THE HONG KONG POLYTECHNIC UNIVERSITY
香港理工大學

SCHOOL OF ACCOUNTING AND FINANCE
會計及金融學院

August 1, 2025

Dear Organizing Committee,

I am writing to apply for participation in the PhD Student Workshop on Climate Finance, to be held on October 9, 2025, in Cambridge, MA. My name is Yajing (Stella) Wang. I am a third-year Ph.D. candidate in Finance at the Hong Kong Polytechnic University and expect to complete my Ph.D. program in June 2025. I am supervised by Professor Jie (Jay) Cao, who has kindly agreed to serve as a reference and can be reached at jie.cao@polyu.edu.hk.

My research focuses on climate change and innovation, examining issues such as the impact of climate change on individual beliefs and its effects on financial markets. The NBER workshop would provide an invaluable opportunity for me to present my ongoing research, receive constructive feedback from leading scholars and peers, and stay abreast of the latest developments in climate finance. I am confident that participating in this workshop will significantly enhance the quality of my research and broaden my academic network.

One of my working papers, "The Salience of Climate Change and Green Patents Review: Evidence from Climatic Disasters," investigates the causal effect of patent examiners' climate change beliefs on their green patent review behavior and green innovation outcomes. Using granular data on U.S. patent examiners across geographic locations from 2012–2020, we leverage climatic natural disasters as plausibly exogenous shocks to examiners' climate change beliefs. We find that examiners grant significantly more green patents following local climatic disasters, with these patents showing significantly higher quality. Further analysis suggests that the effect stems from increased effort by disaster-exposed examiners during green patent reviews. These higher-quality green patents subsequently lead to greater reductions in corporate carbon emissions.

I greatly appreciate your consideration and look forward to hearing from you! Please let me know if you need any additional information.

Sincerely,

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EDUCATION

The Hong Kong Polytechnic University (PolyU) | Hong Kong — 09/2022-Present
Ph.D. Candidate in Finance

The Chinese University of Hong Kong (CUHK) | Hong Kong — 09/2021-07/2022
PhD in Finance (Transferred to PolyU with supervisor)

University of International Business and Economics (UIBE) | Beijing — 09/2017-06/2020
Master of Finance

Shandong University | Shandong — 09/2013-06/2017
Bachelor of Economics

RESEARCH INTERESTS

Corporate Finance: Climate Finance, Innovation,
Asset Pricing: Derivatives, Cryptocurrency

WORKING PAPERS

- The Salience of Climate Change and Green Patents Review: Evidence from Climatic Disasters (with Jie Cao, Tao Shu, Xuan Tian, and Xintong Zhan)
- Opioid Crisis and Firm Downside Risks: Evidence from the Option Market (with Jie Cao, Amit Goyal, Xintong Zhan, and Weiming Zhang)
- Bitcoin Option and Stock Return Predictability (with Jie Cao, Gang Li, and Xintong Zhan)

PUBLICATIONS

- Wang Yajing, Fang Liang, Tianyi Wang, and Zhuo Huang. 2020. Does measurement error matter in volatility forecasting? Empirical evidence from the Chinese stock market. *Economic Modelling 87*, 148-157. (JCR Q1)
- Xintong Zhan and Yajing Wang. 2023. Option Return Predictability. *Tsinghua Financial Review 5*, 97-98.

RESEARCH EXPERIENCE

The Chinese University of Hong Kong (CUHK) | Hong Kong — 08/2020-07/2021
Research Assistant for Prof. Jie (Jay) Cao and Prof. Xintong Zhan

TEACHING EXPERIENCE

- Tutorial Instructor (School of Accounting and Finance, The Hong Kong Polytechnic University)
  AF3313 (Undergraduate): Business Finance, Fall 2023
  AF4513 (Undergraduate): Corporate Social Responsibility, Fall 2024
- Teaching Assistant (School of Accounting and Finance, The Hong Kong Polytechnic University)
  AF5373 (Master): ESG Investment and Green Finance, Spring 2023
  AF6305 (Ph.D.): Asset Pricing and Investment Research, Fall 2023, Fall 2024

SELECTED PRESENTATIONS (*by coauthor)

