COMPETITIVE ADVANTAGE FROM MANDATORY CLIMATE RISK DISCLOSURES:

EVIDENCE FROM THE U.S. INSURANCE INDUSTRY

JIA GUO

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Competitive Advantage from Mandatory Climate Risk Disclosures: Evidence from the U.S. Insurance Industry

Jia Guo

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CERTIFICATE OF ORIGINALITY

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Jia Guo (Name of student)

ABSTRACT

I examine the effect of mandatory climate risk disclosures on insurers' underwriting business by exploiting the U.S. insurance industry's adoption of the Climate Risk Disclosure Survey (CRDS), which mandates that certain insurers respond to questions about their climate risk strategies. Using a staggered difference-in-differences research design, I find that compared to insurers not affected by the CRDS mandate, those affected by it experience an increase in their underwriting business after CRDS adoption. This outcome suggests that the CRDS mandate results in affected insurers gaining a competitive advantage in their underwriting business. This positive effect is more pronounced when insurers' underwriting business is more exposed to customers concerned about climate risk, when they experience more underwriting business competition, or when their headquarters are in a Democratic state. I also perform a textual analysis of the affected insurers' CRDS responses, which offers supplementary evidence of a positive association between insurers' proactiveness in addressing climate risk issues and their future underwriting business. My study offers the novel insight that by encouraging firms to include climate risk in their business strategies and communicate such strategies publicly, mandated climate risk disclosure can enhance firms' competitive advantage.

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A disclosure for climate change risks is necessary because of the potential magnitude of climate change on insurer solvency and insurance availability and affordability across all major categories of insurance: property casualty, life and health. ... Such responses will enable regulators to follow up with questions as necessary and will allow investors and consumers to incorporate additional information into their investment and purchasing decisions.

- National Association of Insurance Commissioners Climate Risks Disclosure Proposal (15 August 2008 draft; quoted in Mills (2009))

1. Introduction

This study examines the effect of mandatory climate risk disclosure on insurers' underwriting business. Climate risk presents the insurance underwriting business with both opportunities and challenges.[1] In its assessment of the potential impact of climate change on insurance regulation, the U.S. National Association of Insurance Commissioners (NAIC, 2008) states:

> Consumers who perceive themselves to be in locations with growing climate-related risks will require more and more information on how they can ameliorate these risks. Here insurers are in an ideal position to inform and educate and hence retain customer business ... Insurance consumers are best protected by a functioning competitive insurance market that delivers products that are affordable and adequately cover risk that consumers face ... Regulators should recognize the legitimate needs of insurers to send appropriate price signals regarding climate change risks, and that regulators should show reasonable flexibility when reviewing innovative discounts, products and other incentives that promote sound environmental practices. (p. 14).

[1] Gatzert and Reichel (2022) study the awareness of climate-related risks and opportunities of European and U.S. insurance companies. They find that property and casualty (P&C) insurers tend to be aware of the risks and opportunities resulting from climate change and that this awareness has a significant positive effect on their Tobin's Q.

In the U.S., the insurance industry is a frontrunner in mandating climate risk disclosures for both public and private insurers via the Climate Risk Disclosure Survey (CRDS). NAIC introduced the CRDS in 2010, providing a nationwide format that U.S. states can adopt.[2] According to the California Department of Insurance (CDI, n.d.), an insurance regulator in a CRDS-adopting state can require insurers operating in that state to annually disclose how they assess and manage their climate-related risk if they exceed certain premium thresholds. California was first to administer the CRDS in 2010 and 2011, and in 2012, the CDI posted insurers' disclosures publicly on its website.[3] New York and Washington joined the survey in 2012, requiring responses from all insurers licensed in those states that write more than $300 million in nationwide direct premiums. In 2013, the premium threshold was lowered by NAIC to $100 million, and the number of participating states expanded to include Connecticut and Minnesota. Illinois, Maryland, and New Mexico began mandating the survey disclosure in 2014, although Illinois and Maryland dropped the requirement in 2015. Later years saw more states mandate the survey. The staggered adoption of CRDS thus offers a unique setting for examining the consequences of mandatory climate risk disclosure.[4]

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[2] The U.S. insurance industry is regulated at the state level. NAIC is an association of state insurance regulators that coordinates regulations across states.

[3] See http://www.insurance.ca.gov/0250-insurers/0300-insurers/0100-applications/ClimateSurvey/.

[4] In his June 14, 2021, letter to the U.S. Securities and Exchange Commission (SEC), Mike Kreidler, Washington state's insurance commissioner, writes, "For 12 years, my fellow state insurance regulators and I have been requiring the largest insurers operating in the United States to report annually on the financial implications of climate change to their businesses … As the SEC considers putting rules in place regarding public company disclosure of risks related to climate change, I encourage you to review the experience that U.S. insurance regulators have already garnered with the insurance industry, given our decade-long disclosure requirements along the lines that the SEC is now contemplating" (Kreidler, 2021).

My broad research question concerns how climate risk disclosure mandates affect firms' competitive position in their product markets. This is an increasingly important question, given the growing, global demand for such disclosure. To examine this impact, I study how various states' staggered CRDS adoption affects insurers' underwriting business by comparing their direct written premiums (i.e., the total amount of an insurer's written premiums without any allowance for premiums ceded to reinsurers) before and after CRDS adoption and with those of their peers not affected by CRDS adoption.

I posit that CRDS disclosure will have a positive effect on the affected insurers' underwriting business for two reasons. First, when acquiring and processing the information needed to respond to the survey, the affected insurers learn more about how climate risk can affect the firm's strengths and weaknesses and the opportunities and threats it presents to the firm's underwriting business. For example, Question 6 of the CRDS asks the insurer to summarize the steps it has taken to encourage policyholders to reduce losses caused by climate-change-influenced events. If responding to this question results in an insurer enhancing its engagement with policyholders, the insurer might learn more about its policyholders' needs, enabling it to improve its existing insurance offerings and to develop new ones. Second, because survey responses filed with the insurance regulator are later publicly disclosed on the CDI's website, the affected insurers gain a platform to market their climate risk efforts to various stakeholders, including policyholders. Some policyholders might prefer to do business with an insurer that takes climate risk into consideration, either because the insurer's engagement with such issues gives the policyholder confidence in the insurer's financial soundness or because the policyholder prefers to purchase from climate-friendly firms.

Because the affected insurers' disclosure lessens the information asymmetry about their climate-risk-related actions (e.g., reduced investment in fossil fuel firms), it could have a positive impact on the affected insurers' business.[5]

To examine the effect of mandated climate risk disclosure on the affected insurers' product market, I employ a staggered difference-in-differences (DID) research design by comparing the direct written premiums for insurers that provide climate risk disclosures following the CRDS mandate (treatment insurers, hereafter) with those for insurers that do not do so (control insurers, hereafter). My primary finding is that relative to the control insurers, the treatment insurers experience statistically significant increases in their direct written premiums after adopting the CRDS. In terms of economic significance, the increase in direct written premiums for the treatment insurers is 25.8% (of average admitted assets) more than it is for the non-disclosers. These results imply that such disclosures offer affected insurers a competitive advantage in generating underwriting business.

My primary finding holds through a variety of robustness checks. First, to provide some evidence on the validity of the parallel trends assumption underlying the DID design, I examine whether the treatment and control insurers experience different trends in the pre-period. The test indicates they do not, and the affected insurers' direct written premiums increase, relative to their unaffected peers, in the post-adoption period only. In light of recent concerns about the staggered DID research design (Baker, Larcker, and Wang, 2022), I further validate the main staggered DID results via two tests: a Goodman-Bacon (2021) diagnostic decomposition and stacked DID estimates. The Goodman-Bacon diagnostic decomposition reveals that the

[5] Section 2 discusses this hypothesis, and the tension inherent in it, in more detail.

positive effect of CRDS adoption on direct written premiums is almost entirely due to the comparison between the treatment and never-treated insurer groups. Using a stacked DID research design, I continue to find that CRDS adoption has a positive effect on direct written premiums. I also document this positive effect in a series of robustness tests that employ alternative dependent variables, samples, and methods to deal with the outliers.

I next run several cross-sectional analyses to delve more deeply into CRDS adoption's positive effect on the affected insurers' underwriting business. The first two analyses focus on addressing climate risk issues as a competitive strategy to attract and retain customers. First, I find that the positive effect is more pronounced for treatment insurers with more climate-risk-sensitive customers, such as those whose underwriting business is concentrated in states more exposed to climate risk or those in states where citizens pay more attention to climate risk issues. Second, I find that the positive effect is more pronounced for treatment insurers facing greater product market competition in their underwriting business. These findings lend support to my argument that CRDS participation can result in affected insurers interacting more with their customers about climate risk issues and then modifying and expanding their insurance offerings to enhance their underwriting business.

My third cross-sectional analysis relies on the notion that when insurers are headquartered in Democratic states, their managers are more likely to adjust insurers' business strategies in response to mandatory climate risk disclosure because of political, regulatory, employee, and even public pressure in the headquarters state. I find that CRDS adoption's positive effect on direct written premiums is more pronounced for treatment insurers headquartered in Democratic states, relative to those headquartered in Republican states. This

finding suggests that when mandatory climate risk disclosure induces managers to be more climate focused, their firms experience a greater boost to its underwriting business.

Finally, I conduct supplementary, textual analyses of affected insurers' responses to the CRDS questions related to engagement with policyholders. I measure insurers' proactiveness in addressing climate risk issues related to their underwriting business using positive versus negative responses, as well as the number of words in detailed responses to specific climate risk issues in insurers' interactions with policyholders and other stakeholders. Between 2013 and 2019, the percentage of insurers responding "yes" when asked whether they interact with policyholders or other stakeholders about climate risk issues gradually increased, and the average number of words used in these responses nearly doubled. I also document a positive association between insurers' proactiveness in addressing climate risk issues and their future underwriting business.

My study contributes to the literature in several ways. First, it adds to the emerging literature on mandatory climate risk disclosure as industries and countries continue to develop such mandates. For example, Mésonnier and Nguyen (2020) and Ilhan, Krueger, Sautner, and Starks (2023) both exploit a mandatory climate disclosure law in France that requires French institutional investors to disclose the climate risk of their portfolio assets. Mésonnier and Nguyen (2020) find that institutional investors subject to the new law reduce their financing for fossil fuel firms. Ilhan et al. (2023) document that institutional investors can influence firms' climate risk disclosures. Using the CRDS setting to study mandated climate risk disclosures, Cheng, Guo, Ng, and Rusticus (2023) find that CRDS adoption leads to an improvement in the environmental friendliness of insurers' corporate investment portfolios, and they link this

improvement to reduced investment performance. To the best of my knowledge, my study is the first to examine how mandated climate risk disclosure impacts the relative competitive positions of affected and unaffected firms. My study uncovers the novel insight that mandated climate risk disclosure about firms' climate risk strategies can cause firms to enhance their competitive advantage by engaging with customers on climate risk issues and adjusting their product market strategies accordingly. My work therefore also extends the literature on the real effects of disclosure (Leuz and Wysocki, 2016).

Second, my study adds to the literature on insurance companies and their underwriting business. Prior studies have documented how insurers' business performance is affected by insurers' characteristics (e.g., Lai and Limpaphayom 2003; Milidonis, Nishikawa, and Shim 2019; Chen, Sun, Yao, and Yu 2020; Ge and Weisbach 2021), regulatory pressures (e.g., Ellul, Jotikasthira, and Lundblad 2011), and financial regulations (e.g., Ellul, Jotikasthira, Lundblad, and Wang 2015; Chen, Higgins, Xia, and Zou 2020). My thesis provides new evidence of the impact of an insurer's mandated climate risk disclosure on its underwriting business performance. Specifically, I document the evidence about the improvement in insurer's underwriting business when the insurer takes climate risk into consideration and communicates its climate risk strategy with its customers as a result of the disclosure.

My research also contributes to the global policymaking discussion about mandatory climate risk disclosure. On June 5, 2021, the G7 nations backed a move to compel companies to provide mandatory climate-related financial disclosures (John, 2021). However, an important challenge in such mandates is the risk of fragmentation from local jurisdictions developing their own unique approaches to climate risk disclosures. To address this issue,

organizations such as the Financial Stability Board and International Sustainability Standards Board are developing standardized frameworks for climate risk disclosure. My study, which leverages the U.S. insurance industry's decade-long experience with the CRDS, shows that high-level, qualitative climate risk disclosure can impact the relative competitive positions of both affected and unaffected insurers. An important strength of my study is the use of a staggered DID research design (within the CRDS setting) to examine the effects of mandatory climate risk disclosure; this design allows me to better identify the causal effects of such disclosure.[6] I believe the evidence in this paper can help policymakers make more informed decisions about climate risk disclosure mandates.

The remainder of the paper is organized as follows. Section 2 introduces the institutional background and develops the hypothesis. Section 3 describes the sample and empirical specification. Section 4 reports the empirical results of the baseline regression, robustness checks, and cross-sectional analyses. Section 5 details the results of the additional analyses. Section 6 concludes.

2. Institutional Background and Hypothesis Development

2.1 NAIC CRDS

NAIC has a long history of developing and adopting regulatory frameworks and reporting formats to assist states in their regulatory roles. It aims to offer a forum for all interested parties to come together to discuss and develop required information standards, including those related to climate risk disclosure:

[6] In their survey of the mandatory CSR and sustainability reporting literature, Christensen, Hail, and Leuz (2021) note that it can be difficult to disentangle the reporting effects from the effects of underlying activities, especially when both are largely voluntary. They call for more research on mandatory CSR reporting.

> However, states are now conducting their own task forces focused on climate risk. Consequently, any NAIC activities will need to mesh with the state initiatives. Moreover, federal government interest in climate change appears to be growing. As the Climate Change and Global Warming Task Force considers disclosure, the content, format and mechanism of collection need to be considered. Industries, like insurance, that span states are rightly wary of multiple reporting requirements. To be effective, NAIC must move decisively yet remain open to refinement over time. (NAIC, 2008, pp. 13–14).

