Exploring the determinants and long-term performance outcomes of corporate carbon strategies

Matthias Damert a, *, Arijit Paul a, Rupert J. Baumgartner b

a University of Graz, Institute for Systems Sciences, Innovation and Sustainability Research and FWF-DK Climate Change, Brandhofgasse 5, 8010 Graz, Austria
b University of Graz, Institute for Systems Sciences, Innovation and Sustainability Research and FWF-DK Climate Change, Merangasse 18, 8010 Graz, Austria

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A B S T R A C T

So far, research has insufficiently addressed the long-term effectiveness of business responses to climate change in delivering actual outcomes. The aim of this article is therefore to analyze the determinants of such strategies and their influence on firms’ financial and carbon performance over time. It is argued that corporate carbon strategies have three main objectives: carbon governance, carbon reduction and carbon competitiveness. To assess the complex interactions between these strategic objectives, their determinants and outcomes, an integrative structural equation model is developed and empirically tested. Data are sourced from a global sample of 45 leading enterprises from the steel, cement and automotive sector, including some of the largest GHG emitters in the world. In order to account for the long-term impacts of strategies, the firm-level change in financial and carbon performance is calculated by comparing two different points in time, namely 2008 and 2013. The results provide empirical evidence for the positive effect of institutional and stakeholder pressure on emission reduction activities. Proof for a positive impact of carbon pressure on organizational capabilities and corporate competitiveness in the context of climate change cannot be established. Surprisingly, the results also indicate no relationship between carbon reduction activities and long-term improvements in carbon performance. However, such measures are linked to long-term financial gains. Advancements in carbon performance, in turn, are not found to be associated with economic benefits.

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1. Introduction

The 5th IPCC (2013) report reinforces the anthropogenic nature of climate change. Among the various human-induced sources of greenhouse gas (GHG) emissions, the role of business corporations is of paramount importance. Historically, only 90 corporations have contributed to nearly two thirds of total global GHG emissions from 1854 to 2010 (Heede, 2014). Hence, if the 2 °C target as agreed during the COP21 in Paris is to be achieved, businesses will need to play a crucial role.

There are several economic, technological and institutional barriers for transitioning towards a low carbon economy. For business organizations in particular, one of the major bottlenecks is the prevalence of the objective of short-term profit maximization (Slawinski et al., 2015). This fundamental business philosophy is in conflict with the long-term goal of stabilization of the atmospheric CO₂ concentration. However, as climate change gains widespread attention globally, businesses are becoming more aware of the central position they occupy in this debate (Enkvist et al., 2008). Hence, it is vital to understand whether businesses are able to accommodate the long-term strategic perspectives related to climate change within their short-term goal of profit maximization. Such insights will be a prerequisite for any realistic assessment of the effectiveness of their mitigation strategies.

Notwithstanding the importance of the existing literature on business strategy and climate change, investigations of corporate GHG mitigation strategies and their effect on corporate carbon performance are limited (Chakrabarty and Wang, 2013) and mostly rely on cross-sectional data (e.g. Böttcher and Müller, 2015; Boriral et al., 2012) or year-to-year comparisons (Doda et al., 2016; Tang and Luo, 2014). However, a key aspect of corporate strategies is their effectiveness of delivering the desired impacts in the long-term (Montabon et al., 2007). As Mintzberg (2000) notes, a strategy is not mere words but words that translate into actions. Climate
change represents a risk factor that rather recently entered the business agenda. Little is known about the antecedents of corporate climate change strategies and their impacts on firm performance over time (Doda et al., 2016). Besides that, existing research does not sufficiently integrate physical and monetary aspects of carbon performance. The consideration of these aspects is seen as having potential in bringing deeper insights into the outcomes of corporate emission reduction activities (Hoffmann and Busch, 2008). Moreover, integrative approaches for assessing the determinants and consequences of corporate GHG mitigation strategies remain scarce (e.g. Boiral et al., 2012; Böttcher and Müller, 2015).

Motivated by the research gaps outlined above, this paper aims at contributing to a better understanding of the determinants of corporate climate change strategies and their long-term impacts on firm performance. Specifically, this study aims at analyzing the following: (1) the influence of institutional pressures to reduce carbon emissions; (2) the role of organizational capabilities for the implementation of climate change strategies; and (3) the impact of the implementation of these strategies on the longer-term carbon and financial performance of businesses.

This paper makes several contributions to the literature on business responses to climate change. Firstly, it proposes a novel framework for an integrated assessment of corporate carbon strategies which can provide valuable assistance for future research. It is argued that such strategies have three main objectives: carbon governance, carbon reduction and carbon competitiveness. Secondly, it adds empirical evidence for the impacts of stakeholder and regulatory pressure and organizational governance practices on corporate climate action (Busch and Hoffmann, 2011; Kolk and Levy, 2001). Third, by comparing practices reported by companies with actual outcomes, this study also makes a contribution to the ongoing debate about whether companies indeed “walk their talk” (Backman et al., 2017). Lastly, to the knowledge of the authors, this study pioneers in estimating the carbon exposure of firms as proposed by Hoffmann and Busch (2008) with secondary data.

To assess the complex interactions between corporate strategies, their determinants and outcomes, an integrative structural equation model (SEM) is developed and empirically tested. For this, a global sample of 45 leading enterprises from the steel, cement and automotive sector is selected due to their major importance for combating climate change. Automotive companies are a major contributor to GHG emissions from transportation, as the sector’s carbon footprint is dominated by road traffic (IEA, 2013). Steel and cement companies, on the other hand, have the largest carbon footprint of all energy-intensive industries (Bloom, 2012). Together, energy-intensive industries and transportation account for 35% of global GHG emissions and for 54% of global final energy use (IPCC, 2014). The results of this study question the efficacy of carbon strategies in the two sectors and provide valuable information for policy-makers and stakeholders alike.

Company data stems from voluntarily disclosed information including corporate reports, websites and the Carbon Disclosure Project (CDP) database. To account for the long-term impacts of strategies, the firm-level change in financial and carbon performance between 2008 and 2013 is examined. To the knowledge of the authors, such a time horizon has not yet been empirically studied in the literature on business responses to climate change and can provide valuable insights into the long-time effectiveness of corporate action.

The rest of the paper is structured as follows. Section 2 provides an overview of the literature on business responses to climate change. It establishes a definition and presents a general framework for corporate carbon strategies. Section 3 elaborates on the determinants and outcomes of corporate carbon strategies, derives an integrated research framework and its underlying hypotheses. Section 4 presents the sample, data collection methods and the SEM. The results of the empirical analysis are outlined in section 5. Sections 6 and 7 are dedicated to the discussion of the results and concluding remarks, respectively.

### 2. Literature review: corporate carbon strategies

The increasing integration of climate change aspects into corporate strategies in recent years led to a growing interest among business scholars. So far, most management research has focused on issues related to climate change mitigation and some on adaptation (Berkhout et al., 2006; Linnenluecke et al., 2013). In line with the research objectives, this study focuses on literature about corporate responses to climate change mitigation issues.

Various terms have been coined for corporate responses to climate change. Table 1 summarizes terms and definitions used in previous studies. As highlighted by Cadz and Czerny (2016), there seems to be little consensus regarding the scope of corporate climate change strategies. While some researchers employ a narrower perspective and focus on measures directly targeted at emission reductions (e.g. Backman et al., 2017; Kolk and Pinkse, 2005a; Weinhofer and Hoffmann, 2010), others also consider activities related to competitive advantages or the exercise of political influence (e.g. Jones and Levy, 2007; Kolk and Pinkse, 2005b; Okereke and Russel, 2010).

