ARM	n/a	n/a	n/a	n	n	n	C	B+	A+	A+	A+
GRI G3 third-party assurance of application level											
AA	n/a	n/a	n/a	n	Limited	y	Limited	Limited	Limited	Limited	n
AL	n/a	n/a	n/a	n	n	n	n	y	y	n	n
FM	n/a	n/a	n/a	n	n	n	Limited	Limited	Limited	Limited	Limited
ARM	n/a	n/a	n/a	n	n	n	n	y	y	y	y

Chronology of GRI Guidelines Adoption – Continued

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Report auditor											
AA	KPMG UK	KPMG UK	KPMG UK	KPMG UK	PWC ZA	PWC ZA	PWC ZA	PWC ZA	PWC ZA	PWC ZA	PWC ZA
AL	none	none	none	ICCR	AL Panel	AccountAbility	none	PWC ☉	PWC ☉	none	none
FM	none	none	Unidentified	Unidentified	Unidentified	Unidentified	CorpIntegrity	CorpIntegrity	CorpIntegrity	CorpIntegrity	CorpIntegrity
ARM	EY ZA†	EY ZA†	EY ZA†	EY ZA†	EY ZA†	none	none	SustServices ZA	SustServices ZA	IRAS ZA	IRAS ZA
Report includes a GRI compliance table/index											
AA	Online	Online	Online	Online	Online	Online	Online	Online	Online	Online	Online
AL	y	y	Online	Online	Online	Online	Online	Online	Online	Online	Online
FM	n/a	n/a	n/a	Online	Online	Online	Online	Online	Online	Online	Online
ARM	n/a	n/a	n/a	n	n	n	y	y	y	y	y

y = yes; n = no; n/a = not applicable.

CorpIntegrity = Corporate Integrity; EY = Ernst & Young; ICCR = Interfaith Center on Corporate Responsibility;
 IRAS = Integrated Reporting & Assurance Service; PWC = PricewaterhouseCoopers; SustServices = Sustainability Services;
 UK = United Kingdom; ZA = South Africa.

* As of 2003, ICMM worked with GRI on a Mining & Metals supplement to GRI guidelines.

** In 2005, AA participated in the review of the GRI G3 guidelines. In 2013, AA and AL transitioned to the new GRI G4 guidelines.

*** Meets GRI G2 guidelines. A supplement was issued later in 2008 to meet GRI G3 guidelines.

☉ Only GHG emissions were audited, not the whole report.

† Annual report, not sustainable development report

AL published its first GRI-compliant report in 2003 and adhered to G2 from 2003 to 2005. After not complying in 2006, reports aligned with G3 from 2007 to 2012, and with G4 in 2013. AL left the ICMM in 2007 and was thus not constrained by ICMM membership requirements to report in accordance with the GRI guidelines from 2007 to 2013. Perhaps reflecting its voluntary compliance, AL did not state its G3 application level from 2007 to 2009, declared an A+-level in 2010 and 2011, a B-level in 2012, and in 2013, converted fully to G4 which has different application levels. Further, AL only had its G3 application level assured by an independent firm in 2010 and 2011. AL provided a GRI index within its sustainability report in 2003 and 2004, then online from 2005 to 2013. Although AL had its reports audited twice over the studied period, it experimented with various types of report feedback, never settling on one. AL solicited shareholder comments from the Interfaith Center on Corporate Responsibility (an association of faith-based institutional investors) in 2006, recommendations from a pilot sustainability report review panel (seen then as an initial step toward third-party assurance) in 2007, an independent commentary on reporting by the consulting and standards firm AccountAbility in 2008, and limited assurance on greenhouse gas emissions by PricewaterhouseCoopers in 2010-2011.

FM released its first GRI report in 2006, three years after AA and AL. FM's reports aligned with the G2 in 2006 and 2007, with G2 then G3 in 2008, and with G3 from 2009 to 2013. FM did not declare its level of application of the G3 guidelines in 2008, but reported the highest level (i.e. A+) as of 2009. From 2009 to 2013, FM had its application level assured by an independent firm, Corporate Integrity, which also audited FM's sustainability reports. FM started publishing a GRI index as of 2006.

ARM's reports first complied with G2 in 2006, and after a GRI-free year in 2007, with G3 from 2008 to 2013. ARM thus started experimenting with GRI guidelines before becoming an ICMM member in 2009, perhaps as a result of its business relations with AA South Africa (see below). As of 2009, ARM declared its G3 application levels, starting with "C" in 2009, "B+" in 2010, and "A+" from 2011 to 2013. ARM obtained independent assurance for its GRI application level and sustainability reports from 2010 to 2013 and included GRI indices in its sustainability reports from 2009 to 2013.

Cross-organizational comparison. The chronology of GRI adoption indicates that AA pioneered the application of GRI guidelines while the other studied organizations followed. In the first stage of analysis, we have determined that AA is the largest company in our sample with

revenues of \$24.9bn in 2003. AL, a close second in revenues/size (\$21.09bn in 2003) adopted GRI reporting two years later. Smaller companies, FM (\$2.21bn in 2003) and ARM (\$0.63bn in 2003 and not an ICMM member until 2009) started releasing GRI reports four years after AA. Larger firms adopted GRI guidelines earlier, perhaps enabled by slacker resources than their smaller counterparts.

In 2003, two years after its inception and the same year as its first annual review, ICMM signed an agreement with the GRI to work on a mining and metals supplement to the G2 guidelines. The chronology of adoption further suggests that the smaller ICMM member and ICMM outsider either did not know about G2, or did not consider its implementation a priority at the time. This shows, first, that some ICMM founders were promoting the adaptation of GRI reporting standards to the mining industry when other mining companies had not started implementing GRI guidelines; and second, that GRI proponents had enough influence to have the trade association engage in discussions with the GRI in the name of all 42 members (15 firms and 27 national and commodity associations) shortly after ICMM's inception. Further, GRI proponents were able to make GRI G2 compliance and external assurance formal requirements for ICMM's corporate members, respectively as of 2006 and 2008. FM adopted GRI reporting one year after the 2006 milestone. So did ARM without obligation, but possibly as a result of its multiple ties to AA. AA South Africa was a shareholder of the company whose restructuring created ARM in 2004. As well, up to four former AA employees were on ARM's board of directors between 2004 and 2013, including the CEO, André Wilkens. Finally, ARM maintained business relationships with AA over the studied period, particularly two joint ventures in platinum mining.