The CRDS, which NAIC introduced in 2010, is a tool used by state insurance regulators to monitor insurers' assessment and management of climate risk. The survey comprises eight questions about how insurers factor climate risk into their mitigation, risk management, and investment plans. See Appendix A for an example of a CRDS notice, including the eight questions, from the California insurance regulator to all licensed insurers in the state.

California was the first state to administer this survey and the only one to do so in 2010 and 2011. Insurers are required to respond if they exceed the threshold for nationwide direct written premiums. In 2010 and 2011, the premium thresholds were, respectively, $500 million and $300 million. In 2012, the states of New York and Washington also began to administer the survey, joining California in mandating disclosure for insurers that write more than $300 million in nationwide direct premiums and that write business in any participating state, regardless of where they are headquartered. In addition, the survey responses were posted to the CDI website.[7] The following year, the premium threshold was further lowered to $100

[7] My research design uses 2012 as the first treatment year, as that is the first year for which CRDS responses are publicly available.

million, and the multi-state group expanded to include Connecticut and Minnesota. In 2014, Illinois, Maryland, and New Mexico also mandated the survey disclosure, though Illinois and Maryland ceased to do so in 2015. In 2021, eight more states (Delaware, Maine, Maryland, Massachusetts, Oregon, Pennsylvania, Rhode Island, and Vermont) and the District of Columbia joined the disclosure survey initiative (CDI, n.d.), bringing the total to 15 members (see Appendix B for the timeline of states' CRDS adoption).[8] The CRDS also attracted the attention of various stakeholders. For example, Ceres (2016), a nonprofit organization advocating for sustainability leadership, relies on CRDS responses to produce an annual report and scorecard for insurers.[9]

The CRDS framework has evolved over time. In 2022, NAIC replaced the 8-question survey with a new framework for reporting climate-related risks. The new framework aligns insurers with disclosure recommendations from the international Task Force on Climate-Related Financial Disclosures (TCFD).[10] The TCFD (2023) recommendations aim to be widely adoptable and applicable across sectors and jurisdictions, and they are designed to solicit decision-useful, forward-looking information that can be included in mainstream financial filings. Organizations are essentially asked to provide qualitative responses around

[8] According to the CDI (n.d.), in 2021, more than 1,400 insurers, comprising nearly 80% of the entire U.S. insurance market in terms of premiums written, were CRDS respondents.

[9] Ceres (2016) relies on its extensive network of investors, companies, and public interest groups to promote the adoption of sustainable business practices and solutions for building a healthy global economy.

[10] Since 2020, the NAIC has encouraged insurers to submit a report aligned with TCFD in lieu of answering the eight questions in the annual CRDS, and insurers have increasingly chosen the TCFD format. When the NAIC mandated the TCFD-aligned disclosure framework in 2022, they followed insurance regulators in France, Switzerland, and the United Kingdom, which already required TCFD-aligned reports. The SEC (2022) also is taking steps to require such reports.

four core elements: governance, strategy, risk management, and metrics and targets.[11] Some insurance regulators believe that the TCFD-aligned disclosure framework will enhance transparency about how insurers manage climate-related risks and opportunities and reduce the negative impact of climate change on insurance consumers (NAIC, 2022).

2.2 Hypothesis Development on the Effect of CRDS on Insurers' Underwriting Business

Climate risk plays an increasingly important role in firms' operations. For insurers, especially property and casualty (P&C) insurers, climate risk presents opportunities for and challenges to underwriting (Mills, 2009; Grimaldi, Javanmardian, Pinner, Samandari, and Strovink, 2020; Baumann et al., 2021). Adverse changes to climates increase consumers and businesses' concerns about property and casualty losses, which in turn increase demand for certain insurance products. However, insurers also face increased underwriting risk because climate change may lead to more and larger insurance claims. For example, in a world first, from July 2020 to April 2021, France's central bank conducted a climate change stress testing pilot exercise. The exercise's key finding is that in the nation's most affected regions, natural disaster-related insurance claims could increase up to five-fold, causing premiums to surge as much as 200% over 30 years (Autorité de Contrôle Prudentiel et de Résolution, 2021). In an article titled "Climate change and P&C insurance: The threat and opportunity" on McKinsey and Company's website, Grimaldi et al. (2020) conclude their analysis of the effect of climate change on the P&C insurance industry as follows: "The P&C insurance industry should change its business model in response to climate risk. Not only can this proactive response better

[11] Both the previous and new CRDS disclosure frameworks require insurers to provide qualitative responses to questions about climate risk. The new framework adds more questions organized around four thematic areas.

protect customers in the long term, but it can also help safeguard the interests of society and serve the foundational purpose of the insurance industry." (p. 8).

As the demand for the information about climate risk increases significantly, many jurisdictions are considering mandating climate risk disclosure.[12] Firms' stakeholders, including policymakers, are concerned about the impact of these disclosures on firms. I posit that the CRDS mandate has a positive effect on the affected insurers' underwriting business, for two reasons.

First, mandatory CRDS disclosure pressures insurers to consider climate risk in their business strategies. During the acquisition and processing of information needed to respond to the CRDS questions, the affected insurers learn more about how climate risk can affect the firm's strengths and weaknesses and the opportunities and threats it presents to the firm's underwriting business. Scientific understanding of climate risk's various impacts is growing and evolving, as is information about consumers' concerns about the issue.[13]

As noted earlier, even NAIC emphasizes that CRDS disclosures can help insurance regulators better understand climate-related risks for the U.S. insurance market. In developing their business strategies, insurers could learn about consumer demand for products and services

[12] For example, the SEC (2023) has proposed rule amendments requiring domestic and foreign registrants to include certain climate-related information in their registration statements and periodic reports (e.g., Form 10-K). In June 2023, the International Sustainability Standards Board issued its first International Financial Reporting Standard (IFRS) on climate risk disclosure, IFRS S2 Climate-related Disclosures.

[13] In his global review of the insurance industry's response to climate change, Mills (2009) notes: "The insurance community has become increasingly accepting of the science and macroeconomic modelling. Some still prefer to dismiss the science or take remaining uncertainties as a reason to wait on the sidelines, while others take it as precisely the reason for insurers not to be complacent. Most agree that reducing vulnerability to weather extremes should be a higher priority, but some dispute the need for insurers to engage in addressing the core drivers of climate change or the need to discern the relative roles of human influence and natural factors." (p. 325).

that respond to climate risk, enhance their efforts to improve disaster resilience, and be more proactive about the climate change threat (Mills, 2009). In fact, increasing public awareness, acceptance, and concerns regarding climate change have led many insurers to introduce new insurance terms and policy exclusions designed to promote behaviors that reduce greenhouse gas emissions and other efforts to protect the environment. According to John Neal, CEO of Lloyd's of London, climate is the "ultimate systemic risk" and represents "the biggest single opportunity the insurance industry has ever seen" (Frangoul, 2021). Gatzert and Reichel (2022) find that P&C insurers in Europe and the U.S. tend to be aware of the risks and opportunities resulting from climate change and that such awareness enhances firm value.

In their CRDS response process, insurers can consider strategies to develop products and services to deal with climate risk. For example, insurers can consider whether to provide climate resilience services to manage and reduce clients' exposure to climate risk and whether to offer tailored underwriting services to deal with climate-related losses (Javandardian, Johansson, McNeill, Ru, and Srivastava, 2022).[14] One CRDS question asks the insurer to summarize the steps it has taken to encourage policyholders to reduce losses caused by climate change-influenced events. As an example, the Zurich American Insurance Company's response to this question in their 2019 CRDS disclosure was as follows (see Appendix C for the full survey response):

> Zurich continuously strives to identify and respond to the risk management needs arising from existing or upcoming climate change legislation … During the first years of its

[14] For an example of such a service offered by Zurich Insurance Group, see https://www.zurich.com/products-and-services/protect-your-business/risk-engineering/climate-resilience.

climate initiative, Zurich has climate-related products, some of which are, at least in part, driven by this legislation. Examples of these products include: (1) directors & officers liability insurance extended for climate-related claims; (2) political and trade credit risk coverage for carbon credit projects; (3) green, efficient and resilient rebuild insurance, allowing for the rebuilding of damaged property with improvements to green, efficiency or weather-resilience standards. Zurich also made specialized insurance available for electric cars and is developing specialized agricultural coverages focused on improving resilience in the face of climate change and natural resource strain. (Written response question 6, para. 3).

The second reason for the CRDS mandate's positive effect on affected insurers' underwriting business lies in the reduction in information asymmetry between insurers and their customers about the former's climate risk strategies. Reduced information asymmetry can improve insurers' consumer protections, which is a key objective of insurance regulation. NAIC (2008) states that to ensure consumer confidence in insurers' financial capability to meet their contractual commitments, insurers should disclose their strategies to address relevant climate risk issues, including appropriate actions with regard to pricing, availability, and reserving as they relate to the insurer's products and incorporating climate risk into investment portfolios. For example, the Zurich American Insurance Company's 2019 CRDS response (see Appendix C) also states how they are trying to communicate with their policyholders about their climate risk strategies:

Zurich uses its skills in risk identification and management to assist stakeholders in better adapting to and mitigating risks of climate change. To that end, a variety of activities,

including formal information sharing, such as congressional testimony or white papers, and more informal means, such as customer and broker meetings, as well as Risk Engineering assessments have been undertaken to share information and collaborate with policyholders and potential policyholders. Zurich has worked with stakeholders to better understand the potential climate change risks that may require risk management solutions to mitigate those risks. (Written response question 6, para. 2).

Related to reduced information asymmetry, some consumers prefer to purchase from climate-friendly firms because of political or moral beliefs, which the literature refers to as green buying (e.g., Mainieri, Barnett, Valdero, Unipan, and Oskamp, 1997; Bonini and Oppenheim, 2008; Gupta and Ogden, 2009; Moser, 2015).[15] CRDS disclosures can serve as a green marketing tool (Cronin, Smith, Gleim, Ramirez, and Martinez, 2011; Boztepe, 2012). Some consumers might be unwilling to buy insurance products from climate-unfriendly insurers and consequently might find insurers' responses to CRDS questions useful to their purchasing decisions (Mills, 2009). Insurers appear to care about the increasing public attention on those providing underwriting services to climate-unfriendly firms or investing underwriting premiums in such firms (Binnie, 2023; PWC, 2023; Sherwood and Sharma, 2023; Sustainable Brands, 2023). For example, in its response to the CRDS in 2019, the Zurich American Insurance Company states, "Zurich is making continued progress in integrating ESG factors, including climate change, into security and asset selection processes across its investment

[15] Prior literature suggests a positive link between a firm's corporate social responsibility activities and its reputation, customer satisfaction, and loyalty, potentially leading to better firm performance (Bhattacharya and Sen, 2004; Luo and Bhattacharya, 2006). Recent literature also presents evidence that corporate customers care about their suppliers' social responsibility (Dai, Liang, and Ng, 2021; She, 2022; Darendeli, Fiechter, Hitz, and Lehmann, 2022).

portfolio. Zurich is also thoroughly assessing responsible investment practices of its asset managers as part of its manager selection and monitoring processes." (Written response question 5, para. 5).

In summary, my primary hypothesis is that CRDS adoption will have a positive effect on the affected insurers' underwriting business due to insurers learning more about the impact of climate risk on their business and the reduced information asymmetry between insurers and their customers about the former's climate risk strategies. However, this hypothesis is not without tension. The extensive disclosure literature highlights that proprietary costs represent an important disclosure cost from the perspective of product market competition (Verrecchia, 1983; Ellis, Fee, and Thomas, 2012; Li, Lin, and Zhang, 2018). The CRDS essentially asks insurers to disclose their strategies for dealing with climate risk issues in various aspects of their business, particularly interactions with consumers about climate risk issues and managing such risks in their underwriting business and investment portfolios. To the extent that such disclosures give useful information to insurers that are not required to respond to the CRDS, these disclosures can damage the disclosing insurers' competitive position. Specifically, if some insurers disclose their climate risk strategies to leverage underwriting opportunities provided by consumers' concerns about climate risk while other insurers do not, an asymmetry will arise in the information flow. Another source of tension might be that affected insurers learn about potential losses from climate change, raise their prices, and lose business to other insurers that are ignorant of climate change's impact. In addition, the CRDS adoption may have no impact on the affected insurers' underwriting business because there might be some insurers that noticed the benefit from climate risk considerations having already considered climate risk

and acted accordingly (e.g., learn how to incorporate climate risk into business strategies and communicate with customers) before CRDS adoption.[16]

3. Research Design

3.1 Sample

I restrict the sample to P&C insurers because they are the predominant type of insurer in the United States and because, as mentioned earlier, climate risk most directly impacts their underwriting business.[17] The sample period is from 2007 to 2019. I end my sample in 2019 to avoid the impact of the COVID-19 pandemic and start it in 2007 to ensure a balanced number of years before and after the staggered CRDS adoption period (i.e., 2012–2014), explained in detail below. I obtain the financial data of 3,273 P&C insurers from the NAIC Annual Statement Database, which covers statutory financial statement data for all U.S. insurers. I match these data to insurers' CRDS response data from the CDI website.

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[16] The reason why at least some insurers do not voluntarily disclose their climate risk exposures before the CRDS mandate is that there are some divergent beliefs in the costs and benefits of taking climate risk into consideration. Such divergent beliefs could be political beliefs (e.g., Democrat versus Republican) or economic beliefs (e.g., cost and benefits of considering climate change). However, climate science is evolving, which would affect the economic beliefs and possibly even political beliefs. There is a growing literature that relaxes assumption that managers have perfect or better knowledge than outsiders and emphasizes that managers can and will learn (e.g., Chen, Ng, and Yang, 2021). In particular, the implementation of accounting standards can affect firms' operations due to their learning process (e.g., Shroff, 2017; Fiechter, Hitz, and Lehmann, 2022). Therefore, insurers can also learn more about how to leverage climate risk to improve their business performance from their preparation for the CRDS mandate and then change their behaviors. In addition, while CRDS seems to increase sales, this does not necessarily mean higher (expected) profits, since writing extra climate change specific policies can expose insurers to higher climate risk.

