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Article

Benefits of Building Organizational Resilience: The Case of Climate Change

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Abstract This paper investigates the time-dependent effects of building organizational resilience. So far, empirical research only finds evidence that organizational resilience provides benefits in the long term. For the short and medium term, the link remains unclear. On the one hand, literature indicates that building organizational resilience is costly. On the other hand, actions to build organizational resilience are perceived by investors, which should provide immediate positive effects for companies. This study investigates these two assumptions in the climate change context. We apply multiple regression analysis to study the relationship between resilience capabilities and different measures of financial performance. For market value and financial volatility, our findings indicate that building organizational resilience provides immediate benefits. For the total stock return index, we find only benefits that materialize with a time lag. We find no evidence at all that building resilience capabilities is related to costs in terms of lower accounting-based financial performance. Overall findings indicate that building organizational resilience is advantageous as it prepares an organization to face the challenges of climate change and, at the same time, provides financial benefits.

Keywords organizational resilience; short-termism; financial performance; market benefits, climate change

1. Introduction

In the strategy literature, several contributions incorporated time as an important factor in the corporate sustainability context (e.g., [1–5]). A recent study addresses the controversy that sustainability research currently provides little attention to the trade-offs between short-term profits and long-term sustainability and resilience [6]. Still, this controversy exists due to the issue of short-termism [7,8]. Here, organizations are subject to the pressure of maximizing shareholder value by implementing short-term strategies [9]. An organization that can manage this trade-off—accepting potential short-term financial losses to realize long-term prosperity—is more willing to implement measures to strengthen its resilience which might be related to costs in the short term but will increase resilience in the long run [6]. This includes a focus on developing the necessary organizational skills to deal with a changing environment—what Limnios et al. (2014) [10] call desirable resilience.

Climate change is considered one of society's greatest long-term challenges [11,12] and strategically relevant to organizations [13,14]. Climate change induces complexity, uncertainty, and rapid change, which, in turn, requires organizations to proactively strengthen their resilience and related capabilities [15]. These efforts can be expected to come along with additional costs. At the same time, however, responses to climate change can be expected to have material long-term effects [12,16]. Thus, developing adequate responses to climate change underlies a general problem of short-termism versus organizational resilience [15].

Corporate responses to climate change represent an interesting case to investigate the benefits of resilience building in detail. So far, there is little empirical research on the actual link between resilience and financial benefits. While some researchers argue that resilience building is costly [5,17], others find that resilience positively influences competitiveness and profitability [18]. There is only one study addressing both, benefits, and costs, of organizational resilience [6]. Thus, their study represents our main conversant [19]. Ortiz-de-Mandojana and Bansal (2016)

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[6] assess companies regarding their sustainable business practices and investigate—retrospectively—whether companies that manifested those practices to a high degree experienced benefits in the long term and find support for sales growth, financial volatility, and survival rates. For the short term, outcomes remain unclear.

Within our empirical study, we prospectively analyze capabilities and practices that lead to organizational resilience. We comparatively assess the manifestation of organizational capabilities of electric utilities using CDP data. In their responses to the CDP survey, companies report on how they internally deal with climate change. We, therefore, contribute to the literature in two regards. Since climate change is a prominent and much debated ecological issue that challenges many business models and, notably, requires urgent action, we expect corporate practices to also have an immediate effect on financial outcomes. We explore, first, whether resilience capabilities influence financial performance by inducing costs and, thus, decreasing accounting-based measures in the short term (one year) and medium term (two to three years). Second, we investigate the link between organizational resilience and its benefits in terms of market-based financial performance in the short and medium term—a perspective that has not yet been investigated. We find evidence that organizational resilience has immediate positive effects on financial volatility and market value. For the total stock return index, we find a positive effect which materializes with a time lag. We further re-examine the cost-related hypothesis [6] in the specific climate change context and find support for their general finding that there is no significant relationship between organizational resilience and lower accounting-based financial performance.

The paper is organized as follows. The following Section 2 provides the theoretical background by explaining the capabilities for creating resilient organizations and challenges related to the specific climate change resilience context. As a result, three hypotheses are deduced in Section 3. Section 4 then presents the chosen method and material. The results of the multiple regression analysis will be presented in Section 5. A discussion, limitations of this study, and avenues for future research are provided in Section 6.

2. Theoretical Background

2.1. The Challenges of Climate Change

Climate change as a phenomenon represents a specific change phenomenon that is addressed in the literature. Following social-ecological literature, resilience should always be studied in a specific change context which is referred to as asking the question "resilience to what?" (e.g., [20]). The challenges of climate change for organizations lie in the wickedness [21], that is, there is "certainty about the occurrence of long-term climatic changes and resulting impacts, but there is considerably less certainty about their type, severity or time of onset" ([22], p. 159). Following Linnenluecke and Griffiths (2012) [23], climate change increases the risks of conditions outside of a company's coping range if, for example, an individual climate event such as rainfall deviates from usual conditions or a critical combination occurs. Besides that, also gradual change can be threatening to organizations if they exceed the companies coping range. To deal with that, a company must possess wide coping ranges to be resilient [23].

Along a similar line, the challenge of climate change lies in its relation to different time horizons. Following Weise et al. (2020) [24], three decision contexts and time horizons influence resilience mechanisms: 1) reactive, when there is an imminent threat and a high pressure to act, 2) adjustive, when the threat is known in general, but there is still time to adapt and 3) provident, when time horizons are very long and the nature of the threats is uncertain, leading to a low willingness to act. Climate change in that context is unique, as it cannot be assigned to just one of these decision contexts. Extreme weather events as a huge part of the climate change crisis can relate to the first category, while some climate change effects are now better known and might fall under the second decision context. However, there are still uncertain effects of climate change with an even longer time horizon that led to a low willingness to adapt and have done so in the past leading to inert corporate action to climate change. Regarding the decision contexts and time horizons, we can only observe resilience capabilities that are in the realm of reactive and adjustive decision contexts. For example, companies that are already exposed to climate change through extreme weather events might have already taken adaptive measures by improving and hardening critical infrastructure or building redundancies in their supply chain by relying on multiple suppliers.

2.2. Capabilities for Creating Resilient Organizations to Climate Change

Literature on resilience in business and management is increasing and has made considerable progress, yet researchers criticize the concept for being ambiguous and lacking clarity in terms of its definition and measurement. Following Hillmann (2021) [25], five disciplinary perspectives and related ontologies, resulting tools, and methods to study the concept led to differences in how organizational resilience is understood. Researchers have borrowed ideas from those perspectives and combined them with other perspectives to provide new insights. However, this wealth of perspectives also led to resilience being a contested concept.