Before the ICMM committed its corporate members to report in accordance with the new G3 guidelines in 2008, AA reviewed the G3 for two years and implemented the G3 for one year at the highest application level, assured by an independent firm. As noted, AA maintained G3 reporting, A+ application level, and independent report assurance until 2013. In contrast, AL did not participate in the review of the G3, and although it started complying with G3 the same year as AA, it declared an application level only four years later and provided application level assurance only in 2010 and 2011. Further, AL did not maintain the highest application level; it went from A+ in 2010-2011 to B in 2012. FM started reporting along the G3 one year after AA and AL, in 2008. That year, FM released a G2-compliant report and a G3-compliant report later on with no application level. FM first declared an application level in 2009, two years after AA

and one year before AL. From 2009 on, FM declared an A+ application level and provided independent assurance, surpassing AL's efforts in the later years. ARM, though not an ICMM member yet, started reporting according to the G3 the same year as FM, and did not declare an application level right away. In 2009, ARM declared a beginner's application level, "C", without independent assurance. In 2010, ARM reported an intermediate application level, "B+", with independent assurance. From 2011 to 2013, ARM filed an advanced application level of "A+" with independent assurance, thus surpassing AL's reporting transparency in 2012. Corporate publication of GRI indices followed a similar adoption pattern, with AA and AL starting in 2003, FM following in 2006, and ARM in 2009. Remarkably, ARM made the extra effort to present GRI indices within the report in contrast with the other firms which provided GRI indices online.

In sum, we find that larger firms in our sample adopted GRI guidelines, their updates, and related practices earlier than their smaller counterparts. One firm in particular, AA, acted proactively by monitoring upcoming guidelines, participating in their review, being the first to publish a GRI index along with its reports, the first to declare a GRI application level and to have it assured, and the first to have its sustainability reports audited. This level of engagement with GRI guidelines distinguishes AA, still an ICMM member to this day, from AL, which left the ICMM in 2009. Our review of other practices such as formal compliance with ICMM sustainability principles, international stakeholder engagement, dissemination of best sustainability practices, and implementation of mining site closure policies suggests that their adoption followed a similar pattern. Larger firms adopted these sustainability practices first, but only one firm anticipated future trends, influencing and experimenting with new practices before others -including the industry association itself- formally adopted them. The other large firm implemented sustainability practices early but inconsistently, occasionally letting smaller companies exceed its sustainability reporting performance. Smaller firms were later adopters, but while FM quietly followed in AA's tracks, ARM became a model complier quickly after joining ICMM.

The Evolution of Organizational Schemas

In this section, we describe the findings of our analysis of change in the schemas of ICMM and the studied corporate members over time. We identified two basic processes of schema evolution -growth and reduction- which form the building blocks of schema change patterns and schema evolution more broadly. We also found that change does not equally affect all schema content. Concepts and relationships which do not disturb existing values often arise and disappear,

whereas concepts and relationships which define existing values persist. We call the former peripheral content, and the latter core content, and depict both in Figure 3.

While we inquired into new schema change patterns and pattern sequences, our data rather exemplified known schema change patterns: common occurrences of bookkeeping (incremental change), infrequent episodes of subtyping (isolation of new ideas), and no instance of replacement (disappearance of an old schema and emergence of a new one) or relocation (coexistence then switch from an old to a new schema). Our data revealed two basic change processes –growth and reduction– that characterize all schema evolution. Growth adds new concepts and relationships to existing schemas, whereas reduction subtracts concepts and relationships. Although growth and reduction occurred repeatedly, growth predominated, consistent with the finding from the first stage of analysis that schemas expand over time. Further, schema growth chiefly followed the values that we exposed in our second set of findings: sustainability strategies enhance credibility and advance strategic goal attainment. Thus, corporate expertise about sustainability deepened as disclosed schemas grew, but new knowledge obeyed persistent values as it connected to extant one. Concepts and relationships changed although broader meaning conformed to relatively invariant values. In this sense, evolving schemas became different yet the same.

As we looked at the continual operation of growth and reduction, the overall homogeneity in the studied schemas at first baffled us. How could blind addition and subtraction of content assemble such a coherent whole? Looking closer, we found that growth and reduction followed certain rules. When a given concept and connecting relationships could not directly impact the ultimate values of credibility enhancement and strategic goal attainment, they would go through many additions and subtractions. We termed these concepts and relationships peripheral content. For example, content related to carbon emissions and climate change (CC) went through numerous changes in FM's disclosed schemas. Initial considerations in 2006 focused on energy conservation. Quickly, concerns emerged regarding carbon regulations and the potential increase of energy and compliance costs. FM's schema on CC thickened with the addition of concepts like greenhouse gases (GHG), and direct and indirect GHG emissions. In 2009, FM first linked CC and water management, stating: "Cyclical weather changes and competing uses may, however, affect water availability and we are evaluating ways to use water more efficiently and develop contingency plans to ensure uninterrupted operations" (FM, 2009). After 2010 though, FM cancelled two out of three GHG emissions reduction initiatives and essentially muted the topic of CC. The potential

impacts of CC in water-stressed regions came back to FM's disclosed schemas in 2013. In this example, we observe that FM's schema about CC underwent various additions -energy conservation, carbon tax mitigation, water management- and subtractions –no emphasis on energy and carbon tax in later years. These additions and subtractions however left strategic goals intact; change in peripheral content preserved underlying schema values.