[17] Obersteadt (2012) shows that P&C insurers tend to provide the most robust CRDS responses and to identify climate risk as a primary concern. In contrast, many life and health insurers report little risk to their business from climate change. A comprehensive analysis of the CRDS's results by Ceres (2013, 2014, 2016) finds that P&C insurers demonstrate advanced understanding of the risk of climate change to their business and that they are much further along in developing tools to manage that risk. In contrast, life and health insurers show widespread indifference to climate risk with regard to both their core business lines and their investment strategies.

As noted earlier, 2012 is the first year the CRDS was mandated and insurers' CRDS responses were made public. Hence, my staggered DID research design employs 2012 as the first year of mandatory CRDS adoption (in California, New York, and Washington state). To avoid confounding effects from a small number of CRDS responses posted by the CDI (n.d.) before 2012, I exclude these 27 insurers from my sample. Illinois and Maryland joined the CRDS in 2014 but exited in 2015. To address these reversals, I exclude 32 insurers for which CRDS disclosure becomes mandatory in 2014 because these insurers meet the nationwide direct premium threshold and do business in Illinois or Maryland but not in other CRDS-participating states (i.e., California, Connecticut, Minnesota, New Mexico, New York, and Washington). By excluding these temporary participants, I effectively treat Illinois and Maryland as non-participants in the CRDS throughout my sample period.[18] I therefore employ the following staggered CRDS adoption pattern: California, New York, and Washington adopted in 2012; Connecticut and Minnesota in 2013; and New Mexico in 2014.

The treatment insurers are those that meet the compulsory CRDS disclosure criteria and have their CRDS disclosures available on the CDI's website. Other insurers comprise the control group. I further exclude insurer-year observations missing data necessary for calculating the main variables in the regression.

Table 1 shows the distribution of treatment and control insurers in the sample period. My sample contains 2,398 insurers, which corresponds to 27,911 insurer-year observations. The number of observations is distributed nearly evenly over the sample period. The treatment

[18] In 2021 (after my sample period), Maryland rejoined the CRDS; Illinois has not followed suit.

group includes 6,858 observations from 532 insurers, and the control group includes 21,053 observations from 1,866 insurers.

3.2 Staggered DID Specification

To test the effect of mandatory CRDS disclosure on insurers' underwriting business, I employ the following staggered DID model specification:

$$Direct\_premium_{i,t} = \alpha_0 + \beta_1 CRDS_{i,t} + \gamma\, Controls_{i,t} + Insurer\ FE + Year\ FE + \varepsilon_{i,t}, \quad (1)$$

where *Direct_premium* measures an insurer's underwriting business, defined as the insurer's nationwide direct written premiums scaled by the average of its beginning and ending total admitted assets; *i* and *t* index the insurer and year, respectively. *CRDS* is a dummy variable that equals one for the first year when the insurer meets the compulsory CRDS disclosure criteria and its CRDS response is disclosed on the CDI's website and for all subsequent years, and zero otherwise. The coefficient β_1 on *CRDS* captures the effect of mandatory CRDS disclosure on insurers' underwriting business.

Following prior literature (e.g., Epermanis and Harrington, 2006; Cole, Fier, Carson, and Andrews, 2015), I include as controls several insurer-level variables that would affect insurers' underwriting business. *Size* is the natural logarithm of the total admitted assets, which are assets permitted to be included in the insurer's financial statements, based on NAIC's Statutory Accounting Principles. *Leverage* is the total liabilities divided by the total admitted assets. *Mutual* is a dummy variable that equals one when the insurer is a mutual, and zero otherwise. *Reinsurance* the percentage of gross premiums written that is ceded to reinsurers. *Geo_concentration* is the geographical Herfindahl-Hirschman index, which is a measure of an insurer's geographic diversification. *Personal_lines* is the proportion of net premiums written

from personal lines (i.e., farm owners multiple peril, homeowners multiple peril, personal automobile physical damage, and personal automobile liability) to the total net premiums written. *Commercial_lines* is the proportion of net premiums written from commercial long-tail lines (i.e., workers' compensation, other liability, commercial automobile liability, and product liability) to the total net premiums written. I also include insurer and year fixed effects to control for characteristics that are invariant across insurers and years, respectively. To mitigate the effect of outliers, I winsorize all continuous variables at the 1st and 99th percentiles by year. I also adopt heteroscedasticity-robust standard errors clustered at the insurer level.

Table 2 details the summary statistics for the main variables used in the analysis. The mean value of *Direct_premium* is 1.102, suggesting that for the insurers in my sample, the average nationwide direct written premiums is 110% of average admitted assets. The summary statistics for the control variables are largely consistent with prior studies (e.g., Epermanis and Harrington, 2006; Cole et al., 2015; Cheng, Qian, and Reeb, 2020).

4. Empirical Results

4.1 Mandatory CRDS Disclosure and Insurers' Underwriting Business

Table 3, Column (1) presents the regression results of the effect of mandatory CRDS disclosure on insurers' underwriting business. I observe a statistically significant positive coefficient on *CRDS* (coefficient = 0.2576, *t*-stat = 2.95). This result suggests that after CRDS adoption, insurers required to respond to the survey experience an increase in their premiums written. In terms of economic significance, the magnitude of the coefficient indicates that after

the mandated climate risk disclosure, the increase in the treatment group's new contracting amount is 25.76% (of average admitted assets) more than that for the control group.[19]

The coefficients on the control variables are generally consistent with those reported in prior literature. For example, the negative and significant coefficient on *Size* is consistent with Choi's (2010) finding that smaller insurers could be relatively new to the market and thus have a greater capacity for growth, compared to larger insurers. The coefficient on *Mutual* is negative and statistically significant, suggesting that mutual insurers' lesser degree of managerial discretion and operational flexibility limits their ability to generate revenue growth (Cole et al., 2015). The coefficient on *Reinsurance* is positive and significant, indicating that insurers ceding more reinsurance have a greater capacity to write more insurance policies (Cole et al., 2015). The negative and significant coefficient on *Geo_concentration* is consistent with the pro-conglomeration argument that geographically diversified insurers should be able to charge higher prices relative to geographically focused insurers due to coinsurance effects (Liebenberg and Sommer, 2008). The negative and significant coefficients on *Personal_lines* and *Commercial_lines* suggest that compared to insurers writing relatively smaller amounts of personal or commercial insurance, those writing relatively larger amounts are subject to significant product market discipline (Epermanis and Harrington, 2006).

The key identifying assumption for the DID model is that in the absence of treatment events, the treatment and control groups should exhibit parallel trends in the dependent variable (Abadie, 2005). Although this assumption is not directly testable, I provide some basic

[19] The mean value of *Direct_premium* in my sample is 1.102, a 25.76% increase indicates that the change in direct written premiums is 23.28% (25.76% / 1.102). The mean value of insurers' direct written premiums in the sample is $240 millions, a 23.28% increase translates into an increase of $55.87 millions in the direct written premiums.

reassurance by investigating whether a divergence existed prior to the treatment. Specifically, I replace *CRDS* with a series of time dummy variables (*CRDS_pre3-*, *CRDS_pre2*, *CRDS _pre1*, *CRDS _post1*, *CRDS _post2*, and *CRDS _post3+*) indicating the year relative to CRDS adoption. I use the CRDS adoption year (*CRDS_adoption*) as the benchmark. The coefficients on these time dummy variables track the difference in underwriting business between the treatment and control groups from the pre- to post-CRDS adoption periods.

Table 3, Column (2) reports the results of this test. The coefficients on *CRDS_pre3-*, *CRDS_pre2*, and *CRDS _pre1* are all statistically insignificant, suggesting that during the pre-adoption period, the difference in direct written premiums for the treatment and control groups does not differ statistically from the benchmark-year difference. This result indicates that the increase in new contracting amounts did not occur before CRDS disclosure became mandatory, which supports the parallel trend assumption. In contrast, the coefficients on *CRDS _post1*, *CRDS _post2*, and *CRDS _post3+* are all significantly positive, reflecting the post-adoption rise in the treatment insurers' contracting amounts. I also plot the coefficients in Figure 1. Consistent with the parallel trend assumption, the coefficients significantly increase only after CRDS became a requirement.

Taken together, the results in Table 3 support my main hypothesis that after CRDS disclosure becomes mandatory, the affected insurers experience an increase in their underwriting business, relative to the control group.

4.2 Further Validation of the Staggered DID Research Design

To address potential bias in the staggered DID estimates (Baker et al., 2022), I perform two validation checks. First, I implement Goodman-Bacon's (2021) diagnostic decomposition

to examine whether my staggered DID estimates are biased by inefficient comparisons. Second, I employ stacked DID estimates to address concerns about heterogeneous treatment effects in the staggered DID estimates.

4.2.1 Goodman-Bacon Diagnostic Decomposition

Following Goodman-Bacon (2021), I decompose the weights from the various cross-group comparisons in the staggered DID estimation. This test allows me to examine whether the staggered adoption pattern causes inefficient comparisons that bias my staggered DID estimates. Table 4, Panel A shows that the weight on the treatment versus the never-treated group comparison is 0.971 and that the average estimated treatment effect for this group comparison is 0.315. These results indicate that most of the estimated treatment effect derives from the comparison between the treatment and never-treated groups (97.1%). Therefore, my staggered DID estimates are not biased by inefficient comparisons.

4.2.2 Stacked DID

To address concerns about the heterogeneous treatment effects in the staggered DID estimation, I follow prior literature and employ stacked DID estimates (e.g., Gormley and Matsa, 2011; Cengiz, Dube, Lindner, and Zipperer, 2019). For each treatment event (i.e., CRDS adoption), I construct a cohort set that includes all insurer-year observations in a window ranging from three years before the event to three years after it. I then drop the treated insurer-year observations from each cohort to ensure the control group is pure. Next, I stack all cohort sets together and estimate the following equation using the stacked panel:

$$Direct\_premium_{i,c,\tau} = \alpha_0 + \beta_1 Treat_{i,c,\tau} + \gamma\, Controls_{i,c,\tau} + Insurer\text{-}cohort\ FE + Year\text{-}cohort\ FE + \varepsilon_{i,c,\tau}, \quad (2)$$

where *i*, *c*, and τ respectively index the insurer, cohort, and event year (i.e., the calendar year minus the treatment year in a cohort). *Treat* is a dummy variable that equals one for the first year when the insurer meets the compulsory CRDS disclosure criteria and its CRDS response is disclosed on the CDI's website and for all of a cohort's subsequent years, and zero otherwise. I include insurer-cohort and year-cohort fixed effects in the model and cluster standard errors at the insurer-cohort level. The other variables are as defined in Equation (1). The coefficient β_1 on *Treat* captures the effect of mandatory CRDS disclosure on insurers' underwriting business.

Table 4, Panel B shows the results of the stacked DID estimates. I observe a positive and statistically significant coefficient on *Treat* (coefficient = 0.1973, *t*-stat = 2.84). This result indicates that my previous finding remains robust to the stacked DID estimation, confirming that my staggered DID estimates are not sensitive to heterogeneous treatment effects.

4.3 Robustness Tests

To further validate my main result, I conduct a variety of robustness tests. First, I use two alternative measures of direct written premiums to capture insurers' underwriting business. Second, I examine my main result's robustness to a series of alternative samples. Last, I adopt alternative methods to deal with the effect of outliers.

4.3.1 Alternative Measures of Direct Written Premiums

In the baseline analysis, I use an insurer's direct written premiums scaled by the average of its beginning and ending total admitted assets to measure its new contracting amount. As a robustness test, I define *Direct_premium_1* as the insurer's direct written premiums scaled by its beginning total admitted assets. I also use the natural logarithm of the insurer's direct written

premiums as an alternative measure of the new contracting amount, *Direct_premium_2*. I then use these two alternative measures as the dependent variable and re-estimate Equation (1) with each measure.

Table 5, Panel A presents the results of this robustness test. In both column (1) and column (2), the coefficients on *CRDS* remain positive and statistically significant, indicating that my main finding is robust to these alternative measures of the new contracting amount.[20]

4.3.2 Alternative Samples

I then test whether my main result is robust to alternative samples. First, I use an alternative sample period of 2010–2019, dropping 2009 and prior years to avoid the impact of the 2008–2009 financial crisis. Table 5, Pabel B, Column (1) shows that my main finding remains robust to this alternative sample period. Next, I test whether my main result holds for both public and private insurers, given their inherent differences. Table 5, Panel B, Columns (2) and (3) show that the positive effect is present in both the public and private insurer samples. The test of the difference between the coefficients on *CRDS* in these two columns suggests that the difference is statistically insignificant (p-value > 0.01). These results indicate that the mandated climate risk disclosure affects private and public insurers similarly.[21]

[20] Table 5, Panel A, Column (2) shows the coefficient on *CRDS* is 0.1104, indicating a 11.04% increase of the treatment insurers' direct written premiums relative to control insurers after the CRDS adoption. The mean value of insurers' direct written premiums in this sample is $201 millions, a 11.04% increase translates into an increase of $22.19 millions in the direct written premiums.

[21] When I add a control variable indicating whether an insurer is public or not in the baseline regression, the result also shows that direct written premiums are not affected by the insurers' public status.

4.3.3 Alternative Methods to Deal with Outliers

In the baseline specification, I winsorize all the continuous variables at the 1st and 99th percentiles by year to mitigate the effect of outliers. In this section, I consider alternative methods to deal with the effect of outliers. One motivation for doing so is the large economic significance documented for the baseline result, which could be because of the outliers. First, I winsorize all the continuous variables at the 5th and 95th percentiles by year. Second, I trim all the continuous variables at the 1st and 99th percentiles by year. Last, to further mitigate the concern about the skewed distribution of *Direct_premium*, I use the natural logarithm of *Direct_premium* (i.e., *Log_Direct_premium*) as the dependent variable and re-estimate Equation (1).