For example, in the ecological literature, resilience is defined as the "measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables" ([26], p. 14). In the context of organizational resilience to climate change, Linnenluecke and Griffiths (2012) ([23], p. 23) define it as the ability "to absorb the impact and recover from the occurrence of extreme weather events". They further raise the issue of context dependency which means that resilience building depends on the specific exposure to aspects of climate change [25] and question whether underlying mechanisms of resilience are transferable to organizations in different sectors or contexts [23]. Following Martin-Breen and Anderies (2011) [20], researchers need to answer the question "resilience to what?" to study resilience. Hereby, it is assumed that resilience differs according to the nature of change and can only be assessed or described for a specific phenomenon.

In the engineering perspective, resilience is typically defined as the ability to quickly return to a previous state after a disturbance. Resilience is needed to restore function and the solution to become resilient is to design it into a system through redundancy, flexibility, and adaptability [25]. Whiteman and Cooper (2011) [27] study resilience in the context of ecological surprises and find that resilience results in fewer hardships when faced with ecological surprises. They define resilience implicitly as the ability to make sense of and respond to feedback from the natural environment [27].

In the safety and reliability perspective, resilience is needed for dealing with failure and minimizing impacts which can be achieved through preparation and anticipation, being mindful and building redundancies [25]. In the positive psychology and organizational development perspective, resilience is about successfully coping with crises and stress through strengthening organizational resilience by strengthening employees and teams [25].

In the strategic perspective, resilience is about sustaining performance and competitive advantage by building resilience capabilities and resources [25]. For example, McCann et al. (2009) ([18], p. 45) define resilience as the "capacity for resisting, absorbing and responding, even reinventing if required, in response to fast and/or disruptive change that cannot be avoided" and show that resilience and agility influences financial performance. In the context of climate change, Sullivan-Taylor and Branicki (2011) [28] define it as the ability to be flexible and adapt to changes in the operating environment. In that perspective, resilience building can create value and, hence, is a source of competitive advantage (e.g., [28,29]).

Recently, researchers in business and management have relied on capability-based theorizing for conceptualizations of resilience [30–32]. Here, resilience goes beyond the restoration of organizational functionality and concerns the advancement of organizational processes and the development of new capabilities [31,33]. In this study, we also draw upon a capability-based conceptualization and define resilience as a set of organizational capabilities by which firms anticipate trends and threats, make sense of and cope effectively with adversity, and adapt to changes to produce a dynamic capability that is directed towards facilitating organizational change [10,30,31]. To account for the dynamic perspective of resilience, researchers have added a process-based perspective to resilience [31,32] and have described capabilities that relate to before, during, and after times of crises: anticipation, coping and sensemaking, and adaptation [31,34].

Anticipation. This dimension includes the ability to anticipate, which involves anticipating risks and possible future developments [35–39]. By that, organizations can increase awareness and reduce their vulnerability [35,40,41]. It refers to the attention organizations give to anticipating unexpected events [38]. Organizations that "attempt to anticipate events, are more likely to take the form of ongoing monitoring of their environment and/or simulating possible unexpected events" ([42], p. 3419). The important element of anticipating trends and risks is an increased organizational ability to understand external effects on the organizational goals or earning drivers [38,39]. Following Hillmann and Guenther (2021) [30], anticipation capabilities are the foundation of an effective response and, thus, realized resilience. The mechanism underlying these capabilities in the case of extreme weather events includes the creation of an emergency plan that encompasses "information regarding the following: potential extreme events, policies for preventing potential extreme, strategies and tactics for how to deal with, identify who will be affected by extreme, creation of effective communication plan regarding how to properly communicate with potentially affected publics, information regarding who will enact and be in charge of plan, and so of forth" ([43], p. 2). Organizations that are exposed to extreme weather events might initiate anticipatory adaptation [44] by building redundancies in their production or supply chain or improving the resilience of critical infrastructure. In the case of electric utilities, climate risk management is important to better prepare utilities against climate change related disruptions of electricity service [45]. Climate change impacts might be observed at generating stations and across transmission and distribution infrastructure [45]. This includes instability and disruption through "specific events (e.g., blackouts, demand spikes, transmission interruption), as well as material risks associated with ongoing operations and maintenance costs (wear, loss, etc.)" ([45], p. 16). This suggests that a comprehensive approach to assessing risk and vulnerability must include more than a simple assessment. Following Gerlak et al. (2018) [45], comprehensive approaches must evaluate social and institutional factors and how they shape risks and engage in an ongoing evaluation of adaptation plans and their implementation, especially whether they successfully reduce vulnerability.

Coping and sensemaking. Following Duchek (2020) [31], coping involves accepting the situation and developing and implementing solutions. The so-called acceptance of reality—being an important part of individual resilience (e.g., [46])—is discussed as "the cognitive challenge" in the organizational context [31,38]. Normally, organizations require too much time to realize and act on those events [31] and tend to deny negative scenarios and developments [34]—especially an observable problem regarding climate change resulting in a lack of corporate action or inertia [47]. Only if they accept the situation and conquer denial, organizations can react quickly and develop appropriate solutions. In crises, this means that organizations are able to put plans into action and find ad hoc solutions [31]. This involves the ability to make sense of the unfolding situation. Sensemaking is an essential part of this process and organizations must be able to sense or recognize changes and interpret those in a meaningful way [27,35,48–50]. The challenge of climate change is that it is difficult to comprehend the consequences due to the high levels of uncertainty and the time horizon [24,44]. Even now that more is known about climate change and the challenges humanity is facing, companies still struggle to address the related grand obstacles effectively [51]. The uncertainty makes it difficult for managers to guide organizations to act and gives sensemaking an essential role in the process [44]. Only then, organizations can take appropriate actions and measures, as it helps to translate the information to the goals of the organization and its influence on the organizational success [27,38,49,52]. Effective sensemaking involves continuous feedback—being an alternating process of understanding and action [53], thus, "sense must continually be made and remade" ([31], p. 228). Following Karman (2020) [43], in the face of an extreme weather event, resilience includes that the situation is brought under control by communicating with the public and the media. By disseminating information, the situation can be brought under control. This further includes a focus on self-efficacy of the people (i.e., showing them how to protect themselves). In the specific context of electric utilities, sensemaking can be improved through risk management processes that go beyond classic risk management and involve stakeholder engagement and cross-sector collaboration [45]. This can enhance cross-sectional learning and helps to identify further arising problems. For example, following Schaeffer et al. (2012) [54], cross-sectoral impacts on energy from climate change include competition for water resources (in electricity generation, oil refining, and irrigation of energy crops) or land competition (for biofuel production).

