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# Three Essays on the Influence of Environmental Performance on Firm Resilience

Brice Foulon

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# THÈSE DE DOCTORAT

**Brice FOULON**

Three Essays on the Influence of Environmental  
Performance on Firm Resilience

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*L'université n'entend donner aucune approbation ni improbation aux opinions émises dans les thèses ; ces opinions doivent être considérées comme propres à leurs auteurs.*

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# Abstract

This thesis is composed of three empirical studies that explore the influence of firms' environmental performance (EP) on their financial resilience. Drawing extensively from the body of research on EP's impact on financial performance, this work seeks to shed light on a relatively understudied facet of financial performance – specifically, financial resilience. Resilience is defined as "*the ability of a system to persist despite disruptions and the ability to regenerate and maintain existing organization*" (Gunderson and Pritchard, 2002; DesJardine et al., 2017). Although high investments in EP might be perceived by shareholders as excessive investment or misallocation of financial resources (Friedman, 1970), potentially diminishing a firm's financial resilience in the face of negative events (Marsat et al. 2021), adopting the Natural Resource-Based View (Hart, 1995), we may expect that firms with high EP are potentially able to mitigate the impacts of such shocks and achieve quicker recovery by leveraging the goodwill of stakeholders (Bruna & Nicolò, 2020; Freeman, 2007; Lins et al., 2017) and gaining sustainable competitive advantages through their reputation for environmental stewardship and possession of specific capabilities that are valuable and difficult to replicate (Aragón-Correa et al., 2008; Branco & Lima Rodrigues, 2006; Hart & Dowell, 2011; Russo & Fouts, 1997; Sharma & Vredenburg, 1998).

The first chapter, titled "*Environmental Performance and Resilience: Setting the Stage for Financial Stability and Flexibility*", serves as the foundational framework for this thesis. This chapter reviews existing literature on the interplay between environmental performance and financial resilience, establishing a theoretical backdrop for the subsequent empirical analyses. By synthesizing key findings and theoretical perspectives, it highlights the critical role of environmental performance in affecting firms' financial stability and flexibility against disruptions. Additionally, this chapter outlines the conceptual definitions and methodological approaches that underpin the investigation, offering a comprehensive overview of how robust

environmental practices can either strengthen or weaken firms against financial adversities and influence organizational resilience.

The second chapter, “*Does environmental footprint influence the resilience of firms facing environmental penalties?*”, is the first empirical enquiry into the relationship between environmental performance and resilience. This chapter details how public firms’ environmental footprint affects their resilience when they receive environmental penalties, the fees they are required to pay to the aggrieved parties when an investigation of the United States Environmental Protection Agency (EPA) finds they have violated environmental protection laws in the US. Based on a dataset of 143 environmental penalties retrieved with Factiva, this study shows a positive effect of EP on resilience as firms with lower environmental footprint require less time than their peers to recover from the financial shock triggered by the penalty. This work expands the range of studies underlining the importance of environmental performance in tackling the disturbances caused by regulatory actions related to the environment.

The third chapter, “*Environmental Footprint, Water Intensity, and Resilience to Droughts*”, explores how environmental performance influences the resilience of public firms confronted with severe drought periods. By relying on data and monthly reports from the United States Drought Monitor (USDM), 19 severe drought events were identified, the resilience of firms in the affected states was then assessed with particular attention to their environmental footprint and their water dependency. The results show a positive effect of environmental performance on the resilience to droughts as firms with lower environmental footprint require less time to recover from the losses caused by the drought than their peers, furthermore, this effect is independent from the water footprint of these firms. This empirical analysis of organizational resilience to extreme weather events expands the literature on business adaptation to climate change and how the resilience approach is relevant to tackle climate risk

by providing an analytical framework under which certain organizational characteristics are identified as contributors to resilience, in this case, environmental performance.

The fourth chapter, “*Environmental Performance and Financial Resilience to the Covid-19 Crisis: International Evidence*”, empirically tests the relevance of environmental performance in confronting a major crisis: the global financial disruption caused by the Covid-19 pandemic. Using financial data from 6,663 public firms from 80 countries, and assessing EP with ESG ratings from Asset4, this study shows an ambiguous effect of EP on resilience: firms with higher environmental ratings than their peers lose less value in the advent of the crisis, but then require more time to recover from the losses. The observation of this stimulating result was only made possible using a bidimensional approach to resilience, which revealed a positive effect of EP on stability, and a negative effect on flexibility. The exploration of components of EP, emissions, environmental innovation, and resource use, further reveal the complexity of the effect of EP on resilience. The results in this chapter underline the context dependency of the resilience process, in showing noticeable differences in the influence of EP on resilience to an event that is not directly related to the ecological environment of the firm, they inform us about the synergies and tradeoff between EP and resilience, extending our theoretical understanding of how EP influences the resilience process.

In conclusion, by showing in three different empirical contexts that EP influences resilience, this thesis provides additional rationale to the idea that both concepts are tied in the overarching context of our changing climate. Although the effect of EP on resilience is ambiguous in the context of the global Covid-19 pandemic, it positively contributes to flexibility following environmental penalties and droughts, which supports the arguments of the Natural Resource-Based View and the stakeholder theory, and the arguments in the resilience literature underlying the context dependency of the resilience process.



## Abstract - Résumé

**Keywords:** Environmental Performance, Organizational Resilience, Financial Resilience, Environmental Disruptions, Survival Analysis, Firm Value, Stability, Flexibility

## Résumé

Cette thèse est composée de trois études empiriques qui explorent l'influence de la performance environnementale (PE) des entreprises sur leur résilience financière. S'inspirant largement du corpus de recherche sur les effets de la performance environnementale sur la performance financière, ce travail cherche à mettre en lumière une facette relativement peu étudiée de la performance financière, à savoir la résilience financière. La résilience est conceptualisée comme "*la capacité d'un système à persister malgré les perturbations et la capacité à régénérer et à maintenir l'organisation existante*" (Gunderson et Pritchard, 2002 ; DesJardine et al., 2017). Bien que des investissements élevés dans la PE puissent être perçus par les actionnaires comme un investissement excessif ou une mauvaise affectation des ressources financières (Friedman, 1970), ce qui pourrait diminuer la résilience financière d'une entreprise face à divers types d'événements défavorables (Marsat et al. 2021), en adoptant la vision basée sur les ressources naturelles (Hart, 1995), nous pouvons nous attendre à ce que les entreprises ayant une PE élevée aient le potentiel d'atténuer les impacts de ces chocs et se rétablir plus rapidement en tirant parti de la bonne volonté des parties prenantes (Bruna & Nicolò, 2020; Freeman, 2007; Lins et al., 2017) et en obtenant des avantages concurrentiels durables grâce à leur réputation en matière de gestion de l'environnement et à la possession de capacités spécifiques qui sont précieuses et difficiles à répliquer (Aragón-Correa et al., 2008; Branco & Lima Rodrigues, 2006; Hart & Dowell, 2011; Russo & Fouts, 1997; Sharma & Vredenburg, 1998).

Le premier chapitre sert de cadre fondamental à cette thèse. Ce chapitre passe en revue la littérature existante sur l'interaction entre la performance environnementale et la résilience financière, établissant ainsi une toile de fond théorique pour les analyses empiriques ultérieures. En synthétisant les principales conclusions et perspectives théoriques, il met en évidence le rôle essentiel de la performance environnementale et ses effets sur la stabilité et la flexibilité des

entreprises face aux perturbations. En outre, ce chapitre présente les définitions conceptuelles et les approches méthodologiques qui sous-tendent la recherche, offrant une vue d'ensemble de la manière dont des pratiques environnementales robustes peuvent renforcer ou affaiblir la capacité des entreprises à faire face aux difficultés financières et influencer leur résilience organisationnelle.

Le deuxième chapitre, "*L'empreinte environnementale influence-t-elle la résilience des entreprises confrontées à des pénalités environnementales ?*", est la première enquête empirique sur la relation entre la performance environnementale et la résilience présentée dans cette thèse. Ce chapitre explique comment l'empreinte environnementale des entreprises publiques influe sur leur résilience lorsqu'elles reçoivent des pénalités environnementales, c'est-à-dire les frais qu'elles doivent payer aux parties lésées lorsqu'une enquête de l'agence américaine de protection de l'environnement (EPA) révèle qu'elles ont enfreint les lois sur la protection de l'environnement aux États-Unis. En analysant un jeu de données de 143 pénalités environnementales récupérées avec Factiva, cette étude montre un effet positif de la performance environnementale sur la résilience, car les entreprises ayant une empreinte environnementale plus faible ont besoin de moins de temps que leurs homologues pour se remettre du choc financier déclenché par la pénalité. Ce travail élargit la gamme des études soulignant l'importance de la performance environnementale dans la lutte contre les perturbations causées par les mesures réglementaires liées à l'environnement.

Le troisième chapitre, intitulé "*Empreinte environnementale, intensité hydrique et résilience aux sécheresses*", étudie l'influence de la performance environnementale sur la résilience des entreprises cotées confrontées à de graves périodes de sécheresse. En s'appuyant sur les données et les rapports mensuels du United States Drought Monitor (USDM), 19 évènements de sécheresse sévère ont été identifiés, la résilience des entreprises dans les états affectés a ensuite été évaluée en accordant une attention particulière à leur empreinte

environnementale et à leur dépendance à l'égard de l'eau. Les résultats montrent un effet positif de la performance environnementale sur la résilience aux sécheresses, car les entreprises à faible empreinte environnementale ont besoin de moins de temps pour se remettre des pertes causées par la sécheresse que leurs homologues ; en outre, cet effet est indépendant de l'empreinte en eau de ces entreprises. Cette analyse empirique originale de la résilience organisationnelle aux phénomènes météorologiques extrêmes élargit la littérature sur l'adaptation des entreprises au changement climatique et sur la manière dont l'approche par la résilience est pertinente pour faire face au risque climatique en fournissant un cadre analytique dans lequel certaines caractéristiques organisationnelles sont identifiées comme contribuant à la résilience, en l'occurrence, la performance environnementale.

Le quatrième chapitre, "*Performance environnementale et résilience financière face à la crise du Covid-19 : résultats internationaux*", teste empiriquement la pertinence de la performance environnementale pour faire face à une crise majeure : la perturbation financière mondiale causée par la pandémie de Covid-19. En utilisant les données financières de 6 663 entreprises publiques de 80 pays et en évaluant la performance environnementale à l'aide des notations ESG d'Asset4, cette étude montre un effet ambigu de la performance environnementale sur la résilience : les entreprises dont les notations environnementales sont plus élevées que celles de leurs pairs perdent moins de valeur au moment de la crise, mais ont ensuite besoin de plus de temps pour se remettre des pertes subies. L'observation de ce résultat paradoxal n'a été possible qu'en utilisant une approche bidimensionnelle de la résilience, qui a révélé un effet positif de la PE sur la stabilité et un effet négatif sur la flexibilité. L'exploration des composantes de la PE, les émissions, l'innovation environnementale, et l'utilisation des ressources, révèlent par ailleurs la complexité de l'effet de la PE sur la résilience. Les résultats présentés dans ce chapitre soulignent la dépendance du processus de résilience au contexte, en montrant des différences notables dans l'influence de la PE sur la résilience à un événement qui

## Abstract - Résumé

n'est pas directement lié à l'environnement écologique de l'entreprise, ils nous informent sur les synergies et les compromis entre la PE et la résilience, élargissant notre compréhension théorique de la manière dont la PE influence le processus de résilience.

En conclusion, en montrant dans trois contextes empiriques différents que la performance environnementale influence la résilience, cette thèse apporte une justification supplémentaire à l'idée que ces deux concepts sont liés dans le contexte global de perturbations du climat. Bien que l'effet de la performance environnementale sur la résilience soit ambigu dans le contexte de la pandémie mondiale liée au virus Covid-19, elle contribue positivement à la flexibilité suite aux pénalités pour violation du droit environnemental et aux sécheresses, ce qui confirme les arguments de la vision fondée sur les ressources naturelles et de la théorie des parties prenantes, ainsi que les arguments de la littérature sur la résilience qui soulignent la dépendance du processus de résilience au contexte dans lequel ce processus se déploie.

**Mots-clés :** Performance environnementale, résilience organisationnelle, résilience financière, perturbations environnementales, analyse de survie, valeur de l'entreprise, stabilité, flexibilité.

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# Abbreviations

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BoP	Base of Pyramid
CSR	Corporate Social Responsibility
EP	Environmental Performance
EPA	United States Environmental Protection Agency
EPI	Environmental Performance Index
ESG	Environmental, Social and Governance
FP	Financial Performance
FR	Financial Resilience
GFC	Global Financial Crisis
GHG	Greenhouse Gas
HRO	High Reliability Organization
IPCC	Intergovernmental Panel on Climate Change
NRBV	Natural Resource-Based View
OR	Organizational Resilience
OLS	Ordinary Least Squares
PDSI	Palmer Drought Severity Index
RBV	Resource-Based View
R&D	Research and Development
SMEs	Small and Medium Enterprises
TQM	Total Quality Management
USDM	United States Drought Monitor
VRIN	Valuable, Rare, Inimitable and Non-substitutable

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*“According to Darwin’s Origin of Species, it is not the most intellectual of the species that survives; it is not the strongest that survives; but the species that survives is the one that is able best to adapt and adjust to the changing environment in which it finds itself.”*

*Leon C. Megginson*

*In “Lessons from Europe for American Business”*

*The Southwestern Social Science Quarterly,*

*Vol. 44, No.1 (June 1963), p. 3-13*



# General Introduction

The only planet we know for certain can support life currently suffers from increasingly tangible climate change, unsustainable consumption of natural resources, land and ecosystem degradation, and biodiversity loss (IPCC, 2022). Although first signs of the possible destabilization of our climate through human actions were evidenced as soon as the late 19<sup>th</sup> century by Svante Arrhenius (1896), linking increases in CO<sub>2</sub> atmospheric levels to significant increases of temperatures on the ground, these signs were largely ignored until the late 1950s (Keeling, 1960; Revelle & Suess, 1957). Ever since the *Limits to growth* report (Meadows et al., 1972), commissioned by the Club of Rome, the level of general environmental alertness has risen significantly among scientists as the report’s simulated exponential growth of wealth and population in a finite supply of resources leads to societal collapse. Given the importance of the threat, the task of defining pathways to preserve humanity’s future was undertaken by the United Nations under the concept of “*sustainable development*” (Brundtland et al., 1987). Substantiating these alarming observations with actual data, climate scientists have gradually improved the assessment of how our climate has been modified since the pre-industrial period, and how it will continue to change depending on our actions. In that regard, one of the earliest official calls from climate researchers to take political action against climate change can be traced back as early as 1988 (World Meteorological Organization, 1988), since then, the pressure on organizations towards reducing their environmental impact has been growing stronger and stronger with every passing decade of climate inaction. The sensitivity of stakeholders to climate issues has dramatically increased since the 1980s (Flammer, 2013). In this year’s Global Risks Report (World Economic Forum, 2024), “extreme weather” is the top cited source of risk believed most likely to present a material crisis on a global scale. In the ten sources of risk estimated to be most impactful over the coming 10-year period, on the right hand side of Figure A, five are environmental risks: “extreme weather events” (rank 1), “critical

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change to Earth systems” (rank 2), “biodiversity loss and ecosystem collapse” (rank 3), “natural resource shortages” (rank 4), and “pollution” (rank 10), all of which can now be directly tied to human environmental influence (IPCC, 2022; Richardson et al., 2023).

Figure A: Ranks of global risks by severity, short and long term



Source: World Economic Forum Global Risks Perception Survey 2023 - 2024

As a result, firms are expected to enforce multiple strategic processes to minimize their impact on the environment. To do so, they set up operations that are commonly defined under Corporate Social Responsibility (CSR), which can be defined as the organizational proficiency to integrate social and environmental concerns in business operations and interactions with stakeholders. Superior CSR orientation supposedly helps companies gain competitive advantages over their competitors by devoting resources to social and environmental welfare improvement policies (Lyon & Maxwell, 2008). With both market and political forces pushing for sustainability, it led to the surge of environmental CSR, which revolves around the proficiencies for pollution reduction (Porter & van der Linde, 1995), “green customer” attractiveness (Arora & Gangopadhyay, 1995; Harbaugh et al., 2011), understanding and influencing environmental regulations (Baron, 2005; Blackman et al., 2006; Denicolò, 2008; Glachant, 2007; Lutz et al., 2000; Segerson & Miceli, 1998; Yu, 2005), screening for socially responsible employees (Brekke & Nyborg, 2008; Hsieh, 2006), and trading at premium prices

## General Introduction

on financial markets (Baron, 2005, 2007; Graff Zivin & Small, 2005). Improving these proficiencies is the most common way organizations can achieve environmental performance (EP), doing so is expected to place the firm in a strategically desirable position *vis-à-vis* its competitors, by reducing its greenhouse gas (GHG) emissions, other sources of pollution, developing eco-efficient products that require less natural resources, by employing a life-cycle approach to develop new products and services to minimize environmental impact, firms can position themselves on the path towards sustainable development, thereby acquiring and nurturing multiple sources of competitive advantages.

In the current economy, the ability of firms to generate EP is strategically relevant for two reasons. First, a large proportion of the expected risks firms will be confronted with in the coming decades stem from disruptions of the ecological environment and their consequences. In this context, possessing strong EP characteristics and revealing it through environmental disclosure is a very efficient way for a firm to signal to its stakeholders that it is committed to protecting the environment and providing products and services that minimize environmental harm (Clarkson et al., 2008; Jorgji et al., 2024; Kothari et al., 2009; Lindblom, 2010; Matsumura et al., 2014; Zahller et al., 2015). By doing so, the firm acquires both positive legitimacy (Zahller et al., 2015) and reputation (Bruna & Nicolò, 2020), which allows it to benefit from increased stakeholder support in crises, and position itself among sustainable prospects, which favors its future position. Secondly, according to the existing empirical literature, EP generally translates into financial performance (FP) under normal market conditions (Endrikat et al., 2014; Friede et al., 2015; Horváthová, 2010; Jo et al., 2015; King & Lenox, 2001). This not only indicates that financial markets value EP, but that the improvement of a firm's corporate environmental performance leads to competitive advantages through other mechanisms, which are discussed in detail in the remainder of this thesis.



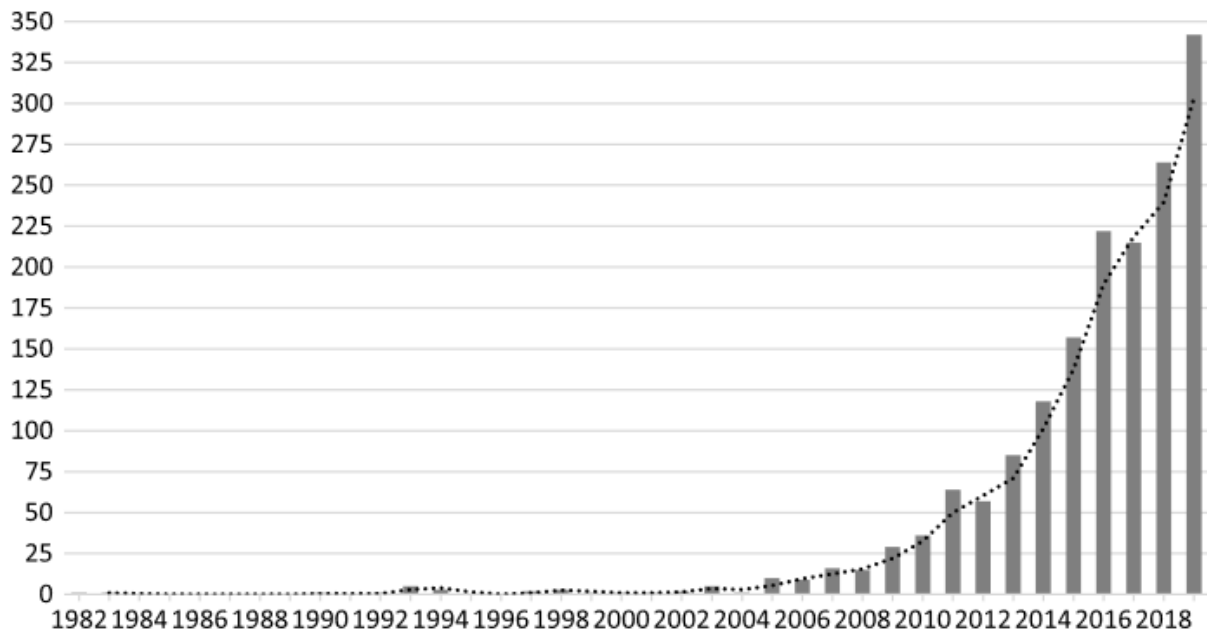
## General Introduction

The establishment of a generally positive relationship between EP and FP under business-as-usual conditions does not ensure this relationship will hold under the changing environmental conditions we should expect for the remainder of the 21<sup>st</sup> century. The disruptions caused by extreme events have tremendous effects on the value of firms on financial markets. For example, the terrorist attacks on September 11, 2001, have greatly shaken the entire airline industry (Gittell et al., 2006), in which firms displayed varying levels of success in handling the shock. Researchers have taken the disruptions caused by such extreme circumstances to empirically analyze the ability of organizations to survive, maintain their position, and sometimes gain advantages because of their superior ability to manage uncertainty and thrive in turbulent times.

In the stream of scientific literature that takes interest in this organizational proficiency to handle disruptions and abrupt changes, the term “*Resilience*” has been used to describe the inherent organizational characteristics that enable efficient firm responses to adversity (Linnenluecke, 2017; Vogus & Sutcliffe, 2007). As Klein et al. (2003), Alexander, (2013) and Su & Junge (2023) emphasized, the term *Resilience* is derived from the Latin verb *resilire*, which means “*to bounce back*”. In the scientific literature at large, it has first been used to describe phenomena in the natural sciences, such as the elasticity of a material to deformations (Snowdon, 1958), or the measure of an ecosystem’s persistence and its ability to absorb change and disturbance while maintaining its core functions (Holling, 1973). Later, it appeared in management research (Meyer, 1982; Perrow, 1984; Wildavsky, 1988) as organizations were increasingly confronted with complex environments and disruptive changes, including extreme events that could potentially threaten their survival. As a result, the interest of academics in organizational resilience has grown substantially in recent years, and it has become one of the hottest topics in the organization-related literature according to Linnenluecke (2017), Raetz et

al. (2022), Su & Junge (2023), as well as Jiang et al. (2024). A visual representation of this trend is provided in Figure B.

Figure B: Trend of scientific publications on organizational resilience  
*Yearly Number of Publications on Organization-Related Resilience (1982–2019)*



Source: Raetz et al. (2022), the data set includes 1,667 articles published across 539 peer reviewed journals between 1982 and 2019 that were identified through a systematic literature search in the Web of Science index.

The use of the resilience perspective in the context of environmental disruptions is especially relevant as the concept holds multiple intrinsic characteristics that are particularly adapted to discuss the ability of a system to tackle environmental jolts. First, despite the multiplicity of definitions mobilized for the term resilience itself in the management literature (Linnenluecke, 2017; Raetz et al., 2022), the common denominator: the ability of entities across levels to deal with adversity, remains a core concept, deeply entrenched within the meaning of resilience. This makes the concept easy to grasp, even for readers who are not familiar with the academic uses of the term. Secondly, as identified by Su & Junge (2023), the pre-eminent use of the concept in ecology (e.g. Holling, 1973) links the use of the resilience concept in organization studies to an environmental perspective related to sustainability, as apparent in most common definitions of resilience in both theoretical and empirical studies.

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Thirdly, the characteristics of resilience make it uniquely compatible with empirical approaches as long as three basic contextual elements are respected: an adverse event that triggers the resilience process, a performance setback or an increase in uncertainty as a result of the event, and a recovery (Su & Junge, 2023). In this thesis, the three empirical settings that are studied with the use of this framework maintain these conditions as being true and thus derive theoretical implications about mechanisms underlying the resilience process.

From a theoretical perspective, the view of the neoclassical economists, which in essence can be summarized in this context with the famous Friedman doctrine (1962, 1970): *“the social responsibility of business is to increase its profits”*, does not seem to support the idea of a positive relationship between EP and resilience, but it does not entirely exclude this possibility. Indeed, improving EP requires the investment of substantial resources in activities and processes that are not directly related to the firm’s ability to generate profits. From a purely capitalistic perspective, the maximization of shareholder value is expected to be the primary objective of any company, therefore the allocation of resources to non-core activities can only positively influence performance if they translate into competitive advantages that the firm can mobilize to generate cash flows. The description of such competitive advantages has been a center of focus in multiple theoretical frameworks, the most prominent of which is the Stakeholder Perspective (Donaldson & Preston, 1995; Freeman, 1984, 2007) whereby, in its instrumental approach, the impacts of an organization’s internal and external constituencies are accounted for in order to achieve corporate goals (Donaldson & Preston, 1995). Under this view, the CSR strategies of a firm, including its EP, are expected to contribute to the firm’s ability to respond to the needs of its stakeholders and obtain beneficial outcomes such as legitimacy, and reputational advantages (Mitchell et al., 1997). Aside from its market-based view, the stakeholder theory can also include a Resource-Based View (RBV) (Phillips, 2003), instrumental in the determination of the strategic resources the organization can mobilize to

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obtain and maintain sustainable competitive advantages (Barney, 1991; Wernerfelt, 1984). In this perspective, the possession of organizational resources that are valuable, rare, imperfectly imitable and not substitutable (VRIN) translates into sources of competitive advantage. In that regard, the ability of a firm to improve its EP and appear more sustainable in the eyes of its stakeholders in times of increasing levels of systemic vulnerability and climate disruptions can constitute such a sustainable competitive advantage.

Furthering these arguments with unique considerations for the organization's natural resources, Hart (1995) extended this theoretical perspective into the Natural Resource-Based View (NRBV) of the firm, where sustainable competitive advantages are derived from specific capabilities that emerge over time as the organization devotes resources and attention to three strategic capabilities: (i) pollution prevention, (ii) product stewardship, and (iii) sustainable development (Hart, 1995; Hart & Dowell, 2011). In essence, (i) pollution prevention participates in enhancing the firm's continuous improvement processes, which allows the emergence of cost reduction opportunities, as highlighted by Porter & van der Linde (1995). (ii) Product stewardship, the minimization of the life cycle costs of products and the cultivation of positive stakeholder interactions, involves deliberate stakeholder integration which in turn allows the firm to gain unique organizational capabilities that translate into firm competitiveness (Sharma & Vredenburg, 1998). Furthermore, the ability of integrating stakeholders into the socially-complex process of product stewardship through eco-innovation was shown by Demirel & Kesidou (2019) as a contributor to multiple organizational abilities that translate in competitive advantages, the first of which is the capability of the firm to address regulatory pressures by self-regulating, which may allow it to establish rules and standards tailored to its superior capability; secondly, it gives access to limited resources, such as knowledge related to specific technological advances that allow for a swifter technology shift towards sustainability; and thirdly, it allows the firm to preempt its competitors thanks to

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superior green market sensing, which allows it to respond quicker to emerging green consumption needs. Finally, (iii) sustainable development, the development of a strong sense of social and environmental purpose that guides the strategy of the organization, shifts its core purpose and ethos from growth at all costs to a prosperity-based approach, with consideration for planetary boundaries (Dixon-Fowler et al., 2013; Russo & Fouts, 1997), and places the firm at the center of a shared vision, facilitating cooperation with its stakeholders, which favors its future position.

While some studies find evidence that EP contributes to organizational performance, the effect of EP on organizational resilience remains equivocal. To take a few examples, Ortiz-de-Mandojana & Bansal (2016) have shown that social and environmental practices lead to positive long-term outcomes such as reduced financial volatility, increased sales growth and better survival rates over a 15-year period (1994 - 2008). They infer from this result that environmental and social performance positively affect organizational resilience. DesJardine et al. (2019) observed a positive effect of social and environmental practices on the stability and flexibility of firms during the subprime crisis, which improved their resilience. Marsat et al. (2021) studied the financial recovery of firms in the same context and showed that companies with high EP before the crisis required more time than others to recover from their loss in countries with high environmental standards, which indicates weaker resilience capabilities. In his three empirical essays investigating the impact of EP on financial resilience, Ullah (2020) reported the same result as Marsat et al. (2021), but also demonstrated that EP positively affects the financial resilience of firms affected by the implementation of the EU ETS, the mandatory disclosure of verified emissions, and that it also positively affects financial resilience in company specific environmental controversies, but only in countries with high environmental standards. In Ullah et al. (2022), it is further shown that firms that developed green supply chain management practices recovered faster from the Covid-19 crisis than their peers. Cardillo et al

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(2022) reported that firms with high ESG ratings performed better during the early period of the Covid-19 crisis in Europe. More recently, Haijun et al. (2024) report a positive effect of the environmental pillar of Environmental, Social and Governance (ESG) performance on resilience in a longitudinal approach for Chinese A-share listed firms from 2009 to 2021.

Given the theoretical contradictions and mixed results in this area, more empirical attention to the ways EP affects resilience to disruptions is expected to contribute to this literature by either providing additional arguments underlining the importance of the three strategic capabilities described by the NRBV, as well as the mechanisms of stakeholder support, in improving the ability of firms to build resilience as a source of competitive advantage, or give a more in-depth understanding about the conditions under which the expenses that firms bear to improve their EP weaken their ability to respond to adversity, as expected by the shareholder theory. To do so, this thesis will attempt to answer the following research question:

### **Does environmental performance affect the resilience of firms?**

The first chapter of this thesis describes the context in which this doctoral work is positioned, as such, it primarily serves as the foundational framework for this thesis. This chapter reviews the existing literature about the links between environmental performance and financial resilience, in the aim of establishing a theoretical structure in which the three subsequent empirical analyses source their arguments. In the review of the preexisting findings and theoretical perspectives, it highlights the potential role of environmental performance in the development of specific capabilities that allow the enhancement of firms' financial stability and flexibility in times of disruption, and outlines the conceptual definitions. Additionally, it identifies the existing gaps in the empirical literature, delineates the theoretical contributions, it develops the research questions that guided this research, and the hypotheses tested in the remainder of the thesis. Finally, this first chapter describes the methodological approaches that underpin the subsequent empirical chapters, offering a comprehensive overview of how robust

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environmental practices can fortify firms against financial adversities and contribute to sustained organizational resilience.

The empirical exploration undertaken in this thesis is divided into three chapters (chapters 2, 3 and 4), each independently enquiring into the EP – resilience relationship in a unique context of disruption.

The second chapter explores the effect of EP on resilience in firm-specific disruptions emanating from regulatory pressure: environmental penalties in the US. As the first empirical enquiry into the relationship between environmental performance and resilience presented in this thesis, this chapter details how the environmental footprint of public firms, taken as a proxy for environmental performance, affects their resilience to the disruption caused by environmental penalties, the fees they are required to pay to the aggrieved parties when an investigation of the United States Environmental Protection Agency (EPA) reveals their guilt in violations of the American environmental protection laws. This investigation relies on a survival analysis approach with a dataset of 143 environmental penalties that were manually retrieved with Factiva. The analysis shows a positive effect of EP on resilience as firms with lower environmental footprints require less time than their peers to recover from the financial shock triggered by the penalty. This result is robust to different model specifications, different models of survival analysis and different time frames, before and after the event. By showing that firms with a heavy negative impact on the environment struggle more when they are targeted by environmental penalties, it suggests that firms that were able to successfully implement pollution prevention policies improve their ability to recover from the shock caused by the environmental penalty in addition to reducing the risk of being targeted by environmental protection authorities in the first place. This work supports the NRBV perspective and expands the range of studies underlining the importance of environmental performance in tackling the disturbances caused by regulatory actions related to the environment.

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After studying the influence of EP on resilience to a disruption caused by regulatory actions, the relationship between EP and corporate sustainability required an examination of how it may also influence the resilience of firms confronted with a disruption caused by direct environmental conditions, preferably related to climate change. For this reason, multiple types of natural disasters and extreme weather events were considered for a study of resilience, this preliminary examination led to the choice of exploiting available data on droughts in the United States, as multiple such events could be observed and well defined to match the resilience methodology, over a long period which is also covered by Trucost's data on environmental footprint.

Therefore, the third chapter focuses on the study of EP on resilience during severe droughts in the U.S., an exogenous source of environmental adversity affecting water dependent firms in a large area. It relies on data and monthly reports from the United States Drought Monitor (USDM), with which 19 severe drought events affecting 345 companies were identified. The resilience of firms in the affected states was then assessed with particular attention to their EP, again proxied by environmental footprint, and their water dependency. Using the same survival analysis approach as chapter 2, the results show a positive effect of EP on resilience to droughts as firms with a lower environmental footprint require less time to recover from the losses caused by the drought than their peers, furthermore, this effect is independent from the water footprint of these firms, and these results are robust to multiple model specifications, different time frames of analysis, and different sample selection methodologies. This rare empirical analysis of organizational resilience to extreme weather events further confirms arguments from the NRBV and expands the literature on business adaptation to climate change. In particular, it shows how the resilience approach is relevant to tackle climate vulnerability by providing an analytical framework under which certain organizational characteristics such as EP are found to enhance organizational resilience to



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extreme weather events, which helps derive recommendations for both managers and shareholders.

After confirming the positive role of EP on resilience to a climate-related disruption, the next important step to discuss the overarching relationship between EP and corporate sustainability was to study the influence of EP on resilience in a context of crisis that is not directly related to environmental issues. In this regard, and in order to complement the two other studies presented in this thesis, the priority was to select a disruption that satisfied the following characteristics: large economic relevance (impact significant enough to justify using the resilience framework), recency (preference was given to events that occurred after the 2015 Paris Agreement), globality (priority was given to events affecting multiple countries), and lack of a direct link to environmental issues. Given these criteria, the most reasonable choice was to use the Covid-19 crisis as a resilience setting, and complement financial data with widely available EP data so as to retain as large a sample as possible.

Then, the fourth chapter focuses on the context of the Covid-19 crisis, the major market disruption that affected the entire global economy, as a single exogeneous shock to observe how EP affected resilience in a deeply disruptive context that is not directly related to the ecological environment of the affected firms. It benefits from wider data availability than chapters 2 and 3, using financial data from 6,663 public firms from 80 countries, and assessing EP with ESG ratings from Asset4. This study is original as it shows an ambiguous effect of EP on resilience: firms with higher environmental ratings lose less value at the start of the crisis, they are more financially stable, but then require more time to recover from the losses, they are less financially flexible. The observation of this paradoxical result was only made possible using the bi-dimensional approach to resilience described in chapter 1, which revealed a positive effect of EP on stability, and a negative effect on flexibility. The exploration of components of EP: emissions, environmental innovation, and resource use, further reveals the

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complex relationship between EP and resilience. Along with the extant literature review provided throughout this thesis, the results in this chapter underline the context dependency of the resilience process. Because it reveals divergences in the influence of EP on different outcome measures of resilience, the results presented in this chapter inform us about the synergies and tradeoff between EP and resilience, extending our theoretical understanding of how EP influences the resilience process. As such, it can be viewed as a counterpoint to the NRBV. It also warns managers about the potential need for arbitrage between “doing good” and “doing well” as developing corporate environmental performance generally improves stability, but it may also hinder flexibility in certain settings of disruption. Furthermore, it informs portfolio managers and investors about the implications of EP for the risk exposure of firms to major market disruptions.

Overall, the findings reveal that EP affects resilience in multiple ways that are contingent to the context of the shock. In situations of environmental disruptions that are related to ecological issues, such as environmental penalties or droughts, EP positively affects the flexibility dimension of resilience, and indications of a weak positive effect on stability are also present. By contrast, disruptions that hold less obvious relationships to the ecological issues surrounding firms’ sustainability, such as the Covid-19 crisis, are contexts in which the EP – resilience relation can be two-fold: in this case EP helps firms reduce their losses in the early period of the crisis, but then it hinders their flexibility and causes them to need longer recovery periods than their peers.

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# Chapter 1 - Environmental Performance and Resilience: Setting the Stage for Financial Stability and Flexibility

## 1.1 Introduction

This chapter introduces the themes of corporate environmental performance and resilience as they are currently envisaged in management research. It first presents and discusses the implications of environmental performance (EP) for organizational resilience (OR) as they are discussed in the existing theoretical and empirical literature in section 1.2 which reviews each of these aspects, and their interactions, in detail. Section 1.3 exposes the theoretical perspective taken throughout the remainder of the thesis, developing each argument potentially linking EP to OR under the shareholder theory, the stakeholder perspective, or the natural resource-based view (NRBV). Section 1.4 details the prior empirical findings on how EP affects OR. In section 1.5, a summary of the expected theoretical contributions and the research gaps addressed by the research undertaken for this thesis is provided. Then, section 1.6 develops the research questions and hypotheses considered in the following chapters. Section 1.7 exposes the methodological approach developed for this thesis. Finally, section 1.8 concludes this introductory chapter.

In the global context of climate deregulation, biodiversity loss, resource exhaustion, and the transgression of six planetary boundaries (Richardson et al., 2023), the maxim of neoclassical economics under which the responsibility of companies is narrowed only to their financial success becomes strongly disputed (Calhoun, 2015). In the meantime, multiple mechanisms, such as carbon markets, have been implemented to constrain organizations to care for the impacts of their activities on the long-term viability of the environment (Bjørn et al., 2021; Liu et al., 2015; Matsumura et al., 2014). The ability of firms to comply with these mechanisms and surpass them, by optimizing inputs and minimizing the environmental impact of outputs for example, comes under the purview of corporate environmental performance

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(Aragón-Correa et al., 2008; Hart & Ahuja, 1996; Ilinitch et al., 1998). For firms, the managerial strategies and policies created in these conditions are expected to drive two major intentions: mitigation and adaptation. Indeed, the increasingly tangible reality of environmental disruptions requires improvements in human systems in two complementary directions. First, in order to minimize the impact of climate change, swift actions must be taken to reduce the emissions of greenhouse gases (GHG), a goal scrutinized by States under the terms of the Paris Agreement, stating the following target in Article 2: *“holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change”* (UNFCCC, 2015). These actions, and all others that aim to reduce the overall impact of human activities on the environment, are referred to as *“climate mitigation”* (IPCC, 2015). Secondly, because the natural disasters and extreme weather events are already worsened by the consequences of climate change and other planetary limit transgressions, and are expected to multiply and intensify (IPCC, 2022), all organizations and individuals should expect to be confronted by more disruptions than their forebears, and as such, plan for these disruptions through efforts referred to as *“climate adaptation”* (IPCC, 2015; Linnenluecke & Griffiths, 2015; Rivera et al., 2022), these efforts should lead to sustainability in its primary sense: the ability of a system to endure despite challenges.

In conjunction with the worsening environmental conditions, the necessity of sustainability becomes increasingly undeniable for all organizations. While the historical approach, particularly predominant in corporate finance, considers potential disruptions under the framework of *“risk management”*, defined in ISO 31000 as *“the effect of uncertainty on objectives”* (Hubbard, 2020), the framing of disruptions inside a systemic view of climate vulnerability, in relationship with our unsustainable trajectory fits more within the view of OR,

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which provides a comprehensive framework of analysis expanding the focus from a single risk to the overall position of the organization in its ability to prepare for, confront, and recover from disruptive circumstances beyond the conditions that organizations are able to cope with (Linnenluecke & Griffiths, 2010, 2015). In “*The Climate Resilient Organization*”, Linnenluecke and Griffiths (2015) define resilience as “*the capacity to absorb, withstand, and recover from adverse impacts from climate change*”, they explore how organizational efforts towards both climate mitigation and adaptation have implications for sustainability and resilience. This thesis work can be considered an extension of this effort, grouping efforts of mitigation and adaptation under the general expression of corporate environmental performance, and empirically testing the effects of EP on the ability of firms to financially absorb, withstand and recover from environmental disruptions.

### 1.2 EP and OR

#### 1.2.1 EP and FP

With increasing pressure on firms for mitigation, adaptation, societal responsibility, and other issues of governance, many managers have sought to integrate such concerns into their business operations and engage with their stakeholders. This trend motivated researchers to take interest in how Corporate Social Responsibility (CSR) influences the performance of firms, under the premise that superior CSR capabilities positively affect the ability of a firm to gain competitive advantages through both “market and political forces” (Lyon & Maxwell, 2008; Surroca et al., 2010). In this context, “market forces” generally include win-win opportunities to reduce production costs through resource use optimization (Porter & van der Linde, 1995a), access to an increasingly large base of “green consumers” who are willing to pay a premium for products and services that cater to their environmental worries (Arora & Gangopadhyay, 1995; Harbaugh et al., 2011), attractiveness for employees that prefer socially responsible

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employment and willing to accept lower wages in exchange for such opportunities (Brekke & Nyborg, 2008; Hsieh, 2006), and the possibility of trading in financial markets with a premium price among “green investors” (Baron, 2005, 2007; Graff Zivin & Small, 2005), reducing the cost of capital. On the other hand, “political forces” involve negative actions such as regulatory threats (Yu, 2005), pressure from governmental agencies to enforce the law (Glachant, 2007; Segerson & Miceli, 1998), boycotts, strikes and other threats which firms with superior CSR are expected to mitigate. In that regard, the role of environmental CSR is generally recognized as particularly central, given the rising importance of the issue of climate change, this led to the multiplication of studies of the influence of corporate Environmental Performance (EP) on varying forms of firm performance, primarily corporate Financial Performance (FP) (Trumpf et al., 2013).

The academic debate in the literature discussing the influence of EP of FP, summarized under the “*does it pay to be green?*” problem (e.g. Ambec & Lanoie, 2008; Dixon-Fowler et al., 2013; Hart & Ahuja, 1996), led to seemingly mixed results. With conceptual arguments and empirical studies supporting either a negative or a non-significant relationship between EP and FP (Freedman & Jaggi, 1986; Friedman, 1962, 1970), as the classical economic perspective expects the large costs of improving EP to exceed the potential benefits (Jaffe et al., 1995), and some empirical studies backing these arguments. Among such studies, Cordeiro & Sarkis (1997) have shown that firms that displayed environmental proactivism in the year 1992 (according to their Toxic Releases Inventory) saw their 1-year and 5-year earnings per share forecasts reduced compared to their peers. This observation was furthered by Hassel et al. (2005), who document that environmental investments leads to increased costs, thereby negatively affecting earnings and market value. Filbeck & Gorman (2004) also reported that the costs of compliance with environmental regulation among electric utility companies outweigh the potential benefits, leading to a non-significant relationship between their industry-

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adjusted measure of EP and returns, and a negative relationship between proactive EP and financial returns.