Table 5, Panel C presents the results. In columns (1)-(3), the coefficients on *CRDS* all remain positive and statistically significant. The coefficients on *CRDS* in column (1) and column (2) are 0.0583 and 0.1158, respectively, suggesting that after the mandated climate risk disclosure, the increase in the treatment group's new contracting amount is 5.83% and 11.58% (of average admitted assets) more than that for the control group, respectively. The coefficient on *CRDS* in column (3) is 0.1147, which indicates that after CRDS adoption, the increase in the treatment group's new contracting amount is 12.15% (of average admitted assets) more than that for the control group.[22]

Note that the results above suggest that the effects of CRDS adoption on insurers' underwriting business, while smaller, are still economically meaningful. The above tests using

[22] I exponentiate the coefficient on *CRDS* (i.e., 0.1147) and then subtract the result by 1 to determine that the increase is 12.15%.

alternative methods to deal with outliers clearly produce the results indicating lower economic significance in the impact of CRDS adoption on insurers' underwriting business compared to the economic significance documented for the baseline result. However, as these methods are less conventional in contemporary accounting research, I will use the method in the baseline specification for other analyses in this paper.

4.4 Heterogeneity in the Effect of Mandatory CRDS Disclosure on Insurers' Underwriting Business

Having documented that mandatory CRDS disclosure has an overall positive effect on the treatment insurers' underwriting business, compared to that of the control insurers, I now explore three conditions prior to CRDS adoption that could moderate this effect:[23] customers' climate risk concerns, product market competition, and managers' willingness to be more climate focused. These analyses delve more deeply into my primary finding. They also might lend support to my arguments that the positive effect is due to the insurer learning how to leverage climate risk to enhance its business and to the reduction in information asymmetry between insurers and their customers about the former's climate risk strategies.

The regression specification used in my heterogeneity tests extends Equation (1) as follows:

$$Direct\_premium_{i,t} = \alpha_0 + \beta_1 CRDS \times Mod\_var_{i,t} + \beta_2 CRDS_{i,t} + \gamma Controls_{i,t} + Insurer\ FE + Year\ FE + \varepsilon_{i,t}, \quad (3)$$

[23] One potential concern about cross-sectional tests pertaining to the beginning of an event is that the event may affect firm characteristics, leading to inconsistent estimates of the treatment effect (Gormley and Matsa, 2014). To mitigate this concern, I use ex ante insurer characteristics measured during the pre-treatment period to construct the moderating variables for the cross-sectional analyses that follow.

where *Mod_var* is a moderating variable and a proxy for a factor expected to generate heterogeneity in the effect of CRDS adoption on underwriting business.[24] The other variables are as defined in Equation (1).

For the heterogeneity analysis using a dummy variable as the moderating variable, the coefficient β_2 on *CRDS* captures the effect of CRDS adoption on insurers' underwriting business in the absence of the characteristic for which the moderating variable is acting as proxy; the coefficient β_1 on the interaction term between *CRDS* and the moderating variable is the incremental effect in the presence of that characteristic. To ease exposition of the heterogeneity analysis with a continuous variable as the moderating variable, I transform the continuous moderating variable by subtracting the mean and scaling by the standard deviation. The transformed variable, which retains the full distribution of the original, thus has a mean of zero and a standard deviation of one. In terms of the exposition, the magnitude of the coefficient on the transformed variable is directly informative of its economic significance. In particular, the coefficient β_2 on *CRDS* can be interpreted as the effect of CRDS adoption on insurers' underwriting business at the mean of the pre-transformed variable; the coefficient β_1 on the interaction term between *CRDS* and the transformed moderating variable can be interpreted as the effect of CRDS adoption on insurers' underwriting business for a one standard deviation increase in the pre-transformed variable.

[24] The proxies remain constant for each insurer during the sample period because they are measured in the year before CRDS adoption; thus, the main effect of the proxies is subsumed when I add insurer fixed effects.

4.4.1 Customer Climate Risk Concerns

First, I investigate how insurance consumers' climate risk concerns influence the effect of mandatory CRDS disclosure on their insurers' underwriting business. This investigation is motivated by NAIC's (2008) statement, quoted in the first paragraph of the introduction, that insurers can retain customers in climate-risk areas by offering solutions to decrease that risk. I posit that when the CRDS pressures affected insurers to implement consumer-focused business strategies (e.g., informing them about their climate-risk-related needs, encouraging them to reduce losses caused by climate change, engaging them on relevant climate-related topics), the consumers with more concerns about climate risk are likely to be more responsive. This responsiveness can involve giving insurers more feedback about their climate-risk-related insurance needs, as well as a willingness to contract with insurers that provide products that cater to their needs. Hence, I hypothesize that the positive effect of CRDS disclosure on the affected insurers will be stronger when insurers' underwriting business is more exposed to regions where consumers are more likely to be concerned about climate risk.

I use two measures to capture insurers' exposure to customers' climate risk concerns. First, I use the Climate Change Risk Index score for each U.S. state, which captures the extent of climate risk faced by each state, to measure customers' concerns about climate risk in that state. Customers in high-risk states are likely to be more worried about climate risk.[25] I then use the direct-premium-weighted-average of the climate risk index score for each state to measure the customer climate risk concerns for an insurer. That is, I weight each state's climate

[25] I obtain states' U.S. Climate Change Risk Index score from SafeHome.org (https://www.safehome.org/climate-change-statistics/).

risk index score by the insurer's written premiums in that state as a percentage of the insurer's total written premiums across all states. As noted earlier, to ease exposition of a heterogeneity analysis that uses a continuous variable as the moderating variable, I transform the weighted average score by subtracting the mean and scaling by the standard deviation. The transformed moderating variable is labeled as *W_CR_exposure*.

Second, I measure customer's attitude toward climate risk for each state using the value of the state-level estimates of the percentage of adults who think their governor should be doing either more or much more to address global warming.[26] I then construct an insurer-level measure, the insurer's direct-premium-weighted-average of the above state-level estimate, which measures the insurer's exposure to customer climate risk concerns. Next, I transform the weighted average estimate by subtracting the mean and scaling by the standard deviation. I label the transformed variable as *W_CR_attitude*. To test this cross-sectional variation, I estimate Equation (3) using *W_CR_exposure* and *W_CR_attitude* as the *Mod_var* proxy.

Table 6 presents the results of this heterogeneity analysis. The coefficients on *CRDS* × *W_CR_exposure* (coefficient = 0.1798, *t*-stat = 2.10) and *CRDS* × *W_CR_attitude* (coefficient = 0.0896, *t*-stat = 2.07) are all positive and statistically significant, consistent with the notion that mandated climate risk disclosure plays a more significant role in the treatment insurers' underwriting business when their customers have more climate risk concerns.

[26] The Yale Program on Climate Change Communication and the George Mason University Center for Climate Change Communication conduct a comprehensive national survey to estimate variation in Americans' climate change beliefs, risk perceptions, and policy support at the state, congressional district, metro area, and county levels. The survey data, which reflect public perceptions of and attitudes about climate risk, are available at https://climatecommunication.yale.edu/visualizations-data/ycom-us/.

4.4.2 Product Market Competition

Next, I investigate how product market competition in the underwriting business influences the effect of mandatory CRDS disclosure on insurers' underwriting business. This investigation is motivated by NAIC's statement, quoted in the first paragraph of the introduction, that insurance consumers are best protected by a functioning, competitive insurance market that delivers affordable and effective products (NAIC, 2008). A key takeaway from the literature on green buying and marketing is that some consumers prefer firms that are marketed as green (Mainieri et al., 1997; Bonini and Oppenheim, 2008; Gupta and Ogden, 2009; Cronin et al., 2011; Boztepe, 2012; Moser, 2015). As noted earlier, because the CDI publishes CRDS responses on its website, insurers can use the survey to market their social responsibility about climate change. Compared to insurers facing less competition for underwriting business, competitive insurers are likely more incentivized to be green (in both underwriting and investment) and to leverage the CRDS to market their greenness. Hence, I hypothesize that the positive effect of CRDS disclosure on the affected insurers will be more pronounced when their underwriting business is exposed to more product market competition.

I adopt four measures to capture an insurer's exposure to product market competition. First, I use the number of insurers underwriting in each state as a proxy for state-level product market competition. I then measure an insurer's level of product market competition using the direct-premium-weighted-average of state-level competition. I transform the weighted average competition measure by subtracting the mean and scaling by the standard deviation. The transformed variable is *W_competitors*. Second, I use an insurer's three-year market share volatility to capture its product market competition, where market share is its direct written

premiums divided by total direct written premiums for all insurers in the year (Caves and Porter, 1978; Athey, Bagwell, and Sanchirico, 2004; OECD, 2021).[27] I transform the volatility measure by subtracting the mean and scaling by the standard deviation. The transformed variable is *Mkt_shr_vol*. The third and fourth measures are constructed based on the notion that non-market leaders are more likely to face more product market competition (e.g., Keune, Mayhew, and Schmidt, 2016). Consequently, I define *Non_mkt_leader_1* (*Non_mkt_leader_2*) as a dummy variable that equals one when the insurer is not a market leader in the year before CRDS adoption, and zero otherwise. I define market leaders as insurers ranked in the top 100 (top 20%) of insurers based on size, according to total admitted assets. To test this cross-sectional variation, I estimate Equation (3) using *W_competitors*, *Mkt_shr_vol,* *Non_mkt_leader_1*, and *Non_mkt_leader_2* as the *Mod_var* proxy.

Table 7 presents the results of this heterogeneity analysis. The coefficients on *CRDS* × *W_competitors* (coefficient = 0.1704, *t*-stat = 2.53), *CRDS* × *Mkt_shr_vol* (coefficient = 0.2491, *t*-stat = 2.00), *CRDS* × *Non_mkt_leader_1* (coefficient = 0.2419, *t*-stat = 2.13) and *CRDS* × *Non_mkt_leader_2* (coefficient = 0.6015, *t*-stat = 3.12) are all positive and statistically significant, consistent with the notion that mandated climate risk disclosure plays a more significant role in the treatment insurers' underwriting business when they are exposed to more product market competition.

[27] In a dynamic Bertrand game, Athey et al. (2004) show that when collusion is present, market shares are more stable than they are in competitive equilibria.

4.4.3 Insurers Headquartered in Democratic States

Last, I investigate how insurance managers' responsiveness to pressure to focus on climate risk influences the effect of mandatory CRDS disclosure on insurers' underwriting business. Though greater responsiveness is likely to make this effect more pronounced, heterogeneity will nevertheless arise in how the treated insurers' managers respond to initiatives such as the CRDS. I posit that managers more responsive to the pressure induced by the CRDS will be more proactive in developing and implementing climate-risk-related strategies to boost their firms' business.

Motivated by the polarized political views about climate-risk-related issues (McCright and Dunlap, 2011; Funk and Kennedy, 2016; Rode et al., 2021), I rely on whether the insurer's headquarters is located in a Democratic state, compared to a non-Democratic state, as an indication of its management's responsiveness to climate risk issues.[28, 29] Political elites both reflect and strongly influence public awareness on this issue (e.g., Brulle, Carmichael, and Jenkins, 2012). Prior literature also provides extensive evidence that political ideology influences firm behaviors (e.g., Gupta, Briscoe, and Hambrick, 2017). For example, Chin, Hambrick, and Treviño (2013) find that compared with conservative CEOs, liberal CEOs exhibit greater advances in corporate social responsibility (CSR). Gupta et al. (2017) find that employees' political ideology helps to shape corporate advances in CSR. Specifically, they find that firms with more Democratic-leaning employees engage in more CSR than do those with

[28] Though my sample comprises public and private firms, there is limited specific information about private firms' managers. Hence, I rely on the political ideology of the state in which the firm is headquartered as a proxy for management's responsiveness to climate risk issues.

[29] Appendix B shows the first three state insurance regulators to adopt the CRDS are from traditionally Democratic states: California, New York, and Washington.

more Republican-leaning employees. I posit that when a firm's headquarters is located in a Democratic rather than Republican state, the firm is more likely to have a greater proportion of Democratic-leaning employees, specifically managers. Even if managers are not Democratic-leaning themselves, the presence of liberal rank-and-file employees at the firm's headquarters or public pressure in the state can induce managers to be more climate focused (Liston-Heyes and Ceton, 2007; Swigart, Anantharaman, Williamson, and Grandey, 2020).

To examine the above hypothesis, I construct two measures to determine whether an insurer's headquarters is located in a Democratic state. Specifically, I define *HQ_Democratic_1* (*HQ_Democratic_2*) as a dummy variable that equals one if the insurer's headquarters state elected a Democratic governor in the gubernatorial election that occurred in the year (three consecutive years) before CRDS adoption, and zero otherwise. I then estimate Equation (3) by using *HQ_Democratic_1* and *HQ_Democratic_2* as the *Mod_var* proxy.

Table 8 presents the results of this heterogeneity analysis. The coefficients on *CRDS* × *HQ_Democratic_1* (coefficient = 0.3902, *t*-stat = 2.25) and *CRDS* × *HQ_Democratic_2* (coefficient = 0.9458, *t*-stat = 3.18) are positive and statistically significant, consistent with the notion that mandated climate risk disclosure plays a more significant role in the treatment insurers' underwriting business when they are headquartered in a Democratic state.

5. Supplementary Analysis of Insurers' Responses to CRDS Questions

In this section, I conduct supplementary textual analyses of affected insurers' responses to the CRDS questions related to the insurer's engagement with policyholders. The results of these analyses may lend further support to my argument that the positive effect of CRDS

adoption on insurers' underwriting business is due to the affected insurers' efforts to learn from policyholders about how to address climate risk and thus enhance their business.

Two of the eight questions in the CRDS relate to the insurer's engagement with its policyholders or other key constituencies on the topic of climate change. Specifically, question 6 asks insurers to "summarize steps the company has taken to encourage policyholders to reduce the losses caused by climate change-influenced events," and question 7 asks them to "discuss steps, if any, the company has taken to engage key constituencies on the topic of climate change." Since 2013, the CDI has compiled insurers' CRDS responses into a uniform format on their website (see Appendix C for an example of the format). For each question, insurers' responses are first summarized as "yes" or "no." I use this binary response to measure the insurer's proactiveness in addressing the climate risk issues that relate to its underwriting business. I define *CRDS_Q6_Y* (*CRDS_Q7_Y*) as a dummy variable that equals one if the insurer responds "yes" to CRDS question 6 (7), and zero otherwise. In addition, I compile the affected insurers' responses to questions 6 and 7 on the CDI's website using Python's Selenium library.[30] After collecting the raw information, I use the Natural Language Toolkit library to delineate the text at the word level and count the number of words in the insurer's response to the CRDS question. Then, I define *CRDS_Q6_words* (*CRDS_Q7_words*) as the number of words in the insurer's response to CRDS question 6 (7).