Adaptation. Adapting to critical situations and adjustments is an important dimension of resilience [31,48,55] and is directed toward organizational advancement [10]. Although being resilient is about creating stability during crises, a resilient organization can handle internal change—resulting from external pressure—at the same time [56]. It includes the adaptation of resources, interpersonal processes, and organizational routines [57,58]. It further includes the ability to renew or innovate [10,18,32,59–61]. Renewal is about proactive change of an organization before the change is desperately necessary [38], and constant renewal through innovation [61]. It means that a company can generate new strategic options [29,62,63]. At the operational level, it is about the ability to implement required measures such as resilience of infrastructure

[64] or building redundancies to ensure the resilience of the supply chain [65,66]. Innovation is important as this ensures the resilience of organizations [61,67] and supports organizations in their creation of value in terms of competitive advantage [38]. In the aftermath of extreme weather events, it is important to identify lessons learned and evaluate the damage, estimate losses to ensure financial liquidity, and identify replacement opportunities [43]. Moreover, communication with stakeholders is needed as it prevents a similar situation in the future [43]. In the context of electric utilities, adaptation actions might include investing in cooling and water efficiency technologies for power plants, diversifying energy portfolios, better demand-side management, or infrastructure hardening [45].

3. Hypotheses

In short, resilient organizations can sense or recognize changes in the environment and interpret those [35,49]. This includes interpreting external information and understanding how specific developments influence the goals and success of the organization [38,49,52]. They have a better understanding of required innovations and strategic opportunities [38].

Organizational resilience stemming from sustainable business practices leads to reduced financial volatility, improved sales growth, and survival in the long term [6]. For the short term, our main conversant [6] hypothesizes a negative relationship with accounting-based financial performance but finds no support. The authors conclude that in the resilience context, the contribution of sustainable business practices to superior short-term outcomes remains unclear. In their investigation, long-term outcomes refer to a period of fifteen years, and short-term outcomes to a time frame of three years. Sustainable business practices are measured by inclusion in the KLD 400. Thus, sustainable business practices may vary to a large extent among the considered firms. Due to this variability, the consideration of these time frames seems adequate. Some practices may have a direct effect on financial performance, while others—such as building trust amongst stakeholders—may only materialize after a decade.

By focusing on one specific aspect—organizational resilience in the case of climate change—we can use a more concise measure. Since climate change is a prominent and much debated ecological issue that challenges many business models and, notably, requires urgent action, we expect corporate practices also to have an immediate effect on financial outcomes. This study, thus, utilizes a time frame that defines short-term as being within one year, medium-term as a minimum of two years, and long-term as above five years [68,69].

3.1. The Trade-off between Short-term Profits and Long-term Resilience

The trade-off between short-term profits and long-term resilience is one of the main challenges of bringing organizational resilience into the corporate boardroom. The development of resilience capabilities requires a long-term perspective, which raises the issue of short-termism [70]. Short-termism stems from different sources such as pressure from capital markets [3,8] or managers thinking in budget periods [68]. It is a systematic characteristic of overvaluing short-term rewards and actions that might have detrimental long-term ramifications [7,8].

The demand for long-term thinking originates in the sustainability debate and includes creating long-term value not just for business, but society as a whole [71,72]. This aspect as well as the time frame are fundamental to managerial decision-making [7]. Still, temporal aspects of firm practices and outcomes are largely ignored and silence about it contributes to that [6]. Following Ortiz-de-Mandojana and Bansal (2016) [6], a resilient organization accepts financial losses for realizing long-term prosperity. However, organizational survival still depends on short-term financial performance [68]. Until this paradox is resolved, management may be tempted to pay less attention to resilience building.

Since literature agrees that the effects of organizational resilience materialize in the long-term and are in the short-term related to costs [5,6,17], this trade-off intensifies the issue of short-termism. Hence, the investigation of benefits from building organizational resilience in the short and medium term represents an open avenue for inquiry.

Resilience capabilities consume corporate resources, which are therefore not available to invest in other profitable and viable strategies [6]. For example, in our chosen context of climate change, financial resources which are invested in improving a company's risk management system to extend and sharpen capabilities to seize and sense opportunities with a strong focus on early detection of global and regional impacts induced by climate change cannot be used for other investments that might be profitable in the short term. Further examples are investments in monitoring operations, investing in safety, or technologies that foster (climate) resilience [73,74]. For the case of electric utilities that are exposed to extreme weather events, this might include investing in hardening transmission and distribution systems [75] or specific asset design to improve impact resistance, ensuring functionality, or fast recovery in the face of natural disasters [76]. Besides financial resources, human resources also must be allocated as they must be involved in the process of monitoring, seizing opportunities, and making sense of unfolding events, for example, building special task forces to implement measures for climate change adaptation. Also, human resources in terms of motivated and innovative employees that are committed to change in general and climate change resilience in specific must be attracted [77,78]. This is related to costs, and it is in the long term, i.e., above five years, that these changes materialize and are transformed into growth opportunities. Thus, we expect a negative effect on accounting-based measures in the short and medium term.

Hypothesis 1: In the short and medium term, firms with a high manifestation of resilience capabilities have lower accounting-based financial performance.

3.2. Resilience Capabilities Reduce Financial Volatility and Are Valued by Investors

Accounting-based measures represent backward-looking measures of a firm's ability to use assets efficiently and generate value [79]. As an example, from the context of climate change resilience for electric utilities, climate change mitigation strives to reduce fossil fuel utilization and carbon dioxide emissions, which redirects the energy sector towards low-carbon energy technologies [80]. Electric utilities can influence the supply side and increase water efficiency, reduce water use, or utilize municipal effluent for cooling [64,76,81].

Here, we expect that building resilience is negatively related to accounting-based measures. In contrast, measures for market-based financial performance reflect the assumptions of investors about a firm's future developments [79,82,83] and include reputational effects and building knowledge which can, later on, create value [84]. We assume that the market and investors already perceive and value building resilience today for the following reasons. Resilient organizations can notice and correct maladaptive tendencies by being able to anticipate, notice, and make sense of the future [45]. Firms that continuously anticipate and develop plans to detect changes are able to deal with unexpected events, e.g., extreme weather events, and adjust to external changes without experiencing trauma [35,38,44]. These activities contribute to stability in terms of less scrutiny and less unsystematic market risk [6]. Low financial volatility is a sign of high organizational resilience and, thus, has a self-reinforcing effect over the medium term. As reduced financial volatility represents one of the expected short- and medium-term benefits of building organizational resilience, market participants view resilient organizations as being less risky and better managed because they are less vulnerable to certain external events. Thus, we expect further benefits in market-based financial performance in terms of total stock return index and market value.