In contrast, when a concept and connecting relationships could directly affect the ultimate values of credibility enhancement and strategic goal attainment, they would go through additions but few or no subtractions. We termed these concepts and relationships core content. For example, content related to trust and respect grew steadily within ICMM's disclosed schemas. The idea that trust and respect condition access to land, capital, and markets popped up from the start. So did the notion that the mining industry needs to prove and improve its contribution to sustainable development in order to build trust and respect (2003-04). Both assumptions persisted and gathered ancillary content over time: collective action (2003), transparency and accountability (2004), dialogue with stakeholders, independent insurance, credibility, reputation (2006), responsible voice for the industry (2007), wide recognition of contribution to sustainable development (2008), being held in high regard, evidence of recognition, being increasingly known, engagement with civil society, respect across core stakeholder groups (2009), ICMM effectiveness, collaboration with stakeholders, open and honest exchange of ideas, strong relationships, pride and integrity (2010), a credible and constructive voice (2011), distrust, trust deficit, conflict, the trust challenge, shared goals, trust is a long-term investment, compliance with laws and regulations, beyond legal obligations, community trust, increasing social awareness of consumers (2012), mutual benefit, joint stakeholder research programs at the country and community levels (2013). In this example, we observe that ICMM's schema about trust persisted and grew with the addition of new concepts and relationships and no subtractions over the studied period. Further, the conceptual relationship between trust and strategic goals was regularly reaffirmed, so that successive additions to the concept of trust energized strategic goals. Change in core content mainly took the form of additions and preserved underlying schema values.

lamented a lack of systematic evidence supporting progress in industry-level sustainability performance.

Our first research question asked: How do corporate schemas evolve over time? Our findings suggest that, fundamentally, schemas evolve through two mechanisms: growth, the addition of new concepts and relationships, and reduction, the subtraction of concepts and relationships from existing schemas. These two mechanisms spark the most basic changes in schemas and can therefore portray all schema change including more elaborate patterns. For example, drawing on the notions of peripheral and core schema content, we might describe bookkeeping (Balogun & Johnson, 2004; Rothbart, 1981) as the incremental addition and subtraction of peripheral content; subtyping (Balogun & Johnson, 2004; Weber & Crocker, 1983) as the substantial addition of core content; replacement (Albert, 1992; Labianca et al., 2000) as the incremental reduction of core content followed by the incremental addition of new core content; and, relocation (Albert, 1992; Labianca et al., 2000) as the substantial addition of new core content followed by the substantial subtraction of existing core content. These distinctions matter for two main reasons. First, explanations of change processes in organizations are too often made of discrete phases connected in a linear sequence and tend to oversimplify the change process and its components (Stevenson & Greenberg, 1998; Van De Ven & Poole, 1995). In contrast, although growth and reduction depict schema change in its simplest manifestations, they highlight the characteristics of change, specifically, the “what” (i.e. core and peripheral content) the “how” (i.e. incremental and substantial change), and the “when” (i.e. different sequences of growth and reduction lead to distinct schema change patterns). Practically, much research conceptualizes schema change as a state followed by a different one. By shedding light on growth and reduction, this paper makes clear that, for one state to follow another, existing schema content must shrink until it disappears and new schema content must appear and grow, not necessarily in that order. Second, there is a significant difference between patterns of schema change and mechanisms of schema change. Patterns of schema change can only be identified *ex-post*, because the sequence of a given pattern needs to unfold before we can recognize it. Growth and reduction combined with the notions of core and peripheral content offer the possibility of an ongoing, fine-grained analysis and description of schema change patterns through the basic mechanisms of addition and subtraction. For example, the description of schema change patterns above suggests that the subtraction of core content is a key distinction between first- and second-order schema change.

Future research can leverage this distinction to facilitate the identification of replacement and relocation which are rarely observed in organizational settings. Also, by allowing a clear description of existing schema change patterns, growth and reduction also facilitate the identification of new schema change patterns in future research.

Further explaining how schemas evolve, our findings reveal that schemas tend to grow over time. Growth and reduction occurred frequently in the studied schemas, but growth predominated and schemas expanded while the companies in our sample, with the exception of Alcoa, disclosed more intricate thinking about sustainability. This is consistent with the theorization that individual expert schemas encompass more “attributes and interrelationships” and “are more complex than the novice’s schemas” (Dane, 2010: 582). Our findings indicate that organizational schemas evolve similarly: schemas tend to grow as corporate expertise on sustainability deepens. We do not affirm that organizational schemas never shrink, but rather that reduction occurs less often. The predominance of schema growth corroborates that organizational members strive not to revise extant schemas (Garfinkel, 1967; Weick, 1995). As noted, we found that some concepts, relationships, and values are central to the schemas under study and underpin the entire schema about sustainability. They depict sustainability strategies in the service of higher strategic goals. We called them core content. Change in core content is prone to cascade through the entire schema, significantly changing the way in which organizations strategically ponder sustainability. We exposed that core content remained stable across companies and over time, and underwent additions but virtually no subtraction. In contrast, some concepts, relationships, and values are on the fringe of schemas. They depict sustainability considerations with little impact on higher strategic goals. We designated them as peripheral content. Change in peripheral content appears to disrupt nearby concepts and relationships, not the whole schema, so that organizations’ look at sustainability remains the same. We uncovered that peripheral content fluctuated across companies and over time, and went through a number of additions and subtractions. By showing that core content is more stable than peripheral content, and growth prevails over reduction, we support prior theorization that organizations prefer not to amend extant schemas when they can and therefore favor first-order schema change over the more disruptive second-order schema change (Pain, 2015).

In sum, the phrase “schema change” may mislead because it obfuscates change mechanisms that add to and subtract from existing content, leading to new one. At the simplest

level, schema change manifests in content addition and subtraction, simple mechanisms that can help future research on documented and perhaps new schema change patterns. As well, not all schema content equally undergoes change. Core content tends to persist and grow over time, which explains how schemas become different yet the same. Peripheral content grows and reduces often, but does not challenge core values. Finally, in the long run, it is less accurate to talk about schema change than about schema growth.