As can be conjectured from these mixed results, the large number of empirical studies on the relationship between EP and FP tend to use a wide variation of measures and definitions of EP, as recognized early by Ilinitch et al. (1998), who reviewed how the EP construct had been defined and measured, listed four dimensions of EP recognizing that this construct is multidimensional, as it involves processes and outcomes that can be internal or external. This observation led to the matrix provided in Table 1-1. While the processes of EP are extremely difficult to quantify, the observation of outcomes, although they tend to rely on voluntarily disclosed data from companies, makes the measurement of EP possible for investors and scholars who rely on quantitative analysis to test its influence on FP. Trumpp et al. (2013) attempted to address the theoretical foundations of EP, bring conceptual clarification, and validate a measurement construct. By doing so, they show that the definition of EP provided in the ISO standard 14031 (International Organization for Standardization, 2021) is consensual over existing academic studies and reads as follows: “*the result of an organization’s management of its environmental processes*”. This approach led to two types of environmental performance indicators: management performance indicators (e.g. process improvement, environmental management systems, environmental R&D expenditures) and operational performance indicators (e.g. environmental impacts, regulatory compliance, input and output volumes). The empirical work undertaken in this thesis primarily relies on operational performance indicators and employs quantitative methodologies to infer qualities about the overall effects of EP. Reviews of such endeavors include Ambec & Lanoie (2008), who explicated the mechanisms through which companies that invest in EP can benefit from opportunities for increasing revenue (green market access, product differentiation, sales of pollution control technologies) and reducing costs (risk management, relations with external



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stakeholders, materials, energy, services, capital, labor). Dixon-Fowler et al. (2013) meta-analyzed the empirical EP – FP literature and concluded in a generally positive effect of EP on FP, extending the conclusions of Orlitzky et al. (2003). By shifting the question from “*does it pay to be green?*” to “*when does it pay to be green?*”, they also opened the line of enquiry to the moderators to the EP – FP relationship. Furthermore, Endrikat et al. (2014) also reveal a generally positive relationship between EP and FP, and suggest that “*the relationship is stronger when the strategic approach underlying [EP] is proactive rather than reactive.*” These studies generally test the effect of EP on FP during normal market circumstances of growth and low levels of uncertainty.

Table 1-1: The Corporate Environmental Performance matrix

	<b>Internal</b>	<b>External</b>
<b>Process</b>	Organizational Systems	Stakeholder Relations
<b>Outcome</b>	Regulatory Compliance	Environmental Impacts

Source: Ilinitich et al. (1998), reproduced by the author.

### 1.2.2 Organizational Resilience

Due to the increasing importance of empirically observing the link between EP and FP in different contexts under the “*when does it pay to be green?*” academic framework, some researchers shifted their gaze from normal market circumstances to times of market upheaval in empirical studies (e.g. Linnenluecke & Griffiths, 2013; Meyer, 2015; Powley, 2009). Many of these efforts refer to the seminal work of Gittell et al. (2006), who have shown that airlines that laid off a significant number of their employees during the crisis triggered by the terrorist attacks of September 11, 2001, inhibited their ability to recover from the crisis in the 4 years that followed by reducing the slack resources necessary for resilience. As such, the empirical papers in this line of enquiry often use the term resilience to describe the ability of firms to

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generate positive organizational outcomes in times of disruptions. Ortiz-de-Mandojana & Bansal (2016) is certainly the first empirical paper explicitly tying the link between EP (considered as Social and Environmental Practices, SEPs) and resilience (measured with survival rates, volatility and sales growth over a 15-year period), which they defined as “*the ability of organizations to anticipate, avoid, and adjust to shocks in their environment*”. In their study of the EP – Resilience relationship with a long-term perspective, they insist on the importance of temporality in the management framework of sustainability, highlighting the fact that resilient organizations should be prepared to concede short term financial losses for the sake of long-term benefits that are reflected in their financial health. This argument compels us to understand how financial performance is not entirely adequate in assessing the effects of EP on the ability of firms to handle critical situations. Contrary to resilience, FP is not a reliable indicator of the long-term value of EP.

The adoption of the resilience framework in this literature is consequential. The word *resilience*, with its roots tangled around the sustainability of ecological systems (Holling, 1973), and its interdisciplinary nature (Linnenluecke & Griffiths, 2015; Linnenluecke, 2017; Ortiz-de-Mandojana & Bansal, 2016), warrants definitional considerations that far surpass those of FP. The earliest uses of resilience in the business and management literature, which Linnenluecke (2017) traces back to Staw et al. (1981) and Meyer (1982), initiated a differentiated set of propositions regarding how organizations cope with external threats. Both papers insist on the fact that resilience, although the term itself is implicit in their work, is born from functional responses to threats that originate in the organization’s environment, and allows long-term sustainability and survival. In the theory developed in Staw et al. (1981), threat conditions place organizations (but also individuals and groups) in a risk avoidance situation of restricted information processing and constricted control which they label “*threat-rigidity effects*”, the tendency to use well established processes in maladaptation to the crisis, instead of flexibility

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and adaptable learning. Meyer (1982) extended and amended this view by studying the environmental jolt caused by a sudden doctors' strike and paying attention to the diversity of adaptation paths that allowed the framing of the abrupt change as a potential source for opportunities of organizational learning rather than a threat to the organization. In his study, organizations can exhibit two types of adaptive response: "*resiliency*", absorbing the impact of the jolt through first-order change and single-loop learning; or "*retention*", a deeper transformation adopting new practices and configurations through second-order change and double-loop learning. This new view on the organizational response to threats had originality in that it allowed for the observation of the processes which can lead to either successful or unsuccessful responses to disruptions, and affect the organization's future position and long-term survival.

Perrow's (1984) book "*Normal Accidents*" brings the first theoretical contribution to the then nascent resilience literature in management research by proposing that resilience is a response not to risk, but to vulnerability, and that high-risk systems carry an intrinsic vulnerability to failure because of their increasing complexity, which causes managerial difficulties for the workforce. This view gave rise to the reliability paradigm, and the study of High Reliability Organizations (HROs), particularly influent in the studies of resilience to new dangers introduced by technological progress (Roberts, 1990; Weick et al., 1999). Insofar as vulnerability in the current economic framework resides strongly in environmental factors related to climate change and the other transgressions of planetary boundaries, the resilience framework was adopted by numerous researchers in the recent decades to study phenomena as diverse as organizational responses to crises, accidents and disruptions (Gittell et al., 2006; Hamel & Välikangas, 2003; Sutcliffe & Vogus, 2003), individual employee responses to disruptions and self-efficacy (Avey et al., 2011; Coutu, 2002; Luthans, 2002; Luthans et al., 2010; Luthans & Youssef, 2007), reliable supply chain designs (Christopher & Peck, 2004;

Jüttner & Maklan, 2011; Kleindorfer & Saad, 2005; Sheffi & Rice Jr., 2005), and management practices that favor sustainability (Linnenluecke & Griffiths, 2010, 2015; Ortas et al., 2014; Ortiz-de-Mandojana & Bansal, 2016).

From the existing reviews of the management research relying on the organizational resilience framework, a set of consensual attributes about the concept emerged. First, resilience is an integrative notion associated with the capability of a system to cope with adversity, recover from the disruption, and sometimes turn it into a source of opportunities (Duchek, 2020; Lièvre et al., 2022). Second, resilience, as a paradigm, opposes vulnerability (Lièvre et al., 2022), because vulnerability, as defined by Adger (2006), is a “*state of susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adapt*”, while resilience is understood as the capacity to cope with and adapt to environmental changes, hazardous events or disruptive situations, and dynamically learn from the event. Third, OR is a multidimensional path-dependent process, it involves capabilities that complement one-another, but which are not necessarily all developed synchronously (Duchek, 2020), these attributes are explored in detail in the following subsection.

### 1.2.3 Attributes of Resilience

*Anticipation and preparedness.* Before the advent of any disruption, some organizations are able to detect critical developments within the organization and in its environment, these resilient systems recognize early signals of potential crises better than others and are able to respond quickly and avoid escalation or reduce the impact of the shock with superior anticipation (Duchek, 2020). The development of proactive strategies and contingency plans to mitigate potential threats participates in the organization’s preparedness for unexpected events, as explained in Raetze et al. (2022), vigilance, alertness, awareness, and environmental

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monitoring all contribute to the ability of organizations to reduce vulnerabilities, thereby minimizing the probability and the severity of negative events.

*Resource availability and social capital.* As was suggested by Meyer (1982), and made clear from the results of Gittell et al. (2006), the availability of slack resources (i.e., a reserve of redundant assets) is a necessity for resilient responses to disruptions, they serve as a buffer to absorb the impact of adverse conditions. To manage crisis effectively, organizations must be able to mobilize sufficient financial, human, technical, and informational resources, which all positively influence the resilience of organizations through coping and adaptation capabilities (Duchek, 2020). The effective use of resources and capabilities to adapt to changing conditions is central in the dynamic capability perspective (Eisenhardt & Martin, 2000; García-Valenzuela et al., 2023; Teece et al., 1997; Williams et al., 2017), which is often cited in the literature on resilience (Su & Junge, 2023). In particular, leveraging strong social relationships both within and outside the organization is an efficient way to foster coordinated responses to crises, this ability is sometimes referred to as “social capital” (Lins et al., 2017; Su & Junge, 2023). Disruptions can also be mitigated through the creation of resilient inter-organizational structures, Linnenluecke (2017) recognized the embeddedness of organizations in “*institutional contexts and highly interconnected supply and inter-organizational structures, which determine their resilience and vulnerability to adverse impacts*” (see also Xavier et al., 2014).

*Adaptation capabilities.* During the period of initial shock in the emergence of disruptions, resilient organizations are able to rapidly adjust to the new circumstances imposed by the crisis, they flexibly ensure the organization is able to thrive despite adverse conditions and create the conditions for opportunities to emerge in the turmoil (Duchek, 2020; Raetz et al., 2022). This approach is closely related to the ability of an organization to position itself in a framework of continuous learning, accommodating organizational practices and strategies to adapt, integrate, and reconfigure resources and skills to harmonize with what the new conditions

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call for. Continuous learning has additional benefits beyond resilience as it also fosters innovative and flexible attitudes within the organization (Raetze et al., 2022). The adaptive capacity of organizations is all about changing before or during episodes of disruption to ensure the efficiency of the processes that enable the system to thrive, as such, it is generally opposed to the “wait and see” attitude (Raetze et al., 2022).

*Cognitive and behavioral resilience.* In the resilience literature, there are multiple arguments pertaining to individual or group resilience that also carry meaning for resilience at the organizational level (see Linnenluecke (2017) for a more thorough review of these strands). In essence, a significant portion of this work is grounded on the seminal work of Weick (1993), who identified four potential sources of resilience: improvisation / bricolage, virtual role systems, an attitude of wisdom, and respectful interaction. At the organizational level, this translates into improved social resources by ensuring all members of the organization are aware of and engaged in processes that ensure resilience and promote a culture of responsiveness and vigilance through respectful interactions: “*face-to-face dialogues rooted in trust, honesty, and self-respect*” (Duchek, 2020; Lengnick-Hall et al., 2011; Weick, 1993; Weick et al., 1999). An organizational culture built upon a solid bedrock of social resources encourages creative problem-solving attitudes, the ability to innovate on the fly during crises (Weick, 1993), as well as the capacity to learn from past crises to improve future resilience (Edson, 2012; Raetze et al., 2022).

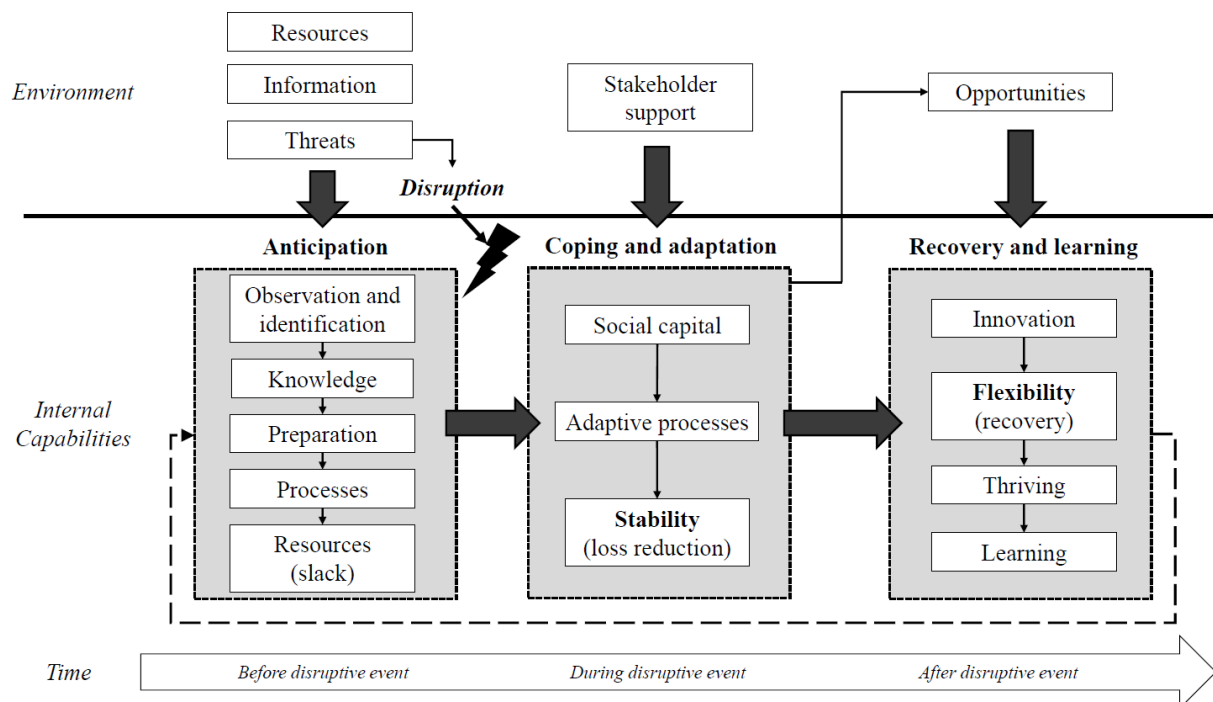
*Strategic management and leadership.* Su & Junge (2023) identified that the role of top management in enhancing organizational resilience is crucial as their decisions, traits, and behaviors will affect the survival and recovery of their organization in adverse conditions, part of the resilience literature pushes this argument by building upon the upper echelons theory (e.g. Buyl et al., 2019; Sajko et al., 2021). In the same way that social capital helps successfully coordinate operations in times of crisis, a strong commitment of leadership to activities and

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processes that promote OR also ensures the organization has a clear vision to continuously support these initiatives. In that regard, it is generally recognized that leadership structures designed around shared goals, shared knowledge, and mutual respect are conducive to superior coordination, thereby improving the overall performance of the organization (Duchek, 2020; Gittell, 2001, 2002; Gittell et al., 2000). The alignment of organizational goals with resilience objectives is possible through a strategic planning process that integrates resilience (Duchek, 2020), and a distribution of decision-making powers and responsibilities that relies on expertise (Linnenluecke, 2017). This enables swift and effective crisis management and foster the development of adaptation capabilities.

Due to the complexity of measuring these attributes so they can be employed in empirical studies that rely on secondary data, choices had to be made concerning the research approach. For the remainder of this thesis, resilience will be explored under the definition of Gunderson & Pritchard (2002): *“both the ability of a system to persist despite disruptions and the ability to regenerate and maintain existing organization”*. This view encompasses the two predominant qualities of resilience which are empirically observed in chapters 2, 3, and 4, they were named *“stability”* and *“flexibility”* by DesJardine et al. (2019). Stability is the ability of resilient organizations to preserve their core functions by reducing losses, and flexibility is mainly the ability of resilient organizations to regenerate by recovering from these losses faster than their peers. Both qualities are positive outcomes of the resilience process, and rely on the attributes described above. A visual summarization of the resilience process is proposed in Figure 1-1.

Figure 1-1: The Organizational Resilience process



Source: created by the author, inspired by Duchek (2020), and adapted to include elements from Linnenluecke (2017), Raetz et al. (2022), and Su & Junge (2023).

## 1.3 Theoretical perspectives on the link between EP and Organizational Resilience

### 1.3.1 Shareholder theory

The most influential view of how Corporate Social Responsibility affects businesses in the last century is definitely the branch of neoclassical economics, sometimes referred to as “neoliberal”, which posits the shareholder primacy (Friedman, 1962), in a view epitomized by the famous Friedman Doctrine : “*the social responsibility of business is to increase its profits*” (Friedman, 1970). This view, central in the description of how capitalism functions in a free-enterprise, private property system (Friedman, 1962; Hayek, 1944), holds that the only goal of a firm is to increase its profits in order to maximize returns for shareholders. While the famous New York Times article is often cited nowadays in a stereotypical way to highlight the defects of shareholder capitalism (Edmans, 2020), the observation that, in the principal-agent perspective and under certain assumptions, the first responsibility of corporate managers is to



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maximize shareholder value informs us about the stakes surrounding the issue of how CSR initiatives, and therefore EP, affect business performance depending on the context. The assumptions upon which the Friedman Doctrine holds are exposed by Edmans (2020) as follows:

- (i) “*A company has no comparative advantage in socially responsible actions*”, and therefore one dollar spent by this company on CSR initiatives is expected to create the same value as a dollar spent by any other agent;
- (ii) “*Governments are well-functioning*”, since there exists an important caveat of the Friedman Doctrine recognized by Friedman himself: “there is one and only one social responsibility of business [...] to increase its profits *so long as it stays within the rules of the game*” (Friedman, 1962, emphasis added), also realizing that the rules may be distorted, through lobbying for example, in favor of corporate profits and in detriment to other socially desirable outcomes such as protecting the environment, or local employment;
- (iii) “[*Profit-focused companies*] can calculate the impact of [*investments in their stakeholders*] on profit”, while the return on investment can be assessed for some ventures (through the calculation of a project’s net present value for example), the sensitivity analysis tools and other risk analysis mechanisms cannot fully cover the uncertainty surrounding investments in CSR.

In conditions where all these assumptions are true, the shareholder theory sees no reason for CSR initiatives to yield financial benefits. As such, the general view is that the shareholder theory opposes the possibility of a positive financial impact of CSR initiatives. In reality, and in Friedman’s actual words, the shareholder primacy may well lead managers to choose to invest in initiatives that do not directly support their firm’s financial performance: “*A group of persons might establish a corporation for an eleemosynary purpose—for example, a hospital or school. The manager of such a corporation will not have money profit as his objective but the rendering of certain services.*” (Friedman, 1970). He also anticipated situations in which investments in CSR initiatives may support the firm’s financial interest, and should thus be

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pursued: *“it may well be in the long-run interest of a corporation that is a major employer in a small community to devote resources to providing amenities to that community or to improving its government. That may make it easier to attract desirable employees, it may reduce the wage bill or lessen losses from pilferage and sabotage or have other worthwhile effects.”* (Friedman, 1970). A similar case can be made for environmental performance. With these assumptions in mind, one can see both the pathways under which corporate investments in favor of EP can lead to long term profits, or to the squandering of financial resources in favor of stakeholders, which should best be left to organizations that have a comparative advantage to handle these issues, to government regulators, so long as the careful estimation of the cost-benefit of such investments does not give a positive result in accordance with the objectives defined by the firm’s shareholders.

In many cases where managers are confronted with the possibility of improving the EP of their organization, the premise in the shareholder theory is that they will consider options and select the one that maximizes shareholder value, as is their responsibility. The consideration is expected to exclude solutions that do not fall within “the rules of the game”. We will see in chapter 2 that, in reality, this assumption is sometimes violated. Furthermore, in the assessment of which option best maximizes shareholder value, multiple uncertainties make this result unlikely: it is not trivial to anticipate the deployment timetable for future environmental regulations and the future costs thereof, the reactions of stakeholders, the value-adding opportunities that early investments in pollution reduction technologies may bring, their cost-cutting potential, and so on. The uncertainties also extend to contextual factors which cannot be fully anticipated or hedged against. In the advent of an unanticipated crisis, the prior financial assessments of existing investment projects within the organization may well be upturned, leading to substantial losses and financial constraints that harm the resilience of the firm.

### 1.3.2 Stakeholder theory

Explanations about the ways through which sustainable practices and environmental performance translate into advantages for organizations can be found in multiple theoretical frameworks. In the studies of this strand of the management literature, references to the stakeholder theory abound. The stakeholder perspective emphasizes the importance of creating value for all stakeholders involved in or affected by business activities (Donaldson & Preston, 1995; Freeman, 1984, 2007). This theory contrasts with the traditional shareholder-centric view, proposing that businesses should manage their relationships with customers, suppliers, employees, communities, and financiers to achieve long-term success, leading to eight main arguments regarding potential advantages EP can bring to enhance organizational resilience. These arguments can be summarized as follows:

- (i) Improved attention to the organization's environment leads to enhanced reputation and trust among stakeholders, which favors resilience (Bruna & Nicolò, 2020; Freeman, 2007; Lins et al., 2017);
- (ii) Firms with strong EP are more likely to receive support from stakeholders during crises, enhancing resilience (Bansal & Clelland, 2004; Parmar et al., 2010);
- (iii) The incorporation of environmental considerations into business strategies contributes to long term sustainability and organizational stability (Bhandari et al., 2022);
- (iv) Employees are more committed and innovative in organizations that demonstrate strong environmental responsibility, which can favor resilience through the organization's social capital (Freeman, 2007; Lins et al., 2017; Powley, 2009);
- (v) Firms with good EP are better positioned to comply with regulations, reducing the risk of legal issues that can disrupt operations, which favors business continuity and resilience (Arora & Gangopadhyay, 1995; Freeman, 2007);

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- (vi) In the process of improving EP, market opportunities can emerge and lead to competitive advantages for the firm, giving it an edge that allows it to thrive better than its counterparts (Parmar et al., 2010);
- (vii) Corporate sustainability policies also involve the development of the organization's ability to manage risks, particularly those related to environmental disasters and climate change, thereby improving the ability of a firm to handle disruptions of all kind (Wang et al., 2020);
- (viii) Positive environmental performance strengthens relations with local communities, giving access to critical information and support in challenging times, which can be crucial for the resilience process (Freeman, 2007).

### 1.3.3 NRBV

Concomitantly, the Resource-Based View (RBV) of the firm, pioneered by Wernerfelt (1984) and Barney (1991), also recognizes that firm performance is not solely built upon market conditions, as it relies on the ability of the firm to manage its internal and external relationships, but also to gain access to valuable, rare, inimitable and non-substitutable (VRIN) resources which induce competitive advantages. The integration of these theories suggests that the resources a firm has access to and leverages are often deeply intertwined with stakeholder relationships. For example, strong EP, seen as a valuable resource, can enhance a firm's reputation and stakeholder trust, leading to greater resilience. Freeman (2007) argues that managing for stakeholders involves creating value for all stakeholders, which inherently includes considering the environmental impact of business operations, thereby aligning with the RBV perspective that such capabilities can be a source of competitive advantage. Moreover, in his definition of firm resources, Barney (1991) includes *“all assets, capabilities, organizational processes, firm attributes, information, and knowledge controlled by a firm”*, implying that when these resources are aligned with stakeholder expectations, they can significantly enhance the firm's ability to sustain competitive advantages and resilience. This

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alignment is crucial in dynamic environments where stakeholder support can be pivotal during times of crisis, as highlighted in the instrumental stakeholder theory. It follows that the evolution of RBV in conjunction with stakeholder theory underscores that a firm's unique resources and capabilities are not developed in isolation but through continuous interactions with its stakeholders. This integrated approach enhances the firm's ability to adapt, innovate, and sustain competitive advantage in a rapidly changing business landscape.

After observing that many changes in the business world emerged from factors related to the natural environment of the firm, Stuart L. Hart (1995) expanded the RBV theory into the Natural Resource-Based View (NRBV) of the firm. This theoretical perspective integrates the natural environment into strategic management, and develops three interconnected strategies through which EP can translate into sustainable competitive advantages: pollution prevention, product stewardship, and sustainable development, which are summarized in Table 1-2, and explained below.

Table 1-2: A Natural Resource-Based View: Conceptual Framework

<b>Strategic Capability</b>	<b>Environmental Driving Force</b>	<b>Key Resource</b>	<b>Competitive Advantage</b>
Pollution Prevention	Minimize emissions, effluents, and waste	Continuous improvement	Lower costs
Product Stewardship	Minimize life-cycle cost of products	Stakeholder integration	Preempt competitors
Sustainable Development	Minimize environmental burden of firm growth and development	Shared vision	Future position

Source: Hart (1995), reproduced by the author.

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*Pollution prevention.* Firms can integrate the pollution prevention strategy by creating processes to reduce waste and emissions at the source, rather than relying on end-of-pipe solutions. Hart emphasizes that, by doing so, companies not only reduce the negative influence of the firm's activities on the natural environment but also lower costs and enhance efficiency. He states that "*Pollution prevention thus appears analogous, in many respects, to total quality management (TQM); it requires extensive employee involvement and continuous improvement of emissions reduction*" (Hart, 1995). By minimizing waste and effluents, companies can save on raw materials and disposal or remediation costs, which leads to a cost advantage over their competitors. Additionally, these firms can avoid potential liabilities and regulatory costs associated with pollution, further enhancing their financial performance and resilience. By reducing operational costs and improving resource efficiency, firms are less exposed to economic fluctuations than their counterparts, which is expected to contribute to their resilience.

*Product stewardship.* The strategy of product stewardship involves the integration of environmental considerations across the entirety of the product lifecycle, from the extraction of raw materials to their disposal or recycling. Underpinning this strategy is the omnipresent concern of external stakeholder engagement, as suppliers, customers, and regulators expect the organization to reduce the environmental impact of its products whenever possible, as long as it doesn't conflict frontally with its other responsibilities. Hart notes, "*Product stewardship thus entails integrating the 'voice of environment,' that is, external (stakeholder) perspectives, into product design and development processes*" (Hart, 1995). By designing products that are more environmentally friendly, firms are able to differentiate themselves in the market, preempt regulatory changes, and build a positive reputation. This strategy is expected to enhance the resilience of sustainable firms in the face of ecological and market changes since these firms are better protected from market volatility and benefit from enhanced customer loyalty.

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*Sustainable development.* A corporate strategy that integrates sustainable development takes the aim of balancing economic growth with environmental sustainability. This strategy is the most long-term, forward-looking segment of the NRBV, in which organizations are expected to develop new technologies and business models that minimize negative environmental impacts, while fostering economic development. In his own words, Hart explains: “*Sustainable development implies both substantial investment and a long-term commitment to market development*” (Hart, 1995). Firms that pursue sustainable development can gain a competitive advantage by positioning themselves as leaders in new, sustainable markets, thereby securing their future competitive position and enhancing their long-term resilience through superior innovation, which allows for more flexibility in the face of disruptions.

The core concepts of the RBV and NRBV rely on firm-specific resources which respect the VRIN conditions for achieving sustainable competitive advantages (Barney, 1991; Hart, 1995). In the interaction between the firm and its dynamic and uncertain environment, it is thus crucial for organizations to be able to renew and adapt these VRIN resources, Teece et al. (1997) describe this process under the term “*dynamic capabilities*”, the bridge between the firm’s internal resources and the rapidly changing external environment. A firm’s dynamic capabilities allow it to adapt, integrate, and reconfigure resources to sustain its competitive advantages. As recognized by Hart & Dowell (2011), the dynamic capability perspective contributes to the NRBV by enhancing our understanding of how firms develop capabilities that support sustainable business practices and respond to environmental challenges.

Among these dynamic capabilities, Aragón-Correa & Sharma (2003) consider proactive environmental strategies to have a particular role in achieving sustainable competitive advantages, they allow firms to continuously innovate and improve their processes, thereby aligning with changing business environments. Such strategies require integrating stakeholder

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perspectives into business processes which enhance firm adaptability, innovation, and differentiation. In their review of the NRBV's progress and influence, Hart & Dowell (2011) showed that empirical research focused mostly on the links between pollution prevention and firm profitability, leaving the other areas of product stewardship and sustainable development much less explored. They pointed out that the factors that affect the firm's ability to gain financial benefits from pollution prevention identified by the research they reviewed were organizational capabilities and managerial cognition (or framing). In particular, It seems firms are more likely to benefit from their pollution prevention strategies if they possess strong innovation capabilities and continuous improvement processes (King & Lenox, 2002), and Sharma & Vredenburg (1998) showed in a survey that companies with proactive environmental strategies benefit from their unique organizational capabilities and generate competitive benefits associated with the emergence of these capabilities, thereby confirming the soundness of the main arguments of the NRBV. Hart & Dowell (2011) also identified two topics that expanded the NRBV: (i) *clean technologies*, which explicit the transition between what Hart (1997) named "greening" strategies (pollution prevention and product stewardship) and "beyond greening" strategies (sustainable development, including clean technologies); and (ii) *base of the pyramid*, or BoP, "*the increased attention to the role of corporations in alleviating poverty for the poorest of the world's citizens*" (Hart & Dowell, 2011), integrated in the NRBV as a fourth strategic capability, relying on the resource of embedded innovation to yield the competitive advantage of long-term growth.

Russo & Fouts (1997) gave an excellent early example of how the NRBV helps empirical research by providing the mechanisms through which environmental performance can yield economic benefits for the firm. They analyzed the EP – FP relationship in a sample of 243 firms over two years and showed that EP favors FP and that this relationship is moderated by industry growth. Their explanation for the first result relies on intangible resources, as



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reputation for environmental leadership helps firms increase sales among customers that are sensitive to environmental issues, while the political acumen that presses green firms to adopt new pollution prevention technologies instead of slowing down the pace of environmental regulation through lobbying helps them meet the political demands of society. According to their study, the link between EP and FP is stronger in industries that see high growth levels because the maturation of technologies is accelerated in such industries, which reduces the levels of risk inherent to investments in emerging pollution prevention innovations, favoring firms that invest early in such technologies with a higher prospective return, and promoting the organizational capabilities that rely on learning. They also emphasize that intangible resources such as reputation are easier to construct in high growth industries because new entries are more likely in such industries, and initial reputation is a matter of choice while changing an organization's established reputation is difficult. The reputation – performance association is thus stronger in growth industries than in mature industries (Shrum & Wuthnow, 1988). The NRBV positions social legitimacy as a criterion of performance, through this view, it is possible to explain the complex social mechanisms that underly multiple forms of sustainable competitive advantage.

Judge & Douglas (1998) furthered this early effort to support the NRBV by showing with survey data that integrating environmental concerns in the corporate strategy positively affects financial and environmental performance, which supports the view that proactive environmental strategies can yield sustainable competitive advantages as suggested by the natural resource-based perspective. Many other, and more recent, empirical validations of the NRBV can be listed. Among these, Chan (2005) demonstrated that the NRBV can also apply to emerging economies as companies operating in China can also benefit from the adoption of environmental strategies. Aragón-Correa et al. (2008) showed that small and medium enterprises (SMEs) also undertake reactive and proactive environmental strategies which foster

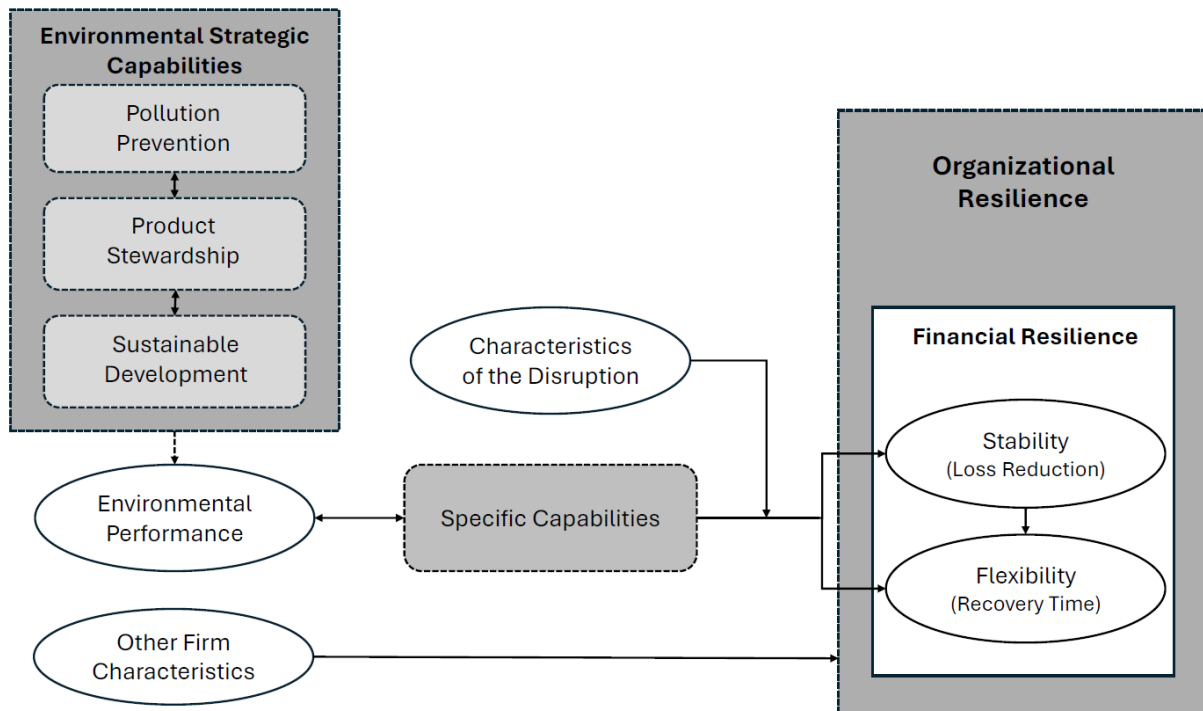
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organizational capabilities (shared vision, stakeholder management, and strategic proactivity) and that firms with the most proactive environmental strategies benefitted from increased financial performance. Kim (2018) supported the view that proactive environmental strategy leads to improved EP, while reactive environmental strategy negatively affects EP. Demirel & Kesidou (2019) delved into the determinants of eco-innovation and showed that it is permitted by 3 important sustainability-oriented capabilities: (i) voluntary self-regulation capabilities, (ii) investments in environmental R&D instead of generic R&D, and (iii) green market sensing capabilities. Bhandari et al. (2022) rely on arguments from the NRBV perspective to contradict the classical view that self-interest and the maximization of profits (Friedman, 1970) generate positive outcomes for society in their empirical demonstration of how the narrow self-interest of a firm degenerates the ecological and social fabrics of society in the current level of resource consumption, thereby challenging the literature to reverse the traditional assumption behind the resources attributes, and view the firm as embedded into society and ecology rather than the opposite, as proposed by Dasgupta (2021). In closer relation to this thesis, Marsat et al. (2022) use NRBV arguments and the methodology of DesJardine et al. (2019) to explain the role of prior EP in improving a firm's resilience against environmental controversies in a sample of 233 such events, they show that the specific capabilities necessary for the development of EP also contribute to the firm's flexibility against environmental controversies, as firms with high levels of EP recovered faster than their counterparts from the financial losses caused by the controversy.

The role of the strategic capabilities described in the NRBV in improving the resilience of firms to environmental disruptions is therefore central to understanding the relationship between EP and firm performance in the current period of rapidly changing environmental conditions and market disturbances. Because the shareholder perspective has difficulty explaining the mechanisms through which EP produces desirable financial outcomes (Endrikat

et al., 2014; Horváthová, 2010), including resilience, and the complexity in the stakeholder theory to view the environment as a fully-fledged stakeholder (Guterman, 2023), it seemed more appropriate to adopt the NRBV as the point of anchoring for the hypothetico-deductive approach developed in the remainder of this thesis. The empirical chapters hereafter aim to provide rationale and evidence behind the idea that strategies for pollution prevention, product stewardship, and sustainable development nurture specific capabilities that allow the company to use its EP to improve resilience to disruptions emerging in its environment. Figure 1-2 provides a graphical expression of the relationships explored in this doctoral work.

Figure 1-2: Thesis Empirical Framework



Source: created by the author. Elements and links in dashes with a gray background are unobservable, those in solid lines and white background are observable.

## 1.4 Empirical findings on EP and Resilience

In the aftermath of the empirical study of resilience by Ortiz-de-Mandojana & Bansal (2016), showing that firms with better anticipation and adjustment to environmental disturbances benefit from lower financial volatility, higher growth and better survival rates,

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other researchers have sought to measure resilience and study the antecedents of this multidimensional construct. Buyl et al. (2019), for example, explored how CEO characteristics affected the resilience of banks during the 2008 Global Financial Crisis (GFC) by observing two distinct outcomes in line with Aven's (2011) description of resilience: (i) the size of the drop in performance directly caused by the shock (measured as the difference in banks' return on assets between the third quarter of 2008 and the third quarter of 2009), and (ii) the time it took to recover to pre-shock performance levels (the number of years until return on assets recovered to Q3 2008 level, or above). They document that banks led by narcissistic CEOs, who tend to take more risks before the crisis, experience a slower recovery to their pre-crisis performance levels. DesJardine et al. (2019) made a similar empirical proposition while adapting their approach to that of Gittell et al. (2006), inferring resilience from movements of firms' market price instead of other measures of performance. By separating social and environmental practices (SEPs) in Strategic SEPs and Tactical SEPs, they show that only strategic practices that establish interdependencies between the organization and its broader social and environmental context benefit the firm's stability (its ability to reduce losses in market value) and flexibility (the time it requires to recover to its pre-crisis market value) in the face of environmental disturbance such as the 2008 GFC.

Since the publication of DesJardine et al. (2019), and the start of this thesis work, other researchers adopt an analogous approach to the study of resilience to environmental disruptions. Following up on Buyl et al. (2019), and relying on the stability / flexibility approach and measures proposed by DesJardine et al. (2019), Sajko et al. (2021) explore how CEO greed affects CSR performance and resilience in the 2008 GFC context. On the basis of a panel of CEOs who were serving at publicly listed firms of the S&P 1500, they observe that CEO greed negatively affects CSR, that pre-shock CSR and CEO greed do not significantly affect stability, and that pre-shock CSR positively affects flexibility as firms with stronger CSR engagement

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before September 2008 are more likely to recover faster than others, while CEO greed negatively affects flexibility. Li et al. (2022) adapt the stability / flexibility methodology of DesJardine et al. (2019) and Sajko et al. (2021) to study the effect of servitization on the resilience of 1,914 manufacturing firms to the Covid-19 crisis. Contrary to expectations, and prior empirical research that focused on the benefits of servitization, they show that manufacturing firms that are highly servitized faced heavier losses in the initial shock of the Covid-19 crisis and then took longer to bounce back from the shock than their peers, thereby exhibiting weaker resilience, which allows them to challenge multiple arguments in the servitization literature by showing the “dark side” of servitization, and insist on the importance of contextual attributes in studies of organizational resilience. Another example showing that the stability / flexibility approach of organizational resilience is particularly efficient to explore how firm characteristics affect resilience to shocks can be found in Ullah et al. (2022), who use an international sample of 5,696 firms to find that the adoption of green supply chain management practices allowed firms to recover their market price faster than other firms following the financial shock caused by the Covid-19 crisis.

Other researchers attempt to empirically test the relationship between EP (or sustainable business practices) and resilience with approaches that do not rely on the stability / flexibility view of resilience, particularly since the lockdowns in response to the Covid-19 pandemic when the number of papers discussing resilience skyrocketed (Jiang et al., 2024). The work of Garel & Petit-Romec (2021) is one of the most relevant among such attempts, they observe the cross-section of stock price reactions to the financial shock triggered by the Covid-19 crisis and show that firms with higher environmental pillar scores (from the ESG ratings of Thomson Reuters Asset4) benefit from significantly higher stock returns during the first month of the Covid-19 crisis (February 20, 2020 to March 20, 2020). They also provide a demonstration that this results from investors rewarding firms with higher environmental scores rather than penalizing firms

with low scores. Furthermore, they decompose the environmental pillar score to show that the investor reward mainly stems from initiatives that address climate responsibility, and that this effect is significantly stronger for firms with greater long-term investor ownership – thereby confirming prior survey evidence that the Covid-19 crisis is perceived by investors as a long-term catalyst of environmental and climate responsibility. Cardillo et al. (2022) also contribute to this line of enquiry by studying the risk-return trade-off and stock market liquidity of 1,204 European firms during the year 2020, they show that firms with high ESG scores perform better during the crisis as they exhibit higher market returns, lower volatilities, and higher stock market liquidity. They additionally show that firms with high ESG scores that retain more cash holdings and liquid assets in the period before the crisis absorb the shock caused by the pandemic better than others, confirming the results of Ding et al. (2021), and the observation of Gittell et al. (2006) that slack resources enable resilience.

### 1.5 Contributions and literature gaps

This thesis work seeks to fill multiple gaps in the resilience literature. First, there currently is a need to better understand the interplay between EP and resilience, as the role of environmental sustainability in building resilience is underexplored (Jiang et al., 2024; Raetze et al., 2022). Second, until recently and as underlined by Linnenluecke (2017), the organizational resilience literature relied largely on conceptual frameworks rather than empirical validation, thus, proposing a set of studies that test the effects of multiple firm characteristics on the resilience process is expected to bring insights into the workings of resilience. Third, Ortiz-de-Mandojana & Bansal (2016) and DesJardine et al. (2019) recognized the importance of examining the long term impact of EP on OR instead of focusing on short-term performance, as sustainable business practices are expected to bear fruits after a longer period of integration through complex social processes inside the organization, this means a

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study of resilience to any crisis should involve at least the entirety of the recovery period for a majority of the studied sample, as is the intent in this thesis. Fourth, the influence of the context of disruption on the relationship between EP and OR is not well understood (Duchek, 2020; Jiang et al., 2024), which calls for studies of organizational resilience that explore different critical situations, particularly crises that are related to ecological issues such as extreme weather events, natural disasters, or consequences of climate change (Rivera et al., 2022). Fifth, the ways in which environmental sustainability contributes to effective crisis management remain understudied (Raetze et al., 2022), so studies of the role of EP in enhancing crisis management capabilities should bring new perspectives in this literature. These gaps indicate that a thesis focusing on the empirical exploration of how EP affects OR bears potential to provide valuable insights and contribute significantly to the existing body of knowledge. By addressing these specific gaps, this thesis is thus expected to extend our understanding of the mechanisms through which environmental practices affect resilience, providing both theoretical advancements and practical implications for organizations aiming to build resilience through sustainability initiatives.