Furthermore, organizations with desirable resilience have business models that create win-win situations for both, stakeholders, and the company itself, by generating a high level of stakeholder consent [10] that is perceived by investors.

Hypothesis 2: In the short and medium term, firms with a high manifestation of resilience capabilities experience less financial volatility.

Hypothesis 3: In the short and medium term, firms with a high manifestation of resilience capabilities have a higher market-based financial performance.

4. Materials and Methods

4.1. Sample

We chose the electric utility industry as a highly climate-vulnerable sector [75]. The facilities of electric utilities are often located in climate sensitive areas. Moreover, utilities need to rely on long-term assets and infrastructure resulting in high and long-term investments [76]. Hence, as utilities cannot react in the short run regarding their assets, they must carefully consider building climate change resilience. Due to that, they are especially exposed to the challenge of short-term thinking versus resilience building and are thus a meaningful sample in this context.

We rely on one distinct industry sector as it is preferred when studying change [85]. In addition, we enhance the comparability of gained results and do not have to control for industry effects [86]. Data stems from CDP, which provides the largest worldwide accepted database for information on climate change and companies [13,87]. CDP offers important data for climate change related strategy analysis [88]. Their reported data refers to the year 2011 and was collected and published by CDP in 2012.

The sample consists of 49 electric utilities from Europe (n = 19), North America (n = 13), South America (n = 10), and Asia (n = 7). We have a cross-country sample, which means that companies are subject to different legal requirements. However, building resilience is primarily about adapting to climate change. While mitigation is highly regulated by law [13], climate change adaptation is not in the hand of the state and is not as regulated worldwide as mitigation [75]. Although there might be specific and local legal regulations that concern climate change adaptation, it is the responsibility of the company to identify their exposure and vulnerability and reflect them in their corporate risk management process. Thus, a comparison of companies across countries is feasible for our research interest.

4.2. Variables

Independent Variable. We chose an innovative approach and derived the independent variable by applying an in-depth content analysis in combination with a comparative assessment of companies. The steps are described in detail below.

Step 1—Preparing the content analysis. We relied on the CDP survey to assess the manifestation of resilience capabilities towards climate change. Table 1 shows how the resilience capabilities as outlined in theory Section 2 are applied in the content analysis. We investigate three resilience capabilities: anticipation, coping and sensemaking, and adaptation. We analyzed which specific question of the CDP survey provides information on those resilience capabilities. Within our research team, members individually determined the relevant questions that provide meaningful answers about climate change related resilience capabilities. Subsequently, the assignment was confirmed by communicative validation in our research team [88]. The assignment of questions to the capabilities is shown in Table 1. To ensure that we truly assessed resilience capabilities and to strengthen the reliability of the coding process, we used the CDP disclosure guideline and scoring methodology [87] for calibration. Thus, we also ensured that we did not code information the organization was not supposed to disclose, and, therefore, we also reduced the subjectivity of coding.

Step 2—Content analysis. We conducted an in-depth content analysis [89] based on the three capabilities and along the CDP disclosure guideline (Table 1). To ensure validity and consistency, we coded one-fifth of the companies as a team—therefore ensuring interrater reliability—and then split the remaining coding procedure among the team members. Thereafter, we examined the coding results and differences were reconciled by negotiation within our team [90]. The content analysis was performed with MaxQDA, a software for computer-aided qualitative data analysis. The file with all codings is available as Supplementary Material. For operational response, we counted the number of realized or intended adaptation measures. The list of adaptation measures is based on prior studies [76,91] and is available as Supplementary Material.

Table 1. Overview of resilience capabilities score (RESCAP) and related questions from the CDP survey.

Score	Capability	Definition as of Theory Section	CDP Questions Used as Indicators for Assessing the Capabilities	Pairwise comparisons (PC), counting and ranking (#)
Resilience capabilities (RESCAP)	Anticipation	Ability to anticipate risks resulting from climate change Ability to sense or recognize changes in the environment Raising awareness through monitoring	General risk management process (2.1. a); scope of process of climate change related risk management process (2.1. a i); frequency of monitoring (2.1. a iv); to whom results are reported (2.1. a vi)	PC 1
	Coping and Sensemaking	Ability to interpret changes in the environment Ability to translate external information and understand how climate change influences goals and success of the organization	General risk management process (2.1. a); how risks and opportunities are assessed at a company level (2.1.a ii); how risks and opportunities are assessed at an asset level (2.1.a iii); criteria for determining materiality/priorities (2.1. a v)	PC 2
			Physical climate change risks (5.1. c description + 5.1. h); financial implications (5.1. d i)	PC 3a
			Other climate change related risks (5.1. e description + 5.1. i); financial implications (5.1. e i)	PC 3b
			Physical climate change opportunities (6.1. c description + 6.1. h); financial implications (6.1. d i)	PC 3c
			Other climate change related opportunities (6.1. e description + 6.1. i); financial implications (6.1. e i)	PC 3d
	Adaptation	Ability to develop and implement required operational measures to climate change	Adaptation measures realized (5.1. d ii + 5.1. f ii + 6.1. d ii + 6.1. f ii)	#
		Ability to adapt on a strategic level	How climate change influences strategy and which specific aspects (2.2.a + 2.2.b i - ii)	PC 4
		Ability to generate innovations and strategic opportunities	Most important components of short- and long-term strategy that have been influenced by climate change (2.2.a iii – iv); how this is gaining competitive advantage (2.2. a v); most substantial business decisions made (2.2 a vi)	PC 5

Step 3—Pairwise comparison. The results of the content analysis build the basis for subsequent pairwise comparison. We use pairwise comparison (PC) [92] for a comparative assessment of companies. It is central to competitor analysis and represents a relative positioning of a company to its peers [93]. This approach differs from prior studies which refer to the KLD where corporate sustainability practices are assessed with a binary coding system [6,74]. We applied pairwise comparison for the following reasons. First, companies' responses given to the CDP were too rich in content that a reduction to 0 and 1 would have diminished the real manifestation of capabilities and value of the comparison between companies, and variability in answers would have been reduced. Second, responses were too individual and did not necessarily follow the detailed guidelines provided by the CDP, which impedes comparability.