In this study, the term “corporate carbon strategy” is used and defined as “a complex set of actions to reduce the impact of a firm’s business activities on climate change and to gain competitive advantages over time”. This definition combines different approaches of previous research and accounts for three important aspects of a corporate carbon strategy: (1) its strategic intention, (2) its

| Term used                                    | Definition                                                                                           | Author(s)                          |
|----------------------------------------------|------------------------------------------------------------------------------------------------------|------------------------------------|
| Climate strategy                             | a firm’s choice between various strategic options in response to climate change                      | Kolk and Pinkse (2005a)            |
| Business response to climate change          | the degree of a firm’s proactivity in response to carbon reduction requirements                      | Jiwani et al. (2008)              |
| Corporate CO2 strategy                       | a pattern in action over time intended to manage a company’s direct and indirect CO2 emissions      | Weinhofer and Hoffmann (2010)     |
| Corporate climate strategy                  | a complex set of both market and non-market (socio-political) activities designed mainly to achieve market gains but also to maintain political influence | Okereke and Russel (2010)         |
| Corporate carbon strategy                   | a firm’s selection of the scope and level of its carbon management activity in response to climate change | Lee (2012)                        |
| Carbon management strategy                  | any corporate effort, which addresses and reduces the impact of a firm’s business activities on climate change | Busch and Schwarzkopf (2013)     |
| Carbon management strategy                  | a firm’s strategy that includes carbon measurement, reporting, reduction, trading and other measures to mitigate climate change-related risks, seize opportunities and enhance corporate competitiveness in a carbon-constrained market place | Yunus et al. (2016)               |
| Climate change mitigation strategy          | a firm’s action to reduce its CO2 emissions via application of alternative carbon practices           | Cadz and Czerny (2016)           |
temporal dynamics, and (3) the centrality of carbon emissions in the debate about climate change mitigation.

Based on the review of literature on business responses to climate change, ten kinds of activities have been identified that companies typically pursue: organizational involvement, risk management, carbon measurement and policy, product and process improvements, carbon compensation, new markets and product development, stakeholder engagement, corporate communications and political activities. By building on previous research, it is argued that these measures can be grouped along three major strategic objectives: (1) carbon governance; (2) carbon reduction; and (3) carbon competitiveness. The resulting corporate carbon strategy framework is illustrated in Fig. 1. Its components are explained in the following.

2.1. Carbon governance

Carbon governance refers to an organization’s managerial capabilities of dealing with risks and opportunities related to climate change mitigation and resulting governance mechanisms (Tang and Luo, 2014). Carbon governance can be broken down into two corporate activities: (1) organizational involvement and (2) risk management.

Organizational involvement aims at engaging a company’s workforce in climate change mitigation efforts (Lee, 2012; Tang and Luo, 2014). A company can assign roles and responsibilities for climate change issues to staff at different organizational levels, it can provide education to its to raise awareness about climate change and to promote climate-friendly behavior, offer monetary and non-monetary incentives and engage employees in innovation processes for emission reductions (Backman et al., 2017; Boral, 2006).

Risk management encompasses the assessment of risks and opportunities related to climate change mitigation (Tang and Luo, 2014). So far, the managing of climate change related risks has been mainly addressed by research on corporate adaptation to the physical impacts of climate change (e.g. Gasbarro et al., 2016; Weinhofer and Busch, 2013; Wilby and Vaughan, 2011). Nevertheless, companies also face issues coinciding with the indirect effects of climate change, such as climate regulation or changing consumer demands (Ernst and Young, 2010), which can positively or negatively affect business operations (Gallbreath, 2010; Hoffman, 2006).

2.2. Carbon reduction

Carbon reduction refers to a company’s commitment to reduce its GHG emissions and the implementation of measures to achieve the set targets (Lee, 2012; Weinhofer and Hoffmann, 2010). Four corporate activities are closely related to this strategic objective: (1) carbon measurement and policy; (2) product improvements; (3) process improvements; and (4) carbon compensation.

Carbon measurement and policy comprises the creation of a policy to reduce GHG emissions and systems to monitor corporate emissions. The starting point is to create an inventory of the company’s carbon emissions (Alvarez, 2012), e.g. through environmental management systems. Subsequently, a company may set and track emission reduction targets (Hoffman, 2006).

Product improvements aim at reducing the GHG footprint of products through emission reductions in the production, use phase or after-life of a product. Following lifecycle analyses, firms may introduce emission reduction targets for products and innovation policies (Weinhofer and Hoffmann, 2010; Yunus et al., 2016). Another option is to decrease the share of products with a relatively high environmental impact in a company’s product portfolio (Sprengel and Busch, 2011) or the substitution of GHG-intensive inputs with renewable or recycled materials (Jeswani et al., 2008).

Process improvements refer to activities targeted at reducing carbon emissions from production and distribution-related processes. In a first step, companies usually assess and track emissions of production processes supported by the implementation of energy management systems (Lee, 2012). Novel production processes or the improvement of existing ones can help to reduce GHG emissions as well (Cadez and Czerny, 2016; Okereke, 2007). Further reductions can be achieved by improving logistic operations up and down the supply chain (Böttcher and Müller, 2015) and by switching to low-carbon energy sources (Haddock-Fraser and Tourelle, 2010; Wittneben and Kiyar, 2009).

Carbon compensation can be considered a special form of emission reduction. It represents a possibility for companies to compensate their emissions or acquire credits for additional GHG emissions instead of changing products or processes. Compensation is a viable measure for companies in sectors that are highly dependent on carbon-based inputs and have limited possibilities for emission reductions (Pinkse and Busch, 2013). Firms can purchase emission allowances in emission trading schemes (e.g. EU ETS) or voluntarily acquire credits through offsetting projects under Kyoto mechanisms such as the Clean Development Mechanism.
2.3. Carbon competitiveness

The third component of a corporate carbon strategy, carbon competitiveness, summarizes corporate activities aimed at retaining or gaining competitive advantages and legitimacy for doing the respective business in the context of climate change mitigation. While some of these measures can be of a rather symbolic nature, others relate to organizational innovativeness, compliance issues or transparency to safeguard a company’s ‘license to operate’ (Talbot and Boiral, 2015). Four activities are linked to carbon competitiveness: (1) new markets and products; (2) stakeholder engagement; (3) political activities; and (4) corporate communications.

New markets and product development refers to the commercialization of products or services in markets, in which climate change aspects form a unique selling proposition. For this, companies may engage in strategic alliances or research and development (R&D) collaborations with other companies, governments or research institutions (Cogan, 2006; Kolk and Pinkse, 2005a). Stakeholder engagement subsumes corporate activities not directly related to a company’s business that are implemented in cooperation with private or public actors. Firms may cooperate with cross-sectoral or sector-specific trade associations (e.g. World Business Council on Sustainable Development), political actors (e.g. UN Global Compact) and non-governmental organizations to establish voluntary emission reduction targets, codes of conduct or business ethics (Eberlein and Matten, 2009; Sullivan, 2010). Another form of stakeholder engagement are corporate citizenship activities, e.g. the provision of academic scholarships, tree-planting projects or public education events (Jeswani et al., 2008; Kolk and Pinkse, 2007).

Political activities aim at influencing regulatory processes related to climate change issues. A firm may indirectly influence political decision-makers through public statements, proposals for policies, engagement in public debates or funding of scientific studies (Kolk and Pinkse, 2008; Sprengel and Busch, 2011) or directly influence politicians through lobbying and funding of political parties (Engau and Hoffmann, 2009). Voluntary business initiatives in the form of self-regulation can also be a form of political influence (Kolk and Pinkse, 2007).

Corporate communications refers to the disclosure of climate change related information. While companies are sometimes legally obliged to disclose information on their approach and performance in terms of climate change mitigation, they can also voluntarily do so (Alvarez, 2012; Galbreath, 2010). A firm can choose between different communication channels (e.g. annual and sustainability reports, Carbon Disclosure Project (CDP), national GHG emission databases) and reporting guidelines (e.g. Global Reporting Initiative, ISO 26000) (Andrew and Cortese, 2011).

3. Theoretical framework and research hypotheses

In this section, the hypothetical relationships between the three strategic objectives outlined in section 2 and the carbon and financial performance of a firm are described. By drawing upon previous research on the determinants of corporate carbon strategies and firm performance, this section derives hypotheses for the empirical analysis. The resulting conceptual framework is illustrated in Fig. 2.