Some relationships explored in the remainder of this work pertain to parts of the NRBV that require further clarification and empirical validation. In particular, as identified by Hart & Dowell (2011), the areas of sustainable development and clean technologies call for more empirical exploration, and there are still details about the relationship between resources, capabilities and EP-FP links that remain underexplored. The relationship between practices that favor EP and the development of firm resources and capabilities needs further empirical study, as the role of proactive environmental strategies in building dynamic capabilities is scarcely explored in empirical studies (García-Valenzuela et al., 2023; Hart, 1995; Teece et al., 1997).

Exploring the role of environmental performance in improving stability and flexibility against environmental disruptions can thus expand our understanding of the benefits of EP

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beyond firm performance in normal circumstances. In that regard, shifting our gaze towards disruptive contexts can yield interesting results that may serve as the basis for future theoretical developments within the NRBV, particularly if the relationship between EP and resilience is equivocal in its direction and significance. Due to the long-term perspective implicit in the resilience paradigm, this work is thus expected to yield theoretical contributions about the contextual factors mediating the relationship between strategic environmental capabilities and resilience. Furthermore, due attention to multiple aspects of EP can potentially lead to interesting conclusions about the underlying mechanisms of proactive environmental strategies and dynamic capabilities that underpin the benefits of EP. As apparent in Figure 1-2, the remaining chapters study how EP affects the resilience of firms in different contexts of disruption. The contextual elements of the EP – Resilience relationship thus constitute another important source of interest in this thesis, which was scarcely explored in detail before.

Aside from the potential theoretical contributions, the remaining chapters of this thesis also aim to fill gaps in the existing empirical literature. First, the way benefits of improved EP outweigh its costs is not entirely clear and demands further examination (Russo & Fouts, 1997), studies that identify the connections between EP and firm performance in periods of crisis are still scarce. Secondly, many studies, particularly before 2005 (e.g. Judge & Douglas, 1998; Sharma & Vredenburg, 1998), used self-reported or survey data which run the risk of introducing biases in the statistical observations, thus using secondary data about both EP and FP around events of resilience mitigates these concerns and allow for measures that are readily comparable between firms in different industries and countries. Third, while there is evidence within the NRBV literature linking proactive environmental strategies with FP (e.g. Chan, 2005), the mechanisms by which these strategies contribute to resilience have not been fully explored. In particular, using measures of EP that directly result from the pollution prevention strategies of firms, such as direct environmental footprint (chapters 2 and 3) is uniquely



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compelling in our understanding of how reducing waste and emissions translates into resilience. Similarly, the decomposition of EP in multiple pillars (chapter 4) is expected to reveal interesting conclusions about what environmental capabilities underlie financial resilience. Fourth, while corporate strategies of sustainable development, including clean technology adoption, have long been observed in their relationship to EP and sustained competitive advantages (Bhandari et al., 2022; Demirel & Kesidou, 2019; Kim, 2018), the possibility for these strategies to mitigate the financial damage of environmental disruptions is currently lacking.

In addition to contributions inside the NRBV, the remainder of this thesis is also expected to bear contributions for the stakeholder perspective, particularly with regards to the relationship between the firm and its shareholders, the regulators of markets where its operations are deployed, and the environment (Gutterman, 2023). Whether or not corporate EP holds value for these stakeholders in critical situations is currently an understudied subject of enquiry, bringing new empirical evidence around the effect of EP on market reactions to disruptions can potentially inform about the place of EP in the ability of companies to improve their relationship with stakeholders. Additionally, EP has been debated into the larger view of CSR, and interpreted within the theoretical perspective thereof (Garriga & Melé, 2004). The following studies of resilience therefore bear potentially engaging observations about the value of CSR during tough times.

The empirical literature on resilience, and how it is affected by CSR and EP also has several gaps which this thesis attempts to fill. First, while many studies, such as Endrikat et al. (2014) or Xiao et al. (2018) focus on the EP – FP relationship, and multiple studies already debate the effect of CSR on resilience (DesJardine et al., 2019; Ding et al., 2021; Ferrón-Vílchez & Leyva-de la Hiz, 2023; Ortiz-de-Mandojana & Bansal, 2016; Sajko et al., 2021), very few empirical papers debate the specific effect of EP on resilience. Secondly, these papers document

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mixed results due to the context dependency of the resilience process; according to Marsat et al. (2022), EP positively affects the resilience of firms in environmental controversies, but it negatively affected the resilience of companies affected by the 2008 GFC (Marsat et al., 2021), which calls for further contextualization as proposed in this thesis. Thirdly, as recognized by (Flammer, 2013), the stakeholder expectations around environmental issues increased over time in the recent decades, this means studies of recent events comparable to the 2008 GFC, for example, may lead to different results as the EP – resilience relationship may be influenced by the perception of stakeholders, particularly shareholders, about the value of EP. Fourth, aside from major market disruptions such as the 2008 GFC (DesJardine et al., 2019; Marsat et al., 2021), or the Covid-19 pandemic (Azeem et al., 2023; Cardillo et al., 2022; Ding et al., 2021; Li et al., 2022; Ullah et al., 2022), extrinsic disruptions that call for corporate resilience have scarcely been studied. At the same time, many researchers and decision makers recognize the need to understand how organizations can manage disruptions related to ecological issues such as natural disasters, extreme weather events, emerging environmental regulation, environmental regulation enforcement, or resource depletion (Lièvre et al., 2022; Linnenluecke & Griffiths, 2015, 2013; Rivera et al., 2022). Addressing the resilience process in contexts of environmental penalties (chapter 2) and droughts (in chapter 3) thus bears potential for original empirical contributions in the resilience literature.

### 1.6 Research questions

Given the growing stringency of environmental regulations as a response to the mounting expectations for business to behave responsibly toward the environment (Flammer, 2013), and concerns over the fact that pollution deterrence mechanisms might not be sufficient to disincentivize environmental misconduct (Brady et al., 2019; Karpoff et al., 2005; Lott et al., 1999), it seems stimulating to consider issues around environmental law enforcement to open

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the empirical work of this thesis as they have not been considered through the lens of resilience yet. Therefore, the first context considered for these empirical studies is that of environmental penalties. In chapter 2, the scrutinized events are cases of firms which were fined following investigations by the US EPA for violating environmental law, these jolts constitute an exogeneous shock of regulatory nature that are directly associated with the relationships firms hold with their natural environment and the regulatory institutions in the United States. In this case, the events of interest are all unique to a firm, as each penalty is associated with only one targeted company, which means the intensity of the disruption varies from one event to the next, reflected in the amount of the penalty, introduced in the statistical models as a control variable. The consideration of these disruptions that emerge from environmental regulatory pressure is entirely original in the resilience literature, and quite rare in the empirical management literature. Additionally, the unconventional use of direct environmental footprint as a proxy of EP brings a fresh perspective on the subject. In essence, this chapter aims at answering the following question:

### *1) Does EP contribute to financial resilience against environmental penalties?*

In accordance with the NRBV, the hypothesized relationship between EP and resilience in this context is positive, meaning companies with less environmental footprint should benefit from specific capabilities that allow them to reduce the severity of the disruption – a positive effect on their stability – and reduce the time they require to bounce back to their pre-crisis firm value – a positive effect on their flexibility.

Following up on the idea of utilizing direct environmental footprint as a proxy of EP, chapter 3 explores how this measure of firms' effective implementation of proactive environmental strategies affects their stability and flexibility against major drought events in the US between 2006 and 2018. While the economic effects of droughts on firms is relatively

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well documented (Huynh et al., 2020; IPCC, 2022; NCEI, 2013; USDA, 2012), in this context as well the resilience framework can contribute to the literature by informing us about the way organizations react to such events, and recover from the damages. In this case, the events of interest affect not only one firm each, but an entire area, identified with drought data by state inside the contiguous USA. Due to the nature of these extreme weather events, the severity of the effect of droughts on the affected companies is related to their water intensity, which is reflected in the selection methodology and integrated in the statistical models. The main originality of this empirical analysis is the attention to slow-onset natural adversity events that affect a large sample of firms in a common area. Here too, the event type, droughts, is entirely original among studies of financial resilience, and scarcely considered in business and management empirical studies. This third chapter mainly aims at answering the following research question:

### 2) *Does EP contribute to financial resilience against droughts?*

In this case as well, the NRBV prompts the hypothesizing of a positive relationship between EP and resilience. The expectation in this view would be that firms which managed to reduce their direct environmental footprint, beyond the reduction of their water dependency, foster internal specific capabilities that allow them to lose less value in the advent of droughts, they are presumably more stable, and recover their pre-crisis value faster than others, thanks to their improved flexibility.

Finally, due to the apparent contradiction between empirical enquiries around the relationship between EP and resilience in contexts of major economic disruption, it seems necessary to apply the same approach to the latest global financial crisis caused by the spread of the Covid-19, as this crisis provides a rare setting of extreme economic disruption affecting most economies worldwide synchronically, and has been the center of interest of many

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researchers attentive to resilience issues in recent years (Cardillo et al., 2022; Ding et al., 2021; Garel & Petit-Romec, 2021; Li et al., 2022). In this chapter, only one event is explored: the start of the international spread of the virus in mid-February 2020, affecting all financial markets around the globe at the same time. While the contextual elements of this chapter are much less original among studies of resilience, the methodological approach brings a fresh perspective, as relatively few researchers interested in the EP – OR relationship have used the stability / flexibility approach to study this event, fewer have taken a global perspective, and none have considered the full length of the recovery period to do so. This fourth and final chapter seeks to answer the following question:

### *3) Does EP contribute to financial resilience against the Covid-19 crisis?*

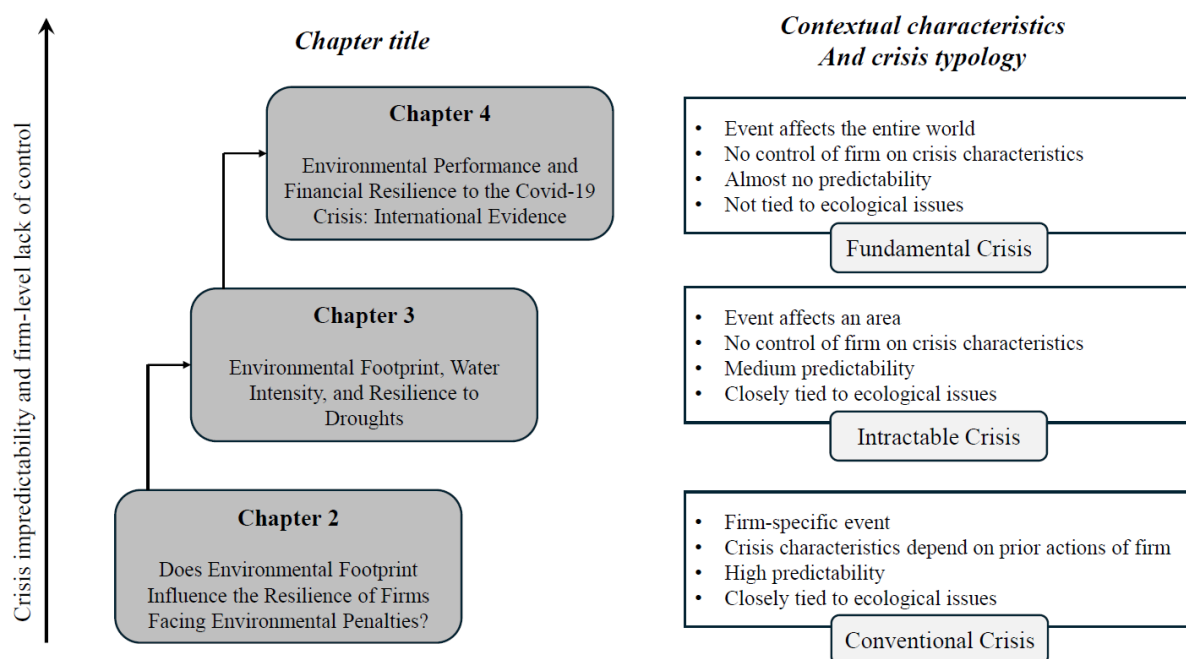
In this context too, the NRBV would suggest a positive hypothesis for the EP – resilience relationship: we would expect firms with higher EP than their peers to benefit from their specific capabilities and reduce both the severity of the loss in value in the initial shock and the length of their recovery period. On the other hand, the preexisting empirical work on how EP affects financial resilience to major financial crises suggests a more nuanced set of expectations, as it may well be that the resource allocation necessary for improving the EP of firms is done at the expense of slack resources that are required for the resilience process.

The order of the chapters described above is established in coherence with two contextual factors: the level of predictability of the crisis, and the level of control the firm can exert on the characteristics of the crisis. According to the typology of crises proposed by Gundel (2005), the environmental penalties studied in chapter 2 can be qualified as “conventional crises”, relatively predictable events that result directly from the actions of the firm (violating the environmental law) which are specific to only one firm, and closely tied to the ecological environment of the firm. The severe droughts studied in chapter 3 may be understood as

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“Intractable crises”, insofar as they can also be predictable within limits, but the firm has no control over the characteristics of the crisis, only on how prepared it is for confronting it, these events are also closely tied to the ecological environment of the firm, but they affect an area rather than a single firm. Finally, the Covid-19 crisis considered for chapter 4 is a textbook example of a wild-card “fundamental crisis” affecting the whole world, the level of predictability for such events is minimal, firms have no control over the crisis characteristics, and it has no relation to their ecological environment. The succession of chapters and the justification above are summarized and visually represented in Figure 1-3.

Figure 1-3: Chapter order and contextual elements



Source: created by the author. Crisis typology relies on the arguments of Gundel (2005).

### 1.7 Methodology

This thesis mainly consists of three empirical enquiries around the ways EP affects the resilience of firms facing environmental disruptions. Each chapter addresses a different context of disruption, and makes use of different sources of data to qualify these disruptions and objectivize the contextual characteristics. While the methodological approach remains similar across chapters, the measures of EP vary. For chapters 2 and 3, data is drawn from the Trucost

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database pertaining to firms' environmental footprint, while chapter 4 makes use of the ESG ratings provided by Asset 4 through Thomson Reuters' Datastream tools. Other minor differences are introduced in the measurements of the stability and flexibility dimensions of resilience depending on the length of the disruptive event, the extent to which it can be anticipated, and other issues which are duly explained in the relevant section of each chapter.

For a proper use of the resilience concept in empirical studies, Su & Junge (2023) suggest three conditions: an adverse event that triggers the resilience process, a performance setback or loss, and a recovery from this loss. In all cases, the first step in all such works should be devoted to event identification. Any event explored through the lens of resilience should be well identified, with particular attention to when it starts and ends, such events should be disruptive enough for a substantial loss to be measured, and the period of analysis should allow enough time for the recovery to be observed. In all cases, this identification process must be grounded on objective data about the event itself. Therefore, for each chapter of this thesis, the precise methodology for event identification is explained in detail to allow other researchers to reproduce these studies if they so wish. This explanation also leads to important contextual elements relative to each event's length, intensity, cause, and other implications that carry meaning for the resilience process and can be included in subsequent statistical models. In all cases, a start date must imperatively be defined for each event, as the remaining data collection will rely on this information. An important second step, and not the shortest to implement, is the identification of firms affected by the retained event(s), and the elimination of observations which are either unaffected, or for which important information is lacking, such as their EP, or financial characteristics. For studies that include multiple events, as is the case in chapter 2 (each observation is a unique event) and chapter 3 (19 drought events, 345 observations), the time factors need to be aligned so all events can be included in the same database. This entails using the event start date as a point of reference to collect the rest of the data for each

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observation, in this case, the share value of each affected firm for a period of time before the event (20 days in chapter 2, 20 weeks in chapter 3), and the share value of each firm at any point in the observation period following the event start, which varies depending on the length of the recovery process, and can be restricted in shorter time windows for robustness tests.

Next, the creation of resilience variables that measure stability and flexibility uses the variations of these share values around the event start date in a method that was spearheaded by DesJardine et al. (2019), and since, further used and adapted by other researchers (Azeem et al., 2023; Li et al., 2022; Marsat et al., 2021, 2022; Ullah et al., 2022). First, a pre-crisis threshold must be defined for each observation. For example, DesJardine et al. (2019) used the firms' share close price preceding the start of the GFC on September 16, 2008; Li et al. (2022) opted for the highest share price in the period before the outbreak of Covid-19 between January 1, 2020 and February 23, 2020. Based on this threshold, the severity of loss can be calculated as the percentage difference between this pre-crisis threshold and the lowest value after the start of the crisis to measure the stability dimension of resilience. Then, the time to recovery can be calculated as the length of the period (in days, weeks, months...) separating the start of the event from the first moment in which the share value of a firm surpasses its pre-crisis threshold (DesJardine et al., 2019). An adaptation of this methodology, introduced in Marsat et al. (2021), and in all chapters of this thesis, includes a period of time for which the share price must remain above this threshold to assess recovery, as financial volatility may cause a firm's share price to momentarily surpass its pre-crisis value before plunging again below this value – should it then really be considered recovered? Adding a necessary period of above-threshold value to the assessment for recovery allows for an arguably more precise measurement of the flexibility dimension of resilience.

The independent variables, which are all related to firms' EP in the cases explored here, are assessed in the period preceding the crisis. For example, in accordance with the observation



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made by Ortiz-de-Mandojana & Bansal (2016) of the long-term temporality in the effects of sustainable management practices, the direct environmental footprint of firms affected by environmental penalties in chapter 2 or by droughts in chapter 3 are taken during the calendar year preceding the start of the event. The same goes for most control variables, characteristics that depict the corporate situation before the crisis, with variables such as firm size, financial leverage, profitability, and momentum, are calculated on the basis of yearly pre-crisis data. Additional qualitative information about the event or the affected firms is often included in statistical models under the denomination of “fixed effects”.

The statistical tools used to assess the effects of EP on resilience variables are mostly similar to those used by DesJardine et al. (2019). First, the stability dimension of resilience is assessed with Ordinary Least Squares (OLS) regressions taking the severity of loss as the dependent variable. In these regressions, a positive coefficient for regressors is associated with a negative effect on stability (the regressor is then associated with an increased severity of loss), the relationships take the following form:

$$SoL_i = \beta_0 + \beta_1 EP_i + \beta_2 X_{i2} + \dots + \beta_k X_{ik} + \epsilon_i$$

Where  $SoL_i$  is the severity of loss of observation  $i$ ;  $\beta_0$  is the intercept representing the value of  $SoL_i$  when all independent variables are zero;  $EP_i$  is the environmental performance for the  $i^{\text{th}}$  observation;  $X_{i2}, \dots, X_{ik}$  are the other independent and control variables for the  $i^{\text{th}}$  observation;  $\beta_1, \beta_2 \dots \beta_k$  are the coefficients corresponding to each independent and control variable, representing the change in the severity of loss associated with a one-unit increase of the respective independent variable, holding other variables constant; and  $\epsilon_i$  is the error term for the  $i^{\text{th}}$  observation, capturing the variation in severity of loss not explained by the independent variables included in the model.

Then, survival analysis regressions are run on the time to recover including a similar set of independent and control variables to assess the net effect of EP on the flexibility dimension of resilience. The most common form of survival analysis regression is the Cox proportional hazards regression model (Cox, 1972), which is often used in medical science to explore the relationship between an event occurring at varying times for the observations in the dataset and predictor variables. In the context of financial resilience, the Cox survival analysis regression estimates the effect of predictors on the hazard function associated with the recovery, this hazard function is given by:

$$h(t|X) = h_0(t) \exp(\beta_1 EP_i + \beta_2 X_{i2} + \dots + \beta_k X_{ik})$$

Where  $h(t|X)$  is the hazard function at time  $t$  for an individual with covariates  $EP_i, X_2, \dots, X_k$ . The hazard function represents the instantaneous risk of the event occurring at time  $t$ , given that the individual has survived up to time  $t$ ;  $h_0(t)$  is the baseline hazard function, which is the hazard when all the covariates  $EP_i, X_2, \dots, X_k$  are zero; and  $\beta_1, \beta_2, \dots, \beta_k$  are the regression coefficients corresponding to each covariate  $EP_i, X_2, \dots, X_k$ , representing the log hazard ratio. These coefficients indicate the effect of the covariates on the hazard rate. It is common in regression tables for survival analyses to report the coefficients rather than the hazard ratios, which can be calculated by exponentiating these coefficients.

Depending on the overall shape of recovery in the sample, which is generally observed with the Kaplan-Meier failure estimates plot, other forms of survival analysis regressions that assume a certain shape of the baseline hazard function are also used in the following studies when they are well fitted to the data. These survival analysis regressions are:

- (i) the Weibull survival model, of which the baseline hazard function is:

$$\lambda \gamma t^{\gamma-1}$$

Where  $\lambda$  is the scale parameter, which is a positive constant that scales the hazard function;  $\gamma$  is the shape parameter, which determines the shape of the hazard function ( $\gamma > 1$  if the hazard rate increases over time,  $\gamma < 1$  if the hazard rate decreases over time, if  $\gamma = 1$  the hazard rate is constant over time, which reduces the model to an exponential distribution).

(ii) the Gompertz survival model, with the following baseline hazard:

$$\lambda \exp(\gamma t)$$

Again where  $\lambda$  is the constant scale parameter; and  $\gamma$  is the shape parameter (here if  $\gamma > 0$  the hazard rate increases exponentially over time, if  $\gamma < 0$  the hazard rate decreases over time).

And (iii) the Exponential survival model where the baseline hazard function is simply  $e^\alpha$ , which takes an exponential form scaled with the estimated parameter  $\alpha$ .

Alternatively, the effect of regressors on the likelihood of recovery before the end of a certain time window of analysis can be assessed with Logit (or Probit) regressions. The dependent variable in the Logit regressions presented in this thesis are binary variables set to 1 if the firm has recovered before the end of the observation period, and 0 otherwise. The effect of predictors on the probability of recovery within a certain time frame is expressed as:

$$P(\text{Recovered} = 1 | X) = \frac{1}{1 + \exp(-(\beta_0 + \beta_1 EP_i + \beta_2 X_{i2} + \dots + \beta_k X_{ik}))}$$

Where  $P(\text{Recovered} = 1 | X)$  is the probability that the dependent variable *Recovered* equals 1 given the predictors  $EP_i, X_2, \dots, X_k$ ;  $\beta_0$  is the intercept term;  $EP_i$  is the environmental performance for the  $i^{\text{th}}$  observation;  $X_{i2}, \dots, X_{ik}$  are the other independent and control variables for the  $i^{\text{th}}$  observation;  $\beta_1, \beta_2 \dots \beta_k$  are the coefficients corresponding to each

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independent and control variable, representing the change in the log-odds of recovery associated with a one-unit increase of the respective predictor, holding other variables constant.

### 1.8 Conclusion

This thesis addresses the issue of organizational resilience to environmental disruptions. The key element of interest purports to the ability of firms to withstand exogeneous shocks and recover their losses quickly. The following chapters are empirical enquiries mobilizing the organizational resilience framework to understand how the environmental performance of firms affects their stability and flexibility in different contexts of disruption. Specifically, we analyze the resilience firms that are hit by environmental penalties, droughts, and the Covid-19 crisis, and explore the effects of EP on their “persistence and regeneration” (Gunderson & Pritchard, 2002).

Chapter 2 expands the analysis of (Brady et al., 2019) in the study of the financial consequences of environmental penalties by addressing these events as triggers of the firms’ financial resilience process. Environmental penalties are fines and remediation costs which companies are legally expected to pay to various aggrieved parties after they have been found guilty of violating environmental laws, or the settlement costs associated with such investigations. Despite the seemingly negligible amount of these penalties relative to the firms’ revenue, they are the cause of important financial consequences for the targets (Karpoff et al., 2005; Lott et al., 1999), but some companies seem to recover better from some shocks than others.

To our knowledge, no study has so far investigated the link between EP and resilience in this context of environmental penalties, the second chapter thus aims to fill this gap by assessing the contribution of the environmental footprint of the targeted companies (with a measure of the total estimated costs of its sources and sinks in the environment provided by

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Trucost) for their resilience to the financial shock caused by an environmental penalty. Given the current importance of environmental issues and their growing centrality for many stakeholders (Flammer, 2013), the stringency of environmental regulation is expected to continue increasing in the coming decades, which will most likely lead to fines that are more numerous and stricter. Our investigation of the influence of EP on resilience to such events may provide some practical insight for managers, investors and regulators that affect the environmental responsibility of firms.

Relatedly, the concern of organizations for the increasing stringency of environmental regulation is embedded within the overarching issue of climate change and general biophysical capacity overshoot (IPCC, 2022; Richardson et al., 2023). In this context, another form of environmental disruption is expected to multiply and intensify: extreme weather events. The modification of patterns in the global climate due to GHG emissions has disturbing effects that cause extreme weather events to multiply, change shape, and intensify (IPCC, 2015). The anthropogenic influence on global weather and water distribution patterns is one of the major causes of droughts, as assessed by the IPCC: “*climate change over the 21st century is projected to reduce renewable surface water and groundwater resources in most dry subtropical regions (robust evidence, high agreement), intensifying competition for water among sectors (limited evidence, medium agreement)*” (IPCC, 2015). In chapter 3, another empirical enquiry focuses on the resilience of firms affected by 19 severe drought events in the contiguous United States over the 2006 – 2018 period, and how their environmental footprint and water intensity affects their stability and flexibility to the financial shock caused by such events.

While the economic repercussions of drought is relatively well documented (Huynh et al., 2020; NCEI, 2013; USDA, 2012), no other attempt, to our knowledge, has been made to study the organizational resilience to droughts. This third chapter is thus expected to fill this gap in the literature, and provide evidence about the effects of EP on financial stability and

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flexibility in this context. This endeavor builds on the efforts of Huynh et al. (2020) to document the “price of drought”, the difference in the cost of equity capital for firms affected by severe drought conditions, they report that investors require a higher rate of return for such firms, and that the associated loss of wealth cannot be entirely mitigated by diversification. Chapter 3 adds an additional perspective to this issue by considering the influence of the environmental footprint of firms, further distinguishing it from their water footprint which is most directly related to the damage caused by extreme dry conditions. Studying the organizational resilience to extreme weather events is particularly important because it is decisive for the sustainability of firms and illustrates their ability to swiftly adapt to changes in their environment, learn, and thrive (DesJardine et al., 2019; Linnenluecke & Griffiths, 2015; Linnenluecke, 2017; Rivera et al., 2022). Consequently, this study is expected to bear compelling implications for managers of companies in regions affected by chronic dryness, and inform the investing community about the value of EP for such companies.

While environmental penalties and droughts are disruptive events which can evidently be tied to the relationship of organizations with their ecological environment, not all environmental disruptions hold such a close association with the embeddedness of firms within their ecological framework. Therefore, moving the attention towards a disruptive context of a distinct nature is expected to bring additional insights into the EP – resilience relationship, which is precisely the objective underlying chapter 4. In this final empirical enquiry, the aim, and originality, is to bring a perspective to the study of the Covid-19 crisis that is original for two main reasons. First, other studies of resilience to the pandemic focus on the initial period of the crisis (Albuquerque et al., 2020; Cardillo et al., 2022; Ding et al., 2021; Garel & Petit-Romec, 2021) and largely ignore the recovery period since it was too early to study it at the time they published their work. And secondly, few such studies use the stability / flexibility approach proposed by (DesJardine et al., 2019), and the studies that do (Azeem et al., 2023; Li

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et al., 2022; Ullah et al., 2022) do not consider the effect of EP on resilience but other independent variables.

While calls for greening efforts in the relief efforts following the initial heat of the crisis were abundant (OECD, 2020; Taherzadeh, 2021), the crisis itself is not caused by a shock of ecological nature. The covid-19 crisis is first and foremost, a health crisis which escalated into a global economic and financial crisis. Because we have evidence that EP can negatively affect the flexibility dimension of resilience in financial crises such as the 2008 GFC (Marsat et al., 2021), this study is expected to bring new results which may clarify the EP – resilience relationship in this specific type of environmental disruption. It should also be a source of implications for managers and investors who are interested in the ability of their organization, or their portfolio constituents, to withstand and recover from major economic shocks.

Together, these three empirical chapters constitute a new corpus of evidence that tests the relationship between corporate environmental performance and financial resilience to three types of environmental disruptions, two of which can be attributed to ecological issues (environmental penalties and droughts) and a third one which is attributed to general economic and financial disturbance (Covid-19 crisis), the results of these empirical studies and their implications for researchers and practitioners are further developed in the general conclusion of this thesis.





## Chapter 2 - Does environmental footprint influence the resilience of firms facing environmental penalties?<sup>1</sup>

### Abstract

This study aims to understand whether prior environmental footprint helps firms to be more resilient against penalties following environmental violations. While the allocation of resources to diminish the company's environmental footprint might be considered detrimental to its financial recovery, the Natural Resource-Based View (NRBV) argues that environmental capabilities may foster firm resilience when faced with the shocks of environmental penalties. We collected data from press releases using Factiva between 2006 and 2019 to constitute an original sample of 143 events concerning US listed firms subjected to fines for environmental misconduct initiated by the Environmental Protection Agency (EPA). Using survival analysis methodology, we empirically find that firms with lower environmental footprints prior to the penalty recover sooner from the financial shock, hence exhibiting higher capabilities of resilience. This finding is robust to different survival analysis models and time windows. Our empirical analysis expands the range of studies supporting environmental performance as a way for organizations to improve resilience in the face of disruptions, in providing clear evidence in the case of environmental fines.

**Keywords:** Environmental penalties, Environmental Footprint, Resilience, Environmental performance, Survival Analysis

**JEL Classification:** G12, M14, O16, Q51

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<sup>1</sup> This chapter is co-authored by Pr. Sylvain MARSAT. It was presented as a draft article at the CIG 2023 conference organized in Nancy's *Institut d'Administration des Entreprises*, and published on June 8<sup>th</sup>, 2023 in the review *Business Strategy and the Environment*: Foulon, B. and S. Marsat (2023). "Does environmental footprint influence the resilience of firms facing environmental penalties?" *Business Strategy and the Environment* **32**(8): 6154-6168. <https://doi.org/10.1002/bse.3478>

After its publication, it was presented in French at the "*Situations Extrêmes et Résilience*" 2024 symposium in Clermont-Ferrand's *Maison des Sciences de l'Homme*.

## 2.1 Introduction

On April 20, 2010, BP's Deepwater Horizon oil rig exploded as high-pressure methane gas from the well rose into the rig and ignited, leading to the death of eleven workers and the discharge of an estimated 780,000 m<sup>3</sup> of oil spanning a maximum area of 176,100 km<sup>2</sup> in the Gulf of Mexico. This event, often regarded as the most disastrous man-made environmental disaster in history, sparked international reactions and debate as containment and cleanup operations were set up for the following months and years. Numerous investigations were led by the U.S. federal Government and, in November 2012, the U.S. Department of Justice and BP settled federal criminal charges as BP pleaded guilty to "11 counts of manslaughter, two misdemeanors, and a felony count of lying to Congress", and agreed to pay a record-setting \$4.525 billion in fines and other payments. In total, charges, penalties and additional cleanup costs regarding this catastrophe were estimated to have cost the company over \$65 billion as of January 2018 (Bousso, 2018). Management scholars have often recognized such industrial disasters as suitable contexts for the study of how organizations respond to threats (Capelle-Blancard & Laguna, 2010; Jones & Rubin, 2001; Karpoff et al., 2005; Rudolph & Repenning, 2002; Sheffi, 2005; Shrivastava, 1995). The Deepwater Horizon oil spill is an extreme example of how pollution can lead to multiple dire consequences, not only on the environment, but also on the financial and reputational situation of organizations that either violate environmental law or disregard the efforts necessary to limit the effects of climate change.

With each additional report on the consequences of climate change, spearheaded by the IPCC (2022), concern about the environment is growing, thereby increasing pressure on firms to behave responsibly toward the environment (Flammer, 2013). In most developed economies, increasingly stringent laws and regulation mechanisms have been put in place to ensure ecological harm is discouraged, in extreme situations where organizations violate

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environmental regulation, financial penalties and remediation actions are imposed by governmental institutions (Gray & Shimshack, 2011; Wang et al., 2019). In the United States, the Environmental Protection Agency (EPA) conducts environmental assessment, investigates violations, and enforces environmental law (Brady et al., 2019; US EPA, 2013). In extreme cases, the Department of Justice may also oversee the legal procedures. In many cases, as is customary in American legal procedures involving large organizations, the process ends in settlement rather than final judgment. A settlement is an agreement before the law to end the dispute, resulting in the voluntary dismissal of any related litigation. To settle violation claims made by the EPA, companies often pay a large amount of money to the aggravated party to avoid being formally denounced as violating federal law on environmental protection. In the remainder of this paper, we will refer to these payments, whether they result from settlement or judgment, as “penalties” or “fines”.

The financial consequences of these penalties are significant for companies despite their seemingly modest amount when considered as a proportion of the targets’ revenue (Greife & Maume, 2020). Using panel data, Romero et al., (2018) find that EPA penalties lead to lower earnings. Besides, Karpoff et al. (2005) find that the financial consequences of environmental penalties are disruptive for the targeted firms. On average, from 1980 to 2000, the announcement of an allegation or of a formal charge following environmental violations was related to a loss of between 1.6% and 1.7% of the average abnormal return of the target (Karpoff et al., 2005). When disentangling the reasons for this loss, Brady et al. (2019) and Karpoff et al. (2005) find that the financial loss also results from harm to the firms’ reputation, which on average accounted for about 20 to 25 percent of the total loss. In addition, the reputational effect was found to be larger in the most recent period (Brady et al., 2019), which suggests the increased general attention to environmental issues described by Flammer (2013) has economic

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relevance. EPA fine announcements constitute a jolt for the affected firms, and therefore create a stimulating setting to study their ability to reduce the losses and recover.

With the multiplication and intensification of crises globally, understanding how organizations bounce back after an adverse event becomes paramount in transforming economies toward sustainability. While such an ability does not always seem desirable; since in some cases, the very core activities of an organization are what makes it unsustainable, as identified by (Bocken & Short 2021), being able to pinpoint what helps business operations endure disruptions is expected help managers make better decisions for the long-term orientation of the system they guide, thereby helping them position their organization in a sustainable path, one that not only maximizes its chances of survival, but also improves its chances to thrive in an economy adapting to climate change. In the case of disruptive situations, the concept of “resilience” is often used and warrants clear definition and justification (Linnenluecke, 2017). In our context, we follow Gunderson and Pritchard, (2002) and consider resilience as a firm’s ability to maintain its core functions, but also to better adapt to exogenous shocks than its competitors. In recent literature, organizational response to external threats has been considered through the lens and concept of organizational resilience (Duchek, 2020; Gittell et al., 2006; Lengnick-Hall et al., 2011; Linnenluecke & Griffiths, 2013); this approach is useful in understanding what characteristics of the firm may help it respond to threats and recover from shocks.

In response to the growing concern about corporate environmental sustainability, firms can respond in various ways. As Lyon & Maxwell (2008) mention, environmental Corporate Social Responsibility (CSR), the organizational proficiency to integrate social and environmental concerns in business operations and interactions with stakeholders, allows firms to gain competitive advantages over their competitors by investing resources in improving social and environmental welfare. From this theoretical perspective, the surge of environmental

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CSR is the result of a combination of market and political forces. Essentially, pollution is sometimes a sign of production inefficiencies, thus pollution reduction policies can potentially lead to reduced costs and "win-win" opportunities (Porter & van der Linde, 1995). This factor is the one addressed mainly in this paper. Other factors include access to a "green customer base", in which some consumers are willing to pay a premium price for eco-friendly products (Arora & Gangopadhyay, 1995; Harbaugh et al., 2011), improved understanding of the workings of the political system to dissuade the enforcement of stringent environmental regulations, build goodwill with regulators, and attempt to reduce the cost of compliance and the sanction associated with noncompliance (Baron, 2005; Yu, 2005), the achievement of voluntary agreements (VA) with regulators (Blackman et al., 2006; Glachant, 2007; Segerson & Miceli, 1998), the anticipation and shaping of such regulations before their implementation if they cannot be preempted (Denicolò, 2008; Lutz et al., 2000), the opportunity of being traded at a premium price among green investors (Baron, 2005, 2007; Graff Zivin & Small, 2005), and screening for employees that seek socially responsible employment, who are willing to accept lower wages (Brekke & Nyborg, 2008; Hsieh, 2006).

By supplementing the Resource-Based-View of the firm (Barney, 1991; Wernerfelt, 1984) with additional considerations for the firm's relationship to the natural environment, Hart (1995) provides a suitable theoretical framework to understand the relationship between environmental performance (EP) and resilience. Supported by subsequent studies (Aragón-Correa et al., 2008; Branco & Lima Rodrigues, 2006; Hart & Dowell, 2011; Russo & Fouts, 1997; Sharma & Vredenburg, 1998), the Natural-Resource-Based View of the firm (NRBV) postulates that EP is derived from three strategic capabilities firms develop internally: pollution prevention, product stewardship, and sustainable development. In this framework, the environmental footprint of the firm can be assessed by taking into account both the land and

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natural resources used through its activities, as well as the negative environmental impacts these activities generate in the form of air pollution, water effluents and waste. As such, using the footprint approach to assess the overall environmental impacts of an organization at a given point in time is a relevant method to study how well this organization was able to implement pollution prevention processes, which in turn improve the organization's EP. According to the available empirical results, EP is likely to enable the firm to "neutralize threats" (Russo & Fouts, 1997). This ability is expected to emerge from tacit environmental skills and dynamic capabilities (Hart, 1995) which allow organizations to "adjust in rapidly changing environments by integrating, building and reconfiguring internal competences" (Teece et al., 1997), enhanced social legitimacy (Russo & Fouts, 1997), greater employee involvement and coordination as well as stronger relationships with suppliers (Branco & Lima Rodrigues, 2006). Demirel et al. (2018) also established that by adopting environmental management systems, firms may improve their ability to address regulatory pressures through the development of unique environmental management capabilities, which includes efficient pollution reduction strategies. Since a growing number of stakeholders expect companies to respect their environment (Flammer, 2013), more attention to the company's environmental footprint is likely to improve the organization's reputation, which contributes to its ability to rely on additional support in challenging times. It follows that this heightened reputation (Bruna & Nicolò, 2020) and legitimacy (Zahller et al., 2015) is likely to help firms mobilize external stakeholders in order to improve their resilience. The reason behind this is that companies with superior stakeholder trust based on reputation and legitimacy diminish the potential legal, economic, or other social sanctions that arise in situations where organizational legitimacy is threatened, as is the case when firms are targeted by an environmental penalty, while illegitimate organizations are exposed to boycotts and loss of market shares, strikes and restricted access to labor, increased regulation, heavier taxation, restricted access to capital and increased cost of capital, as well as

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fewer opportunities for partnerships and joint-ventures (Dhaliwal et al., 2011; Dowling & Pfeffer, 1975; Freeman, 2007, 2015; Kothari et al., 2009; Lindblom, 2010). High EP suggests that the firm has developed multiple capabilities to be able to cope with environmental issues, which are complex by nature (Hart, 1995) and fosters its ability to be proactive, anticipate change and adapt to unforeseen events (Russo & Fouts, 1997), thereby contributing to the ability to bounce back after a disruption.

However, Friedman's (1970) argument that allocating resources to activities that don't directly aim at improving profitability poses a financial constraint on the firm which harms its financial performance, should also be considered. The relationship between CSR and financial performance is non-trivial, as argued by Buchanan et al., (2018) who noted heavier losses for high-CSR firms than their peers in the post-subprime crisis context. In some situations, diverting resources toward the improvement of a firm's ecological footprint may harm its competitiveness in managing its core functions and in generating revenue, which would consequently hurt the organization's ability to both maintain its position and bounce back in the face of shocks such as an environmental penalty. In their study of how EP relates to resilience in the context of the subprime crisis, Marsat et al., (2021) report that, in countries with high environmental standards, high pre-crisis EP increased the time required for the firms' market prices to recover, indicating EP might be an organizational constraint in certain settings. It is thus possible that firms that make an effort to reduce their environmental footprint do so at the expense of valuable resources that may help them reduce the impact of a jolt such as an environmental penalty. As Gittell et al. (2006) show, financial reserves are a requirement for resilience, which implies that companies which use a part of their reserves to invest in pollution prevention and environmental footprint reduction strategies could be less resilient than their competitors.

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From an empirical perspective, studies on the impact of EP in case of adverse events are scarce, and studies of the impact of environmental footprint on resilience to the financial setback caused by an environmental penalty are, to the best of our knowledge, lacking. While the bulk of the literature is focused on the impact of EP on financial performance (Endrikat et al., 2014; Salem et al., 2015; Xiao et al., 2018), or the impact of overall CSR on resilience (Ortiz-de-Mandojana & Bansal 2016; DesJardine et al., 2019), only a few research papers study precisely the role of EP in resilience. Recent studies have considered the effect of EP on resilience in the Covid crisis context, like Albuquerque et al. (2020) who document higher resilience to the shock in the first quarter of 2020 for firms with high Environmental and Social ratings which retain higher returns and benefit from their lower volatility during this period. Ding et al. (2021) found that the drop in stock returns was milder for firms with more CSR activities, and Garel & Petit-Romec (2021) described a tendency for investors to reward environmental responsibility during the pandemic. However, the results are mixed since the impact seems to be negative in the case of the subprime crisis (Marsat et al., 2021) whereas it is positive when considering environmental controversies (Marsat et al., 2022). While environmental controversies are interesting shocks to focus on, controversies may be very heterogeneous, and their intensity is difficult to assess. Relying on a proprietary database of fines enables us to overcome this limitation by precisely measuring the intensity of the shock with the amount of the fine. Moreover, the mechanisms underlying resilience have been described as context-dependent, therefore studying different types of business disruptions is necessary to clarify the “resilience to what” part of the conundrum (Duchek, 2020; Linnenluecke, 2017; Su & Junge, 2023). To our knowledge, no study has directly focused on firm resilience after being affected by the shock of an environmental fine. Our study aims at filling this gap. We believe the use of a variable proxying the direct environmental footprint of



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a firm and how it affects resilience is original as we have found no other studies of resilience considering it.