We provide one example for the questions where companies described physical climate change risks and their implications that was the basis for PC3a (Table 1). A company succeeded over another if it was able to specifically explain operational, strategic, and financial implications of each physical climate change risk driver. For example, American Electric Power identified six risks and shortly explained their impacts on the corporation but did not—in contrast to EDP Energias de Portugal—describe their specific (potential) financial implications. Therefore, EDP Energias de Portugal succeeded over American Electric Power in that particular PC. To increase the transparency of our approach, conducted PCs are available as Supplementary Material.

Step 4—Building the resilience capabilities score (RESCAP). We performed several pairwise comparisons in which we compared company by company regarding the manifestation of the three resilience capabilities. By that, we were able to figure out which company shows a high or low manifestation of resilience capabilities. This resulted in a scoring of companies that allows distance measurement.

The RESCAP score (Table 1) is built based on the three resilience capabilities that were equally weighted and summed up. The reason for that is twofold: first, we consider the equal importance of every single capability and, second, we draw from approaches applied in corporate social responsibility research [74]. Since coping and sensemaking capability consists of five different pairwise comparisons (PC2, PC3a–PC3d), we had to create an overall value for it that included the five pairwise comparisons. Here we could not apply equal weighting because related questions from the CDP survey showed a different level of detail. Thus, the weightings were based on the content they provided to support the assessment of that capability. Questions that were used for PC2 are equally as important as questions of PC3a to PC3d combined. Equal weighting was again applied for questions underlying PC3a to PC3d as they address four different consequences of climate change (risks and opportunities), but with the same content and detail. Hence, PC2 was weighted with 0.5 and PC3a to PC3d with 0.125 each.

For adaptation, we looked at the company's response at the strategic level, at the operational level and innovations and identified strategic opportunities (value creation). For operational response, we build a ranking based on the counted implemented measures to address climate change. Hence, the company with the highest number of adaptation measures received the highest ranking, which is 49 points (due to 49 electric utilities).

Dependent variables. Financial performance (FP) data stems from Thomson Reuters Datastream. For accounting-based measures, we use return on sales (ROS), return on assets (ROA), and return on equity (ROE). They are widely accepted indicators for firm performance in the broader field of strategy [94]. ROS is measured as net income before extra items and preferred dividends (NEBID) divided by total sales revenue; ROA as NEBID divided by total assets beginning-of-the-year; ROE as NEBID divided by total shareholder equity beginning-of-the-year. We use share price volatility (VOL) as our measure of financial volatility, which is measured "by the standard deviation of the monthly stock returns across one year" ([95], p. 217). Drawn from Datastream, we use total stock return index (RI), which illustrates the growth in value of a share over a specified period, assuming that dividends are reinvested to purchase additional assets, and market value (MV), which is the share price multiplied by the number of ordinary shares for market-based financial performance.

Control variables. We rely on prior research and include several measures to control for further impacts on financial performance [96]. Capital intensity (CAPINT) is measured by using capital expenditures divided by beginning-of-the-year total assets. We measure the firm size (SIZE) by using the natural logarithm of number of employees [94,97]. Financial gearing (FG) is measured by dividing total debt by total shareholder equity [98]. For the model where we predict ROE, we use financial leverage (LEV) instead of FG as a control variable, measured as debt to assets [74]. Otherwise, we would include total shareholder equity in the control and dependent variable for predicting ROE. The Climate Change Performance Index (CCPI) allows controlling for country effects as it assesses different countries considering their policy of climate change, level of emissions, and performance regarding efficiency and renewable energies [99].

4.3. Missing Values

To deal with missing values for financial data, we used data from annual reports and, if not possible, data is generated by multiple imputation. In contrast, replacing missing values by mean, multiple imputation has the advantage that it replaces missing items with several values taking into account different possibilities [100]. This is especially helpful with regard to our small sample. As predictor variables for imputation, we use related financial values and generate five imputation models. Some electric utilities are not publicly traded, reducing the sample to $n = 47$ for RI and $n = 46$ for MV and VOL.

4.4. Regression Models

We build three regression models, to explore whether the effects of interest are shown immediately or with a delay (time lag). The first model represents our short-term model which includes studying the relationship between resilience capabilities and financial performance in the same year (Model 1, 2011). For Model 1, we match financial data with the CDP reporting year (2011). We assume that assessed capabilities have been built prior to the reported data. The financial data reflects the financial performance covering the entire year 2011 and, thus, reflects our definition of short-term as being within a one-year time frame. For medium-term outcomes, we consider a two-year time lag (Model 2, 2013) and three-year time lag (Model 3, 2014) and hypotheses are supported if results are significant for at least one-time lag model. Regression models for the same year ($t = 2011$) and time lag read as follows:

$$FP_{t+i,i=[0,2,3]} = \beta_0 + \beta_1 RESCAP_t + \beta_2 CAPINT_{t+i} + \beta_3 SIZE_{t+i} + \beta_4 FG_{t+i} + \beta_5 CCPI_{t+i} + \varepsilon \quad (1)$$

5. Results

5.1. Descriptive Statistics and Regression Results

Descriptive statistics are displayed in Table 2. We checked Pearson's correlation coefficient for all models and variables and data indicate that we can rely on relevant correlations for our regression models. Following Prunier et al. (2015) and Brun et al. (2020) [101,102], a correlation of more than 0.7 among the predictor variables is a sign of multicollinearity. This would be so far problematic, as in that case, it would not be clear which of the variables contributes to the variance explanation. The results of the correlation analysis show that the predictor variables are not correlated higher than 0.7, thus no evidence of multicollinearity was found in any model (see Supplementary Material). As we rely on a data set stemming from social sciences and as we further rely on a small sample, we expected that our data is not normally distributed and found evidence in our further conducted analyses. Related implications will be discussed in the limitations section of our study.

Table 2. Descriptive statistics.