Table 9, Panel A shows the summary statistics for the variables of the characteristics of insurers' responses to questions 6 and 7 from 2013 to 2019. Across those years, I observe a

[30] Selenium is a popular webpage automation testing tool that can be used to download information from a website in batch mode.

gradual increase in the percentage of insurers that respond "yes" to whether they interact with policyholders or other stakeholders about climate risk issues. In addition, the average number of words used in the detailed responses increases significantly during this period, almost doubling between 2013 and 2019.

To further examine whether insurers' proactiveness in addressing climate risk issues contributes to their underwriting business, I estimate the following OLS regression model using the sample of treatment insurers from 2013 to 2019:

$$Direct\_premium_{i,t} = \alpha_0 + \beta_1 Response\_char_{i,t} + \gamma\, Controls_{i,t} + Year\ FE + \varepsilon_{i,t}, \quad (4)$$

where *Response_char* is one of the following characteristic variables of insurers' responses to questions 6 and 7: *CRDS_Q6_Y*, *CRDS_Q7_Y*, *Log_CRDS_Q6_words*, and *Log_CRDS_Q7_words*.[31] The other variables are as defined in Equation (1).

Table 9, Panel B reports the results of this supplementary analysis. The coefficients on *CRDS_Q6_Y* (coefficient = 0.5968, *t*-stat = 2.45), *CRDS_Q7_Y* (coefficient = 0.8652, *t*-stat = 3.91), *Log_CRDS_Q6_words* (coefficient = 0.2177, *t*-stat = 2.31) and *Log_CRDS_Q7_words* (coefficient = 0.3092, *t*-stat = 3.36) are all positive and statistically significant. These results suggest a positive association between an insurer's proactiveness in addressing climate risk issues and its direct written premiums, which provides further evidence of the channel through which mandatory CRDS disclosure affects insurers' underwriting business.

[31] The word count variables used in the earlier summary statistics (i.e., *CRDS_Q6_words* and *CRDS_Q7_words*) employ the raw word count to better interpret the statistics. As the dependent variable is a count variable, the regression uses the natural logarithm of the number of words. *Log_CRDS_Q6_words* (*Log_CRDS_Q7_words*) is the natural logarithm of one plus the number of words in the insurer's response to CRDS question 6 (7).

6. Conclusion

Mandatory climate risk disclosure is an important emerging issue, especially as concerns about climate change increase. My study offers early evidence about the impact of mandatory climate risk disclosure on firms' businesses. Across the globe and across industries, firms are gradually learning how to adapt their business to climate risk changes and evolving climate science and technology. Firms also face public and regulatory pressure to address climate risk. Exploiting the U.S. insurance industry's staggered adoption of the CRDS and using a DID research design, I find that affected insurers experience an increase in their underwriting business, relative to unaffected insurers. The positive effect is more pronounced if the affected insurers' underwriting business is more exposed to customers that are concerned about climate risk, if their underwriting business has more competition, or if the insurer is headquartered in a Democratic state.

My paper uncovers the novel insight that mandating disclosure of climate-risk-related business strategies among insurers can provide a competitive advantage over their non-mandated peers. Some caveats should be noted, however. First, my findings might not be generalizable to other industries, given that the nature of the P&C insurance industry's underwriting business makes it more likely to be heavily impacted by climate risk. Second, the evidence I develop might not be generalizable to later CRDS adopters, as the circumstances surrounding their adoption may be different. For example, many states adopted the CRDS in 2021, during which insurers also had the option to respond to the CRDS using a TCFD-aligned disclosure framework (introduced by the Financial Stability Board). Third, despite various attempts to deal with endogeneity concerns via a staggered DID research design and a host of

robustness tests related to this design, insurers may not be randomly assigned to the treatment and control groups. State insurance regulators may adopt CRDS based on social and political considerations that arguably affect individual insurers' underwriting business. Despite these caveats, I believe the insights in my study are useful to improve understanding of mandatory climate risk disclosures.

Mandatory climate risk disclosure offers significant potential for future research, especially as such mandates begin to appear in more industries and countries. As new disclosure frameworks are developed globally, such as those created by the Financial Stability Board and the International Sustainability Standards Board, they may have different implications. One common challenge is to develop climate risk standards that apply across industries. As noted in Section 2, a mandatory switch was imposed in 2022, when CRDS went from an eight-question disclosure framework to a TCFD-aligned disclosure framework. Further research might want to examine the impact of this switch.

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Appendix A: 2012 Climate Risk Disclosure Survey Notice from the California Department of Insurance

STATE OF CALIFORNIA — Dave Jones, *Insurance Commissioner*

DEPARTMENT OF INSURANCE
EXECUTIVE OFFICE
300 CAPITOL MALL, SUITE 1700
SACRAMENTO, CA 95814
(916) 492-3500
(916) 445-5280 (FAX)
www.insurance.ca.gov

DATE: February 29, 2012
TO: All Licensed Insurers in the State of California
RE: Insurer Climate Risk Survey for Reporting Year 2011

In cooperation with the New York Department of Financial Services, and the Washington State Office of the Insurance Commissioner, the California Department of Insurance ("Department") is implementing a Climate Risk Survey for Reporting Year 2011. The questions contained in the survey were adopted by the National Association of Insurance Commissioners in March 2009 and March 2010. Survey responses will be made available to the public through the following link: http://www.insurance.ca.gov/0250-insurers/0300-insurers/0100-applications/financial-filing-notices-forms/annualnotices/ClimateSurvey.cfm.

Except for insurers within groups notified by New York or Washington that they must respond to the survey, all insurers who are licensed in the State of California and who collected direct written premium amounts of more than 300 million dollars during 2011 must respond to California. All other insurers may provide answers on a voluntary basis. This requirement is consistent and in accordance with the broad investigatory authority of the California Insurance Commissioner. Insurers within the same group may submit uniform responses.

Narrative responses are acceptable. Where an insurer's response to other disclosure mechanisms, such as the Carbon Disclosure Project (CDP) or Global Reporting Initiative, explicitly addresses the subject matter of a question in this survey, the insurer may reference and attach their most recent response to that external mechanism in lieu of providing a duplicative response.

Insurers are required to answer all questions in good faith and with meaningful responses. However, there is no requirement to provide information that is immaterial to an assessment of financial soundness (insurers may choose to disclose such information voluntarily, with no implication that such information is in fact material).

Insurers are not required to provide quantitative information, provide information that they in good faith believe is commercially sensitive or proprietary, or provide forward-looking information. If an insurer chooses to provide forward-looking information, the insurer may disclaim any responsibility for the accuracy of such forward-looking information. If the insurer supplies such information in good faith, it may condition its response with a waiver of any claim under any theory of law based on the inaccuracy of such information.

The completed survey is due **May 7, 2012**. Please submit your survey responses to the Department by going to our online submission link at Online Assistance System for Insurer Submittal (OASIS) System: https://interactive.web.insurance.ca.gov/OASIS/front. Additional information concerning the survey is available at the following link: http://www.insurance.ca.gov/0250-insurers/0300-insurers/0100-applications/financial-filing-notices-forms/annualnotices/ClimateSurvey.cfm. Any questions or correspondence can be directed to: landsmanl@

Your cooperation is appreciated.

DAVE JONES,
Insurance Commissioner

Attachment: Climate Risk Survey for Reporting Year 2011

INSURER CLIMATE RISK SURVEY
For Reporting Year 2011

Survey Questions	Comparable Carbon Disclosure Project Questions
1. Does the company have a plan to assess, reduce or mitigate its emissions in its operations or organizations? If yes, please summarize.	Performance Question 21
2. Does the company have a climate change policy with respect to risk management and investment management? If yes, please summarize. If no, how do you account for climate change in your risk management?	
3. Describe your company's process for identifying climate change-related risks and assessing the degree that they could affect your business, including financial implications.	Risks and Opportunities Questions 1-3
4. Summarize the current or anticipated risks that climate change poses to your company. Explain the ways that these risks could affect your business. Include identification of the geographical areas affected by these risks.	Risks and Opportunities Questions 1-3
5. Has the company considered the impact of climate change on its investment portfolio? Has it altered its investment strategy in response to these considerations? If so, please summarize steps you have taken.	Risks and Opportunities Question 3: "Other Risks" Question 6: "Other Opportunities"
6. Summarize steps the company has taken to encourage policyholders to reduce the losses caused by climate change-influenced events.	Risks and Opportunities Questions 4-6
7. Discuss steps, if any, the company has taken to engage key constituencies on the topic of climate change.	Governance Questions 24, 26, 27
8. Describe actions your company is taking to manage the risks climate change poses to your business including, in general terms, the use of computer modeling.	Risks and Opportunities Questions 1-3

Appendix B: Climate Risk Disclosure Survey Adoption Pattern

Disclosure Year	Participating States (During the Sample Period)	Nationwide Direct Premium Requirement
2010	California	> $500M
2011	California	> $300M
2012	California, New York, and Washington	> $300M
2013	California, Connecticut, Minnesota, New York, and Washington	> $100M
2014	California, Connecticut, Illinois, Maryland, Minnesota, New Mexico, New York, and Washington	> $100M
2015	California, Connecticut, Minnesota, New Mexico, New York, and Washington	> $100M
2016	California, Connecticut, Minnesota, New Mexico, New York, and Washington	> $100M
2017	California, Connecticut, Minnesota, New Mexico, New York, and Washington	> $100M
2018	California, Connecticut, Minnesota, New Mexico, New York, and Washington	> $100M
2019	California, Connecticut, Minnesota, New Mexico, New York, and Washington	> $100M
Disclosure Year	Participating States (Outside the Sample Period)	Nationwide Direct Premium Requirement
2020	California, Connecticut, Minnesota, New Mexico, New York, and Washington	> $100M
2021	California, Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, Minnesota, New Mexico, New York, Oregon, Pennsylvania, Rhode Island, Vermont, and Washington	> $100M
2022	California, Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, Minnesota, New Mexico, New York, Oregon, Pennsylvania, Rhode Island, Vermont, and Washington	> $100M
2023	California, Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, Minnesota, New Mexico, New York, Oregon, Pennsylvania, Rhode Island, Vermont, and Washington	> $100M

Appendix C: Example of an Insurer's Climate Risk Disclosure Survey (CRDS) Response

The Zurich American Insurance Company's 2019 CRDS Response

Survey Details

< Return to Search Results

NAIC Number: 16535

Company Name: Zurich American Insurance Company

Line Of Business: Property & Casualty

Group Filing: Y

Group Number: 0212

Group Name: Zurich American Insurance Company and Affiliates

Question 1:

Does the company have a plan to assess, reduce or mitigate its emissions in its operations or organizations? If yes, please summarize.

Yes/No response question 1: Y

Written response question 1: Certain statements in this document are forward-looking statements, including, but not limited to, statements that are predications of or indicate future events, trends, plans or objectives. Forward-looking statements include statements regarding our understanding of general economic, financial and insurance market conditions and expected developments. Undue reliance should not be placed on such statements because, by their nature, they are subject to known and unknown risks and uncertainties and can be affected by other factors that could cause actual results and plans and objectives of Zurich American Insurance Company, a New York domestic insurance company, and its pooled companies (collectively, the "Company") to differ materially from those expressed or implied in the forward looking statements (or from past results). Factors such as (i) general economic conditions and competitive factors, particularly in our key markets; (ii) the risk of the global economic downturn and a downturn in the financial services industries in particular; (iii) performance of financial markets; (iv) levels of interest rates and currency exchange rates; (v) frequency, severity and development of insured claims events; (vi) mortality and morbidity experience; (vii) policy renewal and lapse rates; and (viii) changes in laws and regulations and in the policies of regulators may have a direct bearing on the results of operations of the Company. The Company undertakes no obligation to update or revise any of these forward-looking statements, whether to reflect new information, future events or circumstances or otherwise.

In January 2013, Zurich Insurance Company Ltd ("Zurich") formed the Group Environmental Performance team. This team is dedicated to support the business in reducing the negative impact its operations have on the environment. They are responsible for managing a comprehensive set of activities to accurately measure, track, and improve Zurich's environmental footprint, helping internal stakeholders understand where and how they can operate in a more sustainable and efficient manner. The four focus areas of the Group Environmental Performance Framework are:

- Standards and Governance: continuous improvement of the Group-wide environmental management system (based on ISO 14001)
- Environmental Reporting (measuring impact): achieving further improvements in the quality of data reported, and ensuring alignment to evolving external reporting standards and best practice, including "The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard (Revised Edition)" developed by the World Resources Institute and the World Business Council for Sustainable Development ("the GHG Protocol")
- Strategy and Projects (mitigating impact): develop new opportunities to achieve efficiency gains across operational and business processes
- Communications, Change and Relationship Management: continue to expand environmental networks across the business and broaden the use of business social tools for more effective information sharing and awareness building to achieve impact

In 2008, Zurich set its first global environmental target to reduce carbon emissions per employee by 10 percent by 2013 as compared to a 2007 baseline. Zurich exceeded the original carbon reduction target in 2012. Following, Zurich set new environmental targets including a 50 percent reduction in carbon per employee and 40 percent reduction in energy per employee, by 2020 compared to a 2007 baseline. In 2016, Zurich exceeded these targets achieving a 53 percent reduction in carbon per employee and 43 percent reduction in energy per employee. In 2017 Zurich committed to further long-term environmental targets to be achieved by 2025 against a 2015 baseline. Those targets include Zurich achieving and maintaining a 20% reduction in total carbon emissions per employee, broken down by facilities and business travel emissions, as well as a 20% reduction in energy per employee.

See June 29, 2017 news release: https://www.zurich.com/en/media/news-releases/2017/2017-0629-01

2018 environmental performance results available here: https://www.zurich.com/en/sustainability/climate-change/environmental-key-performance-indicators

Additionally, Zurich has been carbon neutral since 2014, investing in the Rimba Raya Biodiversity Reserve, a REDD+ project validated under the Verified Carbon Standard.