This work thus aims to understand whether environmental footprint influences the resilience of firms to environmental penalties. To test this hypothesis, we collected data from Factiva to constitute an original sample of penalties resulting from EPA investigation. We also gathered financial data on each targeted company around the announcement of the penalty using Datastream, and environmental performance data with Trucost. Our data were compiled in a single proprietary database, allowing us to run survival analyses to observe the effect of firm characteristics on resilience. We find that, all else equal, a heavy environmental footprint significantly harms the firm's ability to bounce back from an environmental penalty, which implies that high prior EP significantly helps firms to bounce back after an EPA fine, in line with the arguments of the NRBV and environmental CSR. This result proves to be robust to different survival analysis models, control variables, and time windows.

In this paper, we aim at contributing to the literature by merging for the first time, to our knowledge, the literature on environmental penalties (Brady et al., 2019; Greife & Maume, 2020; Karpoff et al., 2005; Lott et al., 1999; Romero et al., 2018; Wang et al., 2019) and the literature on resilience (Duchek, 2020; Fiksel et al., 2015; Gunderson & Pritchard, 2002; Linnenluecke & Griffiths, 2013; Linnenluecke, 2017; Markman & Venzin, 2014; Tisch & Galbreath, 2018) with a survival analysis methodology (Ortiz-de-Mandojana & Bansal, 2016; DesJardine et al., 2019; Marsat et al., 2021, 2022). Moreover, our results empirically support the proactive role of EP that enables the firm to develop dynamic capabilities (Hart, 1995), and highlight its insurance-like benefits (Godfrey et al., 2009). We believe that this finding may interest managers, investors and regulators.

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The rest of the paper is organized as follows: the next section discusses the methodology. The third section presents the results, and we discuss and conclude in the fourth and final section.

### 2.2 Data and methodology

#### 2.2.1 Sample

As with previous financial studies that seek to evaluate the market impact of specific events (Capelle-Blancard & Laguna, 2010; Flammer, 2013; Tanimura & Okamoto, 2013), we used the Factiva database to identify our events of interest and collect information about the penalties, resulting in a proprietary database totaling 143 penalty events in the US, all targeting companies listed in the stock exchange with available environmental information in the Trucost database. The research terms were as follows: all articles in English containing either “EPA” or “Environmental Protection Agency” and at least one word among “Settlement”, “Penalty” and/or “fine”; published between January 1<sup>st</sup>, 2006 and December 31<sup>st</sup>, 2019; and only in financial news sources (DJ Newswires, The Wall Street Journal, MarketWatch, Barron’s and SmartMoney). Table 2-1 presents the details of this selection process and the number of observations eliminated at each step. In this process, the identification of a start date for the event was necessary since it is a requirement for the resilience methodology.

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Table 2-1: Sample Selection Methodology

Firms in the sample	Obs.
Penalized facilities and companies exposed for environmental violation in news articles of financial media during the 2006-2019 period in Factiva using search terms as described above.	927
<i>Less:</i> Observations involving non-listed parent companies and duplicates of single events.	(637)
<i>Less:</i> Observations for which no article can be found containing at least:	
- Name of parent company or name of facility	
- Correct amount of penalty (+/- 5%, allowing for rounding in press)	(47)
- Type of violation and some explanation about the pollution	
<i>Less:</i> Missing data in the TRUCOST Database for the year preceding the date of the article.	(75)
<i>Less:</i> Observations missing important data from Datastream (i.e., Total Assets, ROA/ROE, Volatility)	(25)
Final Sample	143

We consider the shock to be triggered by the first journal article in financial newswire services publicly mentioning the penalty along with sufficient information for the reader to assess its importance: the amount of the penalty, the type of violation and the name of the company and/or the violating facility targeted by the penalty. The starting date to study the recovery in the resilience process is the publication date of this first article. For each observation, the ISIN number of the parent company targeted by the penalty was identified to make the aggregation of financial and environmental data around the date of the event possible. Financial information about the targets was drawn from Thomson Reuters' Datastream, in particular, Return on Assets (ROA), information on the company's size (natural logarithm of the assets), its financial leverage, measures of momentum, and its stock closing value around the event, starting a maximum of 35 trading days before the article and ending 120 days after the article. Finally, a measure of the total direct pollution generated by the firms' activities for the year preceding the event was collected from the Trucost database for each penalized firm.

### 2.2.2 Variables

Using this data and relying on the methodology of DesJardine et al. (2019), we assess resilience based on the market prices around the event. The flexibility dimension is measured through the time necessary for the firm's stock price to recover its pre-shock value and maintain

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it above that threshold for 5 consecutive trading days (for a similar approach, see Marsat et al. (2021, 2022); Ullah et al. (2022)). In accordance with our methodology for assessing resilience, using financial data, it should be assumed, for the remainder of this article, that the mention of the term “resilience” should be understood as the firm’s ability to recover its lost value on the stock market after the shock (DesJardine et al., 2019). Unlike the study published by DesJardine et al. (2019) where the event – the global financial crisis, starting from the bankruptcy of Lehman Brothers – is largely unexpected, in our event of interest, a certain degree of anticipation is possible for investors and other stakeholders since the EPA’s investigation about the violation is not secret and the possibility of a monetary penalty seems more likely as the investigation nears its end. Because of this possibility of anticipation, the targeted firms’ stock price is more volatile during the period preceding the publication of the first article confirming the penalty than it is in normal times, as is the case in Mergers and Acquisitions, for example, between the initial bid and the final offer (Betton et al., 2008). It is common for scholars in such situations to estimate the pre-event value of the target by observing the evolution of its price during the runup period instead of merely its closing price the day before the event itself (Betton et al., 2008; Alexandridis et al., 2010). To take this issue into account and avoid biasing our results, with consideration for the temporality of environmental penalties for which we have enough data to estimate how early the results of the EPA investigation can be anticipated by investors, we decided to take the average closing price during the 20 trading days preceding the event as the threshold over which the stock price should remain afterwards to assess both time to recovery and severity of loss. The stability dimension of resilience was measured as the percentage drop in the firm’s stock value from the average closing price in the 20 days preceding the event to its lowest point during the period immediately following the event. A visual representation of this methodology is provided in Figure 2-1. To assess a firm’s environmental footprint, we mainly base our analysis on a variable named *DirPollutionBn*,

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extracted from Trucost, which is the estimated cost in billion USD of the firm's environmental footprint (sources and sinks), including carbon emissions and other greenhouse gases, land and water pollutants, natural resource use, water cooling and processing, waste landfill, waste incineration, and nuclear waste. In the methodology used by Trucost, for example, the estimated cost of greenhouse gas emissions is based on a CO<sub>2</sub>eq. assessment of greenhouse gas emissions. Air pollutants from the company's activities are assessed in volume and associated with health and/or environmental costs which are also added to the firm's total direct air impact. The estimated cost of water use is assessed based on the cubic meters of water consumed in the firm's direct activities. Toxic or radioactive outputs landfilled by the firm are estimated in metric tons and associated with health and environmental costs depending on the type of waste produced, adding up to the firm's total direct land impact, etc. In summary, for each source or sink that can be listed as part of the firm's environmental footprint, Trucost gathers or estimates the physical amount of the resource used (or discharge in the environment), each source or pollutant is associated with socio-environmental costs so that the total environmental footprint can be calculated. In the absence of disclosure from the company, the cost of water pollution (and all other types of pollution) can also be assessed through third party datasets, sustainability reports, and other sources to estimate how the pollutants discharged by the company in rivers and open water translate into costs for Society. The production of waste and land pollutants is also measured or estimated in cubic tons and associated to costs depending on the toxicity of the discharges<sup>2</sup>. In that regard, our variable *DirPollutionBn* should be considered as a measure of total direct air, water and land pollution in a single instance, and thus a proxy of the overall

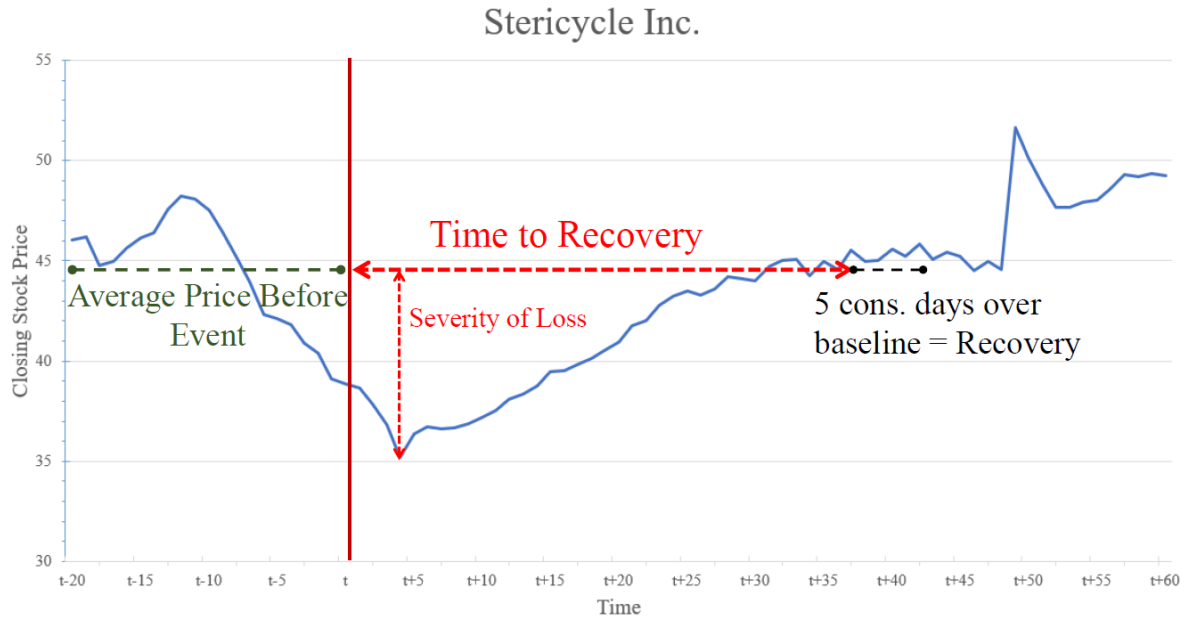
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<sup>2</sup> Details about the methodology used by Trucost to measure and estimate the direct environmental impact of a company is available here: [https://www.support.marketplace.spglobal.com/en/datasets/alternative/Trucost\\_environmental/Trucost\\_environmental\\_data\\_methodology\\_guide.pdf](https://www.support.marketplace.spglobal.com/en/datasets/alternative/Trucost_environmental/Trucost_environmental_data_methodology_guide.pdf)

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environmental footprint of a firm's direct activities<sup>3</sup>, in line with the concept of environmental footprint developed by Hoekstra & Wiedmann (2014) and Matuščík & Kočí (2021).

Figure 2-1: Resilience Measured as Time to Recovery (Company: Stericycle Inc.)



Note: Evolution of Closing Stock Price of Stericycle Inc. in USD.  $t = 18/12/2018$ . [Link to the EPA Press release](#). Baseline to assess recovery: average stock close price before event calculated as mean of close prices from  $t-20$  to  $t-1$ . Recovery is effective only if the closing price remains above the baseline for 5 consecutive days, Time to Recovery is calculated as the difference in days between the first occurrence in press of the penalty and the first of the 5 consecutive days above the baseline, Severity of Loss is the percentage difference between the baseline and the lowest close price after the event. Here, after the EPA reveals Stericycle Inc. was fined on Dec. 18<sup>th</sup>, 2018, its stock value lost 21.24% in the days following the event relative to the baseline, and took 37 trading days to recover a value above the baseline and keep it for 5 consecutive trading days.

Because the resilience process is very likely to be affected by the amount of the penalty, it was important to integrate this factor into our models, and *PenaltyMn* measures this amount in USD Million. Other control variables are presented in our models as resilience is also expected to be affected by the company's characteristics (DesJardine et al., 2019). In particular, we assess the profitability of the company's activities using its return on assets (*ROA*) since firms that are more profitable are likely to benefit from investor support in times of crisis. We assess its size by including 1 plus the natural logarithm of total assets (*Size*), Markman & Venzin

<sup>3</sup> Direct environmental impacts available in the Trucost database include multiple broad categories: carbon emissions, other GHG emissions, land and water pollutants, natural resource use, water cooling, water processing, waste landfill, waste incineration, and nuclear waste. The database also includes indirect impacts in the firm's upstream supply chain, which are not considered in our main independent variable, *DirPollutionBn*.

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(2014) showed that smaller banks were more resilient than their larger counterparts. We measure the firms' financial leverage with the debt-to-equity ratio (*FinLev*), expecting investors to flock toward companies that have a lower leverage ratio in crises. We also consider the firm's stock price momentum in the period preceding the event with a measure based on daily volatility (*Momentum*), and include binary variables to take into account the firm's industry (*Industry*), whether the firm is headquartered in the US (*Country*) since prior literature shows differences in the environmental conduct of foreign-owned companies (King & Shaver 2001) and foreign-owned firms may be treated differently by the EPA because their relationship with US agencies are less entrenched than it could be for US-based companies. We also control for the type of pollution which led to the penalty (*PollutionType*), and the recency of the event with regards to the Paris Climate Agreement (*Post2015*). This last control variable was included on the grounds that the Paris Climate Agreement, by setting clear and actionable objectives to combat climate change, may have spurred a shift in corporate environmental behavior towards more sustainability (Bjørn et al., 2021), thus the relative financial impact of events that happened after the Paris Agreement is expected to be larger than it is for events that happened before it since stakeholders expect more efforts toward sustainability from firms now than they did before the agreement (Heo, 2021; Jakučionytė-Skodienė & Liobikienė 2022; Doan & Lepone, 2023). Ferreira et al. (2019) document changes in the sustainability commitment of firms in the retailing industry following the agreement, for instance.

The final dataset encompasses 143 violations that led to penalties ranging from \$3,000 to \$335.4 million from 2006 to 2019 in the following sectors respectively: 45 in Energy, 35 in Materials, 19 in Utilities and 15 in Consumer Discretionary. The majority of violations were reported under the ICIS as illegal air emissions (80 events), 29 involved illegal discharge of pollutants in water, and 34 involved issues of land waste and soil pollution. All the penalized

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violations in our dataset occurred in the US and were investigated by the EPA. Most of the firms targeted by the penalties are based in the US (90 observations), the 53 remaining cases, companies headquartered out of the US, were grouped in a single category of the corresponding binary variable (*Country*). Table 2-2 presents the sample of the study and Table 2-3 a summary of the variables.

Table 2-2: Sample Description

Year of Event		Sector	Violation Type		Country		
2006	9	Energy	45	Air (ICIS)	80	United States	90
2007	20	Materials	35	Water (NPDES)	29	United Kingdom	19
2008	11	Utilities	19	Waste (RCRA)	34	Germany	9
2009	9	Consumer Discretionary	15			Japan	5
2010	15	Other	29			Mexico	4
2011	9					Canada	3
2012	11					Other <sup>4</sup>	13
2013	16						
2014	8						
2015	6						
2016	6						
2017	10						
2018	6						
2019	7						
N	143		143		143		143

<sup>4</sup> Other regions of headquarters include France (2 obs.), Republic of Ireland (2 obs.), South Korea (2 obs.), Luxembourg (2 obs.), Israel (1 obs.), South Africa (1 obs.), China (1 obs.), Taiwan (1 obs.), and Sweden (1 obs.)



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Table 2-3: Variables Description

Variables	Description	Data Source
TRecov#d	Time in days the firm's stock price took to recover (remain over baseline for 5 consecutive days) (#-day frame)	Datastream
DirPollutionBn	Environmental footprint: estimated cost of the pollution generated by the firm's direct operations in Billion USD (Y-1)	TRUCOST
PenaltyMn	Total amount of penalty from single settlement in Million USD as given in the article	Factiva
ROA	Return on assets	Datastream
Size	One plus natural logarithm of total assets	Datastream
FinLev	Financial leverage (Debt-to-Equity ratio)	Datastream
Momentum	Price momentum, based on daily volatility. Exponentially-weighted moving average of the squared daily log returns over the last 365 days.	Datastream
Industry	Binary variable for industry from the GICS 2-digit classification	TRUCOST
Country	Binary variable for country of Origin (US / Non-US)	Datastream
PollutionType	Type of violation binaries determined by the EPA agency in charge of the case (ICIS, NPDES or RCRA)	Factiva & EPA ECHO
Post2015	Binary variable for events after 2015	Factiva & EPA ECHO

Note: Datastream = Refinitiv Datastream (historical financial database), EPA = United States Environmental Protection Agency, ECHO = Enforcement and Compliance History Online, ICIS = Integrated Compliance Information System, NPDES = National Pollution Discharge Elimination System, RCRA = Resource Conservation and Recovery Act.

To reduce the influence of other events on the affected firms' stock prices we restrict our window of observation to the 60 trading days following the event as it is the limit around which about three quarters of the sample have recovered. Summary statistics are shown in Table 2-4, the average time necessary for firms in our sample to recover from the shock was 5.73 trading days, 107 firms managed to recover in the 60-day time frame, on average the fined firms lost 9.18% of their share price following the event. The average amount of pollution directly generated by their activities is \$1.87 billion, the average penalty is \$10.24 million, their average ROA stands at 7.27, the average of debt-to-equity is 1.16 and the average momentum score is 2.00.

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Table 2-4: Summary Statistics

VARIABLES	N	mean	median	sd	min	max	p25	p75
TRecov60d	107	5.73	1	9.88	1	51	1	5
Recovery60d	143	0.75	1	0.44	0	1	0	1
DepthLoss60d	143	9.18	5.47	11.23	0	62.67	1.40	14.72
DirPollutionBn	143	1.87	0.45	2.75	0.00058	15.85	0.11	3.18
PenaltyMn	143	10.24	1.95	40.38	0.003	335.40	0.98	4.20
ROA	143	7.27	5.58	14.15	-50.45	92.08	2.57	92.07
Size	143	23.83	23.82	1.92	16.91	27.36	22.61	25.55
FinLev	143	1.16	0.50	3.19	0	31.38	0.31	1.02
Momentum	143	2.00	1.82	0.82	0.77	6.09	1.42	2.25

Summary statistics of the sample. Resilience is the number of days of market price recovery calculated in a window of 60 trading days following the penalty announcement. Recovery is a binary variable meant to test the likelihood of recovery in the 60-day frame in Logit models. EP is proxied by the total pollution generated by the firm's direct activity in Billion USD (CO2eq). ROA is the return on assets ratio. Size is one plus the natural log of firms' total assets. FinLev is the financial leverage ratio (total debt divided by total equity). Momentum is the market changes in the 3 years preceding the event.

### 2.3 Results

Since the baseline hazard is not linear, but increasing quickly in the first days after the start of the observation period and then increasing at a diminishing pace over time, the exponential model is best fitted, which is confirmed by the higher LR Chi<sup>2</sup> compared to linear models. We then used exponential models as a baseline to analyze the relationship between EP and resilience, measured as total environmental footprint in billion USD and the survival likelihood over time, respectively. Table 2-5 presents the construction of our main model, the exponential survival analysis over 60 days, with gradual inclusion of control variables. These models predict the probability of recovery at time  $t$  comprised between 0 and 60 days, the relationship can be expressed as:

$$h_i(t) = e^\alpha e^{(X_{ij}\beta_j)}$$

Where  $h_i(t)$  represents the hazard rate of recovery for the  $i^{th}$  observation at time  $t$ .  $X$  is a set of variables as described above,  $e^\alpha$  is the baseline hazard function parameterized as taking an exponential form,  $\beta$  are the regression coefficients for all  $j$  variables. A positive coefficient indicates a positive link with resilience. In Table 2-5 and all other survival analysis models, we

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report the coefficients rather than hazard ratios, and report standard errors in parentheses for each variable beside control binary variables. The coefficient of *DirPollutionBn* is negative and consistently significant. In model Exp 7, where all controls, including binary variables for industry, country, pollution type and recency are included, the coefficient for *DirPollutionBn* is -0.22 and significant at the 99% threshold, meaning a one-unit increase in *DirPollutionBn* reduces the hazard associated with recovery by 19.7%, inducing increased time to recovery and a weaker probability of recovery in a 60-day time frame.

Table 2-5: EP and Resilience: Survival Analysis Baseline Model (Exponential Model, 60-day time frame)

VARIABLES	(1) Exp	(2) Exp 2	(3) Exp 3	(4) Exp 4	(5) Exp 5	(6) Exp 6	(7) Exp 7
DirPollutionBn	-0.06* (0.03)	-0.06** (0.03)	-0.06** (0.03)	-0.05* (0.03)	-0.05* (0.03)	-0.05* (0.03)	-0.22*** (0.05)
PenaltyMn		0.01*** (0.00)	0.01*** (0.00)	0.01*** (0.00)	0.01*** (0.00)	0.01*** (0.00)	0.01*** (0.00)
ROA			-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.01)
Size				-0.05 (0.06)	-0.05 (0.06)	-0.05 (0.06)	0.13* (0.07)
FinLev					0.01 (0.03)	0.01 (0.03)	-0.01 (0.04)
Momentum						-0.09 (0.13)	0.45** (0.18)
<i>Control binaries</i>							
Industry	No	No	No	No	No	No	Yes
Country	No	No	No	No	No	No	Yes
PollutionType	No	No	No	No	No	No	Yes
Post2015	No	No	No	No	No	No	Yes
Constant	-3.62*** (0.11)	-3.69*** (0.11)	-3.66*** (0.12)	-2.51* (1.39)	-2.49* (1.39)	-2.21 (1.44)	-7.79*** (1.89)
LR Chi <sup>2</sup>	4.39**	14.62***	15.34***	16.03***	16.06***	16.53***	59.97***
Observations	143	143	143	143	143	143	143

Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. This table presents the exponential log-relative hazard regressions (survival analysis) for a window of observation of 60 days, with gradual inclusion of variables leading to our main model (Exp 7). In these models, resilience, our dependent variable, is proxied by the time to recovery of firms' market price. The coefficients for control binaries are not reported for the sake of brevity.

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Table 2-6 presents the survival analysis regressions including the same variables as the last model from table 5 with different specifications. In particular, the three different models of survival analysis (Cox, Weibull and Gompertz) also result in a negative and significant relationship between *DirPollutionBn* and resilience, showing our result is not sensitive to the baseline hazard used by the survival analysis regression model. Additionally, we present a Logit regression on the probability of recovery in a 60-day frame following the event (*Recovery60d*), displaying the same relationship; a one-unit increase in *DirPollutionBn* (an increase of one billion USD in estimated cost of pollution for the firm) reduces the probability of recovery in a 60-day period following the event by 18.9% ( $e^{-0.21} - 1$ ).

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Table 2-6: EP and Resilience: Alternative Survival Models and Logit model (60-day time frame)

VARIABLES	(1) Cox	(2) Weibull	(3) Gompertz	(4) Logit
DirPollutionBn	-0.11** (0.05)	-0.13*** (0.05)	-0.13** (0.05)	-0.21** (0.09)
PenaltyMn	0.00 (0.00)	0.01* (0.00)	0.01** (0.00)	0.01 (0.02)
ROA	0.00 (0.01)	-0.00 (0.01)	0.00 (0.01)	-0.00 (0.01)
Size	0.06 (0.07)	0.06 (0.07)	0.09 (0.07)	-0.00 (0.15)
FinLev	-0.00 (0.04)	-0.00 (0.04)	-0.00 (0.04)	0.03 (0.12)
Momentum	0.18 (0.15)	0.18 (0.16)	0.27* (0.16)	-0.04 (0.34)
<i>Control binaries</i>				
Industry	Yes	Yes	Yes	Yes
Country	Yes	Yes	Yes	Yes
PollutionType	Yes	Yes	Yes	Yes
Post2015	Yes	Yes	Yes	Yes
Constant		-3.05* (1.77)	-4.11** (1.76)	1.83 (3.79)
LR Chi <sup>2</sup>	13.18	19.31	18.65	13.59
Observations	143	143	143	143

Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. This table presents additional survival analysis models (Cox, Weibull and Gompertz) and a Logit regression on likelihood of recovery (equals 1 if the firm recovered, 0 otherwise) for a window of observation of 60 days. Control variables are the same as in our main model presented in Table 5 (Exp 7). In survival analysis models, resilience, our dependent variable, is proxied by the time to recovery of firms' market price. The coefficients for control binary variables are not reported for the sake of brevity.

To check the robustness of our results according to different time frames, we also ran the exponential survival analysis regression of model 7 with varying time windows, ranging from 5 to 100 days. These additional regressions are presented in Table 2-7 and support our main result. Finally, despite the strong correlation between severity of loss and time to recovery (0.67; p < 0.01 in our data), we decided to run the baseline model along with our different models of survival analysis and Logit from Table 2-6 including severity of loss, which are reported in Table 2-8 and are in line with our main result. Finally, in order to verify the

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soundness of our method to reduce the effect of anticipation by averaging the price of each firm's stock value over 20 days before the day of the first article and using it as the baseline to observe resilience, we ran our survival analyses and logit models again using 25-, 15-, 10- and 5-day pre-event windows instead, and observe a significant and negative relationship of a comparable magnitude between environmental footprint and resilience to environmental penalties. These tests are not presented here for the sake of brevity but are available upon request. Finally, we tested whether our main independent variable was scaled appropriately by using the natural logarithm of the total direct pollution measure from Trucost, and quartiles of total direct pollution instead of *DirPollutionBn*, and obtained similar results.

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Table 2-7: EP and Resilience: Survival Analysis Baseline Model - Varying time frames (Exponential Model)

VARIABLES	(1) Exp 60d	(2) Exp 5d	(3) Exp 10d	(4) Exp 20d	(5) Exp 30d	(6) Exp 40d	(7) Exp 50d	(8) Exp 100d
DirPollutionBn	-0.22*** (0.05)	-0.24*** (0.06)	-0.22*** (0.05)	-0.21*** (0.05)	-0.21*** (0.05)	-0.22*** (0.05)	-0.22*** (0.05)	-0.19*** (0.05)
PenaltyMn	0.01*** (0.00)	0.01*** (0.00)	0.01*** (0.00)	0.01*** (0.00)	0.01*** (0.00)	0.01*** (0.00)	0.01*** (0.00)	0.01*** (0.00)
ROA	-0.00 (0.01)	-0.00 (0.01)	-0.00 (0.01)	0.00 (0.01)	-0.00 (0.01)	-0.00 (0.01)	-0.00 (0.01)	-0.00 (0.01)
Size	0.13* (0.07)	0.20** (0.09)	0.18** (0.08)	0.17** (0.08)	0.14* (0.08)	0.14* (0.07)	0.14** (0.07)	0.12 (0.07)
FinLev	-0.01 (0.04)	-0.02 (0.04)	-0.01 (0.04)	-0.02 (0.04)	-0.02 (0.04)	-0.01 (0.04)	-0.01 (0.04)	-0.02 (0.04)
Momentum	0.45** (0.18)	0.58*** (0.21)	0.48** (0.21)	0.53*** (0.20)	0.49*** (0.19)	0.46** (0.19)	0.46** (0.19)	0.39** (0.18)
<i>Control binaries</i>								
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
PollutionType	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Post2015	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-7.79*** (1.89)	-9.99*** (2.21)	-9.11*** (2.12)	-9.03*** (2.03)	-8.21*** (1.95)	-8.18*** (1.92)	-8.13*** (1.91)	-7.22*** (1.81)
LR Chi <sup>2</sup>	59.97***	55.26***	50.05***	50.17***	55.58***	58.70***	58.84***	56.48***
Observations	143	143	143	143	143	143	143	143

Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. This table presents variations of our main exponential survival analysis model (Exp 7, here Exp 60d) with varying windows of observation ranging from 5 to 100 trading days following the event. In these models, resilience, our dependent variable, is proxied by the time to recovery of firms' market price. Control variables are the same as in our main model presented in Table 5 (Exp 7), the coefficients for control binary variables are not reported for the sake of brevity.

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Table 2-8: EP and Resilience: Survival Analysis and Logit model including Severity of Loss (60 days)

VARIABLES	(1) Exp	(2) Cox	(3) Weibull	(4) Gompertz	(5) Logit
DirPollutionBn	-0.17*** (0.05)	-0.10* (0.05)	-0.14*** (0.05)	-0.10** (0.05)	-0.37*** (0.14)
PenaltyMn	-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)	0.04 (0.05)
DepthLoss60d	-0.27*** (0.02)	-0.15*** (0.02)	-0.20*** (0.02)	-0.17*** (0.02)	-0.28*** (0.05)
ROA	-0.00 (0.01)	0.00 (0.01)	-0.00 (0.01)	0.00 (0.01)	0.00 (0.02)
Size	0.07 (0.07)	0.06 (0.07)	0.06 (0.07)	0.08 (0.07)	0.08 (0.24)
FinLev	0.01 (0.05)	0.02 (0.05)	0.02 (0.05)	0.01 (0.05)	0.77 (0.50)
Momentum	0.71*** (0.13)	0.42*** (0.14)	0.50*** (0.14)	0.53*** (0.14)	1.15* (0.61)
<i>Control binaries</i>					
Industry	Yes	Yes	Yes	Yes	Yes
Country	Yes	Yes	Yes	Yes	Yes
PollutionType	Yes	Yes	Yes	Yes	Yes
Post2015	Yes	Yes	Yes	Yes	Yes
Constant	-4.02** (1.89)		-2.94 (1.84)	-3.40* (1.81)	0.69 (6.10)
LR Chi <sup>2</sup>	350.44***	101.20***	157.69***	133.39***	88.26***
Observations	143	143	143	143	143

Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. This table presents our main exponential survival analysis model (Exp 7, Exp DL here) with the inclusion of an additional control - severity of loss - for a window of observation of 60 days, it also displays other survival analysis models (Cox, Weibull and Gompertz) with the same specifications. In the Logit model, the dependent variable is likeliness to recover (equals 1 if the firm recovered, 0 otherwise). Control variables are the same as in our main model presented in Table 5 (Exp 7), the coefficients for control binary variables are not reported for the sake of brevity.



## 2.4 Discussion and Conclusion

In this paper, we study whether the environmental footprint of firms affects their resilience to environmental penalties using a proprietary sample of 143 observations including EPA enforcement actions in the United-States from 2006 to 2019. We show that heavier environmental footprint, in the form of higher direct pollution levels, is associated, all else equal, with longer recovery. This result is robust to different model specifications, different models of survival analysis and different time frames, before and after the event. It follows that firms with a heavy negative impact on the environment struggle more than their peers in the aftermath of an environmental penalty. This suggests that firms that were able to implement pollution prevention policies do not only mechanically reduce the risk of being flagged by enforcement agents for illegal pollution levels, but also improve their ability to recover from the financial and reputational shock a penalty for violating environmental regulation might cause.

This result seems to support the NRBV perspective, as the development of strategic capabilities such as pollution prevention, product stewardship and sustainable development in the aim of reducing the negative environmental impact of the firm's activities underlies the creation and expansion of specific capabilities that allow the firm to be better equipped when confronting complex situations, especially when these situations relate to environmental factors (Russo & Fouts, 1997; Ortiz-de-Mandojana & Bansal, 2016). The specific environmental capabilities mentioned above are the foundation upon which sustained competitive advantage can be achieved. Their tacit, socially complex and firm-specific nature makes them difficult to observe in an empirical study such as the one presented here. Nevertheless, these sources of competitive advantage can be inferred from good EP, and in our case, firms with more efficient pollution prevention strategies seem to be more flexible and better able to respond to

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disturbances following environmental violation than their peers, *ceteris paribus*. In that regard, we contribute to the NRBV literature by providing empirical groundwork that confirms the positive association between pollution prevention and financial resilience in a context of a disruption related to the environment. By minimizing emissions, effluents, waste, and resource use through the adoption of environmental management systems, firms are able to foster internal flexibility and address stakeholder expectations, which also provides external competitive advantages such as social legitimacy.

Because pollution prevention is one of the major pillars of EP, we can argue that this paper contributes to the nascent resilience literature in favor of EP as a valuable source of sustainable competitiveness in challenging times (Endrikat et al., 2014; Salem et al., 2015; Garel & Petit-Romec, 2021; Marsat et al., 2022) since reducing their environmental footprint, and thus improving their EP, helps firms reduce the time they require to bounce back from an environmental penalty. Considering that penalties for violating environmental law constitute regulatory pressure on polluting firms, we also add reason to consider the argument expressed by Demirel et al. (2018) and Demirel & Kesidou (2019), that implementing Environmental Management Systems and CSR frameworks allows firms to build unique environmental management capabilities such as pollution prevention, thereby allowing them to effectively address regulatory pressures. Besides, the findings of our study also support the interest of studying environmental violations and penalties as a context of disruption where companies display differential resilience, as exemplified by previous academic papers (Lott et al., 1999; Karpoff et al., 2005; Romero et al., 2018; Brady et al., 2019; Greife & Maume, 2020), the financial consequences of environmental penalties are significant and help reveal firm characteristics and response patterns which favor, or harm, their future position. We therefore expect that these results expand the literature on the impacts of environmental fines.

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This new result has significant managerial, financial, and regulatory implications. First, managers that wish to build resilience into their organization should consider the impact of its activities on the environment. Reducing the environmental footprint of these activities seems to have benefits beyond the ecological efficiency of operations, such as an improved capacity to bounce back from adversity. Improving the organization's footprint requires setting up strategies and processes, organizing teams and allocating budgets that work toward this single objective.

Second, investors may wish to integrate the environmental footprint of their portfolio constituents in their evaluation of the risk associated with their investments. By describing tougher times for heavy polluters following an environmental penalty, we highlight the fact that harming the environment may also harm a firm's stock price in challenging circumstances. We also advise institutional investors to carefully consider the implications of policy changes regarding pollution deterrence for the risk profiles of their portfolios. In the medium- to long-term, it may be that investors which don't value sustainability miss opportunities and yield lower returns, especially in times of crisis.

Third, regulators who are doubtful about the efficiency of the penalty approach to tackle pollution may be interested by the financial relevance of the events considered in this study, but also ponder the limitations of the current deterrence capabilities. For regulators who wish to further reduce the environmental footprint of their economy, an obvious recommendation would be to increase the amounts in penalties, in particular for repeat offenders. Blundell (2020) shows that this approach tends to improve compliance with existing regulations. However, since the amount of the penalty has very limited relevance in our results, we would also recommend efforts to go toward increasing monitoring, control, and repression capacities. Although our study only considers violations that occurred in the US, policymakers and regulators in other

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jurisdictions may take interest in our results as they reflect the financial consequences of pollution deterrence policies. In similar contexts, where corporate pollution is monitored by a governmental agency which has enough resources to conduct investigations and a legal mandate to press charges against polluters so violations can be penalized with substantial severity, publicly traded firms which receive fines following such violations should be affected in a comparable fashion to the firms in our sample. The desirability of this outcome, and the potential for legal improvement thereof could be discussed by policy experts, which falls beyond the scope of this paper.

Tackling global climate change demands effort from all organizations, especially industrial companies which will be required to observe more and more stringent standards and follow increasingly demanding regulation in the coming decades. In this context, building and sustaining EP has benefits beyond improving stakeholder relations as it also enhances the organization's resilience, thereby positively affecting the bottom line over the long term. From an academic perspective, this result contributes to the body of knowledge on how EP relates to financial performance by providing an additional empirical analysis in a specific context. The study of environmental penalties with a resilience perspective is original and contributes to understanding both concepts further. Penalties following environmental violations are economically relevant for firms and can be viewed as disruptive to the company's financial and reputational situation. Such disruptions are especially interesting from the resilience perspective as the affected organizations will display measurable stability in the form of severity of loss, and flexibility through the time they need to recover their pre-shock situation. Methodologically, our paper further supports the use of the resilience approach, associated with survival analyses, to study the financial recovery following a firm-specific disruption.

Our study also contributes to the environmental CSR literature by confirming that pollution reduction policies can lead to other opportunities for competitive advantages. By

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improving their resilience, and in particular their flexibility in rebounding after a jolt, firms that managed to eliminate the production inefficiencies by seeking to reduce their environmental footprint seemingly end up with a competitive advantage over firms that have made less extensive efforts in greening their value-chain. It is likely that the improved financial resilience of high EP firms described in this paper stems from a multiplicity of explaining factors, such as those described in Lyon and Maxwell (2008). Although we lack the data to provide a detailed assessment of how much each of these factors affect the recovery of firms to environmental penalties, which falls beyond the scope of this paper, such an endeavor would certainly lead to interesting results.

This research, of course, is not without limitations. The first limitation is the sample bias introduced in our work by the selection methodology: by only selecting companies targeted by a penalty for violating environmental law, we restrict our sample to firms, and sectors, that are heavier polluters as they are much more likely than others to be targeted by environmental penalties. As a result, firms in polluting sectors are overrepresented in our sample (Energy, Materials, and Utilities in particular), and heavy polluters in each of these sectors are more present in our sample than in the total population of firms that could be targeted by an environmental penalty. The risk for a firm to be targeted by an environmental penalty is not equally distributed, and the study of how some firms are more likely than others to be targeted was not considered in the scope of this paper, but it should be considered for further inquiry in future research. We should also acknowledge that the penalties studied in this paper are not fully exogenous, although we found no relationship between past EP or the level of direct pollution relative to other firms in the same sector with the amount of the fine, we cannot rule out the possibility of the past relationship between the firm and the regulator affecting the amount of the penalty. The second caveat is related to the restricted size of our sample which

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results from the sparse availability of leverageable data on environmental penalties, especially outside of the United States. The development of our database thus relied on secondary sources through the use of Factiva. Thirdly, while it is likely the amount of the penalty and other enforcement actions are related to the EPA agency which investigated the violation because of state level policies, controlling for the state where the violation took place, or at least the EPA region, would have been desirable, unfortunately this information was not systematically provided by Factiva. We also believe empirical research in other national contexts, under different legislations, is required to generalize the positive association between pollution prevention and financial resilience described in this study in accordance with the NRBV theoretical framework. Besides, the availability of better and additional data on EP would contribute to our knowledge of how efforts on reducing the organization's footprint on the environment also affect its overall performance. In particular, data on other dimensions of EP than pollution prevention, namely assessments of product stewardship and sustainable development, per the NRBV, would greatly increase our ability to assess the organizational impact of green policies. An important limitation of our work related to the availability of data lies in the fact that we are not able to consider the entire temporality of our events of interest. We believe researchers willing to explain our results further may be able to do so by adopting a case study methodology and a qualitative approach to investigate how firms respond to environmental penalties as soon as the allegation is declared or as the EPA investigation starts. Finally, while one would expect a higher penalty to incur heavier losses for the targeted companies, the limited relevance of the penalty amount regarding the recovery profile of affected companies in our data should be a subject of perplexity for enforcers. Putting a price on damage done to the environment is tricky, and it also risks favoring the more affluent organizations over the need to reduce the impact of human activities, the implications of this work for pollution deterrence policymakers also warrant consideration.



## Chapter 3 - Environmental Footprint, Water Intensity, and Resilience to Droughts<sup>5</sup>

### Abstract

This empirical study tests the effect of environmental performance on the resilience of 345 public firms headquartered in the U.S. to severe droughts that arose between 2006 and 2018. Using a survival analysis methodology and an assessment of the direct environmental footprint of companies provided by Trucost, the results from the survival analysis methodology exhibit that firms with heavier direct environmental footprint require more time than their peers to recover from the losses caused by the droughts. This effect of environmental footprint on resilience is demonstrated to be independent from the effect of water dependency, and robust to various model specifications, time frames of analysis, and sampling methodologies. This result supports the Natural Resource-Based View, which implies that efficient pollution reduction strategies underly the creation of specific capabilities that lead to sustainable competitive advantages, including resilience to slow-onset nature adversity.

**Keywords:** Drought, Water, Environmental Footprint, Resilience, Environmental performance, Survival Analysis

**JEL Classification:** G12, M14, O16, Q51

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<sup>5</sup> This chapter is adapted from a working paper currently under consideration for submission.



### 3.1 Introduction

The last decade saw substantial economic impact due to drought episodes in the United States, not least of which the 2012 extreme drought affecting most southern states. This extreme weather event demonstrated how severe drought conditions can adversely affect economic stability and organizational resilience. This drought, one of the most extensive and costly in recent history, had profound economic repercussions across multiple sectors, particularly agriculture, energy, and manufacturing. According to the United States Department of Agriculture (USDA), approximately 80% of agricultural land was hit, leading to serious losses in crop yields, with an estimated 27% loss in corn production, and 10% in soybean production, among others (USDA, 2012). Beyond agriculture, the economic effect of droughts typically cascades into other industries, particularly those that depend on water resources. During the 2012 drought, the energy sector, for example, faced major challenges due to water scarcity as hydroelectric and thermal power plants both require large volumes of water, either directly for electricity generation, or for cooling processes. A study from the Congressional Research Service (CRS, 2011) evidenced that drought conditions force these power plants to function at reduced capacity or temporarily shut down due to low water levels in reservoirs and rivers. According to the NCEI's Annual 2012 Drought Report (2013), the economic losses associated with the 2012 drought in the U.S. amount to about \$41.4 billion, and the incurred dryness and heat are responsible for at least 123 deaths.

In the current changing climate, the ability of organizations to withstand and recover from extreme weather conditions and other environmental disaster may spell the difference between success and failure as such events are expected to multiply, intensify, and arise in increasingly unpredictable patterns (IPCC, 2015, 2022). In the case of drought, extensive climate research warns us that the risk of worsening water scarcity gradually increases with greenhouse gas (GHG) emissions, and is expected to exceed the driest periods in Southwest

American geological history during the second half of the 21<sup>st</sup> century (Cook et al., 2015). The economic losses caused by drought episodes is thus expected to increase in the coming decades, forcing managers, investors, and regulators to consider the exposure of their stakes to drought risk and set up mitigation strategies.

From the management research perspective, understanding how organizations prepare for, react to, and recover after drought episodes should reveal important insight about the resilience process, which has been increasingly sought after in recent years (Raetze et al., 2022). It is also expected to lead into compelling recommendations for managers and investors, helping them take better informed decisions.