3.1. Determinants of corporate carbon strategies

Both internal and external factors can be determinants of corporate carbon strategies (Böttcher and Müller, 2015). Regarding external influences, three complementary theoretical approaches are widely employed in the literature: institutional, stakeholder and legitimacy theory. In line with stakeholder theory, pressure exercised by stakeholders is important for the development of corporate carbon strategies (e.g. Pinkse and Busch, 2013; Reid and Toffel, 2009). Stakeholder pressure is often interconnected with the stringency of the regulatory regime in which a company is operating. The influence of these formal rules and norms on organizations is referred to as coercive pressure in institutional theory (DiMaggio and Powell, 1983). In the case of climate change mitigation, coercive pressure in the form of strict regulations may also lead to greater societal concerns over corporate compliance (Lorenzoni and Pidgeon, 2006). This, in turn, amplifies the pressure from investors, non-governmental organizations (NGOs) and customers to reduce carbon emissions (Jones and Levy, 2007; Martin and Rice, 2010).

Multiple researchers provide empirical evidence for the positive relationship between regulatory and stakeholder pressure and the extent of corporate initiatives geared towards climate change mitigation (e.g. Amran et al., 2016; Boiral et al., 2012; Böttcher and Müller, 2015). Especially the introduction of various climate policies has forced companies to revise their business practices to reach regulatory compliance (Pinkse, 2007; Pinkse and Kolk, 2009), resulting in the adaptation of risk management approaches (Weinhofer and Busch, 2013), the initiation of organizational learning processes (Engels, 2009) and the improvement of production processes and products (Kolk and Pinkse, 2005a). Hence, the following hypotheses are formulated:

H1a. Stakeholder and regulatory pressure positively affects the development of corporate governance mechanisms for climate change mitigation issues.

H1b. Stakeholder and regulatory pressure positively affects the implementation of initiatives aimed at reducing GHG emissions.

Societal concerns over climate change have also created a potential legitimacy gap (Ihlen, 2009; Mcdonnell and Bartlett, 2009). To prevent losses of corporate reputation, companies engage in public relation activities and carbon disclosure to show their contribution to climate change mitigation, retain legitimacy for their business and “keep the social contract intact” (Hrasky, 2011). Companies in carbon-intensive sectors are particularly prone to shareholder and stakeholder demands and often exhibit a relatively high engagement in influencing policy processes (Martin and Rice, 2010; Okereke and Russet, 2010). Apart from carbon disclosure and political lobbying, the development and labeling of low-carbon products and services represents another option for gaining legitimacy and ensuring competitiveness (Lee, 2012). Based on these considerations, the following hypothesis is derived:
H1c. Stakeholder and regulatory pressure positively affects the implementation of corporate activities aimed at securing and gaining competitive advantages and legitimacy in the context of climate change mitigation.

The strategic objective of carbon governance (see Section 2.1) is closely linked to the (natural) resource-based view (RBV) of a firm (Backman et al., 2017). RBV stipulates that corporate strategies are influenced by a specific set of organizational resources (Barney, 1991). Resources such as a strong leadership, employee awareness and organizational learning capacities represent important internal drivers for action of corporations on climate change (Gonzalez-Gonzalez and Zamora-Ramirez, 2013). Assigning climate change responsibilities to top-level managers and establishing performance-based incentive mechanisms can create motivations and resources for investments in carbon reduction measures (Backman et al., 2017; Skjæret and Skodvin, 2001; Yunus et al., 2016). This leads to the following hypothesis:

H2a. Corporate governance mechanisms for climate change mitigation issues positively affect the implementation of initiatives aimed at reducing GHG emissions.

More pronounced organizational capabilities can also positively influence a company’s responsiveness to new market developments, its willingness to cooperate with stakeholders and the exertion of influence on climate regulation (Kolk and Levy, 2001; Okereke et al., 2012). Hence, the following research hypothesis is derived:

H2b. Corporate governance mechanisms for climate change mitigation issues positively affect the implementation of corporate activities aimed at securing and gaining competitive advantages and legitimacy in the context of climate change mitigation.

3.2. Linkages between carbon reduction activities and carbon performance

So far, little research has focused on understanding and disentangling the linkages between corporate carbon strategies and carbon performance, i.e. reductions in corporate GHG emissions. Scholarly efforts to shed light on this controversy have only recently gained momentum. There is no scholarly agreement on whether companies actually walk the talk or whether corporate efforts are rather a means of financial performance positively affects a firm's carbon performance (Boiral et al., 2012; Bötcher and Müller, 2015). Thus, the following research hypothesis is formulated:

H3. The implementation of initiatives aimed at reducing GHG emissions positively affects a firm’s carbon performance in the long term.

3.3. Effects of corporate carbon strategies and carbon performance on financial performance

The question of whether it “pays to be green” (Hart and Ahuja, 1996) has a relatively long tradition in business research. In the literature on corporate climate change mitigation, there are two main lines of argumentation. One argument is about the win-win relationship between a firm’s environmental and financial performance (Porter and van der Linde, 1995). Emission reductions can be associated with a decrease in energy and resource consumption leading to overall cost savings (Bunse et al., 2011; Hoffman, 2006; Bötcher and Müller, 2015), yielding the following hypothesis:

H4a. Improvements in a firm’s carbon performance over time positively affects a firm’s financial performance over time.

The reduction of a company’s reliance on carbon-based inputs can also be a form of risk mitigation (Busch and Hoffmann, 2007). Minimizing the exposure to risks associated with climate change mitigation through emission reductions can attract investors and open access to government subsidies (Busch et al., 2012; Hoffman, 2005; Nishitani and Kokubu, 2012). While there are initial costs associated with emission reductions, improvements in carbon performance can therefore have a positive influence on a company’s bottom line in the long run (Boiral et al., 2012; Iwata and Okada, 2011; Lucas, 2010). This leads to the following hypothesis:

H4b. The implementation of initiatives aimed at reducing GHG emissions positively affects a firm’s financial performance in the long term.

The second set of arguments is based on the (natural) resource-based view of a firm suggesting that investments in organizational resources yield competitive advantages (Barney, 1991; Gallego-Alvarez et al., 2015; Hart, 1995). If companies signal their stakeholders that they respond to climate change issues, they can distinguish themselves from competitors and achieve financial benefits in the long term (Gallego-Alvarez et al., 2015; Sharma and Vredenburg, 1998). Developing products with low-carbon aspects as unique selling proposition can be a form of distinction from competitors and attract environmentally-conscious customers. Likewise, being a frontrunner in public disclosure and corporate citizenship in the climate change context may improve legitimacy and be rewarded with positive investor responses (Luo et al., 2012; Sariannidis et al., 2013). Corporate political engagement, in turn, can render climate policies more favorable for business operations and avoid costs associated with emissions allowances or carbon taxes, for example (Levy and Kolk, 2002; Markussen and Svendsen, 2005). Thus, the following hypothesis is derived:

H4c. The implementation of corporate activities aimed at securing and gaining competitive advantages and legitimacy in the context of climate change mitigation positively affects a firm’s financial performance in the long term.

It should be noted that the authors of this study assume no causal relationship between carbon competitive measures and carbon performance. This is because such activities are not targeted at reducing carbon emissions but rather at communicating, justifying and legitimizing a company's carbon footprint.

4. Research methods

4.1. Sample and data collection

Due to their integral role in combating climate change, leading companies from the energy-intensive and automotive sector, respectively, were chosen as unit of analysis. The authors deliberately decided to focus on sector leaders. This is because companies with a high market share are expected to be in a more favorable position compared to smaller peers in making efforts to mitigate...
GHG emissions (Bansal, 2005; Barney and Zajac, 1994; Wernerfelt, 1984). Examining the determinants and outcomes of carbon strategies of such companies can thus provide valuable insights into future contributions to climate change mitigation from the respective sector.