Zurich has achieved these substantial improvements in environmental performance through the following key programs:
• Purchasing renewable electricity – Zurich has set the target to achieve 100% renewable power by end 2022
• Sustainable buildings – Addressing sustainability across the full building life-cycle, starting at building selection, through projects, operations, and finally decommissioning.
• Efficient travel practices – only traveling when necessary and use of video, web and teleconference wherever possible instead. Zurich encourages the transition to a more sustainable car fleet.
• Zurich's workplace strategy program ensures our office space considers evolving workplace trends, enabling the delivery of collaborative, fit-for-purpose work environments, while delivering space efficiency improvements.

Sustainable IT is part of Zurich's sustainable operations focus. Currently, outsourced data centers are not considered part of Zurich's operational control boundary. Energy from data centers that sit onsite in a Zurich premise is included in our environmental footprint.

In 2014, Zurich started sourcing 100 percent renewable electricity at its North America headquarters in Schaumburg, IL. They continued with this commitment at the newly constructed LEED Platinum headquarters which opened in the fall of 2016. As of 2018, Zurich North America sourced 49 percent renewable electricity out of its total electricity demand, while globally, 55 percent of Zurich's electricity comes from renewable sources. Although outside of Zurich's operational control reporting boundary, Zurich has procured 100% renewable power for the strategic data center in Europe.

In addition to purchasing renewable electricity, the new LEED Platinum headquarters boasts a number of best practice examples in sustainable building including: a curtain wall system designed to maximize natural light; a system to provide high-quality indoor air; access to public transportation and accommodations for electric and low-emitting vehicles; incorporation of multiple "green" roofs, totaling more than one acre; landscape including 637 trees and more than 13 acres of native savannah plantings; walking paths and water features; rainwater harvest and re-use; recycling and reduction of waste during construction process and efforts to utilize locally-sourced building materials.

Zurich has also implemented programs to remind employees to power down equipment when it is not in use. Many computer monitors and desktop computers are automatically set to go into a "sleep" or hibernation mode after a short period of inactivity.

Zurich continues to work on reducing the environmental impact from paper and printing. Copier/printer machines in many locations are set for duplex (two-sided) printing and the print/copy default has been set to black and white vs. color. As part of an ongoing plan, Zurich continually looks at optimization of devices based not only on lease expiration, but includes office consolidations, organizational changes, in conjunction with our continued efforts on print reduction. In addition, any new device put in place at lease expiration is the most energy efficient product available. As of 2018, the number of MFDs within our Zurich North America office buildings has been reduced to 215 machines, down from 438 in 2013 (a 51 percent reduction).

Find more information about Zurich's Environmental Performance:

https://www.zurich.com/en/corporate-responsibility/climate-change/minimizing-our-environmental-footprint

Question 2:

Does the company have a climate change policy with respect to risk management and investment management? If yes, please summarize. If no, how do you account for climate change in your risk management?

Yes/No response question 2: Y

Written response question 2: In 2011, Zurich established a Corporate Responsibility Working (now the Sustainability Leaders Council) Group reporting directly to the Group Executive Committee. In July 2014, this group finalized Zurich's climate change position statement. See https://www.zurich.com/en/sustainability/climate-change In 2017 this was further enhanced. According to the statement, we help our customers and communities become more resilient to natural disasters and extreme weather; we make a difference through our responsible investment approach; and we are swiftly reducing our own carbon footprint. We are working closely with communities and policy-makers to place more emphasis on risk reduction, preparedness and resilience rather than purely focusing on recovery and rebuilding. We are also sharing with our customers the best practices and other risk-related insights developed during our 140-year history.

We have made a broad commitment to help facilitate – if not accelerate – the generational shift to a low-carbon economy. In June 2019 Zurich announced that as the first insurance company, it commits to set targets in the framework of the UN Global Compact Business Ambition Pledge that aims at limiting global temperature rise to 1.5°C above pre-industrial levels. Zurich also has expanded its existing thermal coal policy aimed at reducing the use of carbon intense fossil fuels. See https://www.zurich.com/en/media/news-releases/2019/2019-0625-01. In addition, Zurich is adopting the recommendations of the Financial Stability Board's Task force on Climate Change-related Financial Disclosure (FSB-TCFD) and is reporting on progress made in implementing its commitments. See https://www.zurich.com/en/sustainability/climate-change/tcfd

See response to Question 5 for information on Zurich's climate policy with respect to investment management.

Question 3:	Describe your company's process for identifying climate change-related risks and assessing the degree that they could affect your business, including financial implications.
Yes/No response question 3:	Y
Written response question 3:	The mission of risk management at Zurich is to promptly identify, measure, report and monitor risks that affect the achievement of strategic, operational and financial objectives. This includes adjusting the risk profile in line with the company's stated risk tolerance to respond to new threats and opportunities. Zurich's risk management framework is a governance process with clear responsibilities for taking, managing, monitoring and reporting risks. This process relates to all types of risk including climate change. Zurich has a global and interdisciplinary Emerging Risk Group (ERG) that looks at potential risks, including climate-related risks. In May 2016 the Group CRO also established a cross-functional Climate Risk Working Group to assess and coordinate climate risk activities across Zurich. Understanding the potential effects of natural catastrophes is a critical component of risk management. Zurich uses a combination of third-party and in-house models to manage its underwriting and accumulations in modeling areas to stay within intended exposure limits.
Question 4:	Summarize the current or anticipated risks that climate change poses to your company. Explain the ways that these risks could affect your business. Include identification of the geographical areas affected by these risks.
Yes/No response question 4:	Y
Written response question 4:	Physical Risks - Zurich has potential exposure to some physical risks of climate change with respect to its own operations and as a result of exposures of its insureds, including those in the U.S., assumed by Zurich though insurance policies. To address the potential physical risks to its own operations, Zurich maintains and tests robust business continuity plans and also maintains property coverage that addresses flooding, windstorm and other perils. Risks assumed through the issuance of insurance policies to customers are addressed as an integrated part of the underwriting process. Financial Risks - Physical risks impacting Zurich's customers may result in increased frequency and severity of certain claims. These risks are addressed as an integrated part of the underwriting process. Investment Risks - See response to Question 5. Insurability Risks - In general, the insurance sector in the U.S. and globally faces the challenge of maintaining the availability and affordability of insurance products while addressing the pressures imposed by potential changes in climate conditions. A deep understanding of the risks posed by climate change, and options for adaptation to and mitigation of these risks, is necessary to adequately underwrite insurance products exposed to those risks. Regulatory Risks – Zurich has potential exposure to climate-related regulatory risks, both with respect to its own operations as well as those assumed through its products and services. New and enhanced regulation—and the uncertainty leading up to such regulation—in the insurance area and in areas as diverse as emission caps and building codes could impact the insurance sector, directly and indirectly. These risks are addressed as an integrated part of the underwriting process and are monitored by our Government & Industry Affairs function. Reputational Risks – The reputation of companies perceived as not taking the climate change challenge seriously may be affected over time. Zurich has taken an active approach to dealing with these evolving issues, both as a matter of its commitment to customers and with respect to corporate and fiscal responsibilities.

Question 5:

Has the company considered the impact of climate change on its investment portfolio? Has it altered its investment strategy in response to these considerations? If so, please summarize steps you have taken.

Yes/No response question 5A: Y

Yes/No response question 5B: Y

Written response question 5: For purposes of this Question 5, respondent assumes that the term "altered" includes any consideration or integration of environmental factors and/or climate change in its overall investment process or strategy.

In general, Zurich's Investment Policy pursues simultaneously the goals of security and profitability of the assets in which funds are invested to:
• ensure sufficient liquid funding for all future commitments; and
• generate adequate financial return in the form of investment income and capital appreciation.

In general, Zurich's Investment Policy is designed to take careful consideration of several factors, including but not limited to:
• compliance with applicable rules and regulations;
• the economic risk and reward tradeoff of an investment, including any risks and opportunities related to environmental, social and governance (ESG) factors, and how that investment affects the economic risk and reward tradeoff of the entire investment portfolio taken in the context of Zurich's liabilities;
• compliance with internal risk management policies and constraints;
• the accounting treatment of the investment;
• the impact of the investment, if any, on federal, state and local taxes;
• the impact of the investment on regulatory and accounting solvency measures;
• the liquidity or marketability of the investment taken in the context of liquidity needs stemming from Zurich's liabilities; and
• any potential operational or reputational risks involved in making the investment.

Zurich is committed to responsible investment in achieving its investment objectives, and responsible investment practices form an integral part of Zurich's Investment Policy.

Zurich is making continued progress in integrating ESG factors, including climate change, into security and asset selection processes across its investment portfolio. Zurich is also thoroughly assessing responsible investment practices of its asset managers as part of its manager selection and monitoring processes.

In addition to Zurich's established 'business-as-usual' ESG integration practices we have launched, during 2018 we:

• worked with a variety of partner organizations on methodologies that allow for comprehensive assessment of exposure to physical and transition climate risk for equities, corporate bonds, real estate and infrastructure investments;
• updated our macroeconomic climate risk scenarios;
• actively voted on shareholder resolutions regarding climate change disclosures or actions of investee companies;
• reviewed our asset managers climate position;
• divested all equity holdings and put into run off fixed income investments from companies that generate >50% of their revenues from thermal coal mining or use >50% of coal in their energy generation mix;
• advocated for the transition to a low-carbon economy and for the introduction of an economically viable carbon price;
• as part of its impact investing program, Zurich has also invested over USD 3bn carbon and climate resilient investments on a global basis to help communities adapt to, and mitigate climate change.

Detailed information can be found on Zurich's Responsible Investment web page at the link below:
https://www.zurich.com/en/sustainability/responsible-investment

Question 6:	Summarize steps the company has taken to encourage policyholders to reduce the losses caused by climate change-influenced events.
Yes/No response question 6:	Y
Written response question 6:	For purposes of this Question 6, respondent assumes that the phrase "taken steps to encourage" includes general information sharing and education efforts in the area of climate change. Zurich uses its skills in risk identification and management to assist stakeholders in better adapting to and mitigating risks of climate change. To that end, a variety of activities, including formal information sharing, such as congressional testimony or white papers, and more informal means, such as customer and broker meetings, as well as Risk Engineering assessments have been undertaken to share information and collaborate with policyholders and potential policyholders. Zurich has worked with stakeholders to better understand the potential climate change risks that may require risk management solutions to mitigate those risks. As part of its initiative, Zurich continuously strives to identify and respond to the risk management needs arising from existing or upcoming climate change legislation. During the first years of its climate initiative, Zurich has climate-related products, some of which are, at least in part, driven by this legislation. Examples of these products include: (1) directors & officers liability insurance extended for climate-related claims; (2) political and trade credit risk coverage for carbon credit projects; (3) green, efficient and resilient rebuild insurance, allowing for the rebuilding of damaged property with improvements to green, efficiency or weather-resilience standards. Zurich also made specialized insurance available for electric cars and is developing specialized agricultural coverages focused on improving resilience in the face of climate change and natural resource strain. Zurich is expanding its work on supply chain risk management for policyholders to address sustainability needs considering climate change as part of the process. Zurich covers many renewable energy construction projects around the world. Policyholders are also given access to the Zurich Risk Room, which is a risk visualization engine, providing a breakdown of global risks by country that includes climate change as a risk factor.
Question 7:	Discuss steps, if any, the company has taken to engage key constituencies on the topic of climate change.
Yes/No response question 7:	Y
Written response question 7:	Over the past few years, Zurich has engaged in a dialogue with various governments with the aim of educating lawmakers and regulators, highlighting priorities and influencing legal and regulatory developments in a direction that would enable Zurich to effectively contribute to mitigating climate change risks. In addition, Zurich has engaged in many collaborative activities designed to improve information sharing and engagement on climate change risk adaptation and management, including to UNFCCC, UNEP FI, PRI, Geneva Association, Association of British Insurers and ClimateWise. Numerous webinars, briefings, media events and university / academic activities addressing climate change risk management were also held, participated in and supported. Zurich launched a flood resilience program in 2013. It focuses on floods because they affect more people globally than any other type of natural hazard and cause some of the largest economic, social and humanitarian losses. It also represents a new approach to cross-sector collaboration, based on an innovative alliance linking flood research, community-based programs and risk expertise. In July 2018 Zurich announced that the flood resilience alliance led by Zurich will be extended for another five years. The alliance members include the NGOs Concern Worldwide, the International Federation of the Red Cross and Red Crescent Societies (IFRC), Mercy Corps, Plan International and Practical Action as well as research partners International Institute for Applied Systems and Analysis (IIASA), the London School of Economics and the Institute for Social and Environmental Transition-International (ISET). More information is available at the links below: https://www.zurich.com/en/sustainability/working-with-customers https://www.zurich.com/en/sustainability/flood-resilience https://www.zurich.com/en/sustainability/working-with-customers

Question 8:	Describe actions the company is taking to manage the risks climate change poses to your business including, in general terms, the use of computer modeling.
Yes/No response question 8:	Y
Written response question 8:	Zurich maintains a sophisticated mathematical Natural Catastrophe Model to understand the aggregate risk at the Group level. It includes climate-related perils, such as tropical cyclones, extra-tropical cyclones, floods and severe convective storms. The model is not purely relying on a single model vendor (e.g. Risk Management Solutions Inc.) but has the flexibility to use any vendor model's output and implement proprietary adjustments to both the severity and frequency of events to reflect the 'Zurich View' of risk. Zurich aims to understand the assumptions in the models, gain a multi-model view, compare to claims experience and use internal and external insight. The time scale of the changes projected is typically over a period of several decades. In the catastrophe accumulation processes Zurich is continuously adjusting to actual developments over time in a manner appropriate for the instruments modeled. Catastrophe models typically are updated every five years. Zurich considers the impact of climate change on a five year time horizon to be smaller than the impact of the natural climate variability (e.g. ENSO, AMO) and the general variability of catastrophe events. Zurich monitors emerging climate research through internal expertise and gains external insight through the Advisory Committee for Catastrophes, which is made up of world-class scientists, including an author from the Intergovernmental Panel on Climate Change. The requirement for a Zurich View of risk is contained within Zurich's Risk and Underwriting policies and is governed through the Head of Group Underwriting Excellence , the Head of Group Reinsurance and the Cat Technical Expert Group. The work Zurich has done on its view of risk has in some cases led to vendor model change. The model, which has grown from its initial platform developed in 2004, has been re-approved early 2019 by the Swiss regulator, FINMA following a material review during 2018, for use under the Swiss Solvency Test as well as by the Central Bank of Ireland for use under the Solvency II regulation. Zurich has a dedicated Cat Research & Development team as part of the Group Accumulation Management function. The team is currently being expanded by 3 additional resources of which 2 will focus on climate risk. This is for both increasing the focus on the model validation for current risk as well as for linking climate and cat models to establish potential risk views for future climates.