The study of how organizations respond to threats has earned substantial interest recently, not only due to the increased environmental risks resulting from our changing climate, but also from man-made disruptions such as financial crises (e.g. DesJardine et al., 2019; Marsat et al., 2021), terrorist attacks (Gittell et al., 2006), industrial disasters (Capelle-Blancard & Laguna, 2010), and pandemics (Cardillo et al., 2022; Ding et al., 2021; Ferrón-Vílchez & Leyva-de la Hiz, 2023; Garel & Petit-Romec, 2021; Safón et al., 2024), among others. In this literature, the use of the term *resilience* has allowed researchers to both place their enquiries under the same banner, and study critical situations using varying definitions of the same concept, and different empirical methodologies to measure or proxy resilience (Duchek, 2020; Linnenluecke, 2017; Raetze et al., 2022; Su & Junge, 2023). In this chapter, the term *organizational resilience* (OR) is used under the sense provided by Gunderson & Pritchard (2002): “*both the ability of a system to persist despite disruptions and the ability to regenerate and maintain existing organization*”. Furthermore, the intent here is to empirically observe resilience outcomes by adapting the methodology of DesJardine et al. (2019) to measure *stability*, the ability to reduce the impact of a crisis, preserving core functions, and *flexibility*, the ability to recover from adversity and survive environmental disturbances (Foulon & Marsat,

2023; Ortiz-de-Mandojana & Bansal, 2016). Thus, organizational resilience is assessed through two measures of organizational outcomes: the severity of the losses following the advent of the crisis, and the organization's time to recover from the loss. These two measures, further described in the methodological section below, reflect the multidimensional nature of resilience and capture the duality of stability and flexibility implied in the definition of Gunderson & Pritchard (2002).

Because the event of interest in this study is closely related to climate change, there are reasons to believe environmental performance (EP), the ability of an organization to be accountable to itself, its stakeholders, and the public for its actions as they impact the ecological environment, and implement mechanisms to minimize the negative externalities of its activities for the environment, positively affects the resilience of organizations confronted with severe droughts.

Multiple theoretical frameworks support this idea of a positive association between EP and OR in the case of droughts. Primarily, the Natural Resource-Based View (NRBV), articulated by Hart (1995) on the foundations of the Resource-Based View (Barney, 1991; Wernerfelt, 1984), and expanded by Hart & Dowell (2011), provides a compelling framework for understanding the underlying mechanisms through which EP can enhance a firm's resilience to droughts. The NRBV posits that firms can achieve a sustainable competitive advantage by effectively managing their natural resources and integrating environmental strategies into their operational processes and core operations. Under this perspective, firms that actively invest in proactive environmental practices (water conservation, efficient resource allocation), and pollution reduction, can mitigate the risks associated with environmental disruptions such as droughts. By placing sustainability at the heart of their concerns and promoting prosperity rather than growth at any price, these firms are expected to not only reduce their environmental footprint but also build adaptive capabilities that enhance operational flexibility and resource

availability during times of water scarcity. The NRBV emphasized three interconnected strategic capabilities: (i) pollution prevention, (ii) product stewardship, and (iii) sustainable development.

Pollution prevention focuses on minimizing waste and emissions, thereby conserving water resources and reducing vulnerability to drought conditions. Product stewardship extends this approach to the entire lifecycle of products, encouraging firms to innovate and design goods that require less water and are more resilient to dry weather conditions. Finally, sustainable development under the NRBV framework encourages firms to engage in long-term planning and community-oriented strategies that bolster their capacity to withstand and recover from drought-induced disruptions. Empirical studies, such as Aragón-Correa et al. (2008), Bhandari et al. (2022), Branco & Lima Rodrigues (2006), Porter & van der Linde (1995), Russo & Fouts (1997), Sharma & Vredenburg (1998), validated the NRBV's assertion that environmental stewardship is not only an ethical imperative but also a strategic asset that enhances valuable specific capabilities, which may translate into organizational resilience. Therefore, the NRBV provides a valuable theoretical lens to understand how superior environmental performance can equip firms with the necessary tools to resist to the challenges posed by droughts, and better recover from the losses.

In addition to the NRBV, the stakeholder theory posits that firms which improve their environmental performance, do so in the interest of their stakeholders in an attempt to answer the growing expectation for corporate social responsibility (CSR) (Flammer, 2013). This increased attention to CSR is expected to improve the firm's reputation (Branco & Lima Rodrigues, 2006; Bruna & Nicolò, 2020), its legitimacy (Zahller et al., 2015), and its license to operate (DesJardine et al., 2019; Ortiz-de-Mandojana & Bansal, 2016), which in turn leads to fundamental intangible resources, including information, that the firm can mobilize during critical times to improve its resilience through the mobilization of increased support from its

stakeholders to properly face the crisis. Moreover, firms with improved reputation, legitimacy, and license to operate benefit from a reduced risk of negative stakeholder reactions such as boycotts, strikes, hiring difficulties, regulatory scrutiny, capital access restrictions, and restricted access to opportunities (Dhaliwal et al., 2011; Dowling & Pfeffer, 1975; Freeman, 2007, 2015; Kothari et al., 2009; Lindblom, 2010). Conversely, in the view of neoclassical economics, under which “the social responsibility of business is to increase its profits” (Friedman, 1962, 1970), there is *a priori* no reason why a firm should invest in CSR improvements if this investment does not translate into increased profits. There have been indications in academic work that allocating resources to the improvement of a firm’s social and environmental profile can translate into increased financial performance.

Most of this work has historically been classified under the question of “*does it pay to be green?*” (Ambec & Lanoie, 2008; Clarkson et al., 2011; Dixon-Fowler et al., 2013; Hart & Ahuja, 1996; King & Lenox, 2001), which has led to conflicting empirical results, and then the focus crystallized around the relationship between either CSR and financial performance (FP) (DesJardine et al., 2019; Ortiz-de-Mandojana & Bansal, 2016) or EP and FP (e.g. Delmas et al., 2015; Endrikat, 2015; Jo et al., 2015; Salem et al., 2015; Xiao et al., 2018), generally pointing in the direction of a positive effect of either CSR or EP on FP, although this relationship seems mediated by contextual properties.

Despite the recent but significant increase in the number of publications discussing organizational resilience (Raetze et al., 2022), empirical studies of how CSR or EP affect the resilience of firms remain relatively scarce, particularly if we set aside the studies on resilience to the Covid-19 crisis (Albuquerque et al., 2020; Cardillo et al., 2022; Ding et al., 2021; Ferrón-Vílchez & Leyva-de la Hiz, 2023; Garel & Petit-Romec, 2021; Huang et al., 2020). Ortiz-de-Mandojana & Bansal (2016) used measures of long term outcomes such as financial volatility, sales growth, and survival, to demonstrate that social and environmental practices (SEPs)

positively affect organizational resilience. DesJardine et al. (2019) further confirmed this result in a context of crisis, the 2008 global financial crisis (GFC), adding to it the fact that strategic SEPs contribute more to organizational resilience than tactical SEPs, this study also founded a new methodological approach for measuring resilience through two financial outcomes: stability and flexibility. In a similar vein, Marsat et al. (2022) reported a positive effect of EP on resilience to environmental controversies, Foulon & Marsat (2023) also document a positive effect of EP (measured with environmental footprint) on resilience to environmental penalties, Gao et al. (2024) showed recently that proactive green innovation enhances climate resilience by analyzing 113 climate disasters in China.

When it comes to the specific context of droughts, to the best of my knowledge, no empirical study of resilience has attempted to observe how firms respond to extreme dry conditions. Nonetheless, some related work may serve to guide reflections on the subject. Clément & Rivera (2017) specifically address the question of organizational resilience to adverse conditions pertaining to ecological disruptions, they particularly underline the importance of the adaptation of business practices and strategies to achieve a better fit with the evolution of its natural environment, which is generally referred to as “*adaptation to climate change*” (IPCC, 2015), distinguished from “*climate change mitigation*”, the efforts to reduce the impact of climate change on the whole. This line of argument is further discussed in *Business Adaptation to Climate Change* (Rivera et al., 2022), which also underscores the specific difficulties for organizations to confront ecological adversity that is “*slow-onset*”, i.e. adversity that initially emerges in low intensity, then gradually becomes more constraining as the intensity of the disruption increases over time, until it becomes too critical to allow for adaptation, forcing the organization to give up on its adaptive strategies and move towards transformative actions, as suggested throughout their empirical analyses (Oh & Oetzel, 2011,

2022; Rivera & Clement, 2019). They thus propose an inverted U-shaped relationship between nature adversity and protective adaptation.

The most relevant empirical research on the consequences of droughts for companies was provided by Huynh et al. (2020), who identified droughts using meteorological data based on the Palmer Drought Severity Index (PDSI) on a monthly basis. Their results give robust evidence for a difference in the cost of equity capital for firms affected by severe drought conditions, “*the price of drought*”. They suggested that diversification cannot entirely mitigate the loss of wealth incurred by these firms, while investors require a higher rate of returns from firms affected by droughts. Additionally, they report that firms with higher local institutional holdings suffer from a higher cost of capital than others when they are locally affected by a drought, and that the detrimental effect of drought on the cost of equity capital is made worse for firms headquartered in states recently affected by drought conditions. Their endeavor confirms that droughts are a relevant setting for studies of resilience as we can expect the operational and financial shock caused by the advent of severe drought conditions to be significant enough to justify the use of the resilience methodology. The main intent of this chapter is to build upon their work and expand our knowledge of market reactions to droughts by testing whether EP can potentially be a way for firms to both reduce the financial impact of droughts, and recover better by demonstrating enhanced adaptation. Due to the very likely multiplication and intensification of droughts in the coming decades (IPCC, 2015, 2022), this knowledge is expected to prove necessary.

This path led to the following research question: does the environmental footprint of a firm affect its resilience to droughts? The appropriate experimental treatment of this question requires the identification of severe drought events affecting an adequate number of companies for which we can have access to data about both their financial situations before, during and after the drought period, and their environmental footprint before the event. Due to this issue

of data availability, the logical choice was to turn towards firms in the United States for two reasons. First, as discussed above, most of the states in the Southwest and Central Plains areas of the contiguous U.S. have been affected by at least one episode of severe drought in the last two decades due to the ongoing weather patterns influenced by climate change. Secondly, due to the high number of public firms registered in stock markets in the U.S., there is a greater probability of financial data availability, this increased exposure to external investment also prompts these firms to release more information about their environmental footprint, which also pushes independent auditors of environmental performance to pay more attention to firms in the U.S. As a result, the probability of constructing a satisfactorily large sample within a reasonable data recovery time was maximized for drought events affecting the United States.

The main purpose of this study is to attempt to improve our understanding of how environmental footprint affects the resilience of firms to droughts. To test this effect, multiple sources of data were mobilized to construct an original sample of firm-year observations affected by severe drought events in the U.S. The statistical analyses detailed in the remainder of this chapter show that, all else equal, a heavier environmental footprint is associated with a reduced resilience as firms with lower EP require more time to recover from the loss of value caused by the drought. This implies that, in accordance the NRBV and the stakeholder theory, firms with high levels of EP prior to the event are better able to bounce back after the start of a severe drought. This result is robust to different sample selection criteria, survival analysis models, control variables and time windows of analysis. Secondly, the results of this empirical analysis may bring

This work seeks to contribute to the literature by empirically assessing the effect of environmental footprint on resilience in a context for which such studies have not yet been deployed: droughts. Doing so presents the additional opportunity to bridge these literatures for the first time to our knowledge. This effort is expected to improve our knowledge of how



organizations confront extreme weather events and climate change (Huynh et al., 2020; Rivera & Clement, 2019; Rivera et al., 2022; Tisch & Galbreath, 2018), thereby expanding the literature on resilience (Duchek, 2020; Linnenluecke & Griffiths, 2015; Linnenluecke, 2017; Raetze et al., 2022; Su & Junge, 2023), and particularly supplementing the empirical endeavors that rely on survival analysis methodology (DesJardine et al., 2019; Foulon & Marsat, 2023; Li et al., 2022; Ullah et al., 2022). The results presented here also have theoretical implications regarding the role of proactive adaptation to climate change through environmental footprint reduction in the development of dynamic capabilities (Hart, 1995; Teece et al., 1997), as well as the value of EP and its insurance-like benefits (Godfrey et al., 2009). Additionally, it may inform us about the potential damaging effects droughts bear for firms headquartered in areas prone to dryness, and how they can mitigate these disturbances. Finally, the implications of this work should also interest managers and investors.

The rest of this chapter is organized as follows: the following section exposes the sample selection process and other methodological choices made for this study, section 3.3 presents the results, which are then discussed in the final section 3.4, concluding the chapter.

### 3.2 Data and Methodology

#### 3.2.1 Sample

In order to mobilize the concept and methodology of resilience, some conditions need to be met. First, the context must respect three core characteristics (Su & Junge, 2023): an adverse event triggering the resilience process, a performance setback, and a recovery. In the case of droughts, precisely identifying the start of the event is challenging since it is not possible to rely on objective data that would provide a starting point for the impact of dryness. During the preparation process leading to this empirical analysis, the initial approach was to first identify significant drought events affecting the United States from 2006 to 2018, and then

identify the date of publication of the first publicly available information warning of drought conditions affecting a large surface of the state in which firms are headquartered. Retracing the timeline of multiple mentions of severe drought in news media led to the same initial source of information: the reports of the United States Drought Monitor (USDM).

The identification of severe drought episodes was thus done thanks to the use of data from the USDM, which allows the retrieval of weekly data through multiple tools, including “Statistics by Threshold”<sup>6</sup>. The latter allowed the identification of periods when a certain surface of a state’s area was affected by drought conditions of varying severity. The severity of drought conditions is measured using this denomination:

- D0: Abnormally Dry
- D1: Moderate Drought
- D2: Severe Drought
- D3: Extreme Drought
- D4: Exceptional Drought

Using the open data tool, it was possible to observe the cumulated area of all contiguous States affected by drought surpassing any of these levels separately in any week between 01/01/2006 and 31/12/2019, the frame of data also covered by the Trucost database.

The advantages of the USDM data over other sources are its open availability, the possibility to observe fine drought information on a weekly basis rather than a monthly assessment, and its reliance on multiple datapoints in a convergence of evidence approach rather than one single measure. The objective physical indicators of recent precipitation, long-term

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<sup>6</sup>This tool provided via a partnership between the National Drought Mitigation Center from the University of Nebraska-Lincoln, the U.S. Department of Agriculture and the National Oceanic and Atmospheric Administration, is accessible via <https://droughtmonitor.unl.edu/DmData/DataDownload/StatisticsbyThreshold.aspx>

soil moisture, evapotranspiration and reserves, comparable to those used in the PDSI, are complemented with the local expertise of over 400 experts around the United States<sup>7</sup>.

In the absence of previous empirical studies in the management literature using this data to identify periods of severe drought, the creation of a set of rules was necessary. In the main dataset, any period presenting the following characteristics is considered a drought event severe enough to be included in a study of resilience:

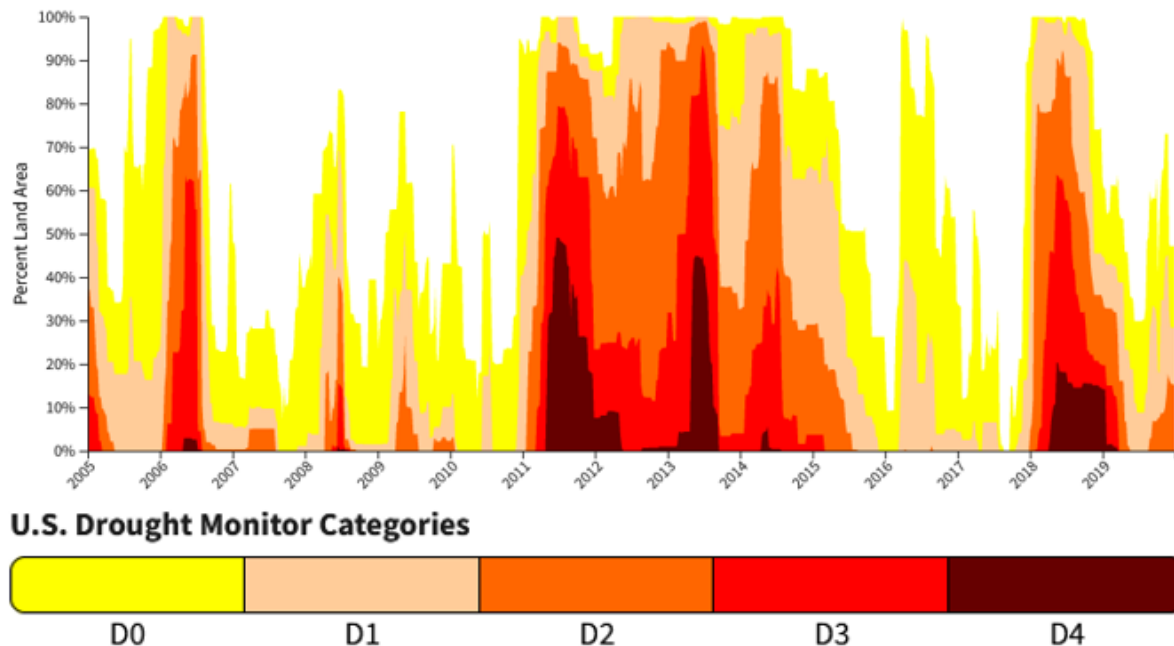
- The state must be confronted with at least 1 week of extreme (D3) to exceptional drought (D4) affecting more than 50% of its area;
- And at least 20 consecutive weeks of moderate (D2) to exceptional (D4) drought conditions affecting at least 70% of its area surrounding the period of extreme to exceptional drought mentioned above (D3 – D4).

The drought event is considered to last until less than 30% of the state is affected by moderate (D1) to exceptional (D4) drought conditions. A visual representation of the data for the state of New Mexico is provided in Figure 3-1. To ensure this approach does not include data selection bias, other values in the rules for event identification will be considered for robustness tests.

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<sup>7</sup> More information on the methods used for the construction of the USDM categories over time can be found via <https://drought.unl.edu/Education/Tutorials/Usdm/Section-Five.aspx>

Figure 3-1: Cumulated are under drought conditions, State of New Mexico, 2005 - 2019



Source: USDM. Note: this graph plots the cumulated land area of the State of New Mexico affected by varying severities of drought conditions for all weeks from 01/01/2005 to 31/12/2019. In accordance with the drought identification methodology, three events were identified: a first, relatively short drought from January 2006 to November 2006; a second, long and intense drought starting in January 2011, and lasting until October 2015; and a third, intense drought from January 2018 to May 2019.

For each drought, an event start date was manually retrieved as the date of the first USDM report mentioning worrying drought conditions for a state around the start of each drought identified in the previous step. These reports are systematically the first publicly available source of information alerting about dryness, the monthly reports of the USDM are then often referenced by news media to warn of the coming/ongoing drought. Whenever a report indicates multiple states being affected, they are all considered to be affected by the same drought event if their affected area respects the 2 conditions detailed above, the end of the drought period can then vary between states affected by the same drought event. This methodology led to the identification of a total of 19 drought events during the 2006 – 2018 period, the full list of these drought events is provided in Appendix 1.

Because the intention of this endeavor is to use material measurements of corporate environmental footprint in this study of financial resilience to droughts in the United States, the

initial dataset is restricted to the companies for which data is available in the Trucost database in the time range considered for the analysis. Initially, all firm-year observations are included, and only those that missed important financial information in Thomson Reuters' Datastream service were dropped. Then, for each drought event, and following the argument of Huynh et al. (2020) that the core business activities of firms occur in close proximity to their headquarters, the exposition of firms to drought is assessed using the state location of their headquarter. This implies the following conjecture: business risk increases for firms when the state in which they are headquartered is affected by a severe drought, which will be revealed in the value of their share on stock markets. All firms headquartered in states not affected by the drought were dropped, and finally, firms from sectors (according to the GICS 4-digit detailed industry description) with a below-median average water intensity score (based on Trucost data) were dropped to restrict the analysis to firms for which water scarcity can cause tangible organizational issues, as required by the approach through resilience, which involves the existence of a shock affecting the subjects (Duchek, 2020; Linnenluecke, 2017; Su & Junge, 2023). These steps resulted in a final sample of 345 observations. A summary of this sample selection methodology including the count of dropped observations at each step is provided in Table 3-1.

Table 3-1: Sample Selection Methodology

Firms in the sample	Obs.
U.S. Firms with data available in Trucost for each year preceding a drought event	21 511
Less: Observations missing important financial data:	
- Return on Assets	(1 231)
- GICS Sector Code	(1)
- Weekly share price around start of drought	(793)
- State of HQ	(444)
- Momentum (Volatility 200 days)	(5 213)
- Debt to Assets Ratio	(29)
- Capital Expenditures	(434)
Less: observations in states unaffected by retained drought events	(12 651)
Less: observations in sectors (4-digits) with below-median water intensity	(370)
Final Sample	345
Panel B – Firms in water dependent industries according to Huyn et al. (2020)	218
<i>Additional subsamples for event selection validation</i>	
<i>SevereDrought</i> – Firms affected by the most severe droughts	272
<i>LongDrought</i> – Firms affected by the longest droughts	256
<i>SevlongDrought</i> – Firms affected by the most severe and long droughts	195

A sample description of the data included in the analysis is provided in Table 3-2, counting the number of observations by year of drought start, firms' sector, and state of headquarters. As shown in this table, the years in which the most firms in our sample saw the start of a drought affecting their activities are 2007 (95 obs.), 2006 (70 obs.), and 2011 (61 obs.). Due to the selection of firms in water dependent industries, the sector distribution of our data is heavily skewed towards sectors that are more water intensive (Energy, Materials and Industrials totalize more than half of the sample). The states most represented in the sample are Texas (130 obs.), California (41 obs.) and Colorado (39 obs.).

Table 3-2: Sample Description

Year of Drought Start		Sector (GICS 2 digits)	State of HQ		
2006	70	Energy	92	Texas	130
2007	95	Materials	63	California	41
2009	3	Industrials	42	Colorado	39
2010	7	Information Technology	36	Arizona	34
2011	61	Utilities	29	Oklahoma	24
2012	39	Consumer Staples	27	Tennessee	13
2015	2	Real Estate	25	Nevada	12
2016	9	Consumer Discretionary	23	Georgia	11
2018	59	Communication Services	4	Kansas	8
		Health Care	4	Other	33
N	345		345		345

### 3.2.2 Variables

Using Thomson Reuters' Datastream service, financial data about the firms in the sample around the drought period was retrieved, in particular, the use of the survival analysis methodology inspired by DesJardine et al. (2019) requires the identification of severity of loss and time to recover measures for each observation. These variables were calculated based on each firm's weekly adjusted share price for a period spanning from 20 weeks preceding the start of the event to 52 weeks after the end of the event in order to capture the full recovery period of most observations. For the calculation of the resilience variables, this paper first followed Li et al. (2022) and assessed the pre-drought value for each observation as the maximum weekly share price in the 20 weeks preceding the event. Contrary to the 2008 GFC studied by DesJardine et al. (2019), the emergence of severe droughts may be anticipated by the affected organizations and their investors, so taking the share price immediately preceding the start of the event runs the risk of missing the full impact of the drought. The *stability* dimension of

resilience is then measured as the percentage difference between the pre-drought value and the lowest weekly share price during the drought period, this value is stored in variable *DepthOfLoss*. Then, the *flexibility* dimension of resilience is measured as the time in weeks necessary for a firm's share price to recover to its pre-drought value, and remain above this threshold for 5 consecutive weeks, this value is stored in variable *TimeToRecover*. For a similar approach, see Foulon & Marsat (2023), Marsat et al. (2022) or Ullah et al. (2022). Any firm that sees its share price recover to the pre-drought value and remain above it for more than 5 consecutive weeks is considered recovered from the crisis, the binary variable *Recovered* takes the value of 1 for such observations. All firms whose price don't overtake the pre-drought value for 5 consecutive weeks during the observation period extending to the 52 weeks after the end of the drought are also identified with this variable; they will have a *Recovered* value of 0.

The firms in the sample registered a loss averaging 47.61% of their pre-drought value at their lowest point during the crisis period, with a minimum loss in the sample of 5.14%, this indicates that all firms in the sample were indeed economically affected by the event, which confirms the soundness of the selection methodology. On average, it took 74.13 weeks for the firms in the sample to recover to their pre-drought value. 84% of the firms in the sample managed to recover their pre-drought value before the end of the observation period.

The variables of interest in this study ascertain different aspects of firms' EP, the water intensity ratio (variable: *WaterIntensity*) previously used in the data selection methodology is included in certain analyses to assess the effect of other factors while holding the intensity of firms' water consumption constant. EP is assessed through the measure of direct environmental footprint, *DirEnvFootprint*, which is the estimated cost of each firm's pollution generated through its direct operations in USD billions<sup>8</sup>.

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<sup>8</sup> The direct environmental impacts assessed in the Trucost database include the following datapoints: carbon emissions, other GHG emissions, land and water pollutants, natural resource use, water cooling, water processing,



## Chapter 3 – Environmental Footprint, Water Intensity, and Resilience to Droughts

According to previous studies of resilience, other factors are expected to affect the stability and flexibility of firms confronted with droughts, to control for these factors, the regression models include measures of profitability (*ROA*), firm size (*Size*), financial leverage (*FinLev*), volatility-based market price momentum (*Momentum*), capital expenditures (*CAPEX*), and add binary variables to control for sector-, state-, and year-fixed effects. The detailed description of all the variables used in this study is provided in Table 3-3, summary statistics are presented in Table 3-4.

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waste landfill, waste incineration, and nuclear waste. The database also includes indirect impacts in the firm's upstream supply chain, which are not considered in the main variable of interest, *DirEnvFootprint*. Details about the methodology used by Trucost to measure and estimate the direct environmental impact of a company are available here: [https://www.support.marketplace.spglobal.com/en/datasets/alternative/trucost\\_environmental/trucost\\_environmental\\_data\\_methodology\\_guide.pdf](https://www.support.marketplace.spglobal.com/en/datasets/alternative/trucost_environmental/trucost_environmental_data_methodology_guide.pdf)

Table 3-3: Variables Description

Variables	Description	Data Source
TimeToRecover	Time in days the firm's stock price took to recover (remain over baseline for 5 consecutive weeks)	Datastream
DepthOfLoss	Maximum percentage loss of firm's stock price after start of drought	Datastream
Recovered	Binary variable for recovery (1 if recovered, 0 otherwise)	Datastream
DirEnvFootprint	Firm's direct environmental footprint, estimated cost of the pollution generated by the firm's direct operations in billion USD (Y-1)	Trucost
WaterIntensity	Water intensity ratio, one plus natural logarithm of firm's direct use + purchased water (cubic meters / revenue in million USD) (Y-1), winsorized at 1% and 99%	Trucost
ROA	Return on assets (Y-1), winsorized at 1% and 99%	Datastream
Size	One plus natural logarithm of total assets (Y-1), winsorized at 1% and 99%	Datastream
FinLev	Financial leverage (Debt-to-Assets ratio) (Y-1), winsorized at 1% and 99%	Datastream
Momentum	Based on stock Price volatility, exponentially-weighted moving average of the squared daily log returns over the 200 days preceding drought start, winsorized at 1% and 99%	Datastream
CAPEX	Capital Expenditures divided by total assets (Y-1), winsorized at 1% and 99%	Datastream
Sector	Binary variables for firm's sector from the GICS 2-digit classification	Datastream
State	Binary variables for firm's state of headquarters	Datastream
Year	Binary variables for year of drought start	Datastream

Note: Datastream = Thomson Reuters' Refinitiv Datastream (historical financial database).

Table 3-4: Summary Statistics

VARIABLES	N	mean	median	sd	min	max	p25	p75
TimeToRecover	345	74.13	16	112.07	1	319	4	74
DepthOfLoss	345	47.61	45.64	25.38	5.14	99.81	25.39	68.80
Recovered	345	0.84	1	0.36	0	1	1	1
DirEnvFootprint	345	0.32	0.02	1.01	0.00	8.96	0.003	0.15
WaterIntensity	345	9.01	8.57	1.97	3.71	14.67	7.78	10.13
ROA	345	5.76	5.28	8.64	-34.68	29.98	2.11	10.18
Size	345	23.22	23.18	1.48	19.31	27.11	22.32	24.22
FinLev	345	28.11	26.52	18.20	0	88.37	15.42	40.37
Momentum	345	1.97	1.74	0.92	0.82	7.07	1.37	2.36
CAPEX	345	0.08	0.06	0.07	0.00	0.44	0.03	0.10

Summary statistics of the sample. Resilience is the number of weeks of market price recovery. Recovered is a binary variable meant to test the likelihood of recovery in Logit models. EP is proxied by the total environmental footprint the firm's direct activities in billion USD. EP is further proxied with the environmental pillar score from ESG data. WaterIntensity is one plus the natural logarithm of the ratio of the firms' direct used and purchased water to its revenue. ROA is the return on assets ratio. Size is one plus the natural log of firms' total assets. FinLev is the financial leverage ratio (total debt divided by total equity). Momentum reflects the firm's market trend in the 200 days preceding the event. CAPEX is the ratio of the firms' capital expenditures to their total assets. All financial control variables and WaterIntensity are winsorized at the 1<sup>st</sup> and 99<sup>th</sup> centiles.

A matrix of pairwise correlations is provided in Table 3-5. Some correlations should be noted. First, as expected, the three variables related to resilience are correlated, in particular, *TimeToRecover* and *Recovered* (-0.95;  $p < 0.01$ ). Secondly, *WaterIntensity* is positively correlated with environmental footprint (0.41;  $p < 0.01$ ). Regarding control variables, *Size* is positively correlated to direct environmental footprint (0.46;  $p < 0.01$ ), it is also negatively correlated to *Momentum* (-0.58;  $p < 0.01$ ). Financial leverage is negatively correlated to *ROA* (-0.38;  $p < 0.01$ ). Given the relatively high correlations listed above, due attention is paid to measures of collinearity in initial OLS models.

Table 3-5: Correlations Matrix

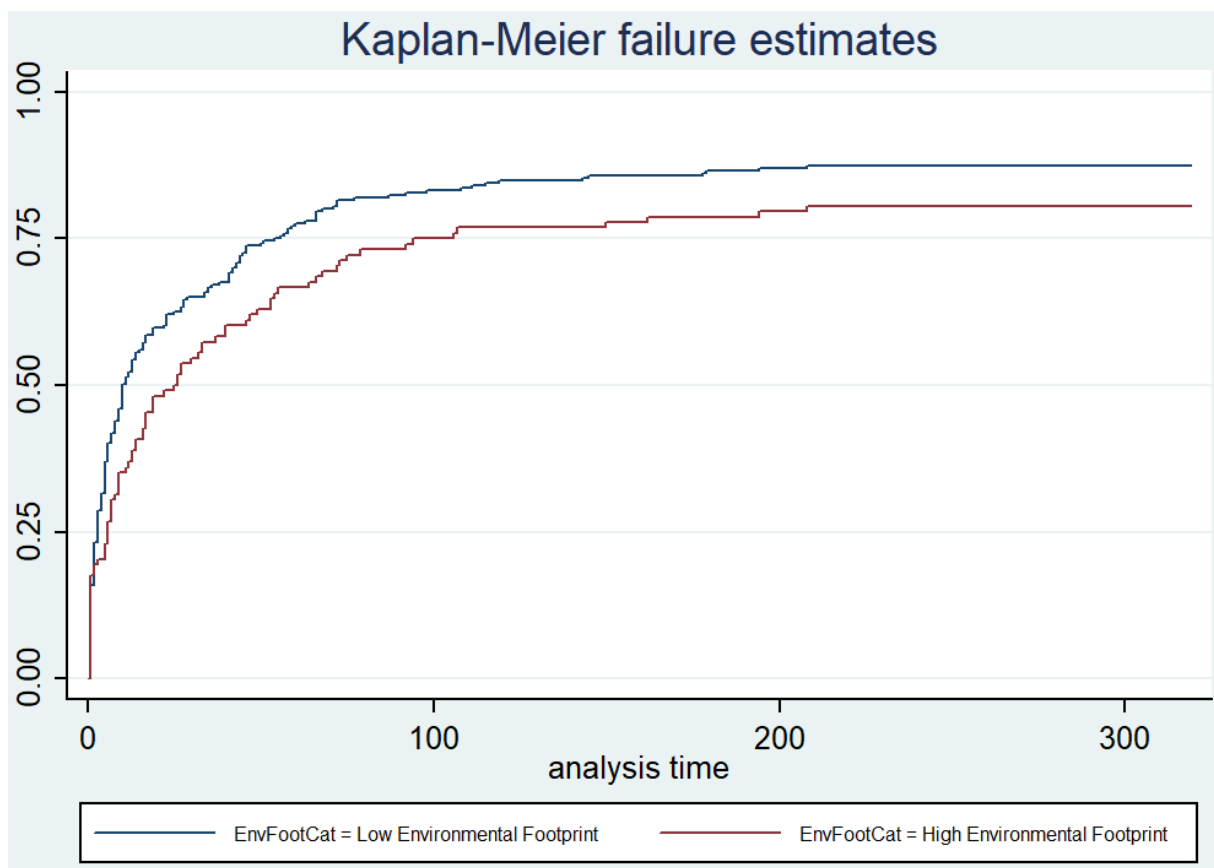
	TimeToRecover	DepthOfLoss	Recovered	DirEnvFootprint	WaterIntensity	ROA	Size	FinLev	Momentum
TimeToRecover	1								
DepthOfLoss	0.35***	1							
Recovered	-0.95***	-0.36***	1						
DirEnvFootprint	-0.05	-0.17**	0.04	1					
WaterIntensity	-0.00	-0.10	-0.01	0.41***	1				
ROA	0.05	-0.03	-0.02	0.03	-0.05	1			
Size	-0.17**	-0.23***	0.17**	0.46***	0.17**	0.05	1		
FinLev	0.03	0.01	-0.06	-0.06	0.03	-0.38***	0.09	1	
Momentum	0.17**	0.29***	-0.16**	-0.22***	-0.16*	0.02	-0.58***	-0.12	1
CAPEX	0.03	0.22***	-0.04	-0.05	0.01	-0.01	-0.08	-0.05	0.00

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ . This table presents the pairwise correlations of all the variables used in the statistical analysis.

### 3.3 Results

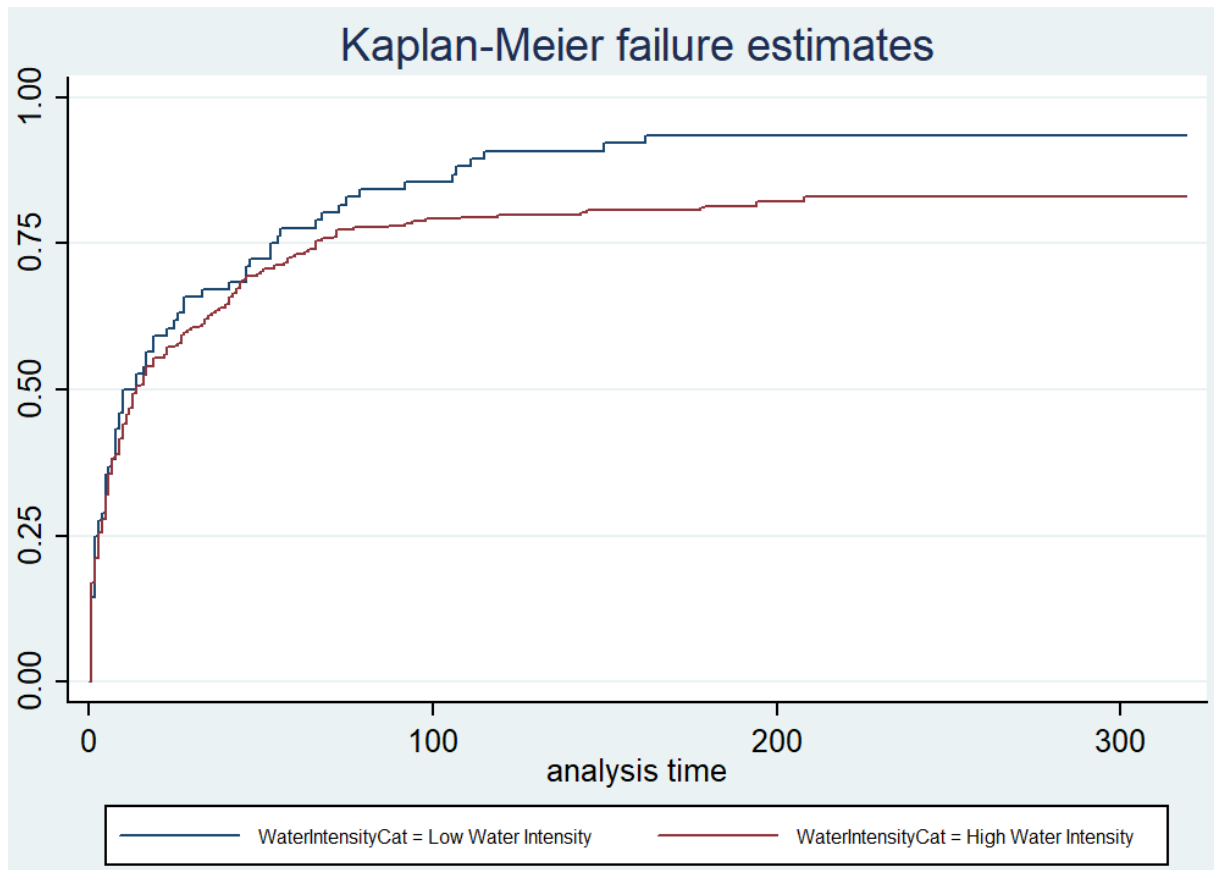
The graph plots in Figure 3-2 and Figure 3-3 show the effect of the variables of interest on the hazard of recovery following all drought events. Based on the differences between curves, it seems firms with low levels of environmental footprint recover faster than the others (Figure 3-2), and firms with lower levels of water intensity recover faster than more water intensive firms (Figure 3-3). An analysis in multivariate regressions is necessary to allow for an assessment of their statistical significance and an enquiry of their effect while holding other control factors equal.

Figure 3-2: Kaplan-Meier failure estimates over groups of Environmental Footprint, separated by the median



Source: created by the author. This graph shows the Kaplan-Meier failure estimates over the timeline of analysis for two groups of environmental footprint. In red: above-median environmental footprint (High), in blue: below-median environmental footprint (Low). The x-axis shows the analysis time in weeks, the y-axis shows the probability to change the state of recovery (to become *Recovered*). A higher curve indicates a higher hazard ratio of the studied event to happen, in this case the recovery from the losses incurred by drought, and thus a higher flexibility. The low environmental footprint group has a comparatively higher probability to recover overall.

Figure 3-3: Kaplan-Meier failure estimates over groups of Water Intensity, separated by the median

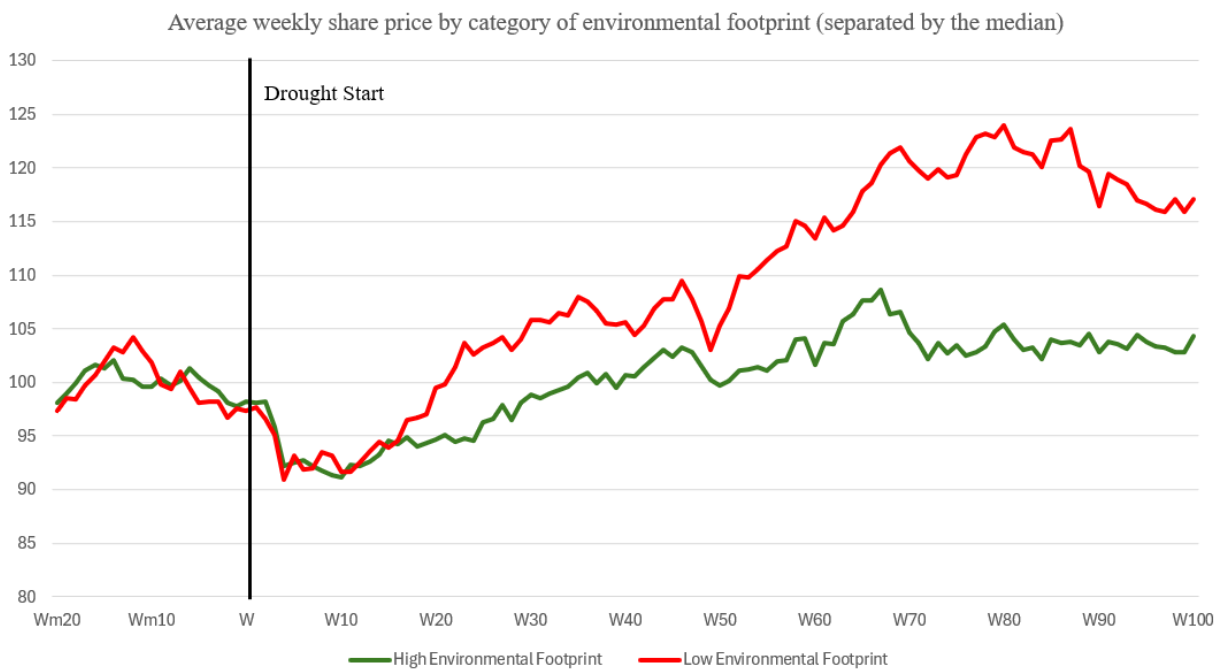


Source: created by the author. This graph shows the Kaplan-Meier failure estimates over the timeline of analysis for two groups of water intensity. In red: above-median water intensity (High), in blue: below-median water intensity (Low). The x-axis shows the analysis time in weeks, the y-axis shows the probability to change the state of recovery (to become *Recovered*). A higher curve indicates a higher hazard ratio of the studied event to happen, in this case the recovery from the losses incurred by drought, and thus a higher flexibility. The low water intensity group has a slightly higher probability to recover overall.