Our second research question inquired: How do powerful schema sponsors influence others' schemas? As discussed, although the companies in our sample all belong to the mining industry, they operate very different businesses in terms of technology, products, scope and geography. It is therefore remarkable that they have been sharing similar and stable strategic goals as regards sustainability over a relatively long period of time. We found that larger companies can influence others' schemas by acting as role models and by espousing more advanced sustainability policies early, as illustrated by the adoption of the GRI guidelines. One large firm, Anglo American (AA), monitored the development of these new standards to keep abreast of their meaning and implications. AA also participated in the development of new GRI standards, likely to assess how they might constrain the company's strategic objectives, and possibly to shape forthcoming guidelines. Presumably, AA also promoted the formal adoption of new sustainability standards within ICMM, eventually impacting a large part of the industry. After studying the emergence of the insurance industry's shared schema about computers (Bingham & Kahl, 2013), Kahl (2017) suggests that trade associations both enable market discourse and influence market cognition. He argues that trade associations can play a key role in the production of market discourse by serving as the social arenas that enable members to discuss certain topics (Kahl, 2017: 2). As such, trade associations have considerable influence on market discourse and cognitions because they represent broader groups than individual corporate communications. Simultaneously, trade associations can shape market cognitions by partially controlling which voices are heard, what content gets discussed, and by offering an authoritative voice within the discourse (Kahl, 2017). Here, we submit that large companies leverage trade associations as vectors to disseminate their own schemas and influence substantial parts of an industry. This resonates with research that has shown trade association founders –typically some of the largest industry members- to demonstrate effective political acumen in the creation and growth of private regulatory trade associations similar to ICMM (Marques, 2016).

We conclude this paper with practical implications for ICMM and its members. Most of the studied firms diminished their environmental impact to revenue ratio over the studied period. From a business sustainability perspective, ICMM and its members have successfully mustered enough credibility to maintain the social licence to operate. From an environmental sustainability point of view, efficiency gains did not translate into environmental impact reduction, admittedly not a goal of ICMM members. There are however a few reasons why the ICMM and its members might want to consider environmental impact reduction as a strategic objective in the future. In 2004, the ICMM adopted the definition of sustainable development from the United Nations' Brundtland report (World Commission on Environment and Development, 1987). Twelve years later, the ICMM's mission is still to strengthen the social and environmental performance of the mining industry and the trade association is officially committed to contributing to the United Nations' Sustainable Development Goals for 2030 (International Council for Mining and Metals, 2016; United Nations General Assembly, 2015). Further, the ICMM's mission remains to build recognition of the industry's contributions to local communities and society at large. To maintain credibility with stakeholders, the ICMM recognizes the need to demonstrate systematic evidence of progress in environmental performance, which ultimately manifests in environmental impact reduction. Ascribing causal importance to strategic cognitions in the explanation of strategy (Narayanan et al., 2011) and performance (Thomas et al., 1993), we submit that ICMM members can hardly boost environmental performance following the same schema that produced few tangible results from 2003 to 2013. Rather, environmental performance needs to partake in strategic objectives, disrupting the core schema content which the ICMM and its members have been cultivating, growing, and preserving since they first collaborated.

GENERAL DISCUSSION

Contributions

Schemas. The first article theorizes that managers and organizations tend to adhere to existing schemas and resist cognitive change because they avoid the experience of schema discrepancy. This mechanism explains why firms favor instrumental schemas (traditional, profit-oriented) and repel integrative schemas (economically, socially, and environmentally balanced): instrumental schemas are the established, prevalent way to think about sustainability in a business context. Some schema sponsors however have a voice that allows them to weigh in on sustainability issues. Powerful schema sponsors perpetuate or challenge existing schemas by promoting schemas that resonate with perceived organizational reality and/or by curving perceived organizational reality through modifications in organizational arrangements that validate sponsored schemas. The second thesis article finds that while firms that collect copious data about the natural environment develop more complex schemas about environmental issues, they do not translate complex schemas into corresponding environmental response. Further, the more firms respond to environmental issues, the more they deteriorate the natural environment. After examining alternative explanations, the study concludes that environmental response is inappropriate, consistent with the finding that corporate response disregards corporate schemas about environmental issues, although other factors such as conflicting corporate priorities or lack of resources might also explain these results. Finally, the last thesis paper reports that sampled firms have been sharing similar instrumental schemas centered on invariant underlying values over a long period of time. Two types of schema content emerged. Core content, which defines underlying corporate values, endures, whereas peripheral content, innocuous to corporate values, varies. Thus, although studied firms developed elaborate schemas over time, new sustainability knowledge obeyed stable underlying corporate values and supported established meanings. Combining these propositions and findings, further insights emerge.

The third paper illustrates the first paper's notion of discrepancy avoidance by highlighting the existence of underlying corporate values that exhibit inertia and significantly affect the development of new knowledge. Schemas become different yet the same to the extent that new schema content adds to previous content while underlying values and meanings persist and guide the interpretation of new knowledge. In the same line of thought, the second paper shows that firms sometimes ignore accumulated topical knowledge. Although the second paper does not offer

an explanation other than the complexity within interpretation-performance relationships (Daft & Weick, 1984; Thomas et al., 1993), the third paper suggests that firms disregard acquired knowledge when new knowledge undermines underlying corporate values. This indicates how important it is for research to distinguish between schema components: concepts, relationships, and values (Bartunek, 1993). As new concepts and relationships are added to schema content, the cognitive map changes, yet the underlying values may not. It is therefore crucial to account for the map as well as for the associated values in studies on schemas. Concepts and relationships provide the map; values supply built-in directions.

The third article also illustrates how schema sponsors build on different power bases (coercive, reward, referent, expert, and legitimate power) to influence others' schemas, as theorized in the first article. Although the sampled companies operate very different businesses, they share similar sustainability goals. Larger companies influence others' schemas by acting as exemplars and adopting progressive sustainability measures early (referent power). One firm scrutinized and partook in the advancement of forthcoming sustainability reporting standards (expert power) to both shape them and foresee their ramifications. Of direct relevance to the conceptualization of power in the first paper is the formal adoption of new sustainability standards within the studied trade association. By achieving change in the trade association's organizational arrangements (legitimate power), proponents of GRI reporting impacted numerous industry players' business reality and thus promoted their own ideas on corporate transparency.