The sampling procedure consisted of four steps. Initially, the respective sectors were screened for firms that allow for an unrestricted application of the carbon strategy framework (Fig. 1). Steel and cement companies on the one hand and automotive suppliers and manufacturers on the other hand were deemed most suitable. This is because more service-oriented sector peers without manufacturing facilities do not possess all necessary characteristics for a meaningful application of the “product improvements” and “process improvements” dimensions of the framework. Secondly, with the help of online databases, companies with a high market share in their sector were identified. Thirdly, corporate reporting databases, including CDP, Global Reporting Initiative (GRI) and CorporateRegister were scanned for companies that disclosed information about their activities in 2008 and 2013; resulting in a sample of 79 companies. These two years were chosen for two reasons: (1) significant improvements in the quality of voluntarily disclosed environmental data has been observed after 2007 and remained relatively constant thereafter (Comyns, 2014; Dragonir, 2012); and (2) it is assumed that in times of corporate “short-termism” (Slawinski et al., 2015) five years represent an appropriate time period for exploring the long-term effects of corporate strategies as long term strategic goals in corporations usually extend up to five years or more (Daft and Samson, 2014). The last step in the sample procedure concerned the amount and complexity of company-specific information required for the empirical analysis, which can be divided into four different categories: qualitative information on strategies, GHG emissions, energy and fuel consumption, and financial figures. After reviewing all collected company-related documents, it turned out that 45 companies provided sufficient data. The final sample of companies, the average size and emission profiles are presented in Table 2 and Table 3, respectively.

To minimize the risk of errors in reported data, triangulation was applied for GHG emissions and energy and fuel consumption. Three data sources were matched: sustainability, CDP and annual reports. Figures from 2008 to 2013 were compared to data from 2009 until 2012. To control for data reliability, a simple regression analysis was performed with sales as the independent variable and emission, energy and fuel data as dependent variables. For the majority of companies, a strong correlation could be observed. Energy and fuel figures that were found to be in wide variance with the regression results were corrected using regression imputation (Tsikriktsis, 2005). In case of discrepancies, the highest reported value of emissions in the respective scope was considered for the sake of conservatism, unless an explanation was provided by the company. This is in line with the principle of conservatism as espoused in EU legislation on the monitoring and reporting of GHG emissions (European Commission, 2012).

All energy and fuel consumption figures were converted to Megawatt hours (MWh). Emission offset data from project-based mechanisms governed by the United Nations Framework Convention on Climate Change (UNFCCC) were taken from the UNFCCC database, CDP and the UNEP-DTU CDM/JI Pipeline.

To estimate the fuel input for electricity consumption a global average electricity efficiency figure of 38% corresponding to the year 2008 was used and kept constant considering a very marginal improvement in the overall efficiency of electricity production between 1990 and 2010 (Hussy et al., 2014). Information about the fuel mix of global electricity production for 2008 and 2013 was obtained from IEA (2010, 2015) reports.

Fuel prices were sourced from the Global Economic Monitor Commodities database of the World Bank, global benchmarks of Saudi Aramco for LPG prices, Gas Energy Australia’s database and Argus Media. European Union Allowance (EUA) prices of the European Union Emission Trading Scheme (EU-EETS) were considered for carbon prices. These were taken from the World Bank reports on carbon markets. ETS prices of Quebec province in Canada, Australia, and New Zealand were sourced from different national reports and databases. All fuel and carbon prices were kept constant on 2008 prices to exclude influences of price fluctuations on the carbon and financial performance variables. Calorific values and carbon contents of fossil fuels were sourced from the IPCC Guidelines for National GHG Inventories and used to calculate the mass fraction of carbon in these fuels. The carbon mass fraction served to estimate the carbon exposure of companies related to fossil fuel usage.

The financial information used in this study was obtained from annual reports and online service providers for corporate financial figures. All currencies were converted to USD by using constant exchange rates from 2008 to avoid exchange rate related distortions in the data set.

### 4.2. Measurement of variables

#### 4.2.1. Carbon pressure

Carbon pressure (CarbPress) was determined by drawing on the Climate Laws, Institutions and Measures Index (CLIMI) developed by the European Bank for Reconstruction and Development (EBRD, 2011) and the Environmental Sustainability Index (ESI) developed by Esty et al. (2005). While the ESI has been used in scholarly work before (e.g. Jira and Toffel, 2013), the application of the CLIMI in the present research context represents a novelty. The CLIMI and the indicators for “Environmental Governance” and “Participation in

### Table 3

| Industry       | N   | Average total CO2 emissions per firm in 2008 (in metric tons; Scope 1 + 2) | Average company size in 2008 (value of total assets in Mio. USD) |
|----------------|-----|--------------------------------------------------------------------------|-------------------------------------------------------------------|
| Steel and cement | 15  | 46,537,889                                                              | 33,366                                                             |
| Automotive     | 30  | 1,771,991                                                                | 55,891                                                             |

### Table 2

| Companies in this study. | Automotive |
|--------------------------|------------|
| Ambuja Cements           | Aisin Seiki Group Co. Ltd. | NHK Spring Co. Ltd. |
| Acercol Mittal           | Akebono Brake Ind Co. Ltd. | Nissan Motor Co. Ltd. |
| Boral                    | BMW Group | NSK Group Ltd. |
| CEMEX                    | Calsonic Kansai Corp. | NTN Corp. |
| China Steel              | Cummins Inc. | Plastic Omnium S.A. |
| Cia. Siderurgica Nacional| Daimler AG | PSA Peugeot Citroen S.A. |
| CRH Plc                  | Denso Corp. | Renault Group |
| Fletcher Building        | Ford Motor Co. | Robert Bosch GmbH |
| Holcim Ltd.              | General Motors | Sumitomo Rubber Ind. Ltd. |
| Lafarge S.A.             | Honda Motor Co. | Suzuki Motor Corporation |
| Outokumpo Oyj            | Hyundai Motor Co. | Toyota Boshoku Corp. |
| POSCO                    | Johnson Controls Inc. | Toyota Industries Corp. |
| Sims Metal Management    | JTEKT Corp. | Toyota Motor Co. |
| United States Steel Corp.| Mazda Motor Co. | Valeo S.A. |
| Vale                     | NGK Spark Plug Co. Ltd. | Yokohama Rubber Co. Ltd. |
International Collaborative Efforts” from ESI served as proxies for regulatory and public pressure. The ESI-indicator “Private Sector Responsiveness” was chosen as a proxy for pressure from the private sector. Both indices provide information on a country-level basis. Therefore, indicator scores were assigned to the analyzed companies based on the location of their headquarters. This is in line with the so-called “home country effect” (Kolk and Levy, 2001).

4.2.2. Carbon governance, carbon reduction and carbon competitiveness

The measurement of corporate carbon strategies followed a quasi-mixed method approach. Corporate reports were analyzed in two steps, in which qualitative data was converted into quantitative figures that can be analyzed statistically.

First, a qualitative content analysis on company reports was conducted using the software MaxQDA. The category system for the content analysis was derived from the corporate carbon strategy framework (see Fig. 1). The three strategic objectives carbon governance (CarbGov), carbon reduction (CarbRed) and carbon competitiveness (CarbComp) served as main categories and the related corporate activities as sub-categories for the coding procedure. Following the recommendations by Neuendorf (2002), a codebook was developed comprising detailed descriptions, examples, and synonymic terms for the ten categories. Consequently, information about the companies' activities were extracted from the reports.

Secondly, the implementation level of CarbGov, CarbRed and CarbComp was assessed by analyzing the associated corporate activities. For this purpose, a rating scheme was designed following similar studies (Kolk and Pinkse, 2005a; Lee, 2012; Montabon et al., 2007). Its underlying general question is: “What is the implementation level of the corporate activity?” A 5-point Likert scale served to assign ratings to each activity for each company (ranging from “1 = low implementation level” to “5 = high implementation level”). The measurement scale was adapted to the context of each corporate activity and is presented in Appendix 2. Two researchers independently conducted the content analysis and the results were compared based on recommendations by Neuendorf (2002). Inter-rater reliability was measured in percent of agreement and amounted to 73.3%. In case of different ratings, a consensus-based decision was made on the final rating.