Figure 3-4 shows the average share price of firms in the sample over the 20 weeks preceding the event and the 100 weeks following the start of the drought. The sample is separated in two subsamples by the median of *DirEnvFootprint*. Base 100 is taken for each firm in the sample as their pre-drought value (maximum price during the 20 weeks prior to the event), all the other prices are plotted against this baseline value. From this graph, three initial observations can be made. First, as apparent from the price variations on the left of the bar, in the 20 weeks preceding the start of the drought, some degree of market anticipation of the event exists, as both curves start declining from their peak about 10 weeks before event start. Secondly, the initial loss in the few weeks that follow the start of the event seems to appear

quickly in the market values, with no notable difference between the two curves. Thirdly, it is apparent from the remainder of the graph that firms with low environmental footprint recover faster than others as the red line overpasses the blue line around the 20<sup>th</sup> week and remains above for the remainder of the period of analysis. This confirms the observations made about the Kaplan-Meier graph in Figure 3-2.

Figure 3-4: Average weekly share price by category of direct environmental footprint, separated by the median



Source: created by the author. This graph plots the average share price of firms in each category of direct environmental footprint (DirEnvFootprint), separated by the median. For each firm in the sample, base 100 is taken as the average share price before the event, then all weekly prices are plotted against the baseline value. Both curves reach their lowest point before week 10, then rebound. The curve for low environmental footprint firms overtakes 100 at week 23, while that of high environmental footprint firms overtakes 100 at week 37, but does not maintain this level for 5 consecutive weeks, according to the methodology, recovery for the average high environmental footprint firm would be assessed at week 41.

All OLS regression models in appendices (Appendices 2 and 3) lead to the same conclusion: although environmental footprint seems to reduce the severity of loss in bivariate analyses and simple regression models, EP does not affect the stability dimension of resilience in the case of droughts in the U.S. when controlling for other factors, and neither does water intensity. The relatively low levels of VIF measures in these models (lower than 4) mitigate our concern for multicollinearity in including the same set of variables in other regression models.

Then, exponential survival analysis regressions are used to test the effect of the variables of interest on the rate of recovery, gradually including control variables. These models predict the probability of recovery at time  $t$  comprised between 0 and 314 days, the relationship can be expressed as:

$$h_i(t) = e^\alpha e^{(X_{ij}\beta_j)}$$

Where  $h_i(t)$  represents the hazard rate of recovery for the  $i^{\text{th}}$  observation at time  $t$ .  $X$  is a set of variables as described above,  $e^\alpha$  is the baseline hazard function parameterized as taking an exponential form,  $\beta$  are the regression coefficients for all  $j$  variables. A positive coefficient indicates a positive link with resilience. In Table 3-6 and the subsequent survival analysis models, the coefficients are reported rather than hazard ratios, and standard errors in parentheses for each variable except fixed-effects binary variables.

These tests point in the direction of a negative effect of *DirEnvFootprint* on the rate of recovery as the coefficient for our main variable of interest is negative and statistically significant ( $p < 0.05$ ) in most models of Table 3-6. The robustness of this result to changes in the selection of the most water dependent firms in the dataset is then tested (Table 3-7) by restricting the dataset to the water dependent sectors identified by Huynh et al. (2020). Further tests for the robustness to changes in the length of the window of recovery observation are provided in Table 3-8 by restricting the length of the recovery period to various windows from 20 to 120 weeks. The robustness of the results to changes in the survival analysis regression model type (Table 3-9) are given by using Weibull and Gompertz survival analysis regression models.

Finally, the set of rules for the selection of drought events is modified to test if the main results hold when the selection process is more restrictive. Firstly, only droughts where the period of severe (D3) to extreme (D4) drought affecting more than 70% (instead of 50%) of the



state's area last for more than 3 weeks (instead of one) are retained in the *SevereDrought* subsample (272 observations). Secondly, a *LongDrought* subsample is created, only accepting events if the drought period lasts for a minimum 1 year (52 consecutive weeks instead of 20, 256 observations). Thirdly, the conjunction of these more restrictive rules leads to a third subsample, respecting the rules of both *SevereDrought*, and *LongDrought*: *SevlongDrought* (195 observations). The results of these robustness tests are presented in Table 3-10, they confirm the main result, and thus reinforce the soundness of the event selection methodology. These tests also show that the positive effect of EP on the flexibility dimension of resilience is particularly relevant for longer droughts that exceed one year.

The effect of *DirEnvFootprint* remains negative and significant across all these specifications. According to these results, the higher the direct environmental footprint of a firm, the slower its recovery from drought events, all else equal. The coefficient in the main survival analysis model ("Exp Full" from Table 3-6) shows that a one-unit increase in *DirEnvFootprint* (an extra billion USD of the total value of environmental footprint) leads to a decrease in the hazard rate of recovery by a factor of 85.63%. A lower hazard rate of recovery translates in increased time necessary for the firm's share price to recover to its pre-crisis value. Furthermore, the relationship between environmental footprint and the flexibility dimension of resilience holds when controlling for water intensity, which is the part of environmental footprint most directly relevant in the case of droughts. This result is an indication that firms that manage to reduce their environmental footprint will yield a positive effect on recovery to droughts beyond just their ability to reduce water dependency.

Table 3-6: Exponential survival analysis regressions on rate of recovery, main model construction

VARIABLES	(1) Exp 1	(2) Exp 2	(3) Exp 3	(4) Exp 4	(5) Exp Full
DirEnvFootprint	-0.189** (0.084)	-0.180** (0.085)	-0.190** (0.085)	-0.188** (0.085)	-0.194** (0.086)
DepthOfLoss	-0.035*** (0.003)	-0.035*** (0.003)	-0.036*** (0.003)	-0.036*** (0.003)	-0.036*** (0.003)
ROA	-0.036*** (0.010)	-0.034*** (0.011)	-0.035*** (0.011)	-0.035*** (0.011)	-0.034*** (0.011)
Size	0.262*** (0.061)	0.252*** (0.064)	0.288*** (0.070)	0.290*** (0.070)	0.280*** (0.070)
FinLev		0.003 (0.005)	0.002 (0.005)	0.002 (0.005)	0.003 (0.005)
Momentum			0.167 (0.128)	0.168 (0.129)	0.157 (0.128)
CAPEX				0.228 (1.253)	-0.121 (1.294)
WaterIntensity					0.059 (0.053)
<i>Control binaries</i>					
Sector	Yes	Yes	Yes	Yes	Yes
State of HQ	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes
LR Chi <sup>2</sup>	460.33	460.68	462.28	462.31	463.56
Observations	345	345	345	345	345

Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. This table presents the coefficients of independent and control variables regressed with the exponential survival analysis method over the dependent variable *TimeToRecover*, the number of weeks required for the firm to recover from the loss following the drought, taking the full period to assess the recovery. A positive coefficient means the variable accelerates the recovery (it increases the hazard rate of recovery). The coefficients for control binary variables are not reported for the sake of brevity.

Table 3-7: Robustness test: exponential survival analysis regressions on rate of recovery, effect of environmental footprint in water dependent industries according to Huynh et al. (2020) (Panel B)

VARIABLES	(2) Exp H	(3) Exp H Full
DirEnvFootprint	-0.254** (0.110)	-0.254** (0.110)
DepthOfLoss	-0.033*** (0.004)	-0.034*** (0.004)
ROA	-0.051*** (0.016)	-0.049*** (0.016)
Size	0.363*** (0.097)	0.348*** (0.098)
FinLev	-0.006 (0.006)	-0.005 (0.007)
Momentum	0.575*** (0.167)	0.546*** (0.174)
CAPEX	-0.593 (1.557)	-0.932 (1.634)
WaterIntensity		0.047 (0.066)
<i>Control binaries</i>		
Sector	Yes	Yes
State of HQ	Yes	Yes
Year	Yes	Yes
LR Chi <sup>2</sup>	266.04	266.54
Observations	218	218

Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. This table presents the coefficients of independent and control variables regressed with the exponential survival analysis method over the dependent variable *TimeToRecover*, the number of weeks required for the firm to recover from the loss following the drought, taking the full period to assess the recovery. A positive coefficient means the variable accelerates the recovery (it increases the hazard rate of recovery). The coefficients for control binary variables are not reported for the sake of brevity. The initial sample is restricted to the water dependent sectors identified by (Huynh et al., 2020).

Table 3-8: Robustness tests: exponential survival analysis regressions on rate of recovery, main model with varying time frames

VARIABLES	(1) Exp 20W	(2) Exp 30W	(3) Exp 40W	(4) Exp 50W	(5) Exp 100W	(6) Exp 120W
DirEnvFootprint	-0.128* (0.077)	-0.141* (0.076)	-0.135* (0.077)	-0.136* (0.077)	-0.152** (0.077)	-0.161** (0.077)
DepthOfLoss	-0.012*** (0.003)	-0.014*** (0.003)	-0.016*** (0.003)	-0.018*** (0.003)	-0.024*** (0.003)	-0.026*** (0.003)
ROA	-0.020** (0.010)	-0.023** (0.010)	-0.026*** (0.010)	-0.028*** (0.010)	-0.030*** (0.010)	-0.030*** (0.010)
Size	0.089 (0.058)	0.116** (0.058)	0.131** (0.058)	0.148** (0.058)	0.209*** (0.059)	0.224*** (0.059)
FinLev	-0.001 (0.005)	0.000 (0.005)	0.000 (0.005)	0.001 (0.005)	0.002 (0.005)	0.003 (0.005)
Momentum	0.069 (0.097)	0.104 (0.098)	0.117 (0.100)	0.132 (0.102)	0.202* (0.105)	0.217** (0.106)
CAPEX	-0.954 (1.092)	-1.108 (1.120)	-1.125 (1.137)	-1.147 (1.151)	-0.874 (1.186)	-0.794 (1.197)
WaterIntensity	0.018 (0.045)	0.024 (0.045)	0.025 (0.045)	0.024 (0.045)	0.036 (0.046)	0.039 (0.046)
<i>Control binaries</i>						
Sector	Yes	Yes	Yes	Yes	Yes	Yes
State of HQ	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
LR Chi <sup>2</sup>	93.25	111.55	127.88	143.38	205.23	228.38
Observations	345	345	345	345	345	345

Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. This table presents the coefficients of independent and control variables regressed with the exponential survival analysis method over the dependent variable *TimeToRecover*, the number of weeks required for the firm to recover from the loss following the drought, taking various periods of analysis (varying from 20 weeks to 120 weeks) to assess the recovery. A positive coefficient means the variable accelerates the recovery (it increases the hazard rate of recovery). The coefficients for control binary variables are not reported for the sake of brevity.

Table 3-9: Robustness tests: other survival analysis regression models on rate of recovery, Weibull and Gompertz models

VARIABLES	(1) Exp Weibull	(2) Exp Weibull 2	(3) Exp Gompertz 2	(4) Exp Gompertz 2
DirEnvFootprint	-0.151** (0.076)	-0.152** (0.078)	-0.136* (0.075)	-0.138* (0.076)
DepthOfLoss	-0.022*** (0.003)	-0.022*** (0.003)	-0.019*** (0.003)	-0.019*** (0.003)
ROA	-0.025*** (0.009)	-0.025*** (0.009)	-0.028*** (0.009)	-0.028*** (0.009)
Size	0.137** (0.057)	0.137** (0.057)	0.132** (0.056)	0.133** (0.056)
FinLev	0.004 (0.004)	0.004 (0.004)	0.004 (0.004)	0.004 (0.004)
Momentum	0.082 (0.095)	0.082 (0.095)	0.084 (0.094)	0.085 (0.094)
CAPEX	-0.179 (1.122)	-0.191 (1.135)	-0.573 (1.112)	-0.602 (1.122)
WaterIntensity		0.003 (0.043)		0.009 (0.043)
<i>Control binaries</i>				
Sector	Yes	Yes	Yes	Yes
State of HQ	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
LR Chi <sup>2</sup>	154.71	154.72	132.17	132.21
Observations	345	345	345	345

Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. This table presents the coefficients of independent and control variables regressed with various survival analysis methods (Weibull and Gompertz) over the dependent variable *TimeToRecover*, the number of weeks required for the firm to recover from the loss following the drought, taking the full period to assess the recovery. A positive coefficient means the variable accelerates the recovery (it increases the hazard rate of recovery). The coefficients for control binary variables are not reported for the sake of brevity.

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Table 3-10: Robustness test: event selection methodology variations, exponential survival analysis models

Subsample	(1)	(2)	(3)	(4)	(5)	(6)
	Exp 1	Exp Full	Exp 2	Exp Full 2	Exp 2	Exp Full 2
VARIABLES	<i>SevereDrought</i>		<i>LongDrought</i>		<i>SevlongDrought</i>	
DirEnvFootprint	-0.143* (0.092)	-0.177* (0.103)	-0.313*** (0.089)	-0.316*** (0.091)	-0.301*** (0.109)	-0.328*** (0.111)
DepthOfLoss	-0.046*** (0.004)	-0.047*** (0.004)	-0.033*** (0.003)	-0.033*** (0.003)	-0.040*** (0.005)	-0.041*** (0.005)
ROA	-0.033*** (0.011)	-0.031*** (0.011)	-0.039*** (0.012)	-0.039*** (0.012)	-0.040*** (0.014)	-0.038*** (0.014)
Size	0.281*** (0.074)	0.289*** (0.074)	0.389*** (0.069)	0.391*** (0.070)	0.390*** (0.086)	0.394*** (0.086)
FinLev	0.001 (0.005)	0.001 (0.006)	0.007 (0.006)	0.007 (0.006)	0.010 (0.006)	0.012* (0.007)
Momentum	0.266* (0.143)	0.264* (0.141)	0.172 (0.151)	0.173 (0.151)	-0.025 (0.233)	-0.009 (0.225)
CAPEX	2.332* (1.404)	1.652 (1.443)	-0.995 (1.462)	-0.994 (1.486)	0.692 (1.905)	0.611 (1.895)
WaterIntensity		0.012 (0.054)		0.010 (0.054)		0.098 (0.062)
<i>Control binaries</i>						
Sector	Yes	Yes	Yes	Yes	Yes	Yes
State of HQ	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
LR Chi <sup>2</sup>	415.47	420.71	346.82	346.85	362.31	364.96
Observations	272	272	256	256	195	195

Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. This table presents the coefficients of independent and control variables regressed with the exponential survival analysis method over the dependent variable *TimeToRecover*, the number of weeks required for the firm to recover from the loss following the drought, taking the full period to assess the recovery. A positive coefficient means the variable accelerates the recovery (it increases the hazard rate of recovery). The coefficients for control binary variables are not reported for the sake of brevity. The sample selected for the regressions vary from the main sample as follows: SevereDrought models only include observations where the period of extreme to severe drought affects at least 70% of a state for at least 3 weeks; LongDrought models only include observations where the period of drought exceeds 52 weeks; SevLongDrought models only include observations that respect the conditions of both previous subsamples.

### 3.4 Discussion and Conclusion

This empirical analysis observes the resilience of 345 firms to severe drought events in the U.S. to determine the effect of their environmental footprint on their stability and flexibility during these extreme climate events. The results exhibit a negative relationship between environmental footprint and resilience, as heavier levels of the value of firms' pollution led to longer recoveries from droughts, *ceteris paribus*. This result is robust to multiple model specifications, different time frames of analysis, and different sample selection methodologies. Correspondingly, firms with a heavier impact on their environment than their peers struggle more than others in the advent of a severe drought, particularly if this drought lasts for more than a year. The implication of this point is that organizations that implemented pollution prevention mechanisms also strengthen their ability to recover from the financial losses caused by droughts.

This result seems to challenge neoclassical economics, and support both the NRBV perspective, and the stakeholder theory. Increased attention to pollution prevention, product stewardship and sustainable development, with the intention of minimizing the impact of an organization's activities on the environment, foster the creation and amplification of strategic capabilities which accrue over time and allow the organization to better confront critical situations, particularly when the situation arises from slow-onset nature adversity (Clément & Rivera, 2017; Ortiz-de-Mandojana & Bansal, 2016; Rivera et al., 2022; Russo & Fouts, 1997). Although tacit and socially complex firm-specific capabilities are difficult to observe empirically, these sources of competitive advantage can be construed from better EP, which leads to the conclusion that firms that devoted more attention and resources to efficient pollution prevention strategies are more flexible, more apt to respond to disturbances arising from severe droughts than their peers, all else equal. This study thus contributes to the NRBV by providing an empirical demonstration of the value of pollution prevention strategies for resilience in the

context of extreme water scarcity conditions. In their efforts to reduce environmental footprint, firms further demonstrate goodwill and respond to stakeholder expectations, which may also explain the result of this study, as stakeholders would be more inclined to support a trusted organization with positive environmental reputation than another, leading to more flexibility during crises.

By supporting the value of pollution prevention strategies, this study also contributes to the growing literature supporting EP as a source of sustainable competitiveness (Endrikat et al., 2014; Foulon & Marsat, 2023; Garel & Petit-Romec, 2021; Salem et al., 2015) because improving their environmental footprint allows firms to recover better from droughts. Besides, the findings in this work also contribute to our understanding of how firms respond to nature adversity (Boudreault et al., 2023; Bourdeau-Brien & Kryzanowski, 2020; Miao et al., 2018; Noth & Rehbein, 2019; Oh & Oetzel, 2022) and droughts in particular (Huynh et al., 2020). By further supporting the point that the financial consequences of droughts are economically significant, this work further strengthens the rationale behind the study of such extreme weather events and the way they affect organizations.

This work also contributes to the flourishing literature on resilience. It is a rare study of the consequences of droughts for firms at a time when they are expected to become increasingly damaging for the global economy (United Nations, 2022), and the United States in particular (Cook et al., 2015). As such, it provides an additional empirical analysis confirming the relevance of the resilience framework (Duchek, 2020; Linnenluecke, 2017; Raetze et al., 2022), and the recently developed methodology for assessing the multidimensional outcomes of the resilience process (DesJardine et al., 2019).

The conclusions of this chapter have additional implications for managers and investors. First, managers worried about the ability of their organization to survive droughts and recover from extreme weather events should consider improving the overall impact of their



organization's activities on the environment. Due attention to the dependency on natural resources, and a particular emphasis on saving water, is expected to yield benefits beyond the ecological efficiency of their operations and addressing stakeholder expectations, it may also encourage the creation and nurturing of underlying capabilities that accelerate recovery, among other sustainable advantages.

Second, the value of environmental footprint reduction may constitute an interesting factor to assess the risk profile of financial assets. Investors that are partial on reducing their exposure to climate risk, or wish to favor the inclusion of more environmentally responsible assets in their portfolio, should pay attention to direct measures of environmental footprint such as the ones provided by Trucost. Throughout the results presented here, it is apparent that heavy polluters face a harder time in the advent of a drought than their peers, this implies that harming the environment has additional consequences on a firm's share price in challenging times. It follows that investors who do not properly assess the sustainability of their portfolio constituents not only run the risk of missing opportunities, they are also exposed to lower returns in the long-term as extreme weather event will multiply and intensify (IPCC, 2022).

The main limit of this study pertains to our constrained access to data. Only a fraction of companies affected by the droughts can be observed, the Trucost dataset does not cover the full population of firms headquartered in the United States, and smaller companies are particularly underrepresented. Additionally, access to data on private equity companies is more restricted, which makes them much more difficult to observe from a financial resilience perspective.

Moreover, the restriction to U.S. Data harms the generalizability of the results presented here. Because readily accessible and precise information about the drought status of areas is not available for most other regions in the world, or measured using different methodologies, it was not convenient to include data from other countries in the analysis. The use of open data

practices, along with good curation of this data, in other climate monitoring agencies around the world would greatly help researchers understand the consequences of climate change for companies and populations, yielding crucial insight for decision-makers. In this effort, it is also important to consider using a common methodology of measuring and tracking climate characteristics so data can be immediately comparable between countries.

Furthermore, the necessary restriction of our data to firms in sectors that are heavily dependent on water resources introduces a sample bias, which reduces the representativeness of the sample, further harming generalizability to other contexts. In other words, the sample used to study the resilience to droughts used here is specific for drought events, the reflections made here should be considered speculative with regards to other types of disruptions, in the absence of reliable empirical evidence.



## Chapter 4 - Environmental Performance and Financial Resilience to the Covid-19 Crisis: International Evidence<sup>9</sup>

### Abstract

This study brings a new perspective on the relationship between environmental performance (EP) and financial resilience by empirically considering two outcomes of resilience: stability and flexibility. Using data from financial markets and environmental performance reporting to study the financial resilience of a sample of 6,663 companies worldwide to the wild card Covid-19 crisis, it reports that while EP and its constituents are predominantly associated with a longer and less likely recovery from the loss, environmental innovation and emissions reduction helped firms by reducing the severity of their loss in the period immediately following the crisis. These results imply that the relationship between EP and resilience is not straightforward and depends heavily on the context of the resilience process, informing both managers and investors about the synergies and tradeoff between EP constituents and resilience. This study extends our theoretical understanding of both the global financial consequences of the pandemic and how EP affects the resilience process.

**Keywords:** Resilience; Environmental Performance; Survival Analysis; Corporate Social Responsibility, ESG Ratings

**JEL Classification:** G12, M14, O16, Q51

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<sup>9</sup> Earlier versions of this chapter were presented as a working paper in the 8<sup>th</sup> NIBES Research Workshop, at the AFFI 2024 and CIG 2024 conferences organized at Lille's *Institut d'Administration des Entreprises*, and at the EFMA 2024 conference at Lisbon's *Instituto Superior de Economia e Gestão*.

## 4.1 Introduction

On February 20<sup>th</sup>, 2020, following the first death from the newly spreading Coronavirus, the mayor of the South Korean city of Daegu urged the 2.5 million citizens of his southeastern city to remain home and wear masks as much as possible (New York Post, 2020). The following day, as many more cases of Covid-19 were reported in multiple areas around the globe, and as many business sectors were expected to be affected by the spread of the virus and the efforts to contain it, stock markets started declining dramatically. By the end of February 21<sup>st</sup>, confirmations of the spread of Covid-19 in 26 countries outside China, and 11 related deaths corroborated the markets' concerns. Over the following weeks, lockdown measures were taken by most of the affected countries during what is now often called the first lockdown period, or “fever” period according to Garel & Petit-Romec (2021). This period marks the end of an eleven-year long bull market that lasted since the Global Financial Crisis following the 2007 – 2008 Subprime Mortgage Crisis, and the start of a bear market. In the initial period spanning over March and April 2020, most market indices fell by loss rates the likes of which hadn't been seen since the Wall Street Crash of 1929. To name a few examples, the U.S. S&P 500 fell by 30% in March, the U.K. FTSE plunged by 29.72%, the German DAX index lost 33.37%, the French CAC 33.63%, and the Japanese NIKKEI dropped by 26.85% (Jabeen et al., 2021). Since then, most market indices have recovered their pre-crisis value. The S&P overtook its February 19<sup>th</sup> level on August 21<sup>st</sup> 2020 and kept increasing afterwards, the FTSE 100 did so in early June 2022, the DAX and the CAC recovered in early January 2021, and the NIKKEI recovered in early September 2020. As financial markets, and economies more generally, have experienced different patterns of recovery, the companies traded on those markets have also undergone radically different processes in confronting the crisis.

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In this episode of massive worldwide disruption, many voices were raised to underline the necessity to make use of the recovery effort to promote sustainability in business practices. These calls for a “Green Economic Recovery” (OECD, 2020; Taherzadeh, 2021) stem from the evident ability of governments to take immediate and dramatic measures to tackle an existential threat, and the possibility for populations to adapt their lifestyles to restrictions, at least temporarily (Koundouri, 2020). For over a decade, firms have been pressurized to reduce their negative impacts on their external environment, and on the climate in particular (Flammer, 2013). In this context, firms rely on Corporate Social Responsibility (CSR), the organizational proficiency to integrate social and environmental concerns in business operations and interactions with stakeholders, and the improvement of their Environmental Performance (EP) in particular, to demonstrate their capability in facing challenges related to climate change, and gradually improve or transform the efficiency of their operations for a sustainable future.

Within the sustainability perspective, the multiplication and intensification of crises at the global scale press for a better understanding of how human systems can resist and bounce back after shocks. Organizational response to threats and crises is where the use of the resilience concept is most useful (Linnenluecke, 2017; Duchek, 2020). In recent academic papers, the resilience framework has been used to empirically explore the response of firms to disruptive events such as the 2008 global financial crisis (DesJardine et al., 2019; Marsat et al., 2021), the terrorist attacks of September 11<sup>th</sup>, 2001 (Gittell et al., 2006), or the COVID-19 crisis (Ullah et al., 2022; Azeem et al., 2023). Many of these studies took interest in the effect of CSR and its constituents on resilience, with contradicting theoretical arguments and results.

The primary intent of this paper is to study the influence of EP on the resilience of firms to the Covid-19 crisis on the global scale, using as large a sample as possible. By doing so, the intention is to bring new answers to the following overarching problem: does environmental performance reduce the impact of financial disruptions and recover the losses?

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Answering this question broadens our knowledge of how firms recovered from the global financial crisis caused by the pandemic because, to my knowledge, aside from Li et al. (2022), who focus on the effect of servitization on the resilience of firms in the US, there is no other empirical study considering the long-term recovery period following the crisis with a methodology that allows for the separation of the outcomes of resilience, stability and flexibility, which supports a more nuanced perception of the effect of EP on resilience, and uses this approach in an international sample. By reviewing the influence of each available constituent of EP, this study further contributes to the academic knowledge about the place EP holds in the relationship between CSR and resilience and which aspect of EP is relevant in a wild card health crisis. This empirical study should also be viewed as a contribution to the literature studying the relationship between EP and the financial performance (FP) of firms. Specifically, it brings empirical evidence that EP significantly affects the financial situation of firms in a disruptive environment as the tests presented in this paper, based on a sample of 6,663 firms from 80 countries, support a positive effect of environmental innovation and emissions reduction on stability, but a negative effect of all EP constituents on flexibility. This research thus calls into question the position of EP as a contributing factor to financial resilience despite the support provided by prior studies (Albuquerque et al., 2020; Foulon & Marsat, 2023; Marsat, Pijourlet, & Ullah, 2022).

The remainder of this paper is organized with the following sequence: the next section reviews the academic literature relevant to the resilience framework, the research on the EP – resilience relationship, as well as the study of the Covid-19 crisis, with a particular attention to studies that employed a survival analysis methodology. Section 4.3 describes the sample construction, the variables used and the methodological choices. Section 4.4 describes the

results obtained and the robustness tests. Ultimately, the results are discussed, and a conclusion is made in Section 4.5.

## 4.2 Literature Review

### 4.2.1 The economic and financial impact of Covid-19

Many researchers interested in empirically studying Organizational Resilience (OR) have done so by observing the way systems respond to adverse events. In his renowned study of the Mann Gulch Disaster, Weick (1993) observed the effects of individual and group characteristics on organizational resilience. Gittell et al. (2006) used the crisis in the U.S. airline industry following the terrorist attacks of September 11, 2001 to determine which firm strategies fostered recovery and which had not. In a very similar manner, as mentioned above, the 2008 Global Financial Crisis gave researchers an empirical context to appraise organizational resilience (Buchanan et al., 2018; DesJardine et al., 2019; Lins et al., 2017; Marsat et al., 2021). Therefore, it is not surprising that the recent financial crisis following the spread of Covid-19 gave way to a significant number of similar studies from researchers interested in OR, risk response, or business continuity. Although it has been argued that the financial consequences of the pandemic situation were predictable due to previously existing instabilities (Wullweber, 2020), most observers and researchers seem to agree that the Covid-19 crisis was not predictable, it was characterized as a “*wild card crisis*” by Safón et al. (2024). An exogenous and disruptive shock constitutes a particularly suitable setting to observe resilience to an adverse event for which preparation was very limited, it allows researchers to alleviate endogeneity issues between EP and financial performance.

Albuquerque et al. (2020), for instance, considered that “the magnitude and speed of the stock market crash [...] took everyone by surprise.” They documented how firms with high environmental and social ratings benefited from significantly higher returns and lower return



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volatility over the first quarter of 2020 in the U.S., thereby indicating EP had a positive effect on resilience in this context, at least on the stability dimension. In another early study of resilience to the Covid-19 crisis, Huang et al. (2020) reported that pre-shock CSR performance positively influenced the organizational resilience of a large sample of Chinese firms from January 20<sup>th</sup> to June 10<sup>th</sup>, 2020, they used the methodology of DesJardine et al. (2019) to support their argument, CSR positively affecting both dimensions of OR (stability and flexibility). The positive effect of CSR activities on the stability dimension of resilience was further confirmed at the international scale by the work of Ding et al. (2021), who also reported that the drop in stock returns was milder for firms with stronger finances before 2020 (cash, undrawn credit, less debt and larger profits). Garel & Petit-Romec (2021) studied the influence of EP on the stock returns of a large sample of U.S. companies, focusing on the crisis period (January 20<sup>th</sup> to March 20<sup>th</sup>). They found that firms with responsible strategies on environmental issues experienced better stock returns, and that the effect was mainly driven by initiatives related to climate change such as emission reduction policies, or energy use reduction. Extrapolating these results a bit, it can be speculated that EP (especially firm policies pertaining to resource use and emissions reduction) favors the stability dimension of resilience. Cardillo et al. (2022) also studied the stock returns in a large sample of firms from 15 European countries over the entire year 2020 and concluded that firms with high ESG scores are less volatile and outperform their peers in terms of stock returns.

Some studies also brought to light some interesting facts about *how* and *why* some firms resisted and bounced back, and some did not. Hermundsdottir et al. (2022) reported that the most environmentally innovative firms in a large sample of Norwegian manufacturers were more impacted by the crisis (lower stability). Using survey data, Ferrón-Vílchez & Leyva-de la Hiz (2023) mainly revealed that resilience is associated with improvements in business

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performance in SMEs, they also underlined how the adoption of social and environmental practices underlies the development of OR. In an analogous spirit, Karman et al. (2023) revealed the effects of the triple bottom line (TBL) approach on firm value. By comparing the crisis period to a more stable period, they managed to establish that the economic and social dimensions of the TBL approach positively influence firm value regardless of the period, but that during the Covid-19 crisis, the ecological dimension did not improve firm value, they concluded that a normal economic period is required for green initiatives to positively affect firm value.

To the best of my knowledge, only a handful of studies employed a survival analysis methodology, analogous to the one employed in the present paper, to assess the flexibility dimension in the Covid-19 period. First, Li et al. (2022) focused on how service-oriented business models (servitization) affected resilience during the Covid-19 outbreak, and conclude that manufacturing firms with more revenue from service businesses endured heavier stock price losses and took longer to bounce back from those losses than their peers, and that the impact was more pronounced in firms providing product-oriented services rather than customer-oriented services. Ullah et al. (2022) used it to document a better flexibility of firms with green supply chain management practices relative to their peers in a large international sample, and Azeem et al. (2023) employed this method to report how boardroom gender diversity negatively impacts flexibility in countries with female directorship quotas, strong governance and lower GDP per capita.

Altogether, I argue that the dual approach addressing both stability and flexibility to assess the full outcome process of resilience is the most thorough approach to properly address how an anticipated factor affects resilience, it also has the advantage to rely on accessible financial data, which allows researchers to leverage large quantities of data in international samples including multiple business sectors. In this research paper, the main objective is to

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assess the effect of EP on financial resilience to the Covid-19 crisis, it is addressed by measuring resilience with the stability and flexibility dimensions in a large international sample. In so doing, this study is expected to contribute to the resilience literature by producing a thorough analysis of how EP and its constituents affect stability and flexibility in a comprehensive international database covering two years of data (2020 – 2021) to cover the full crisis period. By considering the two main outcome characteristics of resilience separately, this paper contributes to the literature by bringing empirical evidence that the effect of a factor on financial resilience can be ambiguous, affecting stability and flexibility in opposing directions. This point suggests more theoretical attention should be given to both antecedents and outcomes in the resilience process, which should not be treated as a monolithic concept, but a conjunction of *ante-crisis characteristics* (e.g. anticipation, preparedness, resources) and *post-crisis outcomes* (e.g. stability, flexibility, learning).

### 4.2.2 Environmental performance, financial performance, and financial resilience

Many empirical researchers have sought to provide evidence on how CSR influences FP. In the 2008 GFC context, Lins et al. (2017) documented that high CSR intensity helped firms generate better financial performance through higher stock returns, profitability, growth, and sales per employee relative to their low-CSR peers. In a meta-analysis, Endrikat et al. (2014) compiled 149 such empirical studies to assert the overall link between EP and FP is positive, partially bidirectional, and is stronger when the strategic approach supporting EP is proactive rather than reactive. Overall, the outperformance of socially responsible assets during times of crises is well established in empirical analyses.

While all organizations face challenges throughout their existence, not all crises can be overcome by every previously existing organization. The ability to overcome disruptions and bounce back gradually became understood as *Organizational Resilience* (OR) in the business

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literature and should be understood as an extension of the ecological concept of resilience, namely the ability for an ecosystem to absorb external shocks (As in Holling (1973): “*there is another property, termed resilience, that is a 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*”). While multiple definitions of organizational resilience have been used in this growing strand of literature (Linnenluecke, 2017), there seems to be an agreement between empirical analysts over the “sustain and recover” approach, for which the definition given in Gunderson & Pritchard (2002) is adapted to properly understand the implications of this concept (DesJardine et al., 2019; Ullah, 2020; Marsat et al., 2022; Foulon & Marsat, 2023). In this paper, the term resilience is used under the same meaning: *the ability of a system to persist despite disruptions and the ability to regenerate and maintain existing organization.*

A narrow body of literature investigated the effect of CSR on resilience, many of which employing various definitions of resilience and sundry methodologies to assess resilience outcomes. For example, in their seminal work on the subject, Ortiz-de-Mandojana & Bansal (2016) proxied resilience (defined as “*the firm’s ability to sense and correct maladaptive tendencies and cope positively with unexpected situations*”) with long-term outcomes such as financial volatility, sales growth and survival on 121 pairs of firms over a 15-year period. Their investigation concluded that social and environmental practices contribute to organizational resilience, and short-term desirable outcomes in the meantime. Other researchers employed qualitative methodology (e.g. Tisch & Galbreath, 2018), but in quantitative empirical papers, one of the most common academic views in recent years is the two-dimensional definition of resilience (Gunderson & Pritchard, 2002), which leads researchers to observe two characteristics: stability, the “*size of the drop in performance*” and flexibility, “*the time it took*

*to recover to pre-shock performance levels”* (Aven, 2011; Buyl et al., 2019; DesJardine et al., 2019; Foulon & Marsat, 2023; Sajko et al., 2021).

The aim of this paper is to bridge these strands of literature by addressing, in detail, the relationship between corporate environmental performance (EP), its constituents, and financial resilience in the context of the Covid-19 global financial crisis. Some studies investigated how EP affects financial resilience, but most did not use a survival analysis methodology, and none did so in the context of the Covid-19 crisis.

#### 4.2.3 Conceptual framework and hypotheses

Because the term resilience itself was adapted from an ecological concept, it is not surprising that multiple authors have attempted to study and describe the relationship between EP and resilience. This leads to multiple theoretical frameworks being useful to hypothesize on the effect of EP on both the persistence and recovery of firms in disruptive environments.

First, organizations can integrate social and environmental concerns in their operations and interactions with stakeholders, thereby expecting to obtain competitive advantages and organizational resources in exchange for their attention to social and environmental welfare. This view of Corporate Social Responsibility (CSR) leads us to various arguments pertaining to the effect of improving EP on resilience. Porter & van der Linde (1995) showed that pollution reduction policies can lead to reduced costs and other “win-win” opportunities as pollution is sometimes a sign of inefficacy in the production process. Arora & Gangopadhyay (1995) explained how overcompliance in green production allows firms to access a “green customer base” with a higher willingness to pay a premium price for environmentally friendly products. Baron (2005) argued CSR efforts help firms understand the workings of the political system in order to dissuade the enforcement of stringent regulation, build goodwill with regulators and reduce the sanction associated with noncompliance (see also Yu (2005) and Foulon & Marsat

(2023)). These efforts may also help firms reach voluntary agreements with regulators (Blackman et al., 2006; Glachant, 2007; Segerson & Miceli, 1998), anticipate and shape regulation when it cannot be stopped (Denicolò, 2008; Lutz et al., 2000), screen for employees interested by socially responsible employment, even if it is associated with lower wages (Brekke & Nyborg, 2008; Hsieh, 2006), and have their shares trade at a premium price among “green investors” (Baron, 2005, 2007; Graff et al., 2005). All these arguments uphold advantages for firms with extensive approach to CSR with regards to their resilience, they should have access to better resources, better anticipate changes, and be able to respond appropriately when a crisis emerges to resist the disruption and perhaps recover their pre-crisis situation, it may also serve as a framework leading the organization to a modified, better adapted position.

Secondly, the stakeholder theory helps complement this initial strand of arguments in favor of a mostly positive relationship between EP and resilience. Flammer (2013) reported that positive information about a firm’s behavior towards the environment see their stock price increase, while negative information leads to a stock price decrease, which demonstrates the market value of EP, but she also shows that this relationship is moderated by the external pressure to behave responsibly towards the environment, and that this pressure has increased dramatically in recent decades. In this view, the increase of firm value derived from EP stems from company reputation (Bruna & Nicolò, 2020) and improved legitimacy (Zahller et al., 2015), which help firms mobilize support from their external stakeholders, or at least mitigate their opposition. It is also expected that this advantageous position in the web of stakeholders helps firms reduce the impact of a crisis and recover faster from the loss. By contrast, organizations impeded by a lack of legitimacy and a negative reputation are exposed to strikes, boycotts, restricted access to labor, restricted access to capital with increased costs, heavier taxation and regulation, and have fewer opportunities for partnerships and joint-ventures

(Dhaliwal et al., 2011; Dowling & Pfeffer, 1975; Freeman, 2007, 2015; Kothari et al., 2009; Lindblom, 2010). While it seems rather clear how EP affects the firm's relationship with stakeholders, the reciprocal relationship is also true; Wang et al. (2020) used a meta-analysis to examine how stakeholder pressures affect corporate environmental strategies. They reported that environmental strategies are mainly driven by pressure from internal stakeholders (shareholders, board of directors, managers, and employees), are more effective in developed countries, and changed with more ease in non-manufacturing sectors. It follows that the development of EP should allow the firm to enter a virtuous circle in terms of its relationship with stakeholders, and respond to both internal and external stakeholder expectations, granting it access to stronger support in the advent of a crisis, and thereby an improved capacity to mitigate losses.

Thirdly, building on the foundations of the Resource-Based View (RBV) theory (Barney, 1991; Wernerfelt, 1984), Hart (1995) brought further theoretical arguments supporting the influence of EP on business performance, which can also help us understand its effect on organizational resilience. In this Natural-Resource-Based View (NRBV) of the firm, EP relies on three strategic capabilities firms can deploy to foster key resources and competitive advantages. (1) *pollution prevention* (minimizing emissions, effluents and waste) helps the firm initiate and reinforce its continuous improvement process, which leads to a cost advantage over its competitors (Porter & van der Linde (1995)). (2) *product stewardship* (minimizing the life cycle cost of products) cultivates positive stakeholder interactions and integration, allowing the organization to preempt competitors by obtaining priority access to important but limited resources, or by establishing a set of rules, regulations and standards tailored to the firm's superior capability. (3) *sustainable development* (minimizing the environmental burden of firm growth and development) nurtures a strong sense of social and environmental purpose and

guides the organization's strategy. This implies working over an extended period to create products and services that align with continued prosperity rather than growth at all costs, with consideration for planetary boundaries. These efforts stimulate the generation of a consensus around a shared vision about the purpose of the organization, which greatly favors its future position.

Since the inception of the NRBV, many studies have attempted to empirically substantiate its main arguments. For example, Russo & Fouts (1997) established a positive relationship between EP and economic performance. Sharma & Vredenburg (1998) documented the emergence of unique organizational capabilities (stakeholder integration, higher-order learning, and continuous innovation) as a result of strategies of proactive responsiveness to environmental uncertainty, without any negative impact on corporate competitiveness. Aragón-Correa et al. (2008) confirmed this result in SMEs which can also develop proactive environmental strategies and benefit from similar capabilities. Dixon-Fowler et al. (2013) revealed in a meta-analysis that the relationship between EP and financial performance is generally positive, supporting the arguments from the NRBV, but stressing the importance of employing a contingency approach since the relationship is context dependent, moving the question from “does it pay to be green?” to “when does it pay to be green?”. Demirel & Kesidou (2019) also relied on the same arguments to document how firms are more likely to produce eco-innovation if they possess three specific capabilities tied to organizational processes: voluntary self-regulation, environmental R&D, and green market sensing.

All the theoretical arguments and empirical results supporting a positive relationship between EP and diverse aspects of firm performance, including resilience, have of course been debated in the scientific literature. The spearhead of this criticism is rooted in neoclassical economics, epitomized in the Friedman doctrine (Friedman, 1970), according to which “the social responsibility of business is to increase its profits”. This principle and other such



prescriptions were applied while he served as an advisor to Ronald Reagan in the U.S. and Margaret Thatcher in the U.K. (Ebenstein, 2009). Fundamentally, this view does not expect any effort toward CSR to have a positive impact on corporate financial performance under capitalism. The rationale behind this argument is that the allocation of resources to activities that do not directly aim at improving profitability is counterproductive, it restrains the capacity for the firm to invest in a cost-effective and lucrative manner to maximize its market value. In this view, it would be expected that a firm which strives to improve its environmental performance does so at the expense of its financial performance, and thus at the expense of its financial sustainability and competitiveness.

Because the relationship between CSR and financial performance is nontrivial, examples of empirical results that support the arguments of the neo-classical view can be found in the recent literature. For example, in their study of how CSR affects firm value around the 2008 GFC, Buchanan et al. (2018) reported that firms with higher CSR scores experienced more losses of value during the crisis than their peers. In the same context of the GFC, Marsat et al. (2021) showed that EP hinders the flexibility dimension of resilience of firms in countries with high environmental standards as it took more time for high-EP firms to recover their pre-crisis market value than for their low-EP counterparts, all else equal. Such studies indicate that investments in EP can constitute an organizational constraint in certain settings. In particular, certain conditions are required for organizations to be resilient in disruptive situations, including sufficient financial reserves (slack resources), as described by Gittell et al. (2006). With this in mind, it seems logical that firms which invest a significant part of their resources to improve their CSR profile, or their EP, have less available resources when an unpredictable crisis emerges, and are at a disadvantage, especially if the crisis is not related to ecological issues for which the company may have developed contingency plans. Relatedly, as argued by

Yang et al (2023), a broad portfolio of CSR activities produces diversification in the firm's CSR initiatives, which complexifies the management processes, dilutes the focus of management and adds intricacy in interdepartmental connections, which may result in slower responsiveness and higher organizational rigidity in critical situations such as the 2020 pandemic. This argument aligns with the results from Sun & Govind (2017) who found that a firm's diversification increases its idiosyncratic risk during turbulent times.