Organizational Cognitions. There has long been a debate as to whether organizations are capable of cognition – mental processes of awareness, perception, reasoning, and judgment related to knowledge acquisition (Maciejovsky, Schwarzenberger, & Kirchler, 2012). Some researchers struggle with the notion that one can treat organizations as living systems whose characteristics may differ from those of people inside (Hedberg, 1981). Yet, organizations possess their own cognitive systems: “Members come and go, and leadership changes, but organization's memories preserve certain behaviors, mental maps, norms, and values over time.” (Hedberg, 1981: 6). One contribution of this thesis is to follow this view and consider organizations as open social systems that process information from their environment (Daft & Weick, 1984), while at the same time acknowledging that group and organizational information processing differ, and integrating group interpretation as a component of organizational interpretation. This thesis therefore contributes to the development of organizational cognition research by making a step toward a multilevel

conceptualization of corporate schemas. One distinctive feature of organizational schemas in the present work resides in the imperfect and incomplete sharing across organizational groups, which highlights the existence of diverging schemas within one organization. One organization can therefore simultaneously harbor different schemas and types of knowledge among various groups. Recognizing schema diversity beyond the conventional focus on managerial schemas, this thesis explains why convergence occurs and how divergence is resolved.

Another key recognition in the literature on organizations as interpretation systems is that: *“organizations influence their members’ learning, and they retain the sediments of past learning after the original learners have left. Organizations can be thought of as stages where repertoires of plays are performed by individual actors. The actors act, but they are directed. They are assigned roles, they are given scripts, and they become socialized into a theatre’s norms, beliefs, and behaviors. Although the repertoires of plays shift, especially with the arrivals of new leaders, directors, or schools, there are rich traditions of plays and standards that remain as time passes.”* (Hedberg, 1981: 6)

The present work clarifies processes through which existing schemas enable and constrain organizational interpretation. First, whereas extant schema change models show patterns of change, they are not explicitly associated with schema growth and reduction (e.g. Balogun & Johnson, 2004; Labianca et al., 2000). Rather descriptions of change imply that old content is discarded as new content comes in. Schema size is ignored. In contrast, growth, by definition, affects size. Growth suits Dane’s (2010) depiction of individual expertise: schemas widen as they become more complex. By proposing that growth is the dominant schema change mechanism, this thesis proposes that old schema content is not replaced, but mostly remains in place, while new content is added. Second, by identifying fundamental mechanisms of schema change -growth and reduction- this thesis allows for a non-traditional depiction of schema change patterns. If we accept growth and reduction as fundamental schema change mechanisms, we may liken bookkeeping to adding a grain of sand; subtyping to creating an outgrowth; replacement with chipping pieces and gradually replacing them with grains of sand; and, relocation with creating and outgrowth and suddenly considering the outgrowth as the new core. In practical terms, not only do extant schemas shape what firms pay attention to and learn, but new experience tends to overlay extant schemas rather than to replace them.

Corporate Environmentalism. Today's companies routinely engage in corporate environmentalism (Whiteman et al., 2013). Yet, whether corporate environmental initiatives remedy environmental issues remains equivocal. Globally, the pace of environmental degradation increases (Field et al., 2014). At the firm level, the second article indicates that corporate response to environmental issues, allegedly a close proxy of corporate environmentalism, magnifies environmental degradation. Further, the third paper portrays companies that have formally committed to sustainable development for years and still crave rigorous evidence of improved environmental performance. In the second paper, an explanation is that firms remain unable to convert environmental knowledge into appropriate response. The third paper however suggests that knowledge conversion may be a symptom and not a cause. Rather, it points to re-ordering the values embedded in corporate schemas.

Re-ordering embedded values implies two different implications depending on whether corporate actions deliberately stem from maps within corporate schemas. First, claims of corporate environmentalism "could well be mere exercises in public relations" (Banerjee, 2001: 499). Decoupling, the loose articulation between corporate structure and operations (Meyer & Rowan, 1977), is indeed a likely explanation for weak corporate environmental performance. However, our three papers taken together suggest that, to the extent that values are implicit and intermittently expressed, firms with genuine intention to redress environmental issues may still fail to do so because implicit values pull them in a different direction. In other words, firms that engage in corporate environmentalism may obstruct their own efforts when they do not acknowledge underlying corporate values within their schemas.

Environmental management. Barrow (2005: viii) proposes that environmental management is the planning and coordination of diverse activities aimed for humans to address environmental challenges and prosper as a species. In a business context, environmental management can be defined as the planning and coordination of activities through which firms address environmental challenges. Environmental management was born in the 1990's following landmark publications such as the Brundtland report (World Commission on Environment and Development, 1987) which conveyed the realization that society, business, and the natural environment were at a turning point, and spurred an emerging consensus in business that the environment is a major challenge in need of responses (Roome, 1992). However, there has been little agreement on strategic options and specific actions for environmental management. Many

researchers have questioned the motivations of companies for environmental management, arguing that they were mostly financial (Boiral, Henri, & Talbot, 2012; Feng & Wang, 2016). This line of research evidenced, for example, that implementing the ISO 14001 environmental certification standard tends to be superficial behavior meant to exhibit conformity (Boiral, 2007). It showed, further, that a minority of managers follow action logics that allow environmental management to change the values and incorporate the complex demands needed to achieve environmental sustainability (Boiral et al., 2009).

Although this thesis acknowledges that there exists decoupling (Wijen, 2014) between corporate environmental discourse and actions, the goal here is not to judge intentions or issue normative statements. Societal pressures push firms in certain directions but it is ultimately enterprise strategists who ponder the role their firm will play in society (Schendel & Hofer, 1979). This thesis rather investigates corporate schemas that shape the thinking of enterprise strategists, management, and other organizational groups, affecting corporate decisions as regards the natural environment. In brief, this work acknowledges corporate motives (i.e. values) but focuses on corporate interpretation. From this perspective, one key contribution to environmental management concerns the business case for sustainability, assuming there exists corporate intention to implement substantive (Carlos & Lewis, 2015) environmental management.