4.2.3. Carbon performance

Carbon performance (CarbPerf) was estimated by using two indicators developed by Hoffmann and Busch (2008): carbon intensity and carbon exposure. By covering physical as well as monetary aspects, the indicators allow a holistic assessment of a firm’s CarbPerf. Carbon intensity has been defined by Hoffmann and Busch (2008) as “a company's physical carbon performance and describes the extent to which its business activities are based on carbon usage for a defined scope and fiscal year”.

The formula for carbon intensity presented in equation (Eq (1)) was used to calculate carbon output intensity. Hoffmann and Busch (2008) also provide another measure of carbon intensity, namely carbon input intensity. However, the determination of carbon input intensity would require access to a company’s material and energy flow data. As this study is based on secondary sources, data at this required level was not available. Instead, emission output data disclosed by the companies were used to calculate the carbon intensity. For all companies only Scope 1 and 2 emissions were included in the calculation. Busch (2010) recommends including Scope 3 emissions for automotive companies, but Scope 3 emissions were not available for 2008 for most companies and were thus not considered. Emissions compensated through CDM or JI were deducted from absolute emissions. Total annual sales were used as business matrix against which carbon intensity was determined.

\[ CI_{i,t} = \frac{\sum_{k=1}^{K} C_{i,t,k} \times P_{i,t} \times BM_{t}}{USD_{annual}} \]

\[ CI_{i,t} = \frac{\sum_{k=1}^{K} C_{i,t,k} \times P_{i,t} \times BM_{t}}{USD_{annual}} \]

For the analysis of change in CarbPerf between 2008 and 2013, the percentage change of each CarbPerf indicator was calculated providing a robust measure for comparing companies across sectors and performance over time (Hart and Ahuja, 1996; Sullivan and Gouldson, 2012).

4.2.4. Financial performance

Return on assets (ROA) and return on equity (ROE) were used as a proxy for financial performance (FinPerf) like in similar studies (e.g. Bansal, 2005; Gallego-Alvarez et al., 2015; Hart and Ahuja, 1996). For assessing the change in performance between 2008 and 2013, the change in percentage points was calculated.

4.2.5. Company size

The size of a company expressed by the value of total assets in USD was used as control variable. This is in line with similar studies that observed an influence of company size on carbon strategies and the performance of firms (e.g. Chakrabarty and Wang, 2013; King and Lenox, 2001).
4.3. Data analysis

4.3.1. Descriptive statistics

Table 4 shows the descriptive statistics for the strategy variables CarbGov, CarbRed and CarbComp. Considering the whole sample, all companies exhibit a high level of engagement. A comparison of means reveals that CarbRed is the most actively pursued strategic objective, followed by CarbGov and CarbComp. In general, automotive companies show the highest commitment to emission reduction activities and display little variation amongst each other. In the case of cement and steel companies, CarbGov ranks higher than CarbRed and CarbComp.

Table 5 presents the descriptive statistics for the performance indicators. The figures clearly illustrate the higher reliance of energy-intensive companies on carbon-based inputs. Considering the whole sample, both carbon intensity and exposure have decreased over time. The same finding holds true when looking at the sectors separately. Moreover, while on average automotive companies could improve their FinPerf, ROE and ROA of the analyzed steel and cement companies have decreased between 2008 and 2013.

4.3.2. Structural equation modelling

For testing the research hypotheses, structural equation modelling (SEM) was used. SEM has become a common approach for evaluating theoretical assumptions in management research over the last years (Henseler et al., 2009) and has the advantage of being able to simultaneously test several linear relationships between latent variables (Shah and Goldstein, 2006). The ability of SEM to analyze the interlinkages between latent variables that are hard to measure and/or not observable makes SEM particularly suitable for studying problems in business research (Wong, 2013).

Partial least squares SEM (PLS-SEM) was chosen as modelling technique. Several researchers have demonstrated that compared to covariance-based SEM (CB-SEM), PLS-SEM works well with smaller sample sizes (n < 50) and non-normally distributed variables as it requires no assumptions about data distributions (Chin et al., 2003; Hair et al., 2011; Jannoo et al., 2014). Therefore, PLS-SEM suits the sample characteristics of the present study for two main reasons. First, the sample size is comparatively small with n = 45 observations. Second, the descriptive statistics of the latent variables indicate a non-normal distribution (see Tables 4 and 5 and Appendix 1).

For the analysis, the theoretical framework presented in Fig. 2 was modelled by using the software package SmartPLS 3.23. In order to construct the latent variables, a reflective measurement scale was chosen for the indicators of the measurement models. The indicators for the latent variables are depicted in Appendix 1.

4.3.3. Evaluation of the measurement models

If reflective measurement is used in PLS-SEM, it is recommended to assess the reliability and validity of the outer models before evaluating the structural model and its underlying hypotheses (Hair et al., 2013; Wong, 2013). Therefore, the measurement model was checked for indicator reliability, internal consistency reliability, convergent validity and discriminant validity as proposed by Wong (2013). Information about these parameters were obtained through the bootstrapping routine in SmartPLS.

Indicator reliability was assessed by calculating the squared loadings of the indicators on their corresponding latent variable. It was found that all indicators exceeded the minimum acceptable value for exploratory research of 0.4 (Hulland, 1999; Weiber and Mühlhaus, 2010; Wong, 2013) except for two indicators for the latent variable CarbRed; namely “product improvement” and “carbon compensation”. While “product improvement” turned out to be only slightly below the

| Indicator | Carbon intensity (t CO₂/Mio. USD sales) | Carbon exposure (USD/USD sales) | ROEA (in %) | ROEA (in %) |
|-----------|---------------------------------------|---------------------------------|-------------|-------------|
| Year      | 2008                                  | 2013                            | 2008        | 2013        |
| Pooled    | n = 45                                | 743.57 (1618.53)                | 737.04 (1530.92) | 0.031 (0.058) | 0.029 (0.047) | 4.99 (23.31) | 7.19 (14.31) | 0.29 (9.27) | 2.54 (4.43) |
| Scores per industry | Steel and cement | | | |
| Mean (SD) | n = 15                                | 2122.90 (2315.19)               | 2115.76 (2115.78) | 0.085 (0.079) | 0.080 (0.054) | 20.91 (25.75) | -3.56 (17.38) | 7.14 (7.76) | -0.45 (5.52) |
| Mean (SD) | Automotive n = 30                     | 5391 (34.87)                    | 47.69 (30.27)    | 0.005 (0.003) | 0.004 (0.002) | -3.54 (14.16) | 12.94 (7.58)  | -3.02 (8.04) | 3.98 (2.83)  |

| Table 4 Descriptive statistics for the three strategy variables. |
|---------------------------------------------------------------|
| Carbon Governance (CarbGov) | Carbon Reduction (CarbRed) | Carbon Competitiveness (CarbComp) |
| No. of indicators* | 2 | 2 | 4 |
| Theoretical range | 1–5 | 1–5 | 1–5 |
| Pooled | n = 45 | 4.22 (0.876) | 4.62 (0.667) | 3.60 (1.413) |
| Scores per industry | Steel and cement | | | |
| Mean (SD) | n = 15 | 4.43 (0.458) | 3.98 (0.810) | 3.90 (0.812) |
| Range | 2.5–5.0 | 2.0–5.0 | 1.5–4.75 |
| Automotive | n = 30 | 4.12 (1.014) | 4.94 (0.204) | 3.45 (1.018) |
| Range | 2.5–5.0 | 4.0–5.0 | 1.5–4.75 |

* The number of indicators for CarbRed was reduced from 4 to 2 in the course of model re-specification to ensure reliability and validity of the latent variable (see section 4.3.3. and Appendix 1, respectively).
recommended values, “carbon compensation” significantly violated the quality criteria. Based on recommendations of Farrell (2010) it was decided to exclude “carbon compensation” from the model. After theoretical considerations, the indicator “product improvement” was merged with “process improvement” by calculating the mean of the two items and creating the new indicator “product and process improvement” as done in similar studies (Cadez and Czerny, 2016). Product improvements are often closely linked to improvements in the production process. Therefore, the exclusion of the indicator “product improvement” would have weakened the theoretical link between CarbRed and CarbPerf and resulted in a loss of information in the model. After a re-specification of the model with the new indicator “product and process improvement”, indicator reliability increased to 0.799 and thus significantly exceeded the threshold value. For evaluating the internal consistency of the constructs, both composite reliability and Cronbach’s Alpha were computed. All constructs were well above the minimum level of 0.6, while only CarbGov (Cronbach’s Alpha = 0.698) was slightly below the preferred value of 0.7 (Bagozzi and Yi, 1988).