Although the conflicting views and empirical results pertaining to the influence of environmental performance on firm resilience to financial crises warrant caution, the empirical enquiry developed here is done in coherence with the preceding chapters of this thesis. As such, the initial position hypothesized in this chapter is that of the Natural Resource-Based View, which supports a positive EP – OR relationship, leading to the following hypotheses:

**H1:** Firms with higher pre-crisis EP benefit from increased financial stability in the period immediately following the Covid-19 crisis.

**H2:** Firms with higher pre-crisis EP yield more financial flexibility than their peers, they require less time to recover from the shock.

## 4.3 Methodology

### 4.3.1 Research design

While recent empirical studies of financial resilience, in the wake of DesJardine et al. (2019) have used a bidimensional approach to measure resilience outcomes in critical situations. It should first be acknowledged that resilience has “three core characteristics: an adverse event as a trigger, a performance setback, and a recovery” (Su & Junge, 2023). In this paper, the start of the massive loss of stock value in exchange markets caused by the Covid-19 pandemic is considered the trigger of the resilience process. February 20th, 2020 is retained as

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the starting date for the period corresponding to the performance setback, and the remainder of year 2020 and year 2021 are taken as the recovery period by observing weekly variations of the stock prices to assess recovery. Garel & Petit-Romec (2021) used the same date to distinguish the pre-crisis from the crisis period based on a graphical analysis, the major international indices started their decline from that date. This approach is expected to expand the results reported by Garel & Petit-Romec (2021) in several ways. First, the extension of the period of analysis up to the end of the year 2021 allows for a more thorough assessment of the recovery of firms, while Garel & Petit-Romec (2021) restrict their analysis to the “fever” period covering only the initial period of the crisis, thereby primarily observing the financial stability of firms confronted with the shock. Secondly, by using the bidimensional resilience approach suggested by DesJardine et al. (2019), this work directly refers to the management literature discussing the resilience of firms to disruptions and employs a methodological approach that fits such endeavors. Finally, the results presented here will be interpreted within the theoretical framework of the NRBV, thereby expanding the range of arguments surrounding the benefits of the proactive environmental strategies of firms.

Given the possible variability in the start of the crisis between countries, exemplified in Chinese markets being affected as early as January 21<sup>st</sup> (Huang et al., 2020), the baseline value for estimating the recovery of firms is determined as the highest weekly value of their stock prior to February 20<sup>th</sup>, since it is admitted all international markets were affected by then. This may lead to recovery periods being longer than what was observed in earlier empirical works using an analogous loss and recovery methodology. I believe this approach contributes to our improved understanding of the recovery period following the heat of the Covid-19 crisis.

Taking a longer recovery period involves setbacks, the first of which is the possibility of observing the consequences of other major events, unrelated to the Covid-19 crisis, which

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would harm the interpretability of the results. While not all firms recovered from the initial shock before the start of 2022, a significant proportion has (about 70%). Extending the time window of analysis is difficult because financial markets were disturbed following the Russian invasion of Ukraine on February 24<sup>th</sup>, 2022, even for firms considered the least exposed to Russia (Leromain & Biermann, 2023). For analogous reasons, Yang et al. (2023) also used this 2-year approach in their study of the flexibility dimension of resilience to the Covid-19 crisis in a sample of Chinese firms.

### 4.3.2 Data collection

The data used in this study was collected based on a screening of the Thomson Reuters' Eikon database for firms which environmental performance data could be drawn for the year 2019 by accessing the Asset4 database through Thomson Reuters Datastream. Financial data for all companies included in ESG data for the year preceding the Covid-19 crisis (2019) were retrieved using Thomson Reuters Datastream. Only observations that were missing important information such as the firm's stock price in the period surrounding February 20<sup>th</sup>, 2020, its (ESG) environmental pillar score or any of its constituents, the firm's number of employees, its return on assets ratio, its momentum, or capital expenditures, were withdrawn so as to retain as large a sample as possible. The sample selection methodology is detailed in Table 4-1. From an initial sample of 8,059 firms worldwide that were screened for having available ESG data in the Asset4 database, a total of 1,396 had to be withdrawn, leading to a sample of 6,663 observations.

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Table 4-1: Sample Selection Methodology

Firms in the sample	Obs.
Screened firms with ESG data available for year 2019.	8,059
Less: Observations missing stock price around Feb 20, 2020	(94)
Less: Observations missing important data:	
- Environmental pillar score and subconstituents	(36)
- Number of Employees	(781)
- ROA	(47)
- Momentum	(142)
- CAPEX	(296)
Final Sample	6,663

Table 4-2 presents some detailed information on the variables drawn for each observation in the sample. Most of these variables were collected using Datastream. Each firm's country of headquarters' Environmental Performance Index (EPI) for the year 2020 was retrieved from the dedicated website of Yale University<sup>10</sup>. The GDP per capita of each firm's country of headquarters was collected from the IMF's website. A great part of the sample is composed by companies headquartered in the United States, 37.04% of the total sample. The rest comprises mostly firms from developed western economies but not only. The detail for the most represented countries is available in Table 4-3, which also presents the breakdown of the sample by sector. The most represented sectors are industrials (1,144 obs, 17.2%), financials (1,042 obs, 15.6%) and healthcare (784 obs, 11.8%).

<sup>10</sup> This data is available at <https://epi.yale.edu>

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Table 4-2: Variables Description

Variables	Description	Data Source
TimeToRecover	Time in weeks for the firm's stock price to recover (remain over baseline for 5 consecutive weeks)	Datastream
DepthOfLoss	Maximum percentage loss of firm's stock price after 20/02/2020	Datastream
Recovered	Binary variable for recovery (1 if recovered, 0 otherwise)	Datastream
Size	One plus natural logarithm of the number of employees, winsorized at 1% and 99%	Datastream
ROA	Return on assets (2019), winsorized at 1% and 99%	Datastream
FinLev	Financial leverage (ratio of Total Debt to Total Assets) (2019), winsorized at 1% and 99%	Datastream
Momentum	Based on stock Price volatility, exponentially weighted moving average of the squared daily log returns over the last 200 days, winsorized at 1% and 99%	Datastream
CAPEX	One plus natural logarithm of Capital Expenditures (2019), winsorized at 1% and 99%	Datastream
Beta19	Firm's beta to local index in 2019. Covariance of the firm's stock price movement in relation to the market's price movement (local index)	Datastream
EPI	Country Environmental Performance Index (EPI) in 2020	Yale University
GDP19	Country GDP Per Capita (Current USD thousands) in 2019	IMF
EScore	Environmental Pillar Score (ESG) (2019)	Datastream (Asset4)
ResourceUse	Resource Use Score (ESG) (2019)	Datastream (Asset4)
EnvInnovation	Environmental innovation Score (ESG) (2019)	Datastream (Asset4)
Emissions	Emissions Score (ESG) (2019)	Datastream (Asset4)
Sector	Binary variable for Sector from the GICS 2-digit classification	Datastream
Country	Binary variable for country of headquarters	Datastream

Note: Datastream = Thomson Reuters' Refinitiv Datastream (historical financial database); IMF = International Monetary Fund

Table 4-3: Sample Description

Sector		Country of HQ	
Industrials	1,144	USA	2,468
Financials	1,042	China	705
Health Care	784	Japan	431
Consumer Discretionary	775	UK	349
Information Technology	611	Canada	268
Materials	572	Germany	180
Consumer Staples	426	Australia	167
Real Estate	383	Sweden	145
Communication Services	338	India	143
Energy	326	France	140
Utilities	262	Hong Kong	135
		Switzerland	131
		South Africa	93
		Italy	87
		Thailand	76
		Brazil	69
		Spain	68
		Other	1,008
N	6,663		6,663

The main variables for resilience analysis are calculated as follows: *DepthOfLoss*, the proxy for stability, is assessed by first identifying each firm's highest weekly stock value between January 1<sup>st</sup> and February 20<sup>th</sup>, 2020, this value is also considered the firm's baseline to assess recovery. Then, the firm's lowest weekly stock value following February 2020<sup>th</sup> is also identified and *DepthOfLoss* is the result of the division of the lowest post-crisis price by the highest pre-crisis price multiplied by 100. *TimeToRecover*, the proxy for flexibility, is calculated with a proprietary algorithm in Stata by identifying the first occurrence of 5 consecutive weeks of stock value over the recovery baseline (the highest stock price before February 20<sup>th</sup>, 2020), it takes the value of the number of weeks until the first of the 5 consecutive weekly prices above the recovery baseline. *Recovered* is a binary variable which takes the value 1 if the firm's weekly stock price manages to recover its pre-crisis value and remain above it for 5 consecutive weeks before January 1<sup>st</sup>, 2022.

## 4.4 Results

### 4.4.1 Descriptive statistics

Table 4-4 presents the summary statistics of the variables used in the analyses presented in this paper. The main variables for resilience reveal a 68% recovery rate for the sampled firms (*Recovered*), which took an average 57.08 weeks to recover from their loss caused by the Covid-19 crisis (*TimeToRecover*). The average loss of market value from the early 2020 peak is 45.3% (*DepthOfLoss*). The average ESG environmental pillar score (*EScore*) is 0.34, the average score for resource use (*ResourceUse*) is 0.37, for environmental innovation (*EnvInnovation*) 0.23, and 0.38 for emissions (*Emissions*). The correlations matrix is also provided in Table 4-5.

Table 4-4: Summary Statistics

VARIABLES	N	mean	median	sd	min	max	p25	p75
TimeToRecover	6,663	57.08	52	33.48	1	98	25	98
DepthOfLoss	6,663	45.30	44.20	18.07	0	99.54	32.37	56.65
Recovered	6,663	0.68	1	0.47	0	1	0	1
Size	6,663	9.19	9.43	2.04	3.64	13.40	7.91	10.61
ROA	6,663	1.87	3.71	15.77	-89.85	31.52	0.93	7.88
FinLev	6,663	24.10	21.82	20.06	0	87.22	6.11	36.81
Momentum	6,663	2.48	2.12	1.32	0.88	8.32	1.65	2.87
CAPEX	6,663	18.90	19.09	2.25	12.00	23.56	17.55	20.44
Beta19	6,663	1.04	1.00	0.56	-7.16	4.76	0.69	1.33
EPI	6,663	50.53	51.10	13.72	18.90	77.90	50	57.20
GDP19	6,663	45.77	48.28	23.04	0.96	167.02	33.63	65.08
EScore	6,663	0.34	0.29	0.29	0	0.99	0.04	0.58
ResourceUse	6,663	0.37	0.33	0.34	0	0.99	0	0.67
EnvInnovation	6,663	0.23	0	0.30	0	0.99	0	0.50
Emissions	6,663	0.38	0.34	0.34	0	0.99	0	0.68

Summary statistics of the sample. The Flexibility dimension of Resilience is *TimeToRecover*, the number of weeks of market price recovery calculated over the 97 weeks following 20/02/2020, until 01/01/2022. The Stability dimension of Resilience is *DepthOfloss*, the maximum percentage loss of the firm's stock price after 20/02/2020. *Recovered* is a binary variable meant to test the likelihood of recovery in Logit models. *Size* is one plus the natural log of firms' number of employees. *ROA* is the return on assets ratio. *FinLev* is the financial leverage ratio (total debt divided by total assets). *Momentum* reflects the market changes in the 200 days preceding the event. *CAPEX* is the firm's capital expenditures in 2019, in Billion USD. *Beta19* is the covariance of the firm's stock price movement in relation to the market's price movement in 2019. All the financial control variables are winsorized at the 1% and 99% levels. *EPI* is the measure of the Environmental Performance Index of the country of headquarters in 2020. *GDP19* is the GDP per Capita of the country of headquarters in 2019. Multiple Scores are derived from the Asset4's ESG databases, these scores range from 0 to 1 and denote a firm's attention and action in differentiated topics related to Environmental, Social or Governance issues.



Table 4-5: Correlations Matrix

	TimeToRecover	DepthOfLoss	Recovered	EScore	ResourceUse	EnvInnovation	Emissions	Size	ROA	FinLev	Momentum	CAPEX	Beta19	EPI
TimeToRecover	1													
DepthOfLoss	0.39***	1												
Recovered	-0.84***	-0.29***	1											
EScore	0.09***	-0.16***	-0.05***	1										
ResourceUse	0.09***	-0.14***	-0.05***	0.91***	1									
EnvInnovation	0.06***	-0.14***	-0.01	0.73***	0.53***	1								
Emissions	0.10***	-0.15***	-0.07***	0.91***	0.84***	0.51***	1							
Size	-0.01	-0.21***	0.03**	0.53***	0.52***	0.37***	0.50***	1						
ROA	0.01	-0.25***	0.03**	0.23***	0.22***	0.14***	0.23***	0.35***	1					
FinLev	0.07***	0.11***	-0.06***	0.13***	0.11***	0.08***	0.11***	0.14***	-0.02	1				
Momentum	-0.06***	0.44***	0.00	-0.32***	-0.29***	-0.25***	-0.31***	-0.36***	-0.49***	-0.02	1			
CAPEX	0.06***	-0.17***	-0.02*	0.56***	0.53***	0.37***	0.54***	0.73***	0.34***	0.27***	-0.37***	1		
Beta19	-0.08***	0.26***	0.08***	-0.05***	-0.04***	-0.01	-0.05***	0.00	-0.17***	0.04***	0.24***	0.01	1	
EPI	0.07***	0.15***	-0.02	0.10***	0.10***	0.08***	0.11***	-0.12***	-0.04**	-0.04**	0.00	-0.09***	-0.07***	1
GDP19	-0.02	0.22***	0.06***	-0.17***	-0.16***	-0.09***	-0.19***	-0.26***	-0.18***	-0.01	0.18***	-0.19***	0.04**	0.57***

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ . This table presents the pairwise correlations of all the variables used in the statistical analysis.

#### 4.4.1 Correlation analysis

Some correlations from Table 4-5 should be noted. *DepthOfLoss* is positively correlated with *TimeToRecover* (0.39,  $p < 0.01$ ), as expected, but not so strongly that they should be systematically mutually exclusive in regressions. *Recovered* and *TimeToRecover* have a strong negatively correlation (-0.84,  $p < 0.01$ ), this is expected as companies that take longer times to recover are, by definition, less likely to recover within the time frame. *Recovered* and *DepthOfLoss* are negatively correlated (-0.29,  $p < 0.01$ ), as expected, companies that lose more value are less likely to recover within the time frame. *EScore* is strongly correlated with its constituents (*ResourceUse*, *EnvInnovation*, and *Emissions*), which is not surprising, the strength of these correlations makes them mutually exclusive in regressions (0.91, 0.73 and 0.91 respectively,  $p < 0.01$ ). The constituents of *EScore* are correlated with one another, all coefficients above 0.5 ( $p < 0.01$ ), so they should not be included in the same model to avoid multicollinearity issues. Because of the high correlation values between multiple variables included in our models, due attention is paid to measures of multicollinearity (VIF) in initial regression models to make sure it does not distort the results.

#### 4.4.2 Analysis of graphs and bivariate tests

First, it is intuitively useful to observe the overall shape of the loss and recovery of the value of the firms in the sample. To do so, Figure 4-1, plots the evolution of the average firm value over the 105 weeks of analysis from 01/01/2020 to 01/01/2022, distinguishing high-EP firms from Low-EP firms. This reveals two curves that seem to support both hypotheses formulated above, as the lowest point for High-EP firms is higher than for Low-EP firms, and the recovery from that low point is then slower for High-EP firms than for Low-EP firms.

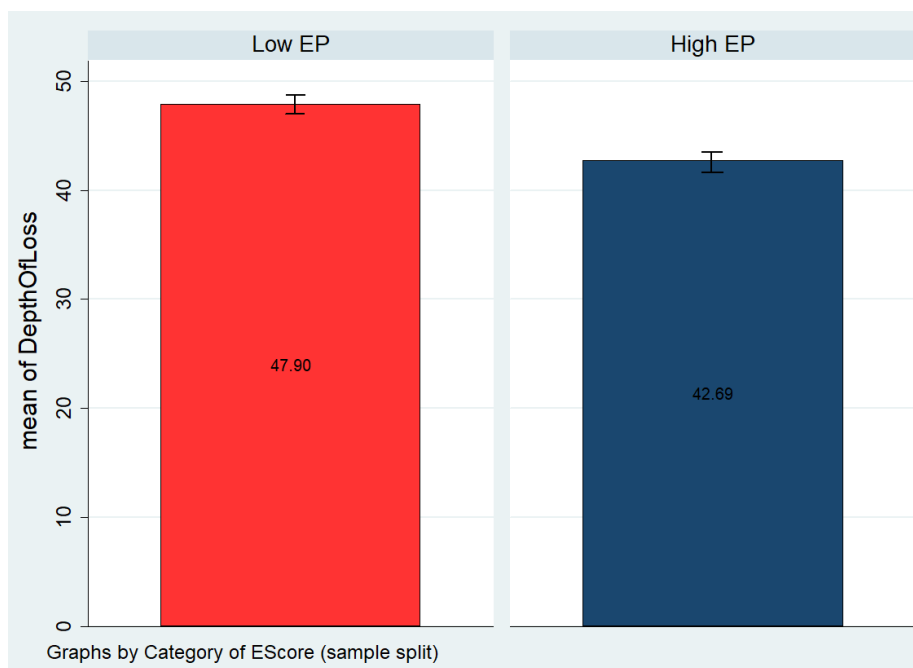
Figure 4-1: Average stock price evolution by category of EP



Source: created by the author. This graph plots the evolution of stock prices averaged over categories of EP, split by the median. Base 100 was taken as the maximum stock value of each firm before February 20, 2020. The curve for High EP firms reaches its lowest point on Week 4 at 62.78, the curve for Low EP also reaches its lowest point at Week 4 at 59.62. The average of Low EP stock prices overtakes 100 at Week 40 (last week of November 2020), while the average of High EP stock prices overtakes 100 at Week 46 (first week of January 2021).

Using the same sample split based on environmental performance (*EScore*) from Figure 4-1, the observation that High EP firms lost less value than Low EP firms on average is confirmed by a bar graph and a t-test comparing the mean of *DepthOfLoss* between the groups of EP separated by the median, Table 4-6 reports this t-test and Figure 4-2 gives a visual representation. On average, Low EP firms experienced losses 5.2% harder than high EP firms.

Figure 4-2: Severity of Loss by category of EP



Note: Graphical representation of the distribution of variable *DepthOfLoss*, the maximum percentage loss of firm's stock price after 20/02/2020, over sample split categories of *EScore*.

Table 4-6: t-test - Equality of means of DepthOfLoss between groups of EP

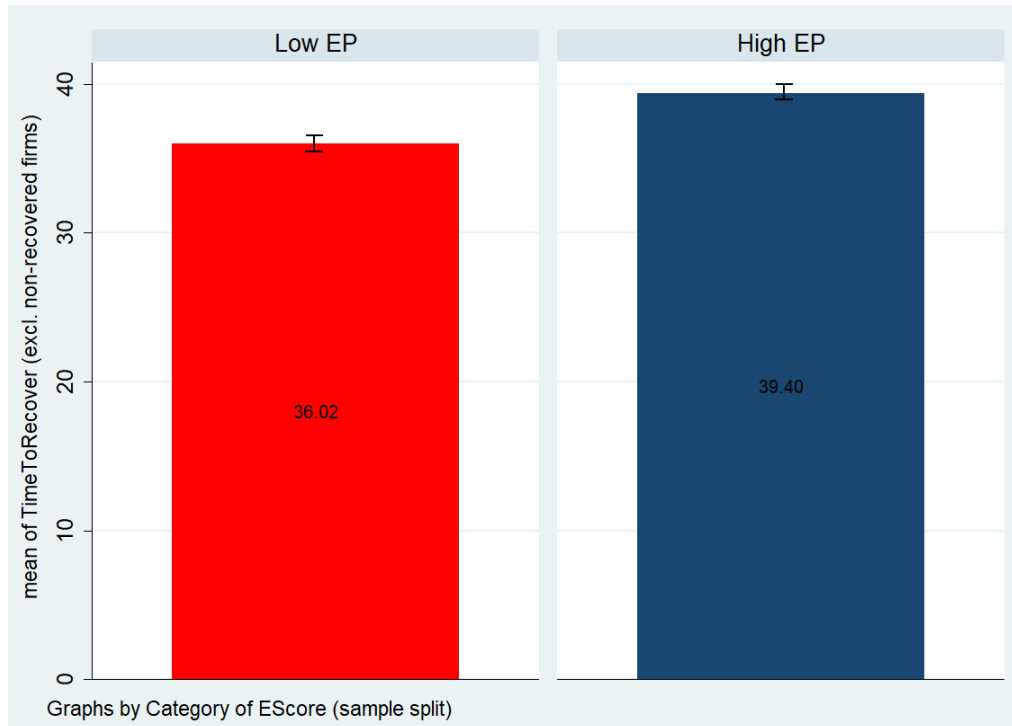
Group	Mean	Std. Err.	Std. Dev.	95% Conf. interval	
Low EP	47.90	0.33	19.18	47.25	48.55
High EP	42.69	0.29	16.48	42.13	43.25
Combined	45.30	0.22		44.86	45.73
Diff	5.20***	0.44		4.35	6.06

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ . This table presents the equality of means test (t-test) for variable *DepthOfLoss* over two categories of *EScore*, separated by the median.

With the same split, it appears from Figure 4-1 that firms with higher EP seem to take a slightly longer time to recover from the shock than their lower EP peers. A t-test comparing the mean of *TimeToRecover* (excluding non-recovered firms) between groups of EP separated by the median confirms this observation. Table 4-7 reports this t-test, and Figure 4-3 give a visual representation showing that among the firms that recovered before the end of 2021 Low EP firms required on average 3.38 weeks less than high EP firms to recover from the Covid-19 shock. If all the data is included so the maximum duration value is applied to unrecovered firms

(Table 4-8), the difference increases to 5.38 weeks on average, which is an indication that high EP firms are also less likely to recover before the end of 2021.

Figure 4-3: Time to recover (excluding non-recovered firms) by category of EP (n = 4,518)



Note: Graphical representation of the distribution of variable *TimeToRecover*, the time in weeks for the firm's stock price to recover (remain over baseline for 5 consecutive weeks), over sample split categories of *EScore*

Table 4-7: t-test - Equality of means of *TimeToRecover* (excluding non-recovered firms) between groups of EP (n = 4,518)

Group	Mean	Std. Err.	Std. Dev.	95% Conf. interval	
Low EP	36.02	0.46	22.10	35.13	36.92
High EP	39.40	0.46	21.61	38.49	40.31
Combined	37.65	0.33	21.92	37.01	38.29
Diff	-3.38***	0.65		-4.65	-2.10

\* p < 0.05, \*\* p < 0.01, \*\*\* p < 0.001. This table presents the equality of means test (t-test) for variable *TimeToRecover* over two categories of *EScore*, separated by the median. Firms that have not recovered before 01/01/2022 are excluded.

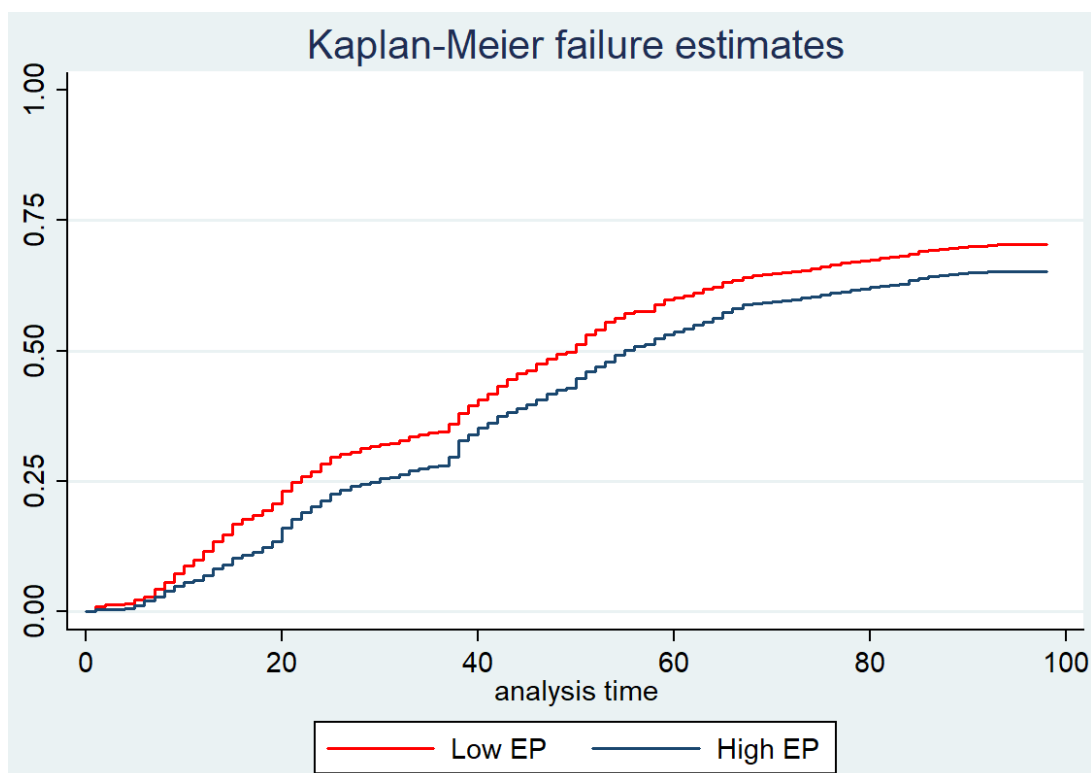
Table 4-8: t-test - Equality of means of TimeToRecover between groups of EP

Group	Mean	Std. Err.	Std. Dev.	95% Conf. interval	
Low EP	54.39	0.59	33.83	53.24	55.54
High EP	59.76	0.57	32.92	58.65	60.88
Combined	57.08	0.41	33.48	56.27	57.88
Diff	-5.38***	0.82		-6.98	-3.78

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ . This table presents the equality of means test (t-test) for variable *TimeToRecover* over two categories of *EScore*, separated by the median. Firms that have not recovered before 01/01/2022 are included.

Before running survival analyses and other regressions, it is common to graphically observe the shape of the recovery hazard, the Kaplan-Meier failure estimate graphs in Figure 4-4 additionally shows how EP affects the recovery of firms to the Covid-19 crisis, with the lower EP curve systematically remaining higher than that of high EP firms, this means firms with high EP require more time to recover from the shock than their peers.

Figure 4-4: Kaplan-Meier failure estimates, sample split by EP



Source: created by the author. Note: Kaplan-Meier failure estimates split between high and low EP groups. This figure shows the Kaplan-Meier failure curves for both groups, which have been split according to the median. The x-axis shows the analysis time in weeks, and the y-axis shows the probability to change the state of recovery (to become *Recovered*). High probability shows better flexibility. The High EP group has a comparatively lower probability to recover overall.

#### 4.4.3 Regression analysis

The OLS regression models of *EScore* on *DepthOfLoss*, gradually including other independent variables and controls in Table 4-9, reveal a negative and statistically significant relationship between EP and severity of loss, that is, a better environmental pillar score reduces the maximum percentage loss of stock value, improving stability. The t-test previously suggested a 5.2% difference of severity of loss between Low EP firms and High EP firms, the coefficient in the OLS regression model 5 of Table 4-9 shows that, all else equal, a one-unit increase of *EScore* is associated with a 2.35% decrease of severity of loss. These results support H1, EP is associated with a stronger stability.

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Table 4-9: OLS regressions on severity of loss – Effect of EScore on severity of loss (stability)

VARIABLES	(1) OLS 1	(2) OLS 2	(3) OLS 3	(4) OLS 4	(5) OLS 5
EScore	-9.861*** (0.748)	-3.453*** (0.827)	-2.616*** (0.828)	-2.036** (0.843)	-2.347*** (0.810)
Size		0.130 (0.151)	-0.654*** (0.142)	-0.608*** (0.142)	-0.094 (0.153)
ROA		-0.084*** (0.014)	-0.012 (0.014)	-0.008 (0.014)	-0.093*** (0.014)
FinLev		0.070*** (0.009)	0.110*** (0.010)	0.108*** (0.010)	0.090*** (0.010)
Momentum		4.708*** (0.168)	5.028*** (0.176)	4.978*** (0.177)	4.750*** (0.169)
CAPEX		-0.114 (0.136)	0.242* (0.135)	0.208 (0.135)	-0.310** (0.138)
Beta19		4.454*** (0.333)	5.474*** (0.353)	5.408*** (0.353)	4.489*** (0.341)
EPI			0.218*** (0.014)	0.180*** (0.018)	0.164*** (0.017)
GDP19				0.039*** (0.011)	0.041*** (0.010)
Sector-fixed effects	No	Yes	No	No	Yes
Country-fixed effects	No	Yes	No	No	No
Constant	48.612*** (0.333)	27.910*** (4.314)	15.790*** (2.293)	16.193*** (2.293)	22.776*** (2.454)
Max VIF	1.00	<b>112.82</b>	2.56	2.58	3.76
R-squared	0.025***	0.421***	0.263***	0.265***	0.361***
Observations	6,663	6,663	6,663	6,663	6,663

Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. This table presents the coefficients of independent and control variables regressed with the Ordinary Least Squares (OLS) method over the dependent variable *DepthOfLoss*, the severity of loss following the Covid-19 crisis. A positive coefficient means the variable increases the losses following the advent of the crisis. The coefficients for control binary variables are not reported for the sake of brevity.

Other statistically significant effects should be noted. *ROA* is negatively associated with severity of loss; more profitable firms lost less value than their peers following the Covid-19 crisis. *FinLev* has a positive and statistically significant relationship with *DepthOfLoss*; firms that are more leveraged were hit harder by the shock than others, losing more value. *Momentum* is also positively associated with *DepthOfLoss*; firms with a price following a stronger



momentum before the advent of the crisis stood to lose more than others. *Beta19* positively affects the severity of loss; the share prices of firms which strongly follow local financial market trends lost more value than their peers. Likewise, Country *EPI* is positively associated with severity of loss; firms headquartered in countries with more stringent environmental regulation lost more value than others. This is expected, according to the results in Xiao et al. (2018), because stakeholders in a country where high EP is expected due to stringent regulation will take such sustainable practices for granted, and firms with high EP will find it harder to capitalize on their efforts in improving their environmental profile. The effect of country GDP per capita is positive and statistically significant in all models in which it is included, suggesting firms headquartered in more developed economies lost more value than others<sup>11</sup>. The specifications of model OLS 5 will be reproduced in robustness checks and other tests.

In the following section addressing the relationship between EP and the flexibility dimension of resilience, Weibull survival analysis regressions are used as the main specification in Table 4-10. Initial tests comparing the LR Chi<sup>2</sup> of different specifications of survival analysis regressions revealed it best fitted the data. Robustness tests will include other types of survival analysis regressions regardless.

The Weibull survival analysis regressions in Table 4-10 show how EP, as well as other independent and control variables affect the rate of recovery. In all survival analysis regressions presented in this paper, a negative coefficient should be interpreted as a negative relationship with the flexibility dimension of resilience, which means it took more time for firms with a

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<sup>11</sup> The sequential inclusion of the control variables shows that country-fixed effects should be excluded in further regressions as it generates multicollinearity issues, which is made explicit by the high VIF observed in model 2 of Table 9 (Max VIF: 112.82). To control for differences in the resilience process of firms headquartered in different countries, it is preferable to replace country-fixed effects with 2 control variables which incur much less multicollinearity issues: *EPI* and *GDP19*. While the inclusion of sector-fixed effects also slightly raises the measure of multicollinearity in model 5, the VIF remains under the threshold of 5 recommended by James et al. (2013). Alternatively, the inclusion of a measure of industry growth in another OLS regression instead of sector-fixed effects allows the control for industry specific effects on the resilience process, the results for EP in this model do not differ substantially from those of model 5, they are not reported here but can be made available upon request.

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higher value of the concerned variable to recover from the shock. In these regression models, the effect of *EScore* is negative and significant in all models, meaning firms with higher environmental pillar scores took more time to recover than their peers. According to the coefficient for *EScore* in model Weibull 4 of Table 4-10, it can be estimated that all else equal, a one-unit increase of *EScore* leads to a multiplicative change in the hazard function of 0.6903, in other words, a reduction of 30.97% of the overall rate of recovery. This leads to the same outcome obtained by observing means difference between groups. In the t-tests reported previously in Table 4-7 and Table 4-8: firms with above-median *EScore* took on average 3.38 weeks more than firms with below-median *EScore* if non-recovered firms are excluded, and 5.38 weeks if they are included. These results contradict H2, as EP is associated with less flexibility.

Table 4-10: Weibull Survival Analysis regression - Effect of EScore on rate of recovery (flexibility)

VARIABLES	(1) Weibull 1	(2) Weibull 2	(3) Weibull 3	(4) Weibull 4
EScore	-0.321*** (0.051)	-0.432*** (0.063)	-0.435*** (0.065)	-0.371*** (0.068)
DepthOfLoss		-0.045*** (0.001)	-0.047*** (0.001)	-0.048*** (0.001)
Size		0.041*** (0.012)	0.062*** (0.012)	-0.008 (0.014)
ROA		0.003*** (0.001)	0.004*** (0.001)	0.002 (0.001)
FinLev		0.001 (0.001)	0.001 (0.001)	0.002*** (0.001)
Momentum		0.233*** (0.013)	0.231*** (0.013)	0.198*** (0.014)
CAPEX		-0.045*** (0.011)	-0.047*** (0.011)	-0.020 (0.012)
Beta19		0.446*** (0.028)	0.470*** (0.028)	0.370*** (0.029)
EPI			0.000 (0.001)	-0.003* (0.001)
GDP19			0.007*** (0.001)	0.007*** (0.001)
Sector-fixed effects	No	No	No	Yes
Constant	-4.918*** (0.067)	-3.932*** (0.171)	-4.392*** (0.187)	-4.296*** (0.219)
LR Chi <sup>2</sup>	39.87***	1873.24***	1979.97***	2456.92***
Observations	6,663	6,663	6,663	6,663

Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. This table presents the coefficients of independent and control variables regressed with the Weibull survival analysis method over the dependent variable *TimeToRecover*, the number of weeks required for the firm to recover from the loss following the Covid-19 crisis, taking the full period (20/02/2020 – 01/01/2022) to assess the recovery. A positive coefficient means the variable accelerates the recovery (it increases the hazard rate of recovery). The coefficients for control binary variables are not reported for the sake of brevity.

Other statistically significant effects should be noted. *DepthOfLoss* is negatively associated with the rate of recovery, this is expected as firms that lose more value generally take more time to recover to their pre-crisis level. Excluding this variable which assesses the stability dimension of resilience does not affect the significance of the negative relationship

between *EScore* and the rate of recovery. *ROA* is positively associated with the rate of recovery in most models, firms that are more profitable require less time than others to recover, as expected. *FinLev* negatively affects the rate of recovery in model 5, firms that rely more heavily on debt took more time to recover than their peers, this is also expected. *Momentum* has a positive effect on the rate of recovery, this suggests that firms with a better momentum before the crisis recover better. Country *EPI* is negatively associated with the rate of recovery in model 5, it seems that firms headquartered in countries with more stringent environmental regulation may experience slower recoveries than firms in less stringent legal environments, but the effect is not significant in other models. *GDP* per Capita is positively associated with the rate of recovery, so firms headquartered in richer economies recovered faster than firms in emerging or developing countries.

The effect of *EScore* on the flexibility dimension of resilience appears to be rather significant in terms of economic relevance. The specifications of Model Weibull 4 will be reproduced in robustness tests.

#### 4.4.4 Robustness of main models

To test the robustness of the result, the main regression model is first rerun to test the effect of *EScore* on the flexibility dimension of resilience using alternative specifications. Reproducing model Weibull 4 with different survival analysis regression specifications shows that the results are not dependent on model specification. Finally, I run a Logit model on the likeliness to recover (*Recovered*), which confirms the results. The effect of *EScore* on the dependent variable is consistently negative and statistically significant ( $p < 0.01$ ), these robustness tests are presented in Appendix 4.

To further examine the robustness of the results, the main models, OLS 5 and Weibull 4 are regressed again, using different windows of observation for the recovery period in

Appendix 5. These additional observation windows end in November 2021 (92 weeks), October 2021 (88 weeks) and September 2021 (84 weeks), respectively. As the results in Appendix 5 show no significant difference with the main result, the effect of *EScore* on either stability or flexibility is confirmed as not sensible to different time specifications.

Finally, the main models are run once again on the dataset that excludes firms that are not headquartered in the US, and alternatively on the dataset that only excludes these firms. The results of these tests are presented in Appendix 6, and display no substantive deviation from the main results, as they show that *EScore* reduces the severity of loss, and the rate of recovery, and that both these effects seem stronger for firms headquartered in the US relative to firms headquartered in other countries.

#### 4.4.5 Effects of Resource Use, Environmental Innovation and Emissions on Stability

By alternatively replacing *EScore* with *ResourceUse*, *EnvInnovation* and *Emissions*, and rerunning the main OLS regression model (OLS 5 from Table 4-9) in the left section of Table 4-11, I obtain results very similar to that of the environmental pillar score for *EnvInnovation* and *Emissions*, but not for *ResourceUse*, which effect is not significant. It would thus seem that the positive effect of EP on the stability dimension of resilience in the Covid-19 crisis is due to the firms' capabilities in environmental innovation and emission reduction, but not resource use.

The same approach is then reproduced for the main survival analysis model (Weibull 4 from Table 4-10), replacing *EScore* by its components, in the right section of Table 4-11. All three components have a negative effect on flexibility, very similar to that of *EScore*, firms with a better score for resource use, environmental innovation, and/or emissions have a reduced rate of recovery in the Covid-19 crisis. Considering the coefficients, the effect of *Emissions* (-0.326) is stronger than the effect of *ResourceUse* (-0.250), which is itself stronger than the effect of

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*EnvInnovation* (-0.159). The coefficient of *Emissions* means a one-unit increase in this score affects the hazard rate by a factor of 0.722 ( $e^{-0.326}$ ), it therefore decreases the hazard rate by 27.8%, meaning firms with higher emissions are expected to take longer to recover from the Covid-19 crisis. The equivalent one-unit increases for *ResourceUse* and *EnvInnovation* induce decreases of the hazard rate of recovery by 22.1% ( $e^{-0.250}$ ) and 14.7% ( $e^{-0.159}$ ), respectively.

Table 4-11: OLS and Weibull regression models - Effects of subcomponents of EScore on stability

VARIABLES	(1)	(2)	(3)	(1)	(2)	(3)
	OLS RU	OLS EI	OLS Em	Weibull RU	Weibull EI	Weibull Em
ResourceUse	-1.091 (0.675)			-0.250*** (0.057)		
EnvInnovation		-2.814*** (0.669)			-0.159*** (0.057)	
Emissions			-1.932*** (0.691)			-0.326*** (0.058)
DepthOfLoss				-0.048*** (0.001)	-0.048*** (0.001)	-0.048*** (0.001)
Size	-0.142 (0.154)	-0.096 (0.151)	-0.112 (0.152)	-0.011 (0.014)	-0.021 (0.014)	-0.010 (0.014)
ROA	-0.092*** (0.014)	-0.096*** (0.014)	-0.093*** (0.014)	0.002 (0.001)	0.002 (0.001)	0.002 (0.001)
FinLev	0.091*** (0.010)	0.090*** (0.010)	0.090*** (0.010)	0.002*** (0.001)	0.002*** (0.001)	0.002** (0.001)
Momentum	4.774*** (0.169)	4.733*** (0.169)	4.752*** (0.169)	0.200*** (0.014)	0.200*** (0.014)	0.198*** (0.014)
CAPEX	-0.357*** (0.137)	-0.336** (0.135)	-0.310** (0.138)	-0.024** (0.012)	-0.029** (0.012)	-0.019 (0.012)
Beta19	4.487*** (0.341)	4.555*** (0.341)	4.478*** (0.341)	-0.003** (0.001)	-0.004*** (0.001)	-0.002* (0.001)
EPI	0.158*** (0.017)	0.162*** (0.016)	0.165*** (0.017)	0.369*** (0.029)	0.375*** (0.029)	0.368*** (0.029)
GDP19	0.044*** (0.010)	0.044*** (0.010)	0.040*** (0.010)	0.008*** (0.001)	0.008*** (0.001)	0.007*** (0.001)
Sector-fixed effects	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>
Constant	23.992*** (2.429)	23.103*** (2.357)	22.992*** (2.439)	-4.194*** (0.216)	-4.052*** (0.211)	-4.285*** (0.217)
R-squared	0.360***	0.362***	0.361***			
LR Chi <sup>2</sup>				2455.7***	2444.1***	2467.9***
Observations	6,663	6,663	6,663	6,663	6,663	6,663

Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. The left section of this table presents the coefficients of independent and control variables regressed with the Ordinary Least Squares (OLS) method over the dependent variable *DepthOfLoss*, the severity of loss following the Covid-19 crisis. A positive coefficient means the variable increases the losses following the advent of the crisis. The right section of this table presents the coefficients of independent and control variables regressed with the Weibull survival analysis method over the dependent variable *TimeToRecover*, the number of weeks required for the firm to recover from the loss following the Covid-19 crisis, taking the full period (20/02/2020 – 01/01/2022) to assess the recovery. A positive coefficient means the variable accelerates the recovery (it increases the hazard rate of recovery). The main independent variable, *EScore* in previous models, is replaced alternatively with its constituents: *ResourceUse*, *EnvInnovation*, and *Emissions*. The coefficients for control binary variables are not reported for the sake of brevity.