In the business case logic, organizational groups who carry integrative schemas often “sell” environmental issues to other groups using a language, assumptions and norms borrowed from the dominant instrumental schema (Anderson & Bateman, 2000; Bansal, 2003; Howard-Grenville, 2007b). One of the most successful issue-selling techniques is indeed the enactment of the recipient group’s schema (Howard-Grenville, 2007a). Accordingly, “framing an environmental issue as a financial opportunity may be one of the keys to a successful championing episode.” (Anderson & Bateman, 2000: 564). As noted, these techniques reinforce existing schemas (Howard-Grenville, 2007a; Weick, 1995) by allowing them to assimilate discrepant experience, a mechanism that characterizes the bookkeeping model. Making the business case for sustainability is a typical example of dominant schema enactment. By showing that sustainability initiatives can contribute to profit making, or avoidance of losses, sustainability champions enact an instrumental schema to promote sustainable behavior. Although this has been shown to generate sustainable behavior in the short term, it also reinforces the extant schema (Howard-Grenville, 2007a), making it relevant and applicable to environmental issues, and precluding integrative pro-environmental behavior in

the longer term. This thesis therefore recognizes the short-term effects of “business case” strategies on environmental management, but simultaneously questions their long-term effectiveness.

Greenwashing. Greenwashing is misleadingly positive environmental communication (Lyon & Montgomery, 2015) which places overly positive emphasis on corporate environmental achievements in order to influence shareholders, the media or the general public in opinion (Delmas & Burbano, 2011). There is a large literature on greenwashing and the disconnection between corporate discourse and actions, especially as regards sustainability reports. Some of this literature has called sustainability reports “simulacra” based on the observation that corporate reporting fails to report environmental incidents most of the time (Boiral, 2013: 1036). Such “organized hypocrisy” may even be required by the contradictory societal and institutional pressures that firms face (Cho, Laine, Roberts, & Rodrigue, 2015), to the extent that failure to meet societal expectations threatens the viability of individual firms and possibly industries (Böhling, Murguía, & Godfrid, 2017). Yet, there are important distinctions between corporate disclosure biases. First, there is greenwashing, as defined above, the exaggeration of environmental achievements (Delmas & Burbano, 2011). Second, one might call camouflage the omission of environmental incidents (Boiral, 2013). Third, researchers have termed “undue modesty” the omission of environmental achievements to avoid public perception of hypocrisy (Eun-Hee & Lyon, 2015: 705). The present work does not deal with camouflage but contributes to the scholarly discussion on greenwashing and undue modesty.

As regards greenwashing, although it is understood that companies inflate environmental actions in public reports to enhance legitimacy and reputation, this thesis argues that overstatements are necessarily limited for several reasons. First, while firms may engage in ceremonial or symbolic environmental management they bear legal liability for the exactness of environmental reports which various stakeholders feed into financial risk assessment. Second, assuming that firms greenwash out of concern for public image, firms equally worry about their public image and market retaliation if greenwashing is revealed. Third, we live times of increased public and media scrutiny (Bowen & Aragon-Correa, 2014) in which external pressure intensifies penalties for environmentally harmful action (Flammer, 2013). As a result, firms need to keep embellishment in environmental reporting credible and therefore limited, a proposition that contrasts with existing depictions of greenwashing as rampant.

As for undue modesty, the second paper's findings show that firms reduce accounts of ecological responding in sustainability reports following periods of poor environmental performance, suggesting an intention to underemphasize corporate environmental initiatives. Given the strategic nature of environmental reporting (Philippe & Durand, 2011) and firms' propensity to greenwash (Delmas & Burbano, 2011), firms need a business-related rationale to underreport environmental achievements. It is advanced here that firms intentionally adopt a low profile to avoid being judged as hypocritical and risking reputational and market penalties. Similarly, findings from the third paper evidence what might be extreme cases of corporate modesty, whereby several environmental reports plainly declare the primacy of corporate economic goals and the consequent impracticality of environmental impact reduction. Such reporting behaviors might be attempts to manage stakeholder expectations and/or to break free from contradictory societal and institutional pressures by exposing them. In contrast with existing accounts of undue modesty, these examples might illustrate how some firms seek a reputation of corporate honesty over one of environmental performance.

In sum this thesis observes that sustainability reports are carefully crafted tools for strategic communication where firms cautiously keep their discourse credible in reaction to increasing public skepticism toward corporate sustainability claims. Acutely aware of public scrutiny, firms have mastered the disclosure of environmental achievements, strategically greenwashing and withholding achievements depending on corporate environmental performance. These explanations contribute to a stream of research advancing that it can be prejudicial for firms to greenwash while under public scrutiny (Lyon & Maxwell, 2011), especially following periods of poor environmental performance (Bowen, 2014; Carlos & Lewis, 2015; Eun-Hee & Lyon, 2015). Corporations that engage in a balancing act between corporate honesty and environmental performance constitute an original addition to this literature.

Implications for managers and policy makers

Implications for managers. One key takeaway from this work is that schema evolution in reaction to changes in the organizational environment affects corporate response to ecological issues. As a corollary, managers who understand strategic schema evolution are better equipped to create change toward integrative schemas than those who do not. Adding the notion that successful organizational change requires schema change (Bartunek & Moch, 1987), it follows that managers who understand strategic schemas are more susceptible to succeed with strategic change, including

toward ecological goals. Understanding strategic schemas, however, is far from trivial, and second order schema change is very difficult to achieve (Bartunek, 1993). Following a schema perspective, managers driving their firm on the sustainability path improve the likelihood of success when they clarify, first, their own beliefs and values (i.e. schemas); second, what change is required in existing schemas; and, how to make organizational members aware of their own schemas and thus capable to change them (Bartunek & Moch, 1987).