- The 2024 Journal of Contemporary Accounting and Economics Annual Symposium (PhD Session), 2024, Hong Kong, China
- The 2024 "Climate Finance and E. S. and G: Shaping a Sustainable Future" Conference (Poster Session), 2024, New York, U.S.
- The 2024 Indonesian Financial Management Association (IFMA) International Conference, 2024, Bali, Indonesia.
- Research in Behavioral Finance Conference (RBFC), 2024, Amsterdam, Netherlands.
- The University of Sydney Business Financing and Banking Annual Workshop, 2024, Sydney, Australia.
- The 37th Australasian Finance and Banking Conference (AFBC), 2024, Sydney, Australia.
- Chinese University of Hong Kong*, 2024, Hong Kong, China
- The 2025 AEA PhD Student Poster Session, 2025, San Francisco, U.S.
- The 2025 AFA PhD Student Poster Session, 2025, San Francisco, U.S.
- Finance Down Under 2025*, Melbourne, Australia
- Deakin University*, 2025, Melbourne, Australia
- Australian National University*, 2025, Canberra, Australia
- Chinese University of Hong Kong-Shenzhen, 2025, Shenzhen, China
- Seoul National University*, 2025, Seoul, South Korea
- Korea University*, 2025, Seoul, South Korea
- Sungkyunkwan University*, 2025, Seoul, South Korea

ACCOLADES

• National Merit Scholarship	10/2018
• Academic First-class Scholarship for Graduates	10/2018
• Outstanding Graduate of Shandong Province (Top 5%)	05/2017
• First-class Scholarship of Shandong University for two consecutive years	2015-2016
• Merit Student of Shandong University for three consecutive years	2014-2016
• Excellent Student Leader of Shandong University for three consecutive years	2014-2016
• First Prize in Summer Social Practice of Shandong University	11/2015
• Second-class Scholarship of Shandong University	12/2014
• Second Prize in Summer Social Practice of Shandong University	10/2014

ADDITIONAL INFORMATION

- Programming: MATLAB, PYTHON, SAS, STATA, LATEX
- Languages: English (fluent), Mandarin (native)

The Salience of Climate Change and Green Patents Review: Evidence from Climatic Disasters[†]

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The Salience of Climate Change and Green Patents Review: Evidence from Climatic Disasters

Abstract

This paper investigates the causal effect of patent examiners' climate change beliefs on their green patent review behavior and green innovation outcomes. Using granular data on U.S. patent examiners across geographic locations from 2012–2020, we leverage climatic natural disasters as plausibly exogenous shocks to examiners' climate change beliefs. We find that examiners grant significantly more green patents following local climatic disasters, with these patents showing significantly higher quality. Further analysis suggests that the effect stems from increased effort by disaster-exposed examiners during green patent reviews. These higher-quality green patents subsequently lead to greater reductions in corporate carbon emissions. We find no comparable effects for either non-green patents or non-climatic natural disasters, highlighting that examiners' climate change beliefs exclusively influence green innovation outcomes.

Keywords: patent examiner, climate change, climatic disaster, green patents, patent quality, greenhouse gas emission

JEL Classifications: G30, G41, O30, Q54, Q55

Green innovation plays a critical role in addressing the challenges posed by climate change and achieving sustainable development, as it develops technologies and practices that reduce environmental impact. Moreover, green innovation drives economic growth by opening new markets, generating green jobs, and encouraging investment in sustainable industries (Cohen, Gurun, and Nguyen, 2024). The transition to a green economy depends on the willingness of key stakeholders–such as business owners, inventors, and patent examiners–to support and prioritize green innovations. Despite its importance, there is a paucity of research on the factors driving the success of such innovation, particularly the role of climate beliefs among decision makers in the innovation process. In this paper, we attempt to fill the gap by investigating how patent examiners' beliefs about climate change influence their evaluation and approval of green patent applications.

Patent examiners serve as gatekeepers of the innovation system, and previous studies have shown that the patent review process and outcomes can be significantly influenced by patent examiners (e.g., Lemley and Sampat, 2012; Frakes and Wasserman, 2017). However, less is known about whether patent examiners hold non-pecuniary beliefs–such as personal views on climate change–and how these beliefs may eventually affect their evaluation of green patent applications. Importantly, a patent application is largely assigned to an examiner in a random fashion (e.g., Farre-Mensa, Hegde, and Ljungqvist, 2020; Shu, Tian, and Zhan, 2022). A patent application is first sent to one of the art units according to the patent's technology field, and then randomly assigned to an examiner within the art units. This random assignment allows us to rule out potential changes in patent applications, as firms may also respond to climatic natural disasters.