Variable		Min	Max	Mean	Std. Dev.
Independent Variable	RESCAP	3.000	218.000	119.878	61.340
Dependent Variables *Accounting-based financial performance*	ROA_2011	−0.052	0.205	0.040	0.040
	ROA_2013	−0.047	0.216	0.031	0.043
	ROA_2014	−0.178	0.448	0.039	0.077
	ROE_2011	−1.612	28.175	0.294	0.887
	ROE_2013	−0.197	0.386	0.098	0.107
	ROE_2014	−0.955	1.053	0.104	0.198
	ROS_2011	−0.272	0.890	0.125	0.145
	ROS_2013	−0.223	1.092	0.108	0.188
	ROS_2014	−0.214	28.627	0.675	4.086

Table 2. (*Continued*)

Market-based financial performance	VOL_2011	0.016	0.141	0.056	0.027
	VOL_2013	0.026	0.182	0.064	0.031
	VOL_2014	0.021	0.190	0.066	0.037
	MV_2011	312.530	53897.543	13078.502	14178.496
	MV_2013	97.684	59631.677	12127.754	13789.144
	MV_2014	62.432	50624.020	13686.018	15152.955
	RI_2011	0.070	11950.260	1933.249	2391.220
	RI_2013	0.086	14597.400	2163.989	2844.549
	RI_2014	0.085	14966.760	2326.196	2994.153
Control Variables	CAPINT_2011	0.000	0.243	0.067	0.043
	CAPINT_2013	0.000	0.130	0.052	0.026
	CAPINT_2014	0.000	0.298	0.053	0.035
	SIZE_2011	4382.000	11930.000	8763.000	1514.000
	SIZE_2013	4394.000	11973.000	8765.000	1517.000
	SIZE_2014	4419.000	11905.000	8750.000	1483.000
	FG_2011	0.000	15842.000	1655.000	1463.000
	FG_2013	0.000	5.490	1.456	1.008
	FG_2014	0.121	7.559	1.548	1.274
	LEV_2011	0.000	1.610	0.360	0.198
	LEV_2013	0.000	0.718	0.356	0.158
	LEV_2014	0.027	1.232	0.358	0.175
	CCPI_2011	43.900	70.500	57.473	9.958
	CCPI_2013	45.160	69.540	57.351	5.936
	CCPI_2014	40.390	69.660	56.720	6.790

Note: For all years, n = 49, except for VOL and MV n = 46, and for RI n = 47 (for all years).

Table 3 shows the results of the regression models. Following Aguinis et al. (2010) [103], we report exact p-value, effect size, and adjusted R^2 for magnitude of effect.[1]

5.2. Results for *Hypothesis 1* (ROS, ROA, ROE)

The F-statistics (Table 3) indicate that the regression models are statistically significant for ROS in the model of two-year time lag ($F = 3.272$, $p = 0.014$) and ROA in all years: no time lag ($F = 2.115$, $p = 0.096$), two-year time lag ($F = 3.519$, $p = 0.009$), and three-year time lag ($F = 2.753$, $p = 0.043$). We do not find any statistically significant results for ROE. Overall, we find no relationship between our independent variable RESCAP and all three accounting-based measures in the short and medium term. These results do not support hypothesis 1, but there are still very interesting findings to be discussed.

Considering the models with no time lag for ROA and ROE, we find negative relationships supporting *Hypothesis 1* for the short term. Interestingly, both relationships turn in a positive direction over time. For ROE, the relationship changes to a positive one with a time lag of two years and for ROA with a time lag of three years. An explanation might be that in the short term, organizations invest in their risk management system to extend and sharpen their capabilities to seize and sense opportunities and therefore, related costs do not allow for other profitable short-term investments. This would imply that investments in building resilience capabilities seem to be less costly than assumed—creating an even bigger case for investing in climate change resilience. However, this possible explanation needs to be analyzed in detail by future research.

[1] Aguinis et al. (2010) [103] argue for the use of α-values that consider the relative seriousness of Type I versus Type II error, which is based on strong theoretical rationales. However, the required variable for computing α cannot be deduced since resilience research lacks a strong theory. Resilience research is influenced by a multitude of theoretical perspectives [20]. We therefore relied on α = 0.10.

Table 3. Regression results.

		Model no time lag			Model 2 yr time lag			Model 3 yr time lag		
		β	*SE β*	*Sign.*	*β*	*SE β*	*Sign.*	*β*	*SE β*	*Sign.*
ROS	RESCAP	0.115	0.167	0.492	0.177	0.150	0.237	0.230	0.172	0.181
	CAPINT	−0.023	0.158	0.885	−0.037	0.140	0.792	−0.157	0.155	0.311
	SIZE	−0.415	0.162	0.010	−0.448	0.150	0.003	−0.234	0.164	0.154
	FG	−0.155	0.192	0.425	−0.203	0.138	0.139	−0.089	0.155	0.567
	CCPI	−0.068	0.147	0.644	−0.179	0.133	0.179	−0.090	0.158	0.570
	Adjusted R^2		*0.090*			*0.192*			*0.022*	
	F-Test		*1.970*			*3.272*			*1.218*	
	p-Value		*0.125*			*0.014*			*0.318*	
ROA	RESCAP	−0.056	0.166	0.734	−0.009	0.148	0.954	0.165	0.160	0.302
	CAPINT	0.090	0.163	0.582	−0.007	0.138	0.962	0.012	0.187	0.951
	SIZE	−0.331	0.160	0.039	−0.420	0.148	0.005	−0.318	0.154	0.038
	FG	−0.150	0.221	0.508	−0.295	0.137	0.031	−0.301	0.165	0.073
	CCPI	0.201	0.147	0.170	−0.073	0.132	0.580	−0.130	0.151	0.391
	Adjusted R^2		*0.103*			*0.209*			*0.242*	
	F-Test		*2.115*			*3.519*			*2.753*	
	p-Value		*0.096*			*0.009*			*0.043*	
ROE	RESCAP	−0.016	0.169	0.924	0.161	0.161	0.318	0.231	0.179	0.198
	CAPINT	0.025	0.232	0.916	−0.168	0.147	0.253	−0.133	0.157	0.398
	SIZE	−0.254	0.198	0.211	−0.395	0.161	0.014	−0.238	0.165	0.150
	LEV	0.049	0.392	0.905	0.048	0.155	0.756	−0.149	0.257	0.577
	CCPI	0.156	0.160	0.334	−0.071	0.152	0.639	−0.217	0.175	0.219
	Adjusted R^2		*0.145*			*0.066*			*0.115*	
	F-Test		*2.807*			*1.675*			*2.303*	
	p-Value		*0.101*			*0.162*			*0.101*	