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Appendix D: Variable Definitions and Sources

Variable	Definition	Source
Dependent variables		
Direct_premium	An insurer's nationwide direct written premiums scaled by the average of its beginning and ending total admitted assets. Total admitted assets are assets permitted to be included in the insurer's financial statements based on NAIC's Statutory Accounting Principles. Assets that cannot be readily converted into cash to pay for liabilities, such as most intangibles, office furniture, and fixtures, are excluded.	NAIC database
Direct_premium_1	An insurer's nationwide direct written premiums scaled by its beginning total admitted assets.	NAIC database
Direct_premium_2	The natural logarithm of the insurer's nationwide direct written premiums.	NAIC database
Log_Direct_premium	The natural logarithm of the insurer's nationwide direct written premiums scaled by the average of its beginning and ending total admitted assets.	NAIC database
Independent variables of interest		
CRDS	Dummy variable that equals one for the first year when the insurer meets the compulsory CRDS disclosure criteria and its CRDS response is disclosed on the CDI's website and all subsequent years, and zero otherwise.	NAIC database CDI website
CRDS_pre3-	Dummy variable that equals one for the three years or more before CRDS adoption, and zero otherwise.	NAIC database CDI website
CRDS_pre2	Dummy variable that equals one for the second year before CRDS adoption, and zero otherwise.	NAIC database CDI website
CRDS_pre1	Dummy variable that equals one for the first year before CRDS adoption, and zero otherwise.	NAIC database CDI website
CRDS _adoption	Dummy variable that equals one for the year of CRDS adoption, and zero otherwise.	NAIC database CDI website
CRDS _post1	Dummy variable that equals one for the first year after CRDS adoption, and zero otherwise.	NAIC database CDI website
CRDS _post2	Dummy variable that equals one for the second year after CRDS adoption, and zero otherwise.	NAIC database CDI website
CRDS _post3+	Dummy variable that equals one for three or more years after CRDS adoption, zero otherwise.	NAIC database CDI website
Treat	Dummy variable that equals one for the first year when the insurer meets the compulsory CRDS disclosure criteria and its CRDS response is disclosed on the CDI's website and for all of a cohort's subsequent years, and zero otherwise. A cohort includes all insurer-years in a window that ranges from three years before the adoption year to three years after it.	NAIC database CDI website
Control variables		
Size	The natural logarithm of total admitted assets.	NAIC database
Leverage	Total liabilities divided by total admitted assets.	NAIC database
Mutual	Dummy variable that equals one when the insurer's legal form is a mutual, and zero otherwise.	NAIC database
Reinsurance	The percentage of gross premiums written that is ceded to reinsurers.	NAIC database

Geo_concentration	The geographical Herfindahl-Hirschman index, which is a measure of the insurer's geographic diversification.	NAIC database
Personal_lines	The proportion of net premiums written from personal lines (i.e., farm owners multiple peril, homeowners multiple peril, personal automobile physical damage, and personal automobile liability) to total net premiums written.	NAIC database
Commercial_lines	The proportion of net premiums written from commercial long-tail lines (i.e., workers' compensation, other liability, commercial automobile liability, and product liability) to total net premiums written.	NAIC database
Cross-sectional variables		
W_CR_exposure	An insurer's weighted-average score capturing the extent of customers' climate risk concerns in states where it has underwriting businesses. Customers' climate risk concern is measured using the state-level climate risk index score, which captures the extent of climate risk faced by each state. The weight used is the proportion of direct premiums written in each state in the year before CRDS adoption. The weighted score is then standardized by subtracting the mean and scaling by the standard deviation.	NAIC database SafeHome.org website
W_CR_attitude	An insurer's weighted-average score capturing the extent of customers' climate risk concerns in states where it has underwriting businesses. Customer's climate risk concern is measured using the value of the state-level estimates of the percentage of adults who think their governor should be doing either more or much more to address global warming. The weight used is the proportion of direct premiums written in each state in the year before CRDS adoption. The weighted score is then standardized by subtracting the mean and scaling by the standard deviation.	NAIC database Yale Program on Climate Change Communication
W_competitors	An insurer's weighted-average score capturing the extent of competition in states where it has underwriting businesses. Competition is measured using the number of insurers operating in each state for the year. The weight used is the proportion of direct premiums written in each state in the year before CRDS adoption. The weighted score is then standardized by subtracting the mean and scaling by the standard deviation.	NAIC database
Mkt_shr_vol	An insurer's three-year market share volatility for the year before CRDS adoption, which is standardized by subtracting the mean and scaling by the standard deviation.	NAIC database
Non_mkt_leader_1	Dummy variable that equals one when the insurer is not a market leader in the year before CRDS adoption, and zero otherwise. A market leader is an insurer ranked in the top 100 insurers by size based on total admitted assets.	NAIC database
Non_mkt_leader_2	Dummy variable that equals one when the insurer is not a market leader in the year before CRDS adoption, and zero otherwise. A market leader is an insurer ranked in the top 20% by size based on total admitted assets.	NAIC database

HQ_Democratic_1	Dummy variable that equals one when the insurer's headquarters state in the year before CRDS adoption is Democratic, and zero otherwise. A Democratic state is defined as a state where the Democratic party won the most recent gubernatorial election.	NAIC database
HQ_Democratic_2	Dummy variable that equals one when the insurer's headquarters state in the year before CRDS adoption is Democratic, and zero otherwise. A Democratic state is defined as a state where the Democratic party consecutively won the three most recent gubernatorial elections.	NAIC database
Additional variables used in Table 9		
CRDS_Q6_Y	Dummy variable that equals one if the insurer responds "yes" to CRDS question 6 (i.e., "summarize steps the company has taken to encourage policyholders to reduce the losses caused by climate change-influenced events"), and zero otherwise.	CDI website
CRDS_Q7_Y	Dummy variable that equals one if the insurer responds "yes" to CRDS question 7 (i.e., "discuss steps, if any, the company has taken to engage key constituencies on the topic of climate change"), and zero otherwise.	CDI website
CRDS_Q6_words	The number of words in the insurer's response to CRDS question 6.	CDI website
CRDS_Q7_words	The number of words in the insurer's response to CRDS question 7.	CDI website
Log_CRDS_Q6_words	The natural logarithm of one plus the number of words in the insurer's response to CRDS question 6.	CDI website
Log_CRDS_Q7_words	The natural logarithm of one plus the number of words in the insurer's response to CRDS question 7.	CDI website

Figure 1: Parallel Trend Analysis

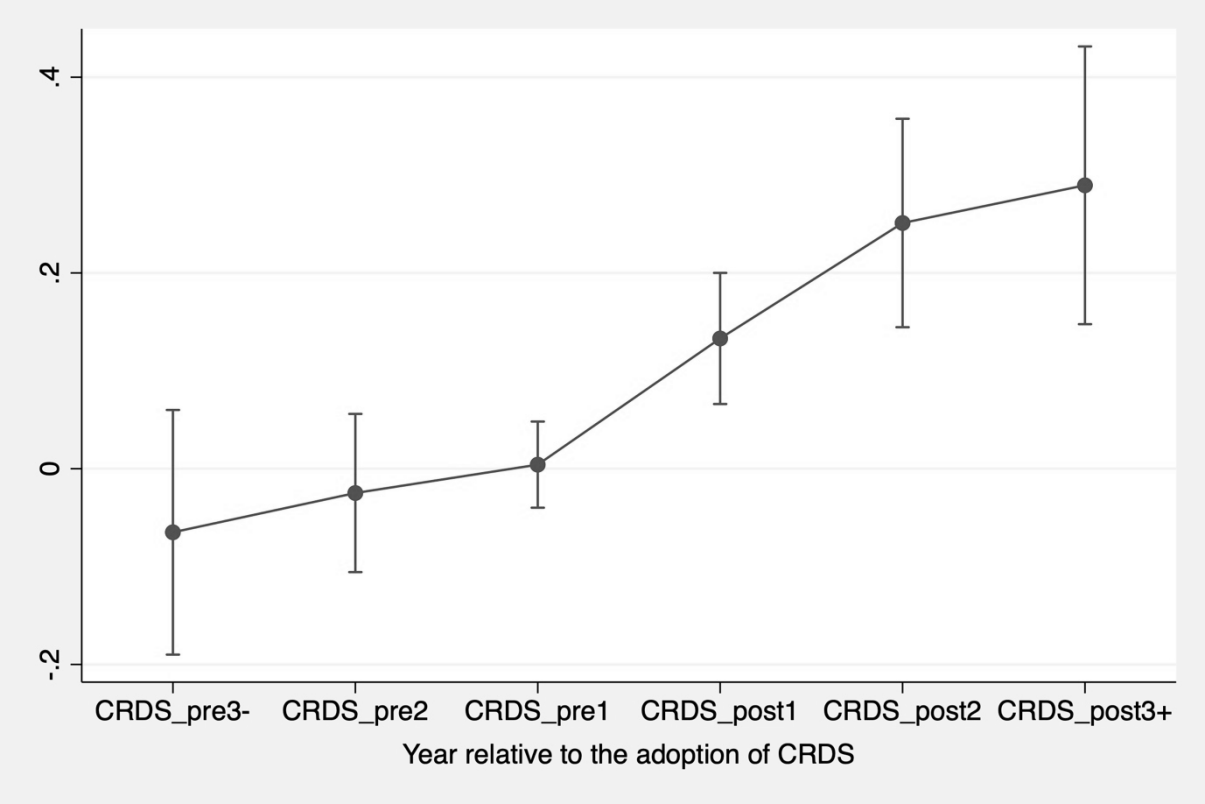

Figure 1 shows the coefficients indicating the difference in the treatment and control insurers' direct written premiums in the years around CRDS adoption. Specifically, I plot the coefficients on the time dummy variables, relative to the CRDS adoption year, and use the CRDS adoption year (*CRDS_adoption*) as the benchmark year (set equal to zero). The coefficients are plotted using 90% confidence intervals based on robust standard errors clustered by insurer.

Table 1: Sample Distribution

Table 1 presents the sample distribution by year for the sample period.

Year	Treatment		Control		Full Sample	
	Freq.	Pct. (%)	Freq.	Pct. (%)	Freq.	Pct. (%)
2007	520	7.58	1,475	7.01	1,995	7.15
2008	524	7.64	1,522	7.23	2,046	7.33
2009	526	7.67	1,556	7.39	2,082	7.46
2010	530	7.73	1,581	7.51	2,111	7.56
2011	532	7.76	1,596	7.58	2,128	7.62
2012	532	7.76	1,614	7.67	2,146	7.69
2013	529	7.71	1,640	7.79	2,169	7.77
2014	528	7.70	1,665	7.91	2,193	7.86
2015	528	7.70	1,675	7.96	2,203	7.89
2016	529	7.71	1,688	8.02	2,217	7.94
2017	528	7.70	1,709	8.12	2,237	8.01
2018	527	7.68	1,686	8.01	2,213	7.93
2019	525	7.66	1,646	7.82	2,171	7.78
Total	6,858	100.00	21,053	100.00	27,911	100.00

Table 2: Summary Statistics

Table 2 presents the summary statistics for the main variables used in the analysis. See Appendix D for the variable definitions.

Variable	N	Mean	SD	P25	Median	P75
Direct_premium	27,911	1.102	2.116	0.237	0.502	1.041
Size	27,911	18.162	1.916	16.775	18.041	19.419
Leverage	27,911	1.455	1.531	0.482	1.143	1.947
Mutual	27,911	0.322	0.467	0.000	0.000	1.000
Reinsurance	27,911	0.508	0.369	0.153	0.478	0.902
Geo_concentration	27,911	0.567	0.393	0.146	0.545	1.000
Personal_lines	27,911	0.269	0.369	0.000	0.001	0.553
Commercial_lines	27,911	0.320	0.359	0.000	0.155	0.602

Table 3: The Effect of Climate Risk Disclosure Survey Adoption on Insurers' Underwriting Business

Table 3 presents the regression results for the effect of CRDS adoption on insurers' underwriting business. Column (1) reports the baseline regression results. Column (2) presents the results of the parallel trend test. Coefficient estimates and *t*-statistics are reported based on robust standard errors clustered by insurer. *, **, and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively. See Appendix D for the variable definitions.

Dep. Var. =	*Direct_premium*	
	(1)	(2)
	Baseline regression	Parallel trend test
CRDS	0.2576***	
	(2.95)	
CRDS_pre3-		-0.0650
		(-0.86)
CRDS _pre2		-0.0248
		(-0.51)
CRDS _pre1		0.0042
		(0.16)
CRDS _post1		0.1331***
		(3.27)
CRDS _post2		0.2510***
		(3.88)
CRDS _post3+		0.2895***
		(3.36)
Size	-0.2591***	-0.2557***
	(-4.66)	(-4.62)
Leverage	0.0259	0.0260
	(1.11)	(1.11)
Mutual	-0.1863**	-0.1845**
	(-2.36)	(-2.34)
Reinsurance	0.4159***	0.4203***
	(6.25)	(6.35)
Geo_concentration	-0.7130***	-0.7158***
	(-3.50)	(-3.52)
Personal_lines	-0.3622**	-0.3640**
	(-2.39)	(-2.40)
Commercial_lines	-0.2456**	-0.2378**
	(-2.32)	(-2.24)
Insurer FE	Yes	Yes
Year FE	Yes	Yes
Observations	27,911	27,911
Adjusted R^2	0.814	0.814

Table 4: Further Validation of the Staggered DID Results

Table 4 presents the results of the tests to further validate the staggered DID results. Panel A shows the results of the Goodman-Bacon (2021) diagnostic decomposition. Panel B shows the estimates from the stacked DID. Coefficient estimates and *t*-statistics are reported based on robust standard errors clustered by insurer. *, **, and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively. See Appendix D for the variable definitions.