Measuring a patent examiner's beliefs poses an empirical challenge, as these beliefs are often correlated with or confounded by other examiner characteristics. To address this identification challenge, we exploit the geographical variations in examiners' locations and the timing of climatic

disasters affecting their regions. Climatic disasters generate plausible exogenous variation in examiners' awareness and concerns about climate change, providing a quasi-exogenous experiment.[1] Since these events are unlikely to be related to examiners' individual traits but likely to influence their perceptions of environmental urgency, they offer a unique opportunity to isolate the effect of climate beliefs on examiners' decision making. We investigate whether examiners exposed to climatic disasters exhibit a greater propensity to approve green patents, as the experiences may reinforce their belief in the importance of climate-related innovation. The answer is unclear ex ante, as inventors might separate their professional decisions from personal beliefs. Moreover, the USPTO's monitoring system could mitigate the influence of examiners' personal beliefs by ensuring consistency in patent evaluations.

We construct a comprehensive data set combining disaster exposure, patent outcomes, and examiner characteristics. Using data from the Spatial Hazard and Loss Database for the United States (SHELDUS), we identify county-year level major climatic natural disasters in the U.S. Patent examiners and patent information are obtained from the official websites of the United States Patent and Trademark Office (USPTO). We obtain examiner location (county-level), as well as their compensation information, from FederalPay.org. We focus on the period starting in 2012, when the USPTO implements its work-from-anywhere (WFA) program, which introduces geographical variations in examiner locations. We restrict our sample to examiner-year observations in which the examiner grants at least one patent, resulting in 58,161 examiner-year observations from 8,248 unique examiners. Based on the Cooperative Patent Classification (CPC)

[1] Climatic natural disasters, such as drought, hurricanes, and wildfires, are extreme consequences of climate change. Since 1980, the U.S. has experienced 377 billion-dollar climatic natural disasters, amounting to a total cost of more than $2.67 trillion.

classifications, our sample includes 220,555 green patents and 2,281,501 non-green patents during 2012-2020.

We begin by investigating whether exposure to climatic disasters affects patent examiners' propensity to grant green patents. For each examiner-year, we construct *Green Patent Ratio* as the share of green patents among all patents granted by the examiner in the year. Using a difference-in-differences (DiD) analysis, we find that in the year following climatic disasters, examiners exposed to such disasters exhibit a significant 10% increase in *Green Patent Ratio* relative to their peers. It is unlikely that a general rise in interest in green technologies drives our results, as we compare examiners with and without disaster exposure in the same year. Moreover, since the USPTO randomly assigns patent applications to examiners, our findings are unlikely to be confounded by shifts in corporate innovation strategies, for example, firms investing more in green technology and submitting more green patent applications.[2]

We acknowledge that while an increase in *Green Patent Ratio* suggests disaster-exposed examiners' greater propensity to grant green patents, it could also result from the exposed examiners' receiving a higher percentage of green patent applications among all patent applications. This alternative explanation is, however, unlikely because any increase in green patent applications is unlikely to be concentrated among disaster-exposed examiners due to the random assignment of patent applications to examiners. We nevertheless directly examine whether climatic disasters increase the proportion of green patent applications assigned to examiners, and find no evidence consistnet with this alternative argument.

[2] Green patents can be categorized into those targeting climate change mitigation and adaptation. We expct our baseline findings to apply to both technology types, as disaster experience underscores the need for both adaptation and mitigation. Consistent with this our prediction, we find climatic disaster exposure increases examiner's propensity to grant green patents across both categories.

We conduct several robustness tests using alternative classifications and test designs. First, we use an alternative classification to define green and non-green patents. Second, to account for potential heterogeneity in technological fields or examiner preferences, we match examiners within the same art unit in the year preceding climatic disasters. Third, we exclude patent applicant firms located in the same state as the examiner to rule out the possibility that geographic proximity facilitates information spillover between examiners and applicant firms. For all these robustness tests, we find coherent results that climatic disasters lead examiners to approve more climate-related green patents in their granted patent portfolio. Fourth, we conduct a placebo test by replacing climatic disasters with other types of natural disasters. We find no evidence that examiners alter their green patent granting behavior following non-climatic disasters. This finding highlights that salient climatic disasters uniquely shape examiners' climate change beliefs and in turn their propensity to grant green patents.