		Model no time lag			Model 2 yr time lag			Model 3 yr time lag		
		β	*SE β*	*Sign.*	*β*	*SE β*	*Sign.*	*β*	*SE β*	*Sign.*
VOL	RESCAP	−0.354	0.147	0.016	−0.618	0.150	0.000	−0.256	0.181	0.156
	CAPINT	0.020	0.159	0.900	−0.005	0.141	0.972	−0.009	0.193	0.964
	SIZE	0.292	0.143	0.042	0.334	0.147	0.023	0.024	0.163	0.883
	FG	0.373	0.148	0.012	−0.031	0.140	0.822	0.273	0.163	0.095
	CCPI	0.240	0.133	0.070	0.271	0.140	0.054	−0.043	0.168	0.798
	Adjusted R^2		*0.290*			*0.258*			*0.083*	
	F-Test		*4.743*			*4.104*			*1.808*	
	p-Value		*0.006*			*0.004*			*0.146*	
RI	RESCAP	0.243	0.157	0.122	0.320	0.155	0.038	0.380	0.166	0.022
	CAPINT	0.028	0.148	0.849	0.204	0.142	0.152	0.187	0.162	0.252
	SIZE	0.137	0.153	0.369	0.100	0.154	0.515	0.097	0.155	0.530
	FG	−0.181	0.149	0.226	−0.131	0.145	0.365	−0.182	0.158	0.252
	CCPI	−0.340	0.138	0.014	−0.345	0.148	0.019	−0.198	0.160	0.214
	Adjusted R^2		*0.219*			*0.168*			*0.166*	
	F-Test		*3.560*			*2.844*			*2.817*	
	p-Value		*0.009*			*0.027*			*0.032*	
MV	RESCAP	0.246	0.119	0.038	0.226	0.123	0.066	0.251	0.128	0.049
	CAPINT	0.022	0.126	0.863	0.178	0.111	0.107	0.161	0.108	0.138
	SIZE	0.608	0.115	0.000	0.590	0.120	0.000	0.561	0.115	0.000
	FG	−0.039	0.116	0.736	−0.109	0.114	0.340	−0.184	0.113	0.104
	CCPI	−0.080	0.107	0.452	−0.025	0.115	0.827	0.088	0.121	0.467
	Adjusted R^2		*0.554*			*0.499*			*0.533*	
	F-Test		*12.144*			*9.904*			*11.188*	
	p-Value		*0.000*			*0.000*			*0.000*	

Note: For all years, $n = 49$, except for VOL and MV $n = 46$, and for RI $n = 47$ (for all years).

For ROS, the regression models in all years indicate a positive relationship and do not support *Hypothesis 1*. An explanation could be that the measure RESCAP might mainly affect assets and equity for building resilience as highlighted above and not sales. Nevertheless, we also wanted to report the results where we predict ROS, as ROS represents one of the main accounting-based measures and thus, future research has better opportunities to compare our results to other studies.

5.3. Results for *Hypotheses 2* and *3* (VOL, MV, RI)

RESCAP is significantly negatively related to VOL ($\beta = -0.354$, $p = 0.016$) for the model without time lag. RESCAP in the model with a time lag of two years ($F = 4.104$, $p = 0.004$) also significantly predicts VOL ($\beta = -0.618$, $p = 0.000$). These results support *Hypothesis 2* and the negative relationship indicates that organizations with a higher score for resilience capabilities effectuate less volatility. Thus, the market positively evaluates organizations that invest in building capabilities for climate change resilience. For the time lag of three years, there is no significant relation between RESCAP and VOL. It might be the case that other effects which are not entirely depicted by our chosen control variables have a stronger impact in year three.

Resilience capabilities highly significantly predict MV in all investigated years, supporting *Hypothesis 3*. For the short term, RESCAP positively relates to MV ($\beta = 0.246$, $p = 0.038$) and explains 55 percent of the variance ($F = 12.144$, $p = 0.000$). Similar results can be shown for the two- and three-year time lag model. Thus, building resilience capabilities increases the market value of an organization.

However, in the case of RI, *Hypothesis 3* cannot be supported since RESCAP does not significantly predict RI in the short term. It might be the case that growth in value of a share over a specified period is not observable in the model with no time lag and that the assumed growth takes some time to be apparent in the chosen measure RI. For the medium-term outcomes, RESCAP significantly predicts RI for the two-year time lag ($\beta = 0.320$, $p = 0.038$) and the three-year time lag model ($\beta = 0.380$, $p = 0.022$). The results of both regressions indicate that the predictor explains almost 16.8 percent ($p = 0.027$) and 16.6 percent ($p = 0.032$) of the variance.

5.4. Sensitivity Analyses

For conducting sensitivity analyses, we tested if a different weighting of capabilities for building the RESCAP score (Table 1) leads to different results. Here, we chose two different approaches. First, we ascribed coping and sensemaking a higher importance as anticipation since some authors argue that the ability to make sense is by far the most critical as it precedes problem-solving or action [27,59] and is essential to avoiding failures [104]. Thus, the three resilience capabilities are weighted as follows: 10 percent (anticipation), 30 percent (coping and sensemaking), and 60 percent (adaptation).

Second, although resilience definitions are very heterogeneous, adaptation can be found to be one common component across definitions. We address adaptation by using the three capabilities of strategic response, operational response, and value creation as a simplified proxy for the whole resilience process. Here, the three capabilities are equally weighted.

In general, results in terms of confirming hypotheses remained stable within conducted sensitivity analyses. It further proved that the chosen original RESCAP score showed a higher explanatory power across all dependent variables and time lag models. This confirms the validity of the originally developed RESCAP score (Table 1).

6. Discussion and Conclusion

6.1. Discussion

Climate change challenges companies in various regards and requires urgent action, such as building organizational resilience. We expected related corporate practices to have an immediate effect on financial outcomes.

First, we considered short-term effects in terms of market-based financial performance and financial volatility and found interesting results. To our knowledge, no prior empirical study has investigated those relationships. For financial volatility and market value, our findings indicate that building organizational resilience provides benefits in the short as well as in the medium term. For the total stock return index, we find a medium-term benefit. A reduced volatility means that stock market prices are more stable and that its variance is lower. A logical explanation stems from reduced uncertainty perceived by investors due to the disclosure of efforts to become more climate change resilient. Investors value organizational capabilities as they result from investments (e.g., in human resources) and lead to enhanced confidence in future earnings. We conclude that the efforts of companies to enhance their organizational resilience in the climate change context are well perceived by investors and are still becoming increasingly important. Especially with the recent development in the areas of sustainable finance. Investors now focus more on climate change and would opt to divest from companies that do not address climate change issues by setting carbon emissions reduction targets to align with the goals of the Paris Agreement. As these issues are increasingly perceived as financially material for companies, investors increasingly focus on climate change (e.g., investor initiatives such as Climate Action 100+, Net Zero Asset Owner Alliance, and many more).