The validity of the latent variables was assessed by checking the average variance extracted (AVE) and the criterion developed by Fornell and Larcker (1981). For the latter, the square root of the AVE of each latent variable should be higher than the cross-correlations with the other variables. None of the square root of AVE of each latent variable should be lower than the cross-correlations with the other variables. None of the constructs violated this assumption and hence convergent validity is given. Additionally, none of the values for the AVE were below 0.5 which assures discriminant validity (Bagozzi and Yi, 1988). The results of testing the measurement model of the re-adjusted model are summarized in Tables 6 and 7. Scores for indicator reliability are presented in Appendix 1. Based on the validity and reliability assessment, it can be concluded that the quality of the measurement model is appropriate for the empirical analysis in this study.

5. Results

5.1. Relationships between latent variables

The results from testing the structural model are shown in Table 8 and Fig. 3 respectively. Table 8 presents the analyzed paths, the underlying research hypotheses, the estimated path coefficients and the effect size in numbers. Fig. 3 graphically illustrates the relationships between the latent variables and shows the variance explained of the constructs.

The values for variance explained of the different constructs ($R^2$ in Fig. 3) show that the model explains 50.1% of the variance in FinPerf, 42.9% in CarbComp, 25.8% in CarbRed, 7.9% in CarbGov, and 3.9% in CarbPerf. The results of the modelling support five out of nine research hypotheses. CarbPress has a positive and significant influence on the CarbRed construct (0.529; p < 0.01) but no significant relationship with CarbComp. Surprisingly, CarbPress negatively influences CarbGov (–0.281; p < 0.05). Thus, while hypothesis H1b is supported, H1a and H1c are rejected.

A higher level of CarbGov, in turn, results in a significantly higher engagement in activities aimed at managing a firm’s CarbComp (0.600; p < 0.001), which supports hypothesis H2b. In contrast to the authors’ expectations, neither the influence of CarbGov on CarbRed, nor the relationship between CarbRed and CarbPerf are significant. Consequently, hypotheses H2a and H3 are not supported. The model also shows no significant relationship between the two performance constructs. This is in contrast to hypothesis H4a, namely that improvements in a firm’s CarbPerf lead to financial benefits. While CarbRed exercises a strong positive influence on FinPerf (0.578; p < 0.001), a surprising result is the negative and significant effect of CarbComp on FinPerf (–0.374; p < 0.01). Hypothesis H4b is therefore supported by the results, whereas Hypothesis H4c cannot be accepted. As stated in section

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**Table 6**

| Latent variable | Composite reliability | Cronbach’s Alpha | Average variance extracted |
|-----------------|-----------------------|-----------------|---------------------------|
| CarbComp        | 0.824                 | 0.723           | 0.542                     |
| CarbGov         | 0.867                 | 0.698           | 0.765                     |
| CarbPerf        | 0.882                 | 0.734           | 0.789                     |
| CarbPress       | 0.900                 | 0.835           | 0.670                     |
| CarbRed         | 0.908                 | 0.800           | 0.832                     |
| FinPerf         | 0.938                 | 0.869           | 0.884                     |

**Table 7**

Correlation matrix of latent variables and square root of average variance extracted (diagonal, in bold).

|        | CarbComp | CarbGov | CarbPerf | CarbPress | CarbRed | FinPerf |
|--------|----------|---------|----------|-----------|---------|---------|
| CarbComp | 0.736    | 0.640   | 0.015    | –0.313    | 0.082   | –0.324  |
| CarbGov  |          | 0.875   | 0.082    | –0.281    | –0.020  | –0.224  |
| CarbPerf |          |         | 0.888    | –0.180    | 0.493   | 0.368   |
| CarbPress|          |         |          | 0.818     | 0.912   | 0.580   |
| CarbRed  |          |         |          |           | 0.940   |         |

---

**Table 8**

Results of testing the structural model.

| Path                | Hypothesis | Path coefficient | t-value | Effect size ($f^2$) |
|---------------------|------------|------------------|---------|---------------------|
| CarbPress → CarbGov | H1a        | –0.281           | 2.216*  | 0.086               |
| CarbPress → CarbRed | H1b        | 0.529            | 3.096** | 0.347               |
| CarbPress → CarbComp| H1c        | –0.144           | 1.201   | –                   |
| CarbGov → CarbRed   | H2a        | 0.129            | 0.966   | –                   |
| CarbGov → CarbComp  | H2b        | 0.600            | 6.932***| 0.580               |
| CarbRed → CarbPerf  | H3         | 0.198            | 1.068   | –                   |
| CarbPerf → FinPerf  | H4a        | 0.165            | 1.415   | –                   |
| CarbRed → FinPerf   | H4b        | 0.578            | 7.102***| 0.640               |
| CarbComp → FinPerf  | H4c        | –0.374           | 3.077** | 0.279               |

***p < 0.001, **p < 0.01, *p < 0.05, otherwise not significant; effect sizes of 0.02, 0.15, and 0.35 indicate small, medium, and large effect (Wong, 2013).
3.3, the authors assumed no causal relationship between carbon competitive measures and carbon performance. This was confirmed by an alternative SEM in which the link between CarbComp and CarbPerf was also considered but found to be non-significant (0.000; p < 0.998).

5.2. Influence of firm size

For examining the influence of firm size on the results of the structural model, the sample was split along the median of the value of total assets of the companies. The multi-group analysis in SmartPLS revealed that the negative effect of CarbComp on FinPerf is significantly weaker for larger companies than for smaller ones. Apart from that, no significant differences were found. Table 9 shows the results.

6. Discussion

The aim of this study was to better understand the determinants and long-term impacts of corporate carbon strategies. By taking the example of two environmentally sensitive industries, pressure to reduce carbon emissions from regulatory bodies, civil society and industry peers has been found to have a significant influence on emission reduction initiatives. This is in line with previous research on the relevance of stakeholder and regulatory pressure for corporate climate action (e.g. Eberlein and Matten, 2009; Jeswani et al., 2008; Sprengel and Busch, 2011) and supports the reasoning of institutional and stakeholder theory.

Interestingly, however, leading companies in the analyzed sectors do not increasingly employ measures to improve organizational capabilities and competitiveness when carbon pressure is high. Quite the contrary, companies headquartered in countries with high institutional pressure exhibit lower implementation levels of carbon governance. From the perspective of institutional and stakeholder theory, this seems to be counterintuitive. When looking at the data again, the authors noticed that the group of companies with a low implementation level of carbon governance is dominated by Japanese firms. Japan belongs to the countries with the highest levels of carbon pressure and respective companies are the most active ones in terms of carbon reduction. However, apart from carbon governance they also score comparatively low in measures aimed at competitive advantages and legitimacy. Thus, Japanese companies might prioritize strategic objectives that are most visible and meaningful to stakeholders, i.e. commitments and actions to reduce GHG emissions. As the empirical analysis is based on secondary data from corporate reports, regional differences in reporting cultures could also be a cause for low scores in carbon governance and carbon competitiveness measures. Japanese companies might disclose less on their internal governance approaches. This would contradict previous findings that Japanese companies disclose significantly more on this regard (Freedman and Jaggi, 2009). However, a closer examination of this subject is beyond the scope of this paper.