Next, we examine plausible mechanisms through which examiners' climatic disaster exposure affects their green patent granting decisions. Given that examiners operate under significant time constraints and cognitive limitations, two competing explanations emerge. First, an increased leniency toward granting green patents could lead to a potential compromise in the quality of these patents (the "leniency" explanation). Alternatively, exposure to climatic disasters could motivate examiners to allocate greater attention and effort to evaluating green innovations. Since rapidly evolving green technologies often involve novel concepts, insufficient examiner effort could result in excessive rejection of qualified green patents. More thorough reviews may enhance both the approval rate and quality of granted green patents (the "effort" explanation).

To distinguish between the leniency and effort explanations, we assess green patent quality using the measure of truncated patent citations (Hall, Jaffe, and Trajtenberg, 2001). Our analysis

reveals that examiners' exposure to climatic disasters significantly increases the quality of granted green patents by 7.4% relative to the mean. In contrast, we find no significant effect of climatic disaster experience on the quality of granted non-green patents. These results support the effort explanation, suggesting that climatic disasters prompt examiners to conduct more thorough evaluations of green patent applications.

To directly assess examiners' effort during patent review, we measure examiner effort using three proxies. First, we analyze the number of claims reviewed per patent application. Given that each claim requires careful examination to establish legal boundaries, a greater number of claims necessitates more examiner effort (Harhoff and Wagner, 2009). Second, we examine the total backward citations (prior art references) required by examiners, as compiling relevant prior art demands significant search and evaluation effort. Third, we examine whether examiners cite at least one prior art reference when rejecting applications for art-based reasons (i.e., lack of novelty or obviousness). Across all three measures, we consistently find that disaster-exposed examiners exert greater effort specifically in reviewing green patent reviews post-disaster, while maintaining their usual examination effort for non-green patent examinations.

An important assumption of our study is that climatic disaster exposure strengthens examiners' climate change beliefs, subsequently affecting their evaluation of green patents. To test this assumption and measure these belief changes, we analyze examiners' political donations to the Democratic Party, which has consistently emphasized climate change initiatives (Di Giuli and Kostovetsky, 2014; Bernstein et al., 2022). Consistent with our argument that climatic disasters strengthen examiners' climate change beliefs, examiners' political donations to the Democratic Party rise by 8.9% relative to the mean after experiencing climatic disasters.

Furthermore, the effect of disaster exposure on examiners' climate change beliefs should be stronger among those who are more sensitive to environmental concerns. To test this conjecture, we conduct cross-sectional analyses using several examiner location characteristics as proxies for climate change sensitivity, including regions governed by the Democratic Party, states that have joined the U.S. Climate Alliance, and climate-change-related Google search volume. Consistent with our conjecture, climatic disasters have a more pronounced effect on examiners who exhibit greater sensitivity to climate change concerns. Moreover, more salient disaster experiences should have a stronger influence on examiners' beliefs. As expected, we find that the effect of disaster exposure is stronger for disasters that cause larger monetary losses, result in more fatalities, have longer durations, and occur consecutively over time.

Next, we investigate the real effects of improved green patent quality linked to examiners' exposure to climatic disasters, focusing on corporate geenhouse gas (GHG) emissions. We find that firms with a greater proportion of green patents granted by disaster-affected examiners experience significantly greater reductions in GHG emission intensity over the subsequent three years. This evidence highlights that the influence of examienrs' climatic disaster exposure extends beyond green patent examination, shaping corporate environmental behavior, enhancing social welfare, and facilitating the transition to a green economy.

Finally, to further validate and generalize our findings, we examine whether another major climatic anomaly similarly influences examiners' patent review behavior. A growing literature shows that extreme heat significantly affects human decision-making (e.g., Graff Zivin and Neidell, 2014; Heal and Park, 2016; Choi, Gao, and Jiang, 2020; Di Giuli, Garel, Michaely, and Romec, 2025). We find that exposure to abnormally high temperature increases examiners' propensity to

grant green patents.[3] Additionally, extreme heat exposure also improves the quality of granted green patents. These results corroborate our main findings on climatic disasters and further support the role of examiners' climate change beliefs in shaping their green patent reviews.