Second, we considered that building organizational resilience represents a long-term process that requires financial and human resources as well as knowledge. Acquiring corresponding capabilities might be related to lower accounting-based financial performance in the short and medium term. Recent research argues that building resilience is costly, but does not provide empirical evidence [5,6,17]. We expected costs in terms of short- and medium-term losses, which is shown in reduced accounting-based measures, but find no support for this link. The assumed argument that building organizational resilience is related to costly investments cannot be proven by our conducted analyses for accounting-based measures. Further studies might focus on the reverse relationship, meaning the hypothesis that organizations that do not build resilience capabilities have lower accounting-based financial performance. This might be comparable to the experienced supply chain problems for those organizations without proper supply chain (risk) management during COVID-pandemic.

However, our results also do not support the findings of [18], who found a positive relationship between organizational resilience and profitability in the short term. For example, in the case of ROS, one precondition for increased sales is that customers and other stakeholders acknowledge and value a firm's efforts in this regard. Firm-specific responses to climate change, however, might not be a determinant of purchase decisions. Second, improvements in sales and profit may need more than four years to develop. Firms have to be able to transform resilience capabilities into growth opportunities by, for example, attracting human resources or developing new products and services that are valued by customers. This transformation may require more time than is included in our time frame. Another reason for inconclusive results in our research context might be that electric utilities can transfer the costs for adaptation measures. For instance, costs for more resilient grids might be directly incorporated in the pricing policy, thus, the firm's profitability is not affected.

We argued that building resilience comes along with building knowledge among employees which can lead to generating innovations. However, those innovations might take some time to create value and enhance financial performance and therefore do not materialize in the short and medium term. We found no support that building resilience capabilities is related to lower accounting-based financial performance in our sample. Thus, in the climate change context, organizational resilience does not seem to be related to accounting-based financial performance in the short and medium term. Unfortunately, our results cannot provide new insights regarding this possible link. We encourage future research to reinvestigate this link in different settings.

6.2. Limitations and Avenues for Future Research

Even though the estimated regression models and additional sensitivity analyses indicate that building organizational resilience is advantageous as it prepares an organization to face the challenges of climate change and, at the same time, provides financial benefits, the analysis is not complete without presenting limitations and further pathways for future research.

The first set of limitations refers to our chosen material. Due to the focus on one specific industry, we rely on a small sample and, thus, a model with one predictor. To be more specific, the study power isn't very strong as we, first, rely on a sample of 49 electric utilities which reported to CDP and, second, regressed across multiple outcome-dependent variables. Even though we acknowledge that our findings cannot be generalized to other industries, they provide a good basis for further studies.

It is advantageous for future studies to focus more on country-specific effects, e.g., when regarding the impacts of and to public policies [105] and to replicate the study within other industries or to conduct a cross-sectoral analysis that considers specific industry differences. For instance, we expect different and interesting outcomes from less regulated industries and from industries, which do not belong to the group relying on asset-heavy infrastructure. However, we are also keen on studies investigating other infrastructure industries (e.g., heat suppliers). Here, we assume reasonably comparable results as those organizations also operate with similar framework conditions such as a highly regulated environment and as those organizations also must deal with the long-term perspective of their business and related assets.

Another reason that could limit the information value of our study is the fact that we do not differentiate results to different sub branches as our chosen sample is too small, but future studies based on larger datasets for electric utilities could differentiate between different sources of energy (coal, gas, etc.). We further recommend relying on CDP with its largest worldwide accepted database for information on climate change and companies [13,87] and relevant data for climate change related strategy analysis [88].

Moreover, one could argue that our data set is quite old as the data we use was collected by CDP 2012. Data thus refers to 2011. As the dataset is the most comprehensive database in this research field available to us—even up-to-date there are only datasets on resilience. In addition, the dataset included survey data from many electric utilities—from different countries. As [106] point out, there are numerous challenges to gather such comprehensive data that enables e.g., cross-country comparisons and we, therefore, decided to use that data set for our study. Following Zimmerman (2008) [107], even older data sets can still act as a source for generating valuable insights, especially in the event of new research field development, it is, according to [107], feasible to draw new knowledge from old data to open a new avenue for further research. Moreover, the data is about 10 years old, nevertheless, in our view, the data has not lost any of its significance or analysis potential as a result. Moreover, in a letter from ([108], p. 415), he qualifies old data as acceptable "if the work is based on 'private/specific/original data that date from several years ago' but for which the phenomenon studied is still of current interest". As we are convinced that these criteria apply in our case, and as such, we decided to use that rich and great dataset—although it represents a further limitation of our study.

A further avenue for future research refers to the time perspective. As our study focuses on the short- and medium-term perspective, it would be timely that future studies follow the argumentation of [6] and thus, add the long-term perspective to investigate the path-dependency of analyzed organizations.

Within our chosen approach to measure organizational resilience, we define firms with a high manifestation of resilience capabilities based on their relative performance to other analyzed companies in the sample (pairwise comparison). We argue that firms with high manifestation should be more resilient than their peers. This approach—in combination with the contested concept of resilience in general—represents the second set of limitations of our study. Nevertheless, future empirical studies can rely on our applied measurement approach and develop a more sophisticated measurement scale for organizational resilience in other research contexts. Moreover, the results of this study may pave the way for future research on studying the dynamic reconfiguration of capabilities for resilience.

This paper investigates the time dependent effects of building organizational resilience in the context of climate change. Findings indicate that building organizational resilience is advantageous as it prepares an organization to face the challenges of climate change and, at the same time, provides financial benefits.

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Supplementary Materials

Supplementary Material 1: MaxQDA Codings, available at https://www.hos.pub/articles/hsustain1040017/s01

Supplementary Material 2: Pairwise comparison and adaptation and list of adaptation measures, available at https://www.hos.pub/articles/hsustain1040017/s02

Supplementary Material 3: Correlation analysis, available at https://www.hos.pub/articles/hsustain1040017/s03

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Author Contributions

Julia Hillmann and Anne Bergmann were responsible for the research design of the study. Edeltraud Guenther gave constant feedback on the research design. Julia Hillmann contributed with the theoretical background and reviewed the literature on resilience. Anne Bergmann contributed to reviewing the literature on climate change and electric utilities. Julia Hillmann and Anne Bergmann were responsible for the data preparation and the conduction of the content analysis, pairwise comparisons, multiple regression analysis, and interpretation of the raw data and final data interpretation. The data interpretation was reviewed by Edeltraud Guenther. The manuscript was written by Anne Bergmann and Julia Hillmann and reviewed by Edeltraud Guenther.

Conflicts of Interest

The authors have no conflict of interest to declare.

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