A possible explanation for the non-significant relationship between carbon governance and carbon reduction activities is that the analyzed companies actually “talk” before they “walk”, i.e. that corporate commitment to reduce emissions is an antecedent of building organizational competencies. This opposes arguments put forward by the (natural) RBV proponents (e.g. Backman et al., 2017). The results furthermore indicate that companies showing a higher level of organizational involvement and awareness of the risks and opportunities attached to climate change, engage more actively in}

![Fig. 3. Results of the structural model with hypotheses, path coefficients and variance explained (***p < 0.001, **p < 0.01, *p < 0.05, otherwise not significant).](image)

| Path                        | Hypothesis | Difference in path coefficients (small – large) | p-Value (significant if p < 0.05 and p > 0.95) |
|-----------------------------|------------|-----------------------------------------------|-----------------------------------------------|
| CarbPress → CarbGov         | H1a        | 0.029                                         | 0.335                                         |
| CarbPress → CarbRed         | H1b        | 0.156                                         | 0.357                                         |
| CarbPress → CarbComp        | H1c        | 0.090                                         | 0.337                                         |
| CarbGov → CarbRed           | H2a        | 0.060                                         | 0.576                                         |
| CarbGov → CarbComp          | H2b        | 0.228                                         | 0.370                                         |
| CarbRed → CarbPerf          | H3         | 0.025                                         | 0.486                                         |
| CarbPerf → FinPerf          | H4a        | 0.048                                         | 0.565                                         |
| CarbRed → FinPerf           | H4b        | 0.191                                         | 0.785                                         |
| CarbComp → FinPerf          | H4c        | 0.484                                         | 0.971                                         |
activities aimed at gaining competitive advantages. In contrast to the findings regarding corporate governance and carbon reduction measures, this supports the RBV of a firm.

The empirical analysis shows, however, that a higher level of engagement in activities aimed at ensuring and increasing competitiveness and legitimacy does not necessarily yield long-term financial pay-offs. To the contrary, investments in carbon competitiveness negatively impacted the financial performance of the firms analyzed. The reason might be high costs associated with research and development for new products and markets, human resources and management systems for carbon disclosure, corporate citizenship activities or lobbying. Therefore, while such measures can help to improve a company’s reputation and to legitimate its operations, their benefits might not outweigh the costs, even in the long-term. This challenges arguments for a positive relation between investments aimed at gaining competitive advantages in the climate change domain and improvements in financial performance (e.g. Haddock-Fraser and Tourelle, 2010; Luo et al., 2012).

According to the empirical investigation and in contrast to carbon competitiveness activities, initiatives targeted at emission reductions are positively correlated with financial benefits in the long term. An interpretation of this linkage can be that a company which shows a relatively high commitment to climate change attracts investors and environmentally-conscious customers and might have easier access to government subsidies. This supports arguments advocated in previous studies (e.g. Busch et al., 2012; Hoffman, 2005; Nishitani and Kokubu, 2012). While the present research therefore confirms past findings about the positive affect of corporate commitment (Boiral et al., 2012), it contradicts the results of a study by Böttcher and Müller (2015) that found no direct relationship between corporate action on climate change and financial performance. The findings also contribute to the general controversy about the indirect win-win relationship between organizational capabilities related to environmental issues and financial performance (Porter and van der Linde, 1995; Hoffman, 2006).

Surprisingly, no significant link has been found between emission reduction initiatives and long-term carbon performance improvements. This is particularly interesting for two reasons. First, it underpins the “talking before walking” argument as explanation for the missing link between carbon governance and carbon reduction activities. Second, it adds important empirical findings to previous research that has been very limited and rather ambiguous so far. While studies based on survey data found a positive relationship between corporate action on climate change and financial performance. The findings also contribute to the general controversy about the indirect win-win relationship between organizational capabilities related to environmental issues and financial performance (Porter and van der Linde, 1995; Hoffman, 2006).

This study makes several contributions to the research on business responses to climate change. First, it proposes a novel framework for corporate carbon strategies. It is argued that corporate carbon strategies have three main objectives: carbon governance, carbon reduction and carbon competitiveness. Secondly, it demonstrated the feasibility of calculating the carbon exposure of companies by using secondary data. Nevertheless, the data requirements are quite extensive and data availability remains limited. This might change in the future, if more companies disclose climate change related information and reporting guidelines become more consistent. Third, empirical evidence is provided for the positive effect of institutional and stakeholder pressure on the implementation level of carbon reduction activities. The results, however, indicate no relationship between such activities and long-term improvements in carbon performance. Apart from that, proof for the positive impact of institutional pressure on improving organizational capabilities and a firm’s competitiveness could not be established. While carbon performance advancements were not found to be positively associated with financial benefits over time, investments in carbon competitiveness exhibited a negative influence on financial performance.

Although the current study extends the knowledge about the determinants and outcomes of corporate carbon strategies, its results should be viewed in the context of its limitations. The primary source of limitation for this study stems from the use of voluntarily disclosed data for the analysis. A major concern for using such data is the degree of credibility and hence the relevance of the results from analyzing such data. An examination of the quality and consistency of voluntarily disclosed corporate data is especially important in the case of longitudinal studies as corporate reporting practices and guidelines may change over time. Although triangulation was applied to increase data reliability, the results obtained may be influenced by inconsistencies in reporting practices, such as the use of different emission or energy conversion factors, the lack of third-party assurance, the extent of estimated emissions or different reporting guidelines. Future research should especially address potential differences in reporting practices regarding the disclosure of risk management and organizational involvement in the context of climate change.

A second limitation concerns the generalizability of the findings. The focus of this study lies on large multinational steel, cement and automotive companies. Consequently, results from the empirical analyses might not apply to companies in other business sectors or to smaller companies within the sectors analyzed. Moreover, due to limited data availability, the sample size is comparatively small. Having said this, structural equation modelling was found to be appropriate for statistically analyzing the determinants and outcomes of corporate carbon strategies. Therefore, the chosen companies can be regarded as an indicator for climate change mitigation trends in their sectors.

A third limitation concerns the measurement of the carbon strategy variables. While the measurement scale for corporate carbon strategies allows for the interpretation of the implementation level of activities, it does not fully assess the ambition of the activities. Future research should thus control for the effect of the ambitiousness of such activities on firm performance.

The present study points at several other avenues for future research. The empirical analysis shows that carbon pressure can...
lead to both positive and negative organizational outcomes. To understand the negative implication of carbon pressure on corporate carbon governance it would be necessary to explore the differential relationships between different forms of carbon pressure and carbon governance in more detail. Further research is required to explain this complex interaction.

Moreover, a further investigation of the linkages between a firm’s (reported) practices and carbon performance outcomes promises to be a fruitful endeavor since empirical results remain ambiguous. In-depth case studies of companies would be especially interesting and could yield additional information about the impacts of different strategies on carbon performance. Comparisons of companies from the same sector operating in different institutional environments could help to shed light on the influence of climate policies and stakeholder pressure on climate mitigation efforts. Such studies should attach particular importance to the examination of the long-term implications of strategic approaches.

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Appendix 1. Descriptive statistics, reliability and validity of the measurement model

| Latent variable         | Indicator                                         | Mean (SD)     | Indicator reliability (squared loadings) | Remarks                                      |
|-------------------------|---------------------------------------------------|---------------|------------------------------------------|----------------------------------------------|
| Carbon pressure         | CLIM Index                                        | 0.59 (0.146)  | 0.564                                    |                                               |
|                         | ESI Environmental Governance                     | 0.93 (0.380)  | 0.558                                    |                                               |
|                         | ESI Private Sector Responsiveness                 | 1.36 (0.676)  | 0.790                                    |                                               |
|                         | ESI Participation in International               | 1.04 (0.518)  | 0.767                                    |                                               |
| Carbon governance       | Collaborative Efforts                             | 4.44 (0.540)  | 0.826                                    |                                               |
|                         | Organizational involvement                       | 4.00 (1.382)  | 0.704                                    |                                               |
| Carbon competitiveness  | New markets & product development                | 4.24 (1.250)  | 0.402                                    |                                               |
|                         | Stakeholder engagement                           | 3.80 (1.470)  | 0.465                                    |                                               |
|                         | Political activities                             | 2.89 (1.505)  | 0.712                                    |                                               |
|                         | Corporate communications                         | 3.47 (0.833)  | 0.589                                    |                                               |
| Carbon reduction        | Carbon measurement and policy                     | 4.62 (0.769)  | 0.865                                    |                                               |
|                         | Process improvements                              | 4.73 (0.573)  | –                                        | Merged with “process Improvements” after re-specification of model to ensure reliability and validity of latent variable |
|                         | Product & process Improvements                    | 4.62 (0.676)  | 0.799                                    | Merged with “product Improvements” after re-specification of model to ensure reliability and validity of latent variable |
|                         | Carbon compensation                              | 1.49 (1.025)  | –                                        | Excluded after re-specification of model to ensure reliability and validity of latent variable |
| Carbon performance      | Decrease in carbon intensity (in percentage, difference between 2008 and 2013) | 6.06 (21.712) | 0.826                                    |                                               |
|                         | Decrease in carbon exposure (in percentage, difference between 2008 and 2013) | 2.28 (34.806) | 0.750                                    |                                               |
| Financial performance   | Increase in return on equity (in percentage points, difference between 2008 and 2013) | 2.20 (28.727) | 0.895                                    |                                               |
|                         | Increase in return on assets (in percentage points, difference between 2008 and 2013) | 2.25 (10.772) | 0.874                                    |                                               |