Our study contributes to the growing literature on green innovation. Prior research has examined the drivers of green innovation, such as firms' exposure to environmental spills (Chu, Liu, and Tian, 2021) and the nature of business (Cohen, Gurun, and Nguyen, 2024). However, we still lack evidence on how the patenting system, particularly patent examiners, shapes green innovation. We fill this gap by showing that examiners' climate change beliefs affect both the volume and quality of green patents. [4] Furthermore, while existing studies present mixed evidence on whether green innovation reduces corporate carbon emissions (e.g., Bolton, Kacperczyk, and Wiedemann 2024; Hege, Pouget, and Zhang, 2024; Cheng, Lin, and Yang, 2024), our findings provide new light on this debate. By employing a plausibley exogenous shock to green patent quality, i.e., examiners' exposure to climatic disasters, we show that higher-quality green patents lead to significant reductions in corporate carbon emissions.

Our paper also adds to the literature on climate finance, particularly in the realm of belief formation. Prior research has demonstrated that heightened attention to climate risks significantly affects the beliefs and actions of investors and firms and consequently financial markets.[5] Hong, Wang, and Yang's (2023) theoretical study shows that major climatic disasters may alter

[3] In economic terms, the impact of extreme temperature exposure is about 25% as large as climatic disasters, which is unsurprising given that disasters are far more salient than abnormal temperature events..

[4] Guo, Hu, and Wang (2024) run regressions of the number of green patents on extreme weather exposures at the monthly level, using data only from Beijing, China. The key distinction between our study and theirs is that we conduct an in-depth analysis of patent examiners' beliefs and the patent examination process at the examiner-year level, considering factors such as patent quality and examiners' effort, whereas their analysis is limited to documenting an increase in green patents following extreme heat and rainfall in Beijing.

[5] An incomplete list of these papers includes Alok, Kumar, and Wermers (2020), Krueger, Sautner, and Starks (2020), Bolton and Kacperczyk (2021), Ilhan, Sautner, and Vilkov (2021), Cao, Titman, Zhan, and Zhang (2023), Huynh and Xia (2023), Cao, Li, Zhan, Zhang, and Zhou (2025), Cao, Goyal, Zhan, and Zhang (2025).

households' perceived risks and beliefs toward climate change. A recent experimental study by Bernard, Tzamourani, and Weber (2025) further finds that making climate change information more salient motivates individuals to take action against it. Our paper provides novel empirical evidence on how the salient climate events shape individuals' beliefs and professional behavior.

Finally, our paper extends the growing literature on patent examiners. While prior research has highlighted examiners' significant role in shaping patent approval and quality (e.g., Lemley and Sampat, 2012; Frakes and Wasserman, 2017; Kovács, 2017; Farre-Mensa, Hegde, and Ljungqvist, 2020; Choudhury, Foroughi, and Larson, 2021; Shu, Tian, and Zhan, 2022; Baek, 2023), these studies primarily examine general patent grants. We contribute to this literature by providing novel evidence on how examiner beliefs form and their disproportionate impact on a specific category of innovation, i.e., green patents.

1. Data and Sample

This section describes the data sets, including the sources of data on climatic natural disasters, patents, and patent examiners, as well as the process of sample construction.

1.1 Climatic Natural Disasters

We collect county-level information on natural disaster events in the U.S. from 2011 to 2019 using the Spatial Hazard and Loss Database for the United States (SHELDUS), maintained by Arizona State University. SHELDUS defines disaster areas as counties directly impacted by 18 types of natural disasters. For each county-year observation, the database reports the total dollar damage, the total number of injuries or fatalities, and the total duration of each disaster type.[6] We follow Alok, Kumar, and Wermers' (2020) methodology and incorporate a classification-assisted

[6] The disasters mentioned later all refer to specific types of disaster events.

ChatGPT to categorize natural disasters into two groups: those with strong links to climate change (*climatic natural disasters*) and others. Appendix B provides detailed scientific evidence supporting the association between each climatic natural disaster and climate change.

After identifying climatic natural disasters, we retain only disaster-county-year observations when the total estimated damage exceeds $10 million (in 2020 constant dollars) and the total duration is less than 30 days following Huynh and Xia (2023). We further require that each observation has at least one injury or fatality to ensure the disaster is salient enough to patent examiners in the affected county. Following these filters, our sample comprises six types of climatic disasters: flooding, hurricanes, tornados, wildfires, windstorms, and hailstorms. Panel A of Table 1 reports summary statistics for these climatic natural disasters, aggregated by disaster type. Tornados exhibit the lowest average annual monetary damage ($390 million), while hurricanes have the highest average monetary damage ($2.65 billion). Additionally, flooding causes the highest average injuries and fatalities (23), followed by hurricanes and tornados (15 and 10). Our final example consists of 57 disaster-county-year events across these six types of climatic disasters, collectively responsible for $113.05 billion in damages and 1,383 casualties.