Panel A: Goodman-Bacon Diagnostic Decomposition

DID Comparison	Weight	Average DID Estimates
Earlier treatment vs. Later control	0.013	-0.317
Later treatment vs. Earlier control	0.016	-0.095
Treatment vs. Never treated	0.971	0.315

Panel B: Stacked DID

Dep. Var. =	*Direct_premium*
Treat	0.1973***
	(2.84)
Size	-0.2105***
	(-5.13)
Leverage	0.0298*
	(1.77)
Mutual	-0.0819*
	(-1.77)
Reinsurance	0.3498***
	(10.03)
Geo_concentration	-0.5376***
	(-4.95)
Personal_lines	-0.2052**
	(-2.44)
Commercial_lines	-0.2269***
	(-3.58)
Insurer FE	Yes
Year FE	Yes
Observations	40,466
Adjusted R^2	0.861

Table 5: Robustness Tests

Table 5 presents the results of the robustness tests. Panel A reports the results of the tests that use alternative dependent variables. Panel B reports the results of the tests that use alternative samples. Panel C reports the results of the tests that use alternative methods to deal with the effect of outliers. Coefficient estimates and *t*-statistics are reported based on robust standard errors clustered by insurer. *, **, and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively. See Appendix D for the variable definitions.

Panel A: Alternative Measures of Direct Written Premiums

Dep. Var. =	*Direct_premium_1*	*Direct_premium_2*
	(1)	(2)
CRDS	0.1901**	0.1104***
	(2.14)	(3.06)
Size	-0.1869***	0.9749***
	(-3.24)	(23.44)
Leverage	0.0474*	0.0442***
	(1.82)	(3.24)
Mutual	-0.1604*	-0.1955*
	(-1.90)	(-1.82)
Reinsurance	0.4477***	1.4194***
	(6.13)	(14.72)
Geo_concentration	-0.7258***	-1.8901***
	(-3.47)	(-12.62)
Personal_lines	-0.3134**	0.2084**
	(-2.04)	(2.19)
Commercial_lines	-0.2733**	-0.0047
	(-2.41)	(-0.04)
Insurer FE	Yes	Yes
Year FE	Yes	Yes
Observations	27,911	28,133
Adjusted R^2	0.798	0.914

Panel B: Alternative Samples

Dep. Var. =	*Direct_premium*		
	(1) Alternative sample period: 2010–2019	(2) Public insurer sample	(3) Private insurer sample
CRDS	0.2727***	0.2467*	0.2580**
	(3.23)	(1.72)	(2.25)
Size	-0.2415***	-0.1605*	-0.3360***
	(-3.96)	(-1.65)	(-4.77)
Leverage	0.0192	0.0844	0.0095
	(0.82)	(1.36)	(0.52)
Mutual	-0.1639**	0.0000	-0.1814**
	(-2.02)	(.)	(-2.00)
Reinsurance	0.3249***	0.3104**	0.4866***
	(4.83)	(2.49)	(6.06)
Geo_concentration	-0.5704***	-0.3244	-0.9136***
	(-2.73)	(-0.74)	(-4.29)
Personal_lines	-0.4797***	-0.7119*	-0.2780*
	(-3.16)	(-1.86)	(-1.85)
Commercial_lines	-0.2912**	-0.3075**	-0.2385
	(-2.48)	(-2.00)	(-1.47)
Insurer FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	21,780	8,271	19,615
Adjusted R^2	0.855	0.839	0.793
Test of differences between the coefficients on *CRDS*		0.426	

Panel C: Alternative Methods to Deal with Outliers

Dep. Var. =	*Direct_premium*		*Log_Direct_premium*
	(1)	(2)	(3)
	Winsorize at the 5th and 95th percentiles by year	Trim at the 1st and 99th percentiles by year	Winsorize at the 1st and 99th percentiles by year
CRDS	0.0583**	0.1158**	0.1147***
	(2.40)	(2.22)	(3.32)
Size	-0.1295***	-0.2438***	0.0407
	(-4.75)	(-4.89)	(0.97)
Leverage	0.0835***	0.0283*	0.0479***
	(7.28)	(1.66)	(3.40)
Mutual	-0.1052*	-0.1670**	-0.1846*
	(-1.89)	(-2.24)	(-1.71)
Reinsurance	0.5985***	0.5920***	1.3901***
	(15.37)	(8.57)	(14.71)
Geo_concentration	-0.4433***	-0.5449***	-1.7480***
	(-7.38)	(-4.02)	(-11.81)
Personal_lines	-0.0516	-0.2840**	0.2168**
	(-0.85)	(-2.09)	(2.30)
Commercial_lines	-0.2215***	-0.3526***	0.0485
	(-4.24)	(-3.55)	(0.45)
Insurer FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	27,911	25,490	27,911
Adjusted R^2	0.856	0.807	0.826

Table 6: Cross-sectional Analysis: Customer Climate Risk Concerns

Table 6 presents the results of the cross-sectional analysis based on customers' climate risk concerns. Column (1) ((2)) reports the results of the test using as the moderating variable insurer's standardized scores for direct-premium-weighted-average climate risk exposure (attitude) in the year before CRDS adoption. Coefficient estimates and *t*-statistics are reported based on robust standard errors clustered by insurer. *, **, and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively. See Appendix D for the variable definitions.

Dep. Var. =	*Direct_premium*	
	(1)	(2)
Mod_var =	*W_CR_exposure*	*W_CR_attitude*
CRDS × *Mod_var*	0.1798**	0.0896**
	(2.10)	(2.07)
CRDS	0.2577***	0.2570***
	(2.96)	(2.95)
Size	-0.2643***	-0.2631***
	(-4.78)	(-4.77)
Leverage	0.0250	0.0264
	(1.06)	(1.13)
Mutual	-0.1828**	-0.1877**
	(-2.33)	(-2.38)
Reinsurance	0.4118***	0.4120***
	(6.14)	(6.18)
Geo_concentration	-0.7171***	-0.7162***
	(-3.55)	(-3.52)
Personal_lines	-0.3543**	-0.3595**
	(-2.40)	(-2.37)
Commercial_lines	-0.2378**	-0.2454**
	(-2.24)	(-2.32)
Insurer FE	Yes	Yes
Year FE	Yes	Yes
Observations	27,911	27,911
Adjusted R^2	0.814	0.814

Table 7: Cross-sectional Analysis: Product Market Competition

Table 7 presents the results of the cross-sectional analysis based on product market competition. Column (1) reports the results of the test capturing insurers' product market competition using the standardized, direct-premium-weighted-average number of insurers operating in each state in the year before CRDS adoption. Column (2) reports the results of the test where the moderating variable is the insurer's standardized three-year market share volatility for the year before CRDS adoption. Column (3) reports the results of the test using a dummy variable as the moderating variable. The dummy variable equals one when the insurer is not a market leader in the year before CRDS adoption, and zero otherwise. A market leader is defined as an insurer ranked in the top 100 insurers based on size. Column (4) reports the results of the test using a different dummy variable as the moderating variable; in this case, the dummy variable equals one when the insurer is not a market leader in the year before CRDS adoption, and zero otherwise. I define a market leader as an insurer ranked among the top 20% insurers based on size. Coefficient estimates and *t*-statistics are reported based on robust standard errors clustered by insurer. *, **, and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively. See Appendix D for the variable definitions.

Dep. Var. =	*Direct_premium*			
	(1)	(2)	(3)	(4)
Mod_var =	*W_competitors*	*Mkt_shr_vol*	*Non_mkt_leader_1*	*Non_mkt_leader_2*
CRDS × *Mod_var*	0.1704**	0.2491**	0.2419**	0.6015***
	(2.53)	(2.00)	(2.13)	(3.12)
CRDS	0.2569***	0.2606***	0.0481	-0.0051
	(2.95)	(2.97)	(0.80)	(-0.10)
Size	-0.2660***	-0.2638***	-0.2603***	-0.2662***
	(-4.82)	(-4.77)	(-4.67)	(-4.76)
Leverage	0.0265	0.0272	0.0253	0.0225
	(1.13)	(1.17)	(1.08)	(0.95)
Mutual	-0.1891**	-0.1803**	-0.1895**	-0.1935**
	(-2.39)	(-2.26)	(-2.40)	(-2.44)
Reinsurance	0.4106***	0.4134***	0.4126***	0.4148***
	(6.14)	(6.22)	(6.18)	(6.27)
Geo_concentration	-0.7173***	-0.7093***	-0.7123***	-0.7098***
	(-3.53)	(-3.49)	(-3.50)	(-3.53)
Personal_lines	-0.3565**	-0.3668**	-0.3547**	-0.3351**
	(-2.36)	(-2.44)	(-2.35)	(-2.26)
Commercial_lines	-0.2466**	-0.2334**	-0.2439**	-0.2252**
	(-2.33)	(-2.23)	(-2.30)	(-2.09)
Insurer FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	27,911	27,891	27,911	27,911
Adjusted R^2	0.814	0.815	0.814	0.815

Table 8: Cross-sectional Analysis: Insurers Headquartered in Democratic States

Table 8 presents the results of the cross-sectional analysis based on whether the insurer's headquarters is located in a Democratic state. Column (1) reports the results of the test using a dummy variable as the moderating variable. The dummy variable equals one when the insurer's headquarters state in the year before CRDS adoption is Democratic, and zero otherwise. I define a Democratic state as a state where the Democratic party won the most recent gubernatorial election. Column (2) reports the results of the test using a different dummy variable as the moderating variable; in this case, the dummy variable equals one when the insurer's headquarters state in the year before CRDS adoption is Democratic, and zero otherwise. Here, a Democratic state is one where the Democratic party won all three of the most recent gubernatorial elections. Coefficient estimates and *t*-statistics are reported based on robust standard errors clustered by insurer. *, **, and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively. See Appendix D for the variable definitions.

Dep. Var. =	*Direct_premium*	
	(1)	(2)
Mod_var =	*HQ_Democratic_1*	*HQ_Democratic_2*
CRDS × *Mod_var*	0.3902**	0.9458***
	(2.25)	(3.18)
CRDS	0.0701	0.0502
	(0.70)	(0.68)
Size	-0.2589***	-0.2530***
	(-4.65)	(-4.58)
Leverage	0.0277	0.0268
	(1.20)	(1.16)
Mutual	-0.1756**	-0.1821**
	(-2.20)	(-2.27)
Reinsurance	0.4172***	0.4147***
	(6.22)	(6.18)
Geo_concentration	-0.7066***	-0.7171***
	(-3.47)	(-3.56)
Personal_lines	-0.3652**	-0.3711**
	(-2.40)	(-2.45)
Commercial_lines	-0.2444**	-0.2341**
	(-2.32)	(-2.24)
Insurer FE	Yes	Yes
Year FE	Yes	Yes
Observations	27,911	27,911
Adjusted R^2	0.814	0.816

Table 9: Supplementary Analysis of Insurers' Responses to Climate Risk Disclosure Survey Questions

Table 9 presents the results of the supplementary analysis of insurers' responses to CRDS questions. Specifically, CRDS question 6 asks insurers to "summarize steps the company has taken to encourage policyholders to reduce the losses caused by climate change-influenced events," and question 7 asks insurers to "discuss steps, if any, the company has taken to engage key constituencies on the topic of climate change." Panel A shows the yearly mean for the variables related to insurers' responses to CRDS questions. Panel B shows the results of the test of the association between insurers' responses to CRDS questions and their underwriting business. Coefficient estimates and *t*-statistics are reported based on robust standard errors clustered by insurer. *, **, and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively. See Appendix D for the variable definitions.

Panel A: Yearly Mean for Variables Related to Insurers' Responses to CRDS Questions

Variable	2013	2014	2015	2016	2017	2018	2019
CRDS_Q6_Y	0.793	0.798	0.798	0.818	0.835	0.836	0.841
CRDS_Q7_Y	0.739	0.747	0.746	0.758	0.774	0.768	0.797
CRDS_Q6_words	222.119	236.530	238.165	245.165	256.620	297.364	403.484
CRDS_Q7_words	198.476	233.862	243.737	254.871	293.015	352.979	380.415

Panel B: Association between Insurers' Responses to CRDS Questions and Their Underwriting Business

Dep. Var. =	*Direct_premium*			
	(1)	(2)	(3)	(4)
CRDS_Q6_Y	0.5968**			
	(2.45)			
CRDS_Q7_Y		0.8652***		
		(3.91)		
Log_CRDS_Q6_words			0.2177**	
			(2.31)	
Log_CRDS_Q7_words				0.3092***
				(3.36)
Size	-1.0397***	-1.0583***	-1.0786***	-1.0981***
	(-7.56)	(-7.65)	(-7.49)	(-7.59)
Leverage	-0.2441**	-0.2411**	-0.2458**	-0.2331**
	(-2.55)	(-2.56)	(-2.53)	(-2.44)
Mutual	0.2568	0.2591	0.2898	0.2887
	(0.77)	(0.78)	(0.87)	(0.88)
Reinsurance	1.0572***	1.0270***	0.9060**	0.7785**
	(3.20)	(3.34)	(2.47)	(2.22)
Geo_concentration	-0.7379	-0.6487	-0.7790	-0.6470
	(-1.40)	(-1.23)	(-1.47)	(-1.23)
Personal_lines	-0.1221	-0.0837	-0.1463	-0.0764
	(-0.45)	(-0.33)	(-0.53)	(-0.29)
Commercial_lines	-0.8336***	-0.8522***	-0.8039***	-0.7171**
	(-2.73)	(-2.82)	(-2.71)	(-2.42)
Year FE	Yes	Yes	Yes	Yes
Observations	3,425	3,425	3,368	3,368
Adjusted R^2	0.357	0.363	0.359	0.367