#### 4.5 Discussion and Conclusion

In this study, I investigate the relationship between environmental performance and the resilience of an international sample of public firms to the Covid-19 crisis, and consider the effects of the constituents of EP: resource use, environmental innovation and emissions. The results described above reveal that EP positively affects the stability dimension of resilience in the Covid-19 context, meaning firms with better environmental performance lose less value after the shock appears, all else equal. The positive effect of EP on stability is only confirmed for two constituents: environmental innovation and emissions. The results of the survival analyses present a contradicting effect of EP on the flexibility dimension of resilience, as EP is associated with both a longer recovery period and decreased likeliness to recover, all else equal. These results are robust to multiple model specifications and are not sensible to variations in the period of analysis.

Consequently, firms which made extensive efforts towards improving their EP before the crisis relative to their peers can benefit from the improved stability of their organization and reduce the financial impact of a crisis such as the Covid-19. But in the following period, these high-EP firms are less likely to rebound quickly as they will require a longer period to recover to their pre-crisis value relative to their peers. This contrasting result confirms and denies various theoretical arguments in the context of the recent pandemic.

For the stability dimension of resilience, the results presented here complement those of Garel & Petit-Romec (2021) and support the CSR literature, the stakeholder theory and the NRBV. According to the CSR literature, the improved stability of firms with better environmental initiatives may come from advantages such as the access to a loyal green customer base (Arora & Gangopadhyay, 1995), lower production costs thanks to improvements in the production process towards pollution reduction (Porter & van der Linde, 1995), good



relationships with regulators (Baron, 2005), less costly and more motivated workers (Brekke & Nyborg, 2008), or retaining a higher market price for their shares thanks to “green investors” remaining loyal (Baron, 2007; Graff et al., 2005). This last argument is also supported by the stakeholder theory as investors that screen for socially responsible investment are able and willing to pay a premium price following positive information about the firm’s environmental actions (Flammer, 2013). Tenants of the stakeholder theory may also consider that by behaving more responsibly towards the environment, high EP firms should benefit from improved reputation and legitimacy (Bruna & Nicolò, 2020; Zahller et al., 2015), and as such garner more support from their stakeholders to maintain continuity in their business processes, thereby improving stability. The NRBV of the firm adds that firms that effectively implement pollution prevention, product stewardship, and sustainable development strategies benefit from sustainable competitive advantages over their competitors thanks to improved capabilities (Hart, 1995). The improved economic performance resulting from these capabilities (Russo & Fouts, 1997) helps the firm overcome the initial tremors of a crisis such as a pandemic situation, remain more stable than their peers because of increased attention to their environment and better preparedness for business discontinuity in the form of contingency plans.

This paper contributes to these strands of theoretical literature by providing empirical support to the positive relationship between EP and the stability dimension of resilience. Firms with better environmental performance, and particularly environmental innovation and emissions reduction proficiencies, benefit from advantages because of their CSR profile, better reputation and legitimacy with stakeholders, and improved capabilities based on pollution prevention, product stewardship and sustainable development resources and routines. They can withstand the major financial shock resulting from the Covid-19 crisis better than their peers, all else equal.

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Though these arguments can be verified in the relationship between EP and stability, it seems the advantages described above don't apply to the flexibility dimension of resilience in the case of the Covid-19 crisis. In essence, it is possible that efforts made to improve EP deviate resources from the core business processes which primarily aim at improving profitability, this in turn deteriorates flexibility in the advent of a pandemic. After all, one of the most critical requirements for resilience, as described by Gittell et al. (2006), is slack resources, the ability for the firm to constitute a stock of resources and retain redundant capacities to allow for critical situations to generate some losses without jeopardizing core business continuation. The main argument in this case is that a major unpredictable crisis such as Covid-19, which results in immense losses, is only limitedly mitigated by preparedness, even for organizations which deploy extensive efforts to maintain their license to operate (DesJardine et al., 2019; Ortiz-de-Mandojana & Bansal, 2016) and anticipate environmental disruptions. As a result, these firms take longer to recuperate because they are less endowed in financial resources when the crisis erupts. Furthermore, the process diversification required for creating and maintaining CSR commitments generates managerial complexities and communicational intricacies (Yang et al., 2023) which slow the response of organizations and reduce their flexibility. They are also less likely to renege on commitments for environmental sustainability if these engagements are embedded in their long-term strategy towards sustainable development, which makes them relatively less flexible in the long recovery period following the market crash of February-March 2020. Because the market crash was rapid and historically massive, the results presented here align with those of some previous studies in the 2007 - 2008 Subprime Mortgage Crisis context (Buchanan et al., 2018; Marsat et al., 2021).

This paper contributes to the literature on the financial impact of environmental policies. By assessing the effect of EP on resilience in an international exogenous crisis, further developments of the academic knowledge about business continuity strategies and the input of

environmental sustainability activities are brought. The EP – FP literature is both supported and challenged here in observations highly robust to different specifications, with a substantial international sample and a long period of observation. The positive effect of EP on the stability dimension of resilience for the environmental innovation and emission reduction capabilities is confirmed, whereas efforts in reducing the use of resources do not seem to affect stability.

At present, no theoretical arguments stand in this stream of literature to explain the perplexing result that EP hinders flexibility, which leads to the following conclusion: more qualitative research is required to develop new theoretical explanations pertaining to the relationship between dimensions of EP and the flexibility dimension of resilience, which is beyond the scope of this empirical study.

Furthermore, this work contributes to the empirical financial literature on resilience by highlighting important methodological implications for researchers. As demonstrated here, resilience should not be empirically treated as a single outcome but the conjunction of multiple post-crisis outcomes as these may not be affected in a similar fashion by a pre-crisis characteristic. The intrinsic positive relationship between stability and flexibility does not mean an organizational attribute positively affecting one, also improves the other. This partly explains why the papers that previously studied the effect of EP on resilience focusing on a single of these outcomes led to opposing results; some mostly studied stability in the short-term consequences of the shock, and few focused on flexibility, with samples limited to a single country and timelines of analysis that only allowed the study of a part of the recovery period. In addition to the bidimensionality of post-crisis resilience, this paper also addresses our lack of knowledge about the context dependent nature of the resilience process recognized by previous research on the subject (Duchek, 2020; Linnenluecke, 2017; Su & Junge, 2023) within its limits. In that regard, properly categorizing the type of crisis studied in empirical analyses of resilience is a necessary stage of any such study, as it allows a proper understanding of why

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certain organizational traits such as good EP may positively affect stability or flexibility in a certain disruptive context, and negatively in another.

The arguments and results presented in this document also have managerial implications for managers and investors. Managers should be conscious about the implications of devoting more resources and time to improve environmental performance for the financial resilience profile of their organization. In a way, an arbitrage is required between “doing good” and “doing well” as improving EP strengthens the organization’s financial stability in the advent of a major financial crisis such as the one triggered by the spread of Covid-19, but also hinders its flexibility after the initial shock period. Furthermore, portfolio managers and investors need to properly evaluate the implications of voluntary environmental policies, as these policies might increase the risk exposure of firms to major systemic disruptions such as the Covid-19 pandemic.

This study has limitations and calls for further research to better grasp how EP affects financial resilience, by observing the relationship in other contexts, and particularly other recent exogeneous shocks. It is possible the attention devoted by media, corporate leaders and other stakeholders on environmental issues has deepened since 2020 because of the many calls to make use of recovery funds to improve the environmental sustainability of our societies. Consequently, it is possible that the effect of EP on resilience to wild card crises evolves. From a research standpoint, it would also be fruitful to assess the relationship between EP and resilience in other types of shocks, such as natural disasters, extreme weather events, and other ecological disruptions. While EP may have a detrimental effect on flexibility in financial crises, it may also serve as a hedge in environmental shocks of a different nature.



# Appendices

Appendix 1: List of drought events in the dataset

<b>Drought Event ID</b>	<b>Start</b>	<b>End</b>	<b>Number of affected states</b>
1	02/01/2006	March 2008	6
2	03/07/2006	September 2008	5
3	05/02/2007	December 2010	2
4	01/03/2007	February 2009	1
5	01/03/2007	November 2010	1
6	02/04/2007	December 2008	1
7	11/06/2007	May 2009	3
8	09/09/2009	November 2010	1
9	15/06/2010	April 2012	1
10	15/07/2010	March 2013	4
11	11/01/2011	August 2015	3
12	15/02/2011	February 2016	3
13	19/01/2012	February 2017	4
14	15/05/2012	May 2015	6
15	15/08/2012	August 2013	1
16	03/09/2013	July 2014	1
17	12/08/2015	November 2015	1
18	11/05/2016	May 2017	3
19	12/01/2018	May 2019	6

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Appendix 2: OLS regressions on severity of loss, effect of environmental footprint

VARIABLES	(1) OLS Base	(2) OLS 1	(3) OLS 2	(4) OLS 3	(5) OLS 4	(6) OLS 5	(7) OLS 6	(8) OLS Full
DirEnvFootprint	-4.373*** (1.358)	-2.479* (1.490)	-2.452 (1.492)	-0.737 (1.627)	-0.261 (1.637)	-0.804 (1.596)	-0.667 (1.592)	-1.056 (1.613)
ROA			-0.092 (0.166)	-0.093 (0.164)	0.044 (0.178)	0.025 (0.173)	0.003 (0.172)	0.014 (0.172)
Size				-2.541** (1.005)	-3.016*** (1.028)	-0.676 (1.134)	-0.435 (1.138)	-0.521 (1.138)
FinLev					0.180** (0.090)	0.174** (0.088)	0.170* (0.087)	0.173** (0.087)
Momentum						7.834*** (1.796)	7.988*** (1.791)	7.929*** (1.789)
CAPEX							37.053* (20.530)	31.455 (20.880)
WaterIntensity								1.274 (0.906)
<i>Control binaries</i>								
Sector	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State of HQ	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj R <sup>2</sup>	0.03	0.24	0.24	0.25	0.26	0.30	0.31	0.31
Observations	345	345	345	345	345	345	345	345

Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. This table presents the coefficients of independent and control variables regressed with the Ordinary Least Squares (OLS) method over the dependent variable *DepthOfLoss*, the severity of loss following the drought. A positive coefficient means the variable increases the losses following the advent of the crisis. The coefficients for control binary variables are not reported for the sake of brevity.

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Appendix 3: OLS Regressions on severity of loss, effect of water intensity

VARIABLES	(1) OLS Base	(2) OLS 1	(3) OLS 2	(4) OLS 3	(5) OLS 4	(6) OLS 5	(7) OLS 6
WaterIntensity	-1.158 (0.706)	1.166 (0.915)	1.155 (0.917)	1.443 (0.908)	1.524* (0.904)	1.424 (0.879)	1.173 (0.892)
ROA			-0.097 (0.166)	-0.090 (0.164)	0.056 (0.177)	0.038 (0.172)	0.016 (0.172)
Size				-2.878*** (0.915)	-3.255*** (0.927)	-1.094 (1.032)	-0.815 (1.044)
FinLev					0.188** (0.089)	0.186** (0.087)	0.181** (0.086)
Momentum						7.687*** (1.784)	7.846*** (1.783)
CAPEX							32.530 (20.796)
<i>Control binaries</i>							
Sector	No	Yes	Yes	Yes	Yes	Yes	Yes
State of HQ	No	Yes	Yes	Yes	Yes	Yes	Yes
Year	No	Yes	Yes	Yes	Yes	Yes	Yes
Adj R <sup>2</sup>	0.01	0.24	0.24	0.26	0.27	0.31	0.31
Observations	345	345	345	345	345	345	345

Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. This table presents the coefficients of independent and control variables regressed with the Ordinary Least Squares (OLS) method over the dependent variable *DepthOfLoss*, the severity of loss following the drought. A positive coefficient means the variable increases the losses following the advent of the crisis. The coefficients for control binary variables are not reported for the sake of brevity.



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Appendix 4: Robustness checks, multiple survival analysis models on rate of recovery and logit model on likeliness to recover

VARIABLES	(1) Cox	(2) Gompertz	(3) Exp	(4) Logit
EScore	-0.370*** (0.068)	-0.347*** (0.068)	-0.331*** (0.068)	-0.485*** (0.133)
DepthOfLoss	-0.048*** (0.001)	-0.044*** (0.001)	-0.042*** (0.001)	-0.060*** (0.002)
Size	-0.013 (0.014)	-0.007 (0.014)	-0.008 (0.014)	0.003 (0.025)
ROA	0.002 (0.001)	0.002 (0.001)	0.002 (0.001)	0.005** (0.002)
FinLev	0.002** (0.001)	0.002** (0.001)	0.002** (0.001)	0.003 (0.002)
Momentum	0.202*** (0.014)	0.183*** (0.014)	0.174*** (0.014)	0.235*** (0.031)
CAPEX	-0.017 (0.012)	-0.020 (0.012)	-0.019 (0.012)	-0.044** (0.022)
Beta19	0.362*** (0.029)	0.345*** (0.029)	0.323*** (0.029)	0.627*** (0.062)
EPI	-0.003** (0.001)	-0.003* (0.001)	-0.003* (0.001)	-0.006** (0.003)
GDP19	0.007*** (0.001)	0.007*** (0.001)	0.007*** (0.001)	0.015*** (0.002)
Sector-fixed effects	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>
Constant		-3.249*** (0.210)	-3.078*** (0.210)	2.686*** (0.405)
LR Chi <sup>2</sup>	2378.8***	2198.5***	2112.2***	1393.0
Observations	6,663	6,663	6,663	6,663

Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. This table presents the coefficients of independent and control variables regressed with varying survival analysis methods over the dependent variable *TimeToRecover*, the number of weeks required for the firm to recover from the loss following the Covid-19 crisis, taking the full period (20/02/2020 – 01/01/2022) to assess the recovery. A positive coefficient means the variable accelerates the recovery (it increases the hazard rate of recovery). It also presents Logit regressions of the same independent and control variables over the binary variable *Recovered*, which equals 1 if the firm has recovered, 0 otherwise, to test the effect on the likeliness to recover. A positive coefficient in a Logit model means the associated variable increases the likeliness to recover. The coefficients for control binary variables are not reported for the sake of brevity.

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Appendix 5: Robustness checks, multiple OLS and survival analysis windows

VARIABLES	(1) OLS Nov	(2) OLS Oct	(3) OLS Sep	(4) Weibull Nov	(5) Weibull Oct	(6) Weibull Sep
Escore	-2.425*** (0.805)	-2.337*** (0.803)	-2.217*** (0.802)	-0.384*** (0.069)	-0.383*** (0.069)	-0.371*** (0.070)
DepthOfLossNov				-0.048*** (0.001)		
DepthOfLossOct					-0.048*** (0.001)	
DepthOfLossSep						-0.048*** (0.001)
Size	-0.099 (0.152)	-0.125 (0.152)	-0.154 (0.152)	-0.008 (0.014)	-0.003 (0.014)	-0.003 (0.014)
ROA	-0.085*** (0.014)	-0.083*** (0.014)	-0.081*** (0.014)	0.002* (0.001)	0.002* (0.001)	0.002* (0.001)
FinLev	0.094*** (0.010)	0.096*** (0.010)	0.096*** (0.009)	0.002*** (0.001)	0.002*** (0.001)	0.002*** (0.001)
Momentum	4.470*** (0.168)	4.294*** (0.168)	4.192*** (0.168)	0.188*** (0.014)	0.183*** (0.014)	0.183*** (0.014)
CAPEX	-0.299** (0.137)	-0.275** (0.137)	-0.253* (0.137)	-0.018 (0.012)	-0.021* (0.012)	-0.022* (0.013)
Beta19	4.490*** (0.339)	4.500*** (0.338)	4.505*** (0.338)	0.366*** (0.029)	0.365*** (0.030)	0.362*** (0.030)
EPI	0.168*** (0.017)	0.169*** (0.017)	0.169*** (0.017)	-0.003** (0.001)	-0.003** (0.001)	-0.003** (0.001)
GDP19	0.044*** (0.010)	0.047*** (0.010)	0.050*** (0.010)	0.008*** (0.001)	0.008*** (0.001)	0.008*** (0.001)
Sector-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Constant	22.524*** (2.441)	22.366*** (2.434)	22.177*** (2.433)	-4.438*** (0.221)	-4.456*** (0.223)	-4.492*** (0.226)
R-squared	0.354***	0.350***	0.348***			
LR Chi <sup>2</sup>				2419.1***	2427.3***	2450.4***
Observations	6,663	6,663	6,663	6,663	6,663	6,663

Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. This table presents the coefficients of independent and control variables regressed with the Ordinary Least Squares (OLS) method over the dependent variable *DepthOfLoss* in the left section, and with the Weibull survival analysis method over the variable *TimeToRecover* in the right section, assessing the recovery over different periods than the main analysis, with observation windows finishing at the end of November 2021, October 2021, and September 2021, respectively. A positive coefficient in OLS models means the variable increases the losses following the advent of the crisis. A positive coefficient in Weibull survival analysis models means the variable accelerates the recovery (it increases the hazard rate of recovery). The coefficients for control binary variables are not reported for the sake of brevity.

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Appendix 6: Robustness checks, OLS and Weibull survival analysis on US and Non-US subsamples

VARIABLES	(1) OLS USA	(2) Weibull USA	(3) OLS Non-USA	(4) Weibull Non-USA
EScore	-7.301*** (1.537)	-0.401*** (0.123)	-1.402* (0.908)	-0.189** (0.079)
DepthOfLoss2		-0.048*** (0.002)		-0.053*** (0.002)
Size	-0.194 (0.279)	0.000 (0.024)	-0.034 (0.190)	-0.031* (0.018)
ROA	-0.085*** (0.019)	-0.005*** (0.002)	-0.149*** (0.024)	0.004* (0.002)
FinLev	0.103*** (0.015)	0.001 (0.001)	0.067*** (0.013)	0.000 (0.001)
Momentum	3.782*** (0.244)	0.144*** (0.020)	5.346*** (0.233)	0.259*** (0.020)
CAPEX	-0.041 (0.245)	0.043** (0.021)	-0.516*** (0.178)	-0.046*** (0.016)
Beta19	3.660*** (0.512)	0.318*** (0.042)	4.882*** (0.462)	0.400*** (0.043)
EPI			0.237*** (0.019)	0.004** (0.002)
GDP19			-0.053*** (0.014)	-0.000 (0.001)
Sector-fixed effects	Yes	Yes	Yes	Yes
Constant	34.661*** (3.880)	-5.502*** (0.345)	23.013*** (3.104)	-3.448*** (0.286)
R-squared	0.364***		0.330***	
Observations	2,468	1051.62*** 2,468	4,195	1612.98*** 4,195

Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. This table presents the coefficients of independent and control variables regressed with the Ordinary Least Squares (OLS) method over the dependent variable *DepthOfLoss*, and with the Weibull survival analysis method over the variable *TimeToRecover*, assessing the recovery over different periods than the main analysis, separated in two subsamples, regressions on the left side are restricted on observations headquartered in the US, the regressions on the right side are the same regressions for the remainder of the sample. A positive coefficient in OLS models means the variable increases the losses following the advent of the crisis. A positive coefficient in Weibull survival analysis models means the variable accelerates the recovery (it increases the hazard rate of recovery). The coefficients for control binary variables are not reported for the sake of brevity.

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## General Conclusion

The organizational abilities to contribute to climate change mitigation, and to anticipate disturbance resulting from environmental disruptions with climate adaptation, are both under heavy scrutiny as we rely on all organizations to implement the changes that will place human activity once again within the limits imposed by our planet (Flammer, 2013; Linnenluecke & Griffiths, 2015; Richardson et al., 2023; Rivera et al., 2022; Steffen et al., 2015). By addressing both issues of mitigation and adaptation, firms foster specific capabilities related to environmental performance, which in turn favor the development of sustainable competitive advantages (Hart, 1995; Hart & Dowell, 2011). Among such advantages, the most documented is certainly the increased financial performance as a result of good EP (Dixon-Fowler et al., 2013; Endrikat et al., 2014; Horváthová, 2010; King & Lenox, 2001), and additional advantages have been put to the fore, such as insurance-like benefits (Godfrey et al., 2009), reduced financial constraints (Banerjee et al., 2020), and reduced levels of risk (Cai et al., 2016).

Given the numerous challenges and crises organizations face in their extended lifetime, and the potential for these crises to multiply and intensify because of the complexification of their environment and the interdependencies thereof, surviving and thriving in our turbulent times call for a surge of organizational resilience (Duchek, 2020; Lièvre et al., 2022; Linnenluecke, 2017; Raetze et al., 2022). In spite of the growing management literature addressing resilience (Jiang et al., 2024), a relatively narrow stream of studies precisely address the underlying mechanisms that tie EP to organizational resilience, and such studies show little variety in the contexts of disruptions they observe. Because of its multidimensional and long-term processual nature, OR, defined as *“both the ability of a system to persist despite disruptions and the ability to regenerate and maintain existing organization”* (DesJardine et al., 2019; Gunderson & Pritchard, 2002), seems much more relevant than FP in understanding

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how firms anticipate environmental disruptions, cope and adapt when they emerge, and recover, eventually learning from the experience and thriving.

### *Main results*

On the grounds of this definition of OR, this thesis brings clear answers about the effects of EP on organizational resilience to environmental disruptions. These results are summarized below and synthesized in Figure C.

Figure C: Synthetic summary of thesis empirical results

Empirical Chapter	Disruption type and characteristics	Effect of EP on Stability	Effect of EP on Flexibility	Conclusion: Effect of EP on OR
2 – EP and Resilience to Environmental Penalties	<b>Environmental Penalties</b> Regulatory shock, linked to ecological environment	?	+	+
3 – EP and Resilience to Droughts	<b>Droughts</b> Extreme weather event, linked to ecological environment	? Weak +	+	+
4 – EP and Resilience to the Covid-19 Crisis	<b>Covid-19 crisis</b> Severe economic and financial disruption, not linked to ecological environment	+	-	? Mixed

Source: created by the author

In chapter 2, the EP – OR relationship is tested on a sample of 143 environmental penalties that result from violations of environmental law in the US. In this context of environmental disruption, where the shock is directly linked to the ability of firms to reduce the negative impact of their activities on their ecological environment, the main result clearly displays a positive effect of the ability of firms to reduce their environmental footprint on their resilience; the higher their EP, the faster they will recover from the losses caused by the environmental penalties they face. This result confirms the hypothesis suggested by the NRBV

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that firms that embed proactive environmental strategies into their managerial structure foster specific capabilities that translate into more flexible responses to environmental penalties.

The study of the same relationship in the context of 19 severe drought events in the contiguous US, affecting 345 firms in chapter 3 echoes a very similar main result: in this context of environmental disruption where firms are confronted with extreme scarcity in an essential resource, water, those that manage to reduce their environmental footprint, aside from their water consumption, are more resilient against droughts. The higher their EP, the faster these firms recover from the losses incurred because of droughts, with a weaker indication that EP may also reduce the severity of the losses. In other words, this study also supports the NRBV hypothesis that companies that reduce their impact on sources and sinks necessary for the development of their activities benefit from the specific capabilities that emerge in the process and are more flexible when handling droughts.

The last empirical chapter of this thesis, chapter 4, is an attempt to expand the observation of the EP – OR relationship to a context of disruption that does not immediately concern the ecological environment of companies, in this study of how EP affects the resilience of 6,663 firms from countries around the globe, the result is much more nuanced. The effect of EP on the stability dimension of resilience is positive and significant. Guided primarily by their environmental innovation and emissions reduction capacities, firms that have a higher environmental pillar score in their ESG profile benefit from a reduction of the value lost in the initial period of the pandemic, which partly confirms the NRBV hypothesis that they foster specific capabilities that allow them to better adapt in the initial period of disruption and exhibit stability. However, the effect of EP on the flexibility dimension of resilience is negative and significant: high EP firms are hindered by their superior environmental capabilities and require a longer period of time than their peers to recover from the loss, which strongly contradicts the NRBV hypothesis in this context. It would seem the additional expenses required for the

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development and nurture of superior EP are made at the expense of slack resources which are indispensable in the recovery from the major losses caused by large financial crises such as the one caused by the 2020 pandemic. In a way, this result may be an indication that the disruption caused by the Covid-19 crisis placed firms in market conditions that conform to the assumptions made by Friedman (1962), and therefore their expenses in improving EP are made in detriment to their resilience in this context. Furthermore, the managerial complexities and communicational intricacies that emerge with the creation and maintenance of CSR commitments (Yang et al., 2023) seem to slow the response of high EP firms, and reduce their flexibility, which may be further affected by the embeddedness of long-term sustainable strategies within these organizations; they are then more engaged in projects that benefit stakeholders and are reluctant to rule out these projects, even in times of crisis.

### *Contributions*

The empirical approach that integrates both the resilience perspective and the NRBV to describe the influence of EP on OR in environmental disruptions broadens the economic debates around both the value of EP, and the antecedents of OR. By adopting this stance, this thesis further bridges these literatures, contributing to both in multiple ways.

Adopting a sound empirical methodology answers the call of Linnenluecke (2017) to employ empirical methods to study resilience and complement the conceptual frameworks in the literature with empirical validation. In that regard, the demonstration of a positive relationship between EP and the flexibility dimension of OR in environmental disruptions (environmental penalties in chapter 2, droughts in chapter 3), also addresses the understudied question of resilience to climate change-related disruptions, as identified by Rivera et al. (2022), and extends the relevance of EP in the OR process in understudied contexts of disruption, answering other calls within the resilience literature (Duchek, 2020; Raetze et al., 2022). Additionally, the systematic use of secondary data that is available for a large population of



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firms allows this work to contribute to the empirical studies of OR by observing the resilience process of relatively large samples of firms, whereas many studies, particularly the earliest ones that relied on survey methods, could not.

The types of data used for the empirical studies in this thesis also allow the emergence of a new perspective on the relationship between proactive environmental strategies and resilience. The measurement of the direct environmental footprint of firms used in chapters 2 and 3 is a physical result of the ability of these firms to implement strategies for pollution prevention, product stewardship, and sustainable development. The use of this type of data is altogether new in studies of resilience, it presumably allows for a more objective measure of EP than ratings (such as the ESG scores used in chapter 4), which are not free from criticism (Billio et al., 2021), but are more widely used in empirical studies due to their advantageous availability and coverage, both qualities that were deemed necessary for the study of firm resilience to the Covid-19 crisis, due to its far-reaching financial impact. Furthermore, the decomposition of the environmental pillar score in chapter 4, and the study of its constituent scores reveal that the positive effect of EP on stability holds for environmental innovation and emission reduction scores, but not for resource use, whereas the effect of EP on flexibility is significant and negative for all three constituents. This approach is relatively rare, particularly in studies of resilience that use this type of measures, and brings interesting observations about which capabilities underlie the EP – stability relationship in the context of major economic crises.

Because of the care devoted to event identification in the studies presented here, systematically ensuring that the observation period following the event of disruption is long enough to observe the full recovery of a majority of the samples, and building upon the latest adaptations to the stability / flexibility approach proposed by DesJardine et al. (2019) (Li et al., 2022; Marsat et al., 2021), the empirical chapters of this thesis contribute to the financial

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resilience assessment methodology by further integrating multiple attributes of OR expressed in the resilience literature such as long-term temporality, and multidimensionality (Duchek, 2020; Lièvre et al., 2022; Linnenluecke, 2017; Ortiz-de-Mandojana & Bansal, 2016; Raetze et al., 2022).

The empirical studies of chapters 2 and 3 show that proactive environmental strategies set up by firms to reduce their environmental footprint lead to improved flexibility against environmental penalties and droughts, both of which are disruptions related to these firms' relationship with their ecological environment. The empirical validation of the NRBV in these contexts is new, and contributes to our understanding of the relationships within proactive environmental strategies, as pollution prevention fosters product stewardship, which in turn favors sustainable development (Hart, 1995). It also shows that the dynamic capabilities (Teece et al., 1997) that underly such strategies further benefit firms through an improved ability to recuperate from the shocks of ecological disruption than their peers – an additional feature of their sustainable competitive advantages. This work also complements the research linking EP to FP and sustained competitive advantages (Bhandari et al., 2022; Demirel & Kesidou, 2019; Endrikat, 2015; Endrikat et al., 2014) by placing resilience among these competitive advantages, as strategic capabilities that foster specific capabilities for environmental performance also mitigate the financial hardships of ecological disruptions. These results may additionally be interpreted in support for arguments from the stakeholder theory, as the positive effect of EP on the flexibility dimension of resilience could be a sign of the firm's enhanced reputation and trust among stakeholders (Bruna & Nicolò, 2020; Freeman, 2007; Lins et al., 2017), which entails stronger support from stakeholders in critical times (Bansal & Clelland, 2004; Parmar et al., 2010), particularly from employees in the form of enhanced social capital (Freeman, 2007; Lins et al., 2017; Powley, 2009).

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In chapter 4, EP affects OR in a seemingly inconsistent manner, it favors stability, reducing the losses in the initial period of the Covid-19 crisis, but hinders flexibility, slowing the recovery from these losses. This surprising result, hitherto unobserved in any study of resilience, makes sense of the conflicting prior results that EP can both positively affect the stability dimension of resilience to economic disruptions (DesJardine et al., 2019), insofar as this dimension is observed in the initial period of the crisis (e.g. Cardillo et al., 2022; Ding et al., 2021; Garel & Petit-Romec, 2021), and then negatively affect the flexibility dimension, slowing the recovery process (Marsat et al., 2021); it seems these prior results did not consider the full picture of financial resilience by detailing the effect of EP on both dimensions, and thus report either a positive EP – OR relationship, or a negative EP – OR relationship, whereas the effect of EP is seemingly more complex, it can actually affect these two outcome dimensions of resilience in opposite ways in contexts of economic disruption, informing us that contextual characteristics moderate the link between EP and OR. The evolution of the stakeholder expectations over time, and variations in the perception of shareholders of the value of EP described by (Flammer, 2013) seem to have indeed influenced the influence of EP on resilience when it comes to major economic crises, as the results of chapter 4 give a different view from those presented in the literature for the 2008 GFC (DesJardine et al., 2019; Marsat et al., 2021). The end effect of EP on firm resilience in the case of the Covid-19 crisis, is predominantly negative, as the reduction of losses does not counterbalance the weaker flexibility of high-EP firms in this context. This result may be a sign that the conditions underpinning the shareholder theory (Friedman, 1970), are better satisfied in such a context of major financial disruption, leading to a situation where firms are expected to (re-)establish the primacy of profit over their CSR if they wish to emerge faster from the difficulties.

By studying different types of environmental disruption, this work improves our understanding of the contextuality of the resilience process, which was recognized as lacking

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by Duchek (2020) and Jiang et al. (2024). Overall, the results presented here point towards a strong influence of the context of disruption on the flexibility dimension of OR, as EP helps firms affected by environmental penalties and drought to recover from the loss faster than their peers, but slows the recovery of firms affected by the Covid-19 crisis. Although we have indications of a positive effect of EP on the stability dimension of OR in chapter 4, the relationship is not statistically significant in the cases of environmental disruptions presented here, while it is positive and significant in the economic disruption caused by the Covid-19 pandemic, this may be an indication that the effect of EP on the stability dimension of OR is also context-dependent, which should be the subject of further scrutiny in future studies.

This thesis also brings arguments that have theoretical implications within the NRBV. As identified by García-Valenzuela et al. (2023), the role of proactive environmental strategies, such as those that reduce environmental footprint or improve the environmental pillar score of ESG, in favoring the development of dynamic capabilities (Hart & Dowell, 2011; Teece et al., 1997) is scarcely studied in empirical research. By providing three studies that discuss the mechanisms and relationships between resources and capabilities that guide the EP – OR relationship, this thesis partially validates some of these arguments and provides a nuanced rationale when EP does not seem to support the development of these dynamic capabilities, or when they are not sufficient to counterbalance the costs inherent to proactive environmental strategies, as is the case in chapter 4.

With consideration to the stakeholder perspective, and particularly the “environment as a stakeholder” view (Gutterman, 2023), this work brings interesting contributions. First, our study of environmental penalties in chapter 2 indicate that corporate EP does not only help build goodwill with regulators, but also that it reduces the impact of sanctions, at least in the case of environmental violations, by helping firms recover better from the resulting financial shock. Secondly, the study of droughts in chapter 3 provides a rationale supporting the advantages EP

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builds in improving access to resources, water in this case, thanks to positive stakeholder interactions. In this case it may well be that the superior flexibility of high EP firms results from their ability to mobilize external stakeholders and gain access to additional water reserves more easily than their peers, and perhaps at a better price than their low EP counterparts. Thirdly, the Covid-19 crisis setting studied in chapter 4 saw an initial reaction to the spread of the virus that greatly shrank the value of most firms on financial markets. In this context it is possible that the superior stability of high EP firms is caused by their positive relationship with shareholders, who can be inclined to believe that these sustainable firms are better positioned for the anticipated post-crisis market conditions, as a result, they are more willing to hold the shares of these firms than others in the advent of such a crisis.

Finally, OR has been described as a context-dependent construct, and thus the effect of EP on resilience is moderated by the context, with the results presented here revealing the role of environmental performance for the stability and flexibility of organizations against disruptions, and show that when these disruptions are related to the ecological environment of a firm, a high prior level of EP helps it recover faster than its peers. This result expands our understanding of the conditions underlying the EP – OR relationship, it seems contextual attributes are important as they can moderate the relationships linking EP to both stability and flexibility. A clear demonstration of this point appears in the results of chapter 4, when high EP firms are confronted with a deep economic crisis that isn't directly related to their ecological environment. In the EP – OR literature, the contextual factors are not always discussed thoroughly by researchers, the attention to contextual factors in the chapters of this thesis contributes to clarify their influence on the resilience process in its association with EP. All in all, these results expand our understanding of which critical circumstances allow EP to carry benefits, and which situations prevent this synergy. Towards the creation of a general theory of

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resilience, we have confirmation here that resilience is a context-dependent process, which underlines the significance of the “resilience to what?” conundrum.

### *Practical implications*

Many of the findings described in this thesis have important implications for corporate managers, investors, and regulators.

The most evident takeaway from this work for managers is that the activities of their organizations, the managerial processes they set up to develop these activities, and the strategies that guide them, all contribute to create a network of interdependencies between the organization’s resources, the driving forces of social capital, their specific capabilities, and stakeholders. The adoption of proactive environmental strategies that reduce environmental impact, through pollution prevention, product stewardship, and sustainable development, creates a synergistic force within this network which reinforces multiple links both inside and outside the organization. The result of these synergies is a set of sustainable competitive advantages such as reduced costs, better access to VRIN resources than competitors, improved stakeholder relationships, and a generally favorable future market position. The first result of this thesis is that, in addition to these advantages, creating a managerial framework that supports the development of EP, made visible by a lower environmental footprint than the firm’s peers for example, conjointly allows the firm to recover better from environmental disruptions related to ecological risks. This remark holds particular relevance for business continuity when put in front of the fact that these disruptive events top the 2024 Global Risks Report of the World Economic Forum (see Figure A), they are thus most likely to materialize during the next 10 years (World Economic Forum, 2024), and beyond (IPCC, 2022). In addition to the deployment of proactive environmental strategies, managers who wish to place their organization favorably in the fight against ecological crises should devote more attention to their dependency on natural resources, and how these resources are renewed through ecosystemic services (Costanza et al.,

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1997) that may exhibit patterns of exhaustion. This increased attention to ecological cues may place the organization in environmental awareness, a cognitive position that is expected to nurture preparedness for disruption, and thus organizational resilience. However, the results of the study of resilience to the Covid-19 crisis presented in the fourth chapter of this thesis should also serve as a source of caution: in deeply disruptive economic crises, the devotion of resources to EP may lead to less flexibility in the recovery period, which causes such organizations to require more time to recover their pre-crisis value. This means that certain critical situations call for an arbitrage between “doing good” and “doing well”, where managers might have to choose between respecting their commitment to proactive environmental strategy, and a swifter recovery of lost value through bold adaptive measures of emergency that place EP on the back burner.

For investors, the results of this thesis mean that the risk profile of their portfolio constituents is affected by their EP. The use of measures such as environmental footprint, or the inclusion of constituent scores under the environmental pillar of ESG reports, should be warranted when assessing the value of an asset or conducting a risk analysis as this factor is expected to affect the way these assets respond to market disruptions. In disruptive contexts that pertain to the ecological environment – which, again, are expected to multiply and intensify in the coming decades (IPCC, 2015, 2022), it is very likely that these high EP firms recover better from shocks and yield benefits that beat the market average during periods of upheaval. When other types of risk materialize though, particularly major economic crises such as the one triggered by the Covid-19 pandemic, it seems the value of EP is different, as it is likely these assets will lose less value in the initial period of the shock, but then require more time than others to return to their pre-crisis value. In the long run, there is a good chance that investments in high EP firms is the better choice due to the very high, and growing, concerns surrounding ecological issues. Besides resilience, there is growing evidence that EP favors access to new

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market opportunities and nurtures internal specific capabilities that boost the efficiency of business operations, which should be of interest for investors that wish to avoid missing out on growth opportunities.

From a regulatory perspective, the empirical work in this thesis, particularly in chapter 2 where the context of disruption is directly related to environmental law enforcement, supports the idea that more stringent regulation is necessary to push firms to be more prepared for the ecological disruptions that will inevitably materialize and affect a significant proportion of them. One must also not lose sight of the important role deterrence plays in directly protecting the environment, in pushing firms to adopt transition plans to mitigate the effects of climate change, and more generally, in reducing the strain of human activities on planetary boundaries. As observed by Brady et al. (2019), the level of environmental penalties relative to firms' market valuations has decreased recently in the US, whereas it has been empirically demonstrated that more severe penalties, particularly for repeat offenders, improve compliance with environmental law (Blundell, 2020). That being said, the role of the regulatory framework should also reside in creating incentives for organizations that wish to go beyond regulatory requirements, as these organizations often pioneer what then becomes the new standards of environmental stewardship. Moreover, as far as the recovery of firms in a particular market also depends on relief efforts from governments, there may be opportunities for transforming major crises into turning points, with large shifts of resource allocation towards a more sustainable society, as highlighted by Taherzadeh (2021). In such contexts, it would make sense to align the economic recovery budgets ("Green Economic Recovery" efforts) with sustainable development goals, for example, they should clearly prioritize organizations that make tangible proactive efforts to reduce the strain of human pressure on planetary systems over those that do not, in the Schumpeterian spirit of creative destruction (Schumpeter, 1911).



### *Limits and directions for future research*

The results and interpretations in this thesis have a good degree of robustness within the studied contexts of disruption. However, this work is not without limitations, which should also be considered as openings for future research endeavors.

The most prominent of these limits is common to most empirical research efforts that rely on secondary data, particularly in social sciences: while the overarching objective is to discuss the relationships that exist between complex social mechanisms such as strategic capabilities, environmental performance, and organizational resilience, our ability to measure these concepts precisely is highly dependent on the availability and quality of data. Most of all, the entanglement of the multiple capabilities that underpin EP makes it a difficult factor to quantify. In the empirical chapters of this thesis, two types of measure are used, the first is based on a material assessment of all environmental sources and sinks that can be translated in costs for society, provided by Trucost, which is termed “direct environmental footprint”. This measure has multiple advantages for empirical researchers, it is reliable, comparable, original, and relatively easy to grasp and interpret, but it also suffers from its narrower coverage than other available assessments of EP, which leads to smaller samples, hindering the strength of statistical analyses. The fourth chapter and final empirical study uses a more widely available measure: the environmental pillar score of ESG provided through Thomson Reuters’ Datastream tools by Asset4. On the flip side, this type of measure suffers from drawbacks, the scores are subjectively assessed by experts who grade items (Asset4 covers approximately 60 environmental indicators) pertaining to details about the way a firm handles environmental issues relative to its peers, with significant variance between rating agencies (Billio et al., 2021). This observation must serve as an encouragement for future research to further resolve this issue by adopting reliable sources of data and a comparative approach with other results in the literature that takes this point into consideration.

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Relatedly, while it would have been profoundly useful to study the effect of different strategic capabilities on OR in confirming the theoretical perspectives of the NRBV, the measures of EP that were used in this thesis do not clearly allow the separation of effects among the different strategic environmental capabilities of pollution reduction, product stewardship, and sustainable development. This means the effect of EP on resilience can only be interpreted as a combined effect of all the strategic environmental capabilities of the firm. Efforts to observe differentiated effects of constituents of EP in chapter 4 partially answer this issue, but yield results that are mostly aligned with the overall effect of EP, aside from the non-significant influence of resource use on the stability dimension of resilience. The academic attention to disentangle the channels through which EP influences OR should grow in importance if we wish to conduct empirical analyses that contribute to the NRBV.

The measures of organizational resilience used in this thesis are also imperfect. As already identified by DesJardine et al. (2019), using the reaction of market prices to assess the stability and flexibility dimensions of OR is relevant, but it does not represent the entire conceptual reality of OR, merely an outcome perspective that relates to its financial resilience within a limited time frame where other disruptive events can also impact the market value of firms. Moreover, behavioral finance shows that prices can overreact to news (De Bondt, 2020; De Bondt & Thaler, 1985), and are not perfect proxies of the actual impact of the event on the firm (Shiller, 2000, 2003). Still, organizational resilience is not simply a set of outcomes, but is a path-dependent, latent, socially complex, and multidimensional attribute of organizations which has implications for their performance beyond times of crisis. In that regard, the empirical chapters of this thesis are efforts to address the long-term perspective inherent to the resilience paradigm with long periods of observation that allow for the study of recovery over periods of time that are longer than in event studies, but it leaves important attributes of the resilience concept outside the window of observation. Future empirical studies of OR may be

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inspired by this work to turn their focus towards other steps in the resilience process: anticipation, preparedness, adaptive innovation, thriving, and learning. Investigations around these capabilities open particularly appealing avenues of enquiry within the nascent organizational resilience theory.

Finally, while this thesis partially addresses the dependence of the EP – OR relationship on contextual characteristics, it is limited to only three different contexts of disruption. As should be evident from the findings provided in these empirical chapters, there is room for deeper understanding of the mediation effect of contextual characteristics on the influence of EP on resilience. In particular, contexts of disruption that do not emerge merely from economic or financial issues, such as natural disasters, biodiversity loss, resource exhaustion, terrorist attacks, accidents in HROs, technological disasters, social and governance controversies, or cybersecurity breaches, all seem vastly understudied in the resilience literature. Hence, future empirical work considering these disruptive contexts as the background for studies of OR should bring compelling contributions in this growing strand of management research.

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