But the path to sustainability is not always obvious: what schema to pursue often needs defining (Hahn et al., 2014). Based on the finding that there exists a relationship between ecological scanning and understanding, managers seeking to determine appropriate sustainability approaches and goals should be aware that data acquisition helps meaning attribution. In other terms, organizations and their members who expose themselves to a variety of sustainability information sources are more likely to develop an understanding of sustainability issues that permits to formulate appropriate approaches and goals. Further, this thesis has identified groups with different schemas wielding power within and around organizations. The presence of multiple schema sponsors suggests that exposure to sustainability information should not be restricted to management but offered to as many individuals and groups as possible. The sensitization of varied groups who have a dynamic relationship to power may be a fruitful way to turn a company around.

Managers remain influential schema sponsors and, once a path to sustainability is determined, they can shape corporate schemas in the long term through modifications in organizational arrangements, social norms, and language (Ferraro et al., 2005). As noted, “Language transformation can be a pathway to behavioral transformation” (Weick, 1995: 108–109). *Norms* establish adequate behaviors and actions (Howard-Grenville, 2007b). Finally, organizational arrangements –structures, reward systems, measurement practices, selection processes- reflect the schemas of their designers and create the conditions that make schemas come ‘true’ over time (Ferraro et al., 2005: 9). However, recent research suggests that, when modifying organizational arrangements toward green goals, managers should try to mitigate disruption, or at least to frame disruption as minimal (Dowell & Muthulingam, 2017).

Importantly, mitigating disruption should not imply consonance with existing schemas. As discussed, managers are under increasing pressure to engage in eco-friendly initiatives (Flammer, 2013) and to adopt a ‘business case’ approach to environmental management which encourages the pursuit of profitable environmental initiatives (Dowell & Muthulingam, 2017). This thesis

contends, however, that the business case approach enacts and reinforces dominant instrumental schemas (Howard-Grenville, 2007b). As such, although a business case approach can generate instrumental ecological actions in the short term, it may forestall integrative initiatives and be counterproductive in the longer term.

Implications for policy makers and society. There is evidence that schemas, or similar cognitive structures, exist at the industry-level (Bingham & Kahl, 2013; Kahl, 2017) and societal level (Hoffman, 2015). In organizations, schemas survive long after they have ceased to be useful (Hedberg, 1981), and sometimes after they have been replaced (Zietsma, Winn, Branzei, & Vertinsky, 2001). In society, the existence of persistent cognitive structures may explain why some ignore accumulating environmental evidence and multiplying extreme weather events (Hoffman, 2015). Extrapolating the above discussion on organizational arrangements to societal arrangements, this thesis suggests that policy makers may effect societal change by instilling integrative schemas into societal arrangements which have perpetuated instrumental schemas, such as business education (Ferraro et al., 2005) and business law (Newton, 2002: 530).

As well, past research has shown that regulatory decisions can have a decisive impact in triggering schema and organizational change: Faced with the prospect of drastic sanctions, firms engage in efforts to alter existing schemas, structure and actions (Poole et al., 1989). Although more stringent regulations might trigger schema and organizational change throughout industries, this thesis indicates that radical regulatory change will trigger strong resistance, cueing policy makers to ponder trade-offs between change and resistance. Further, following evidence from studies on environmental certification (Aravind & Christmann, 2011; Christmann & Taylor, 2006), more stringent enforcement of existing regulations may lead to increased CEP. Because stringent enforcement involves using coercion, reward, and other power bases, this thesis suggests that regulatory agencies stay within their legally prescribed and socially-accepted area of authority lest they lose power and legitimacy (French & Raven, 1959).

On a different note, corporations often act as policy makers, for instance within industry associations, chambers of commerce, and similar interest groups which practically replace environmental legislators in several branches of activity (Marques, 2016). Within such contexts, this thesis illustrates how larger companies can influence others' schemas by adopting progressive ecological policies early. Strategies revealed here involve monitoring the development of new standards and participating in the development of new standards, allowing participating firms to

assess and shape upcoming opportunities and constraints. Large companies may also promote the formal adoption of new standards within trade associations with the prospect of impacting a large part of the industry. Research has proposed that trade associations have considerable influence on industry-level discourse and cognitions because they represent large groups as opposed to individual firms (Kahl, 2017): trade associations can shape market cognitions by selecting which voices are allowed to communicate and what content is debated. This thesis submits that large companies leverage trade associations as vectors to disseminate selected schemas and influence which ecological standards an industry follows.

Limitations

Some scholars criticize the use of sustainability reports to capture corporate level cognitions, specifically the assumption that disclosed and corporate schemas reasonably overlap so that disclosed schemas represent corporate schemas and actions to a certain extent (Narayanan & Fahey, 1990). This comment is rooted in the literature on greenwashing and the disconnection between corporate discourse and actions, notably in sustainability reports (e.g. Boiral, 2013; Cho et al., 2015). As discussed above, this work acknowledges and contributes to the literature on greenwashing. Further, it recognizes that schema complexity prevents full disclosure. Consequently, firms only communicate what they are *willing* and *able* to disclose. At the same time, firms must keep distortions limited for legal, reputational, and market reasons. In the current social context characterized by intense public scrutiny, sustainability reports provide a reasonable, admittedly imperfect, reflection of corporate schemas and actions. Some authors also comment that many companies mandate public relations agencies to prepare sustainability reports, and question the corporate ownership of reports. Many reports used in this thesis openly display the names and contact information of such communication agencies. However, the plural involvement of management, sustainability departments, and public relations companies in sustainability reports brings forth, not the ideas of select persons, but shared, corporate considerations. Collaborative involvement in the preparation of sustainability reports contributes to the collective, corporate nature of their contents, and constitutes an asset within the framework of this thesis, which attempts to capture a corporate-level construct.

The second paper has created, validated, and employed three dictionaries of ecological terms. While rigorously developed, these dictionaries need further validation through tests with various samples to demonstrate external validity. Practically, various types of corporate

communications can demonstrate the generalizability of findings across settings: annual reports, 10-K forms, etc. As well, to show the dictionaries' capacity to predict distinct but theoretically linked concepts (i.e. nomological validity), further testing will be needed. Corporate environmentalism (Van Marrewijk & Werre, 2003) and environmental orientation (Banerjee, 2001), may prove useful to this end.