Appendix 2. Rating schemes for corporate strategies and related activities

Category 1: Carbon governance

| Rating | Description                                                                                                                                                                                                 |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | The company does not mention or has no plans for organizational involvement.                                                                                                                                |
| 2      | The company has intentions and/or plans for organizational involvement (e.g., establishment of environment committee, implementation of workshops).                                                           |
| 3      | The company has a code of conduct related to environmental protection and/or conducted measures to raise employees’ awareness of environmental protection without specific relation to climate change or GHG emission reductions. |
| 4      | The company has conducted activities to raise employee’s awareness related to climate change mitigation (e.g., energy-saving workshops, tree planting for carbon compensation) or has assigned responsibilities to staff for managing issues related to climate change mitigation (e.g., energy managers, environment committee, global warming taskforce). |
| 5      | The company has conducted activities to raise employee’s awareness relate to climate change mitigation, has assigned responsibilities to staff for managing issues related to climate change mitigation and provides incentives for GHG emission reductions (e.g., variable remuneration, energy-efficiency awards). |
### b. Risk management

| Rating | Description                                                                 |
|--------|------------------------------------------------------------------------------|
| 1      | The company does not mention or has no plans for risk management related to climate change mitigation. |
| 2      | The company has intentions and/or plans for assessing risks or opportunities related to climate change mitigation. |
| 3      | The company views itself not to be exposed to climate change risks and opportunities, without providing any details. |
| 4      | The company mentions general risks (e.g. market trends or legislation) or opportunities related to climate change mitigation without stating that climate change is integrated into its risk management procedures |
| 5      | The company has integrated climate change mitigation aspects into their risk management procedures and provides details about risks and/or opportunities. |

### Category 2: Carbon reduction

#### a. Carbon measurement and policy

| Rating | Description                                                                 |
|--------|------------------------------------------------------------------------------|
| 1      | The company does not have or does not mention a GHG inventory or emission reduction targets. |
| 2      | The company has intentions or plans for estimating its GHG emissions. |
| 3      | The company has estimated its GHG emissions but has no reduction targets. |
| 4      | The company has estimated its GHG and wants to reduce its GHG emissions, without providing any details. |
| 5      | The company has estimated its GHG emissions and has clear targets for the whole company and/or its processes and products and tracks emissions from year to year. |

#### b. Product improvements

| Rating | Description                                                                 |
|--------|------------------------------------------------------------------------------|
| 1      | The company does not mention or has no plans for product improvements related to carbon emissions. |
| 2      | The company has intentions and/or plans for product improvements related to carbon emissions, without providing any details. |
| 3      | The company has estimated product emissions (e.g. through LCA), but does not provide examples of product improvements. |
| 4      | The company provides examples of product improvements (e.g. eco-friendly or energy-efficient products) that can lead to emission reductions, but does not provide details about improvements related to emission reductions. |
| 5      | The company provides examples of product improvements and provides details about improvements related to emission reductions (e.g. percentage weight reduction, fuel consumption in litres, carbon emissions saved). |

#### c. Process improvements

| Rating | Description                                                                 |
|--------|------------------------------------------------------------------------------|
| 1      | The company does not mention or has no plans for process improvements related to carbon emissions. |
| 2      | The company has intentions and/or plans for process improvements related to carbon emissions, without providing any details. |
| 3      | The company has estimated process emissions (e.g. related to energy consumption), but does not provide examples of process improvements. |
| 4      | The company provides examples of process improvements (e.g. new energy-saving equipment, fuel switch, renewable energy sources), but does not provide details about emission reductions. |
| 5      | The company provides examples of process improvements and provides details related to emission reductions (e.g. improvements in energy efficiency, carbon emissions saved). |

#### d. Carbon compensation

| Rating | Description                                                                 |
|--------|------------------------------------------------------------------------------|
| 0      | The company does not mention or does not engage in voluntary offsetting or compensation schemes. |
| 1      | The company has plans for compensation/offsetting, without providing any details. |
| 2      | The company is preparing for compensation/offsetting initiatives (e.g. takes part in a pilot project that has not generated emission credits yet). |
| 3      | The company engages in emission compensation/offsetting initiatives (e.g. JI, CDM) or has bought additional emission credits (e.g. in EU ETS). |

### Category 3: Carbon competitiveness

#### a. New markets & product development

| Rating | Description                                                                 |
|--------|------------------------------------------------------------------------------|
| 1      | The company does not mention or does not plan to launch new products or enter new markets related to low-carbon aspects. |
| 2      | The company has intentions and/or plans for launching new products or entering new markets related to low-carbon aspects, but does not provide details. |
| 3      | The company has concrete intentions and/or detailed plans for launching new products or entering new markets related to low-carbon aspects. |
| 4      | The company prepares the launch of new products or a market entrance (e.g. research partnerships, participation in pilot projects), acquisition of a new company for technical know-how, development of prototypes related to low-carbon aspects. |
| 5      | The company has launched new products or entered new markets related to low-carbon aspects. |
b. Stakeholder engagement

| Rating | Description |
|--------|-------------|
| 1      | The company does not mention or does not plan to engage in voluntary initiatives related to climate change mitigation. |
| 2      | The company has general intentions and/or plans for engaging in voluntary initiatives related to climate change mitigation. |
| 3      | The company has concrete intentions and/or detailed plans for engaging in voluntary initiatives related to climate change mitigation. |
| 4      | The company engages in voluntary business/sector initiatives (e.g. WBCSD) or initiatives in cooperation with NGOs, research institutes, governments or civil society that are related to climate change mitigation. |
| 5      | The company engages in both voluntary business/sector initiatives (e.g. WBCSD) and initiatives in cooperation with NGOs, research institutes, governments or civil society related to climate change mitigation (e.g. tree planting, public education events, research funding). |

c. Political activities

| Rating | Description |
|--------|-------------|
| 1      | The company does not engage in political lobbying or does not mention it. |
| 2      | The company lobbies through trade associations or provides funding to research organizations related to climate change mitigation. |
| 3      | The company engages in direct lobbying with policy makers related to climate change mitigation. |
| 4      | The company engages in a combination of any two from the following: lobbying through trade associations, funding of research organizations, direct lobbying of policy makers related to climate change mitigation. |
| 5      | The company engages in all three forms of lobbying related to climate change mitigation. |

d. Corporate communications

| Rating | Description |
|--------|-------------|
| 1      | The company reports about climate change mitigation aspects but does not have any formal reporting policy on environmental or climate-related disclosure. |
| 2      | The company reports about climate change mitigation aspects and has a formal reporting policy on environmental or climate-related disclosure but does not refer to any reporting guidelines. |
| 3      | The company reports about climate change mitigation aspects and refers to specific reporting guidelines (e.g. CDP, GRI, ISO26000), but has no rating. |
| 4      | The company reports about climate change mitigation aspects according to GRI, CDP or similar standards and has a rating. |
| 5      | The company reports about environmental issues according to GRI and CDP or similar standards and ranked/scored among the highest scoring band (e.g. CDP score above 90, GRI A+). |

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