Finally, the measure of CEP in the second paper partially comes from self-reported corporate data and may be subject to social desirability bias. For reasons already explained above, information distortion in sustainability reports is likely limited. In addition, Trucost -the company which provides our measure of CEP- uses proven economic modeling techniques sanctioned by independent experts to estimate unavailable data, thus mitigating potential biases from self-reporting. Indeed, Trucost's environmental impact is deemed one of "the most significant measures of environmental performance" in the literature (Delmas et al., 2013: 259). It offers good credibility and practicality.

Future research directions

Sustainability and environmental performance. Researchers have explored the "business case for sustainability", through which green initiatives enhance economic performance (Bondy et al., 2012) and the "social license to operate", in which green initiatives serve to obtain social legitimacy from stakeholders (Aguilera et al., 2007). Both these perspectives are instrumental in that green initiatives are instruments to achieve economic and sociological goals, profit and legitimacy. So far, these perspectives have produced limited results in terms of corporate environmental performance. Meanwhile, global ecological indicators deteriorate and point to alternative perspectives. The continued development of people, planet and business requires a shift from the business case for sustainability to the sustainability case for business. In a way, this shift is already happening locally and regionally as air pollution forces the temporary closure of industry clusters in North Eastern China (Reuters, 2016), or when extreme drought causes farm closures and city evacuations in the Australian Queensland (Neubauer, 2014). Alternative perspectives are needed, but few management papers research such approaches (for exceptions, see Whiteman & Cooper, 2011; Whiteman et al., 2013). This thesis calls for management research to explore alternative integrative perspectives that deliberately step away from instrumental views.

Contrary to extant research (Daft & Weick, 1984; Thomas et al., 1993) and a fundamental assumption in strategy research and Western rationalist thinking, results indicate that corporate

ecological understanding does not translate into proportionate action. Results also suggest that firms engage in inappropriate responses that worsen environmental performance. This interpretation is supported by the finding that firms' responses to environmental issues are incommensurate to ecological understanding. The disconnection between firms' ecological understanding and ecological responding may explain the inadequacy of the latter. In turn, this inadequacy may be attributable to various factors ranging from changing corporate goals, lack of resources, competing priorities, or environmental ambivalence. Future research could investigate the relationships between these factors, corporate response, and CEP to reveal the more robust explanations.

Schemas. This thesis raises a number of questions related to schema discrepancy and the power of schema sponsors. Does high discrepancy consistently trigger subtyping? Research has shown that extreme discrepancy can disable interpretation (e.g. Weick, 1993). What happens then if extreme discrepancy is sustained? Integrating temporality, research may ask how long discrepancy needs to be sustained in order to generate second-order schema change. Does the intensity of discrepancy affect the speed of schema change? Can the power of schema sponsors affect the speed of schema change? Does the frequency of exposure to discrepancy affect schema evolution? A wide array of quantitative and qualitative methods can help investigate these questions, to the extent that they can track schema content and evolution over time.

This thesis is embedded in a stream of research that looks at the links between strategic cognitions, actions, and their consequences (Narayanan et al., 2011). Researchers have addressed divergent schemas and their cognitive outcomes (Hahn et al., 2014), as well as schema interactions through competing sponsors who wish to shape strategic decision-making and action (Kaplan, 2008). Little research exists however on the performance outcomes of such competitions. Further, recent research have investigated how organizational members make sense of past events in light of present and upcoming goals (Kaplan & Orlikowski, 2013). This thesis suggests that past performance relates to corporate actions and future research could explore the mutual influence between the interpretation of past performance and performance outcomes.

The scholarly conversation on internal and external predictors of CEP may also benefit from the consideration of other organizational factors that shape schemas and performance. The first paper discusses the relationship between schema evolution and structural change (Bartunek, 1984; Ranson et al., 1980) and thus points to firm structure. Extant research suggests that alignment

between corporate schemas, structure and actions produces better environmental performance outcomes (Russo & Harrison, 2005). Whether firms can simultaneously align schemas, structure, and actions with multiple types of performance remains to be explored, in theory and in practice.

Methods. Among other activities, this thesis has required the development of three dictionaries for use in computer-aided text analysis to capture terms and phrases related to environmental monitoring, environmental phenomena and impacts, and environmental restoration. These dictionaries can contribute to future research by capturing environmental terms in various textual sources.

The concepts of schema growth and reduction identified in the third thesis paper describe schema change in its simplest manifestations. The development and use of methods based on growth and reduction can help research highlight the characteristics of change: Does core and/or peripheral content change? Is change incremental or radical? What changes when? Future research building on such methods, including but not limited to cognitive mapping, can overcome simplistic conceptualizations of schema change as a succession of states and shed light on schema change mechanisms and patterns. Methods that capture growth and reduction together with core and peripheral content offer the possibility of detailed analysis of schema change patterns. As noted, for example, applying a growth and reduction lens on schema change patterns suggests that the subtraction of core content distinguishes first- and second-order schema change. Future research can explore and use this distinction to identify replacement and relocation patterns rarely captured in organizational settings, and perhaps new schema change patterns.

Conclusion: All Roads Lead to Rome

The central idea of this thesis is that to understand firms' response to environmental issues, one must comprehend how strategic thinking evolves in reaction to changes in the organizational environment. Based on the longstanding assumption that strategic maps prompt actions, changes in maps should result in new actions and different results. Yet this thesis found otherwise: firms are sometimes unable to convert knowledge into corresponding actions. Despite the widespread metaphor, schemas are not just maps. They are maps with directions. Concepts and relationships form the map and values give directions. Although firms might use the maps to go anywhere, they tend to go where the directions point. All roads lead to Rome. Core and peripheral map contents are unequal in the face of change. Core content tends to remain stable while peripheral content is temporary. Core content defines values and gives meaning to the rest of the map. Most of the time,

directions remain essentially the same when the map changes, and firms tend to go places they already know.

Taken in its entirety, this thesis suggests that dynamics of schema evolution both enable and significantly constrain corporate response to environmental issues. Evolution dynamics help explain how firms with high levels of corporate environmentalism may fail to reap the expected environmental benefits.

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