1.2 Examiners and Patents

We obtain data on all issued utility patents and patent examiners from the U.S. Patent and Trademark Office (USPTO).[7] The patent records include patent IDs, examiner names, and issue dates. Using examiner names from the USPTO database, we match each examiner with their geographic location and salary information from FederalPay.org, a publicly available resource of U.S. government employee data.[8]

[7] The data websites are https://www.uspto.gov/ip-policy/economic-research/research-datasets/patent-examination-research-dataset-public-pair and https://patentsview.org/.
[8] See https://www.federalpay.org/employees/patent-and-trademark-office.

In the United States, the USPTO evaluates patent applications to determine their eligibility based on a set of standardized criteria. Specifically, inventions must be novel, non-obvious, useful, patent-eligible, and accompanied by comprehensive disclosures. Patent applications submitted to the USPTO contain detailed specifications, precise claims describing the invention's scope, and relevant prior art documentation. After an initial procedural screening, applications are classified based on technology classes and then assigned to specialized art units. Each art unit comprises patent examiners focused on specific technological domains. Within an art unit, patent applications are generally assigned to individual examiners by supervisory patent examiners in a largely random manner (e.g., Farre-Mensa, Hegde, and Ljungqvist, 2020; Shu, Tian, and Zhan, 2022). Prior research finds no systematic correlation between application assignment and application quality, supporting the view that the assignment process is mostly unbiased (e.g., Merges, 2001; Lemley and Sampat, 2012).

Our empirical strategy exploits geographical variation in examiner locations. Following the Telework Enhancement Act signed by President Obama in December 2010, which standardized remote work policies across federal agencies, the USPTO implemented the Telework Enhancement Act Pilot Program (TEAPP) in early 2012. This program introduces a work-from-anywhere (WFA) policy, enabling examiners to reside and work anywhere in the contiguous United States. Crucially, the USPTO maintains uniform compensation for WFA participants regardless of their distance from headquarters. Therefore, we begin our sample in 2012 to capture meaningful geographical dispersion resulting from this policy change. As shown in Figure 1, while examiner locations remain concentrated near USPTO headquarters in Alexandria, Virginia, the WFA program generates substantial nationwide dispersion. This spatial variation allows us to identify the causal effects of exogenous climatic disasters on patent examiners across different

locations.

We identify green patents using the Cooperative Patent Classification (CPC) codes, jointly defined by the USPTO and the European Patent Office (EPO). Following the CPC scheme, patents classified under Y02 codes are green patents, as this category specifically contains technologies intended for climate change mitigation or adaptation. This classification approach aligns with established practice in the literature (Calel, 2020) and is broadly consistent with the OECD definition of environmental technologies (Dussaux, Agnelli, and Es-Sadki, 2023). Similar to Cohen, Gurun, and Nguyen (2024), we use the most recent Y02 categorization scheme for identifying climate-related patents.[9]

1.3 Summary Statistics

Our sample period starts from 2012 to 2020. We identify 8,248 unique patent examiners with complete name and location information who grants at least one patent during this period, resulting in an examiner-year sample of 58,161 observations. We merge these examiner-year observations with climatic disaster data using year and county identifiers. To measure disaster exposure, we construct a binary measure, *Disaster*, that equals 1 if an examiner experiences any climatic disaster in their county of residence during year *t-1*, and 0 otherwise. Approximately 1% of examiner-year observations have *Disaster* = 1. At the examiner level, about 3.5% of patent examiners experience at least one climatic disaster during our sample period. This reflects the relatively rare incidence of climatic natural disasters in our sample period.

To capture an examiner's green patent review activity, we count an annual measure, *Green Patent Ratio*, as the proportion of green patents among all patents granted by the examiner in the

[9] Cohen, Gurun, and Nguyen (2024) also include a small number of patents from other environmentally oriented categories. As a robustness test, we apply their broader classification and find that our results remain consistent.

year. This measure captures the examiners' propensity to grant green patents while controlling for her overall patent grants. As shown in Panel B of Table 1, green patents account for about 8% of all granted patents in our sample. *Green Patent Ratio* has a standard deviation of 0.16, indicating substantial variation across examiners in their attitudes towards green innovation. In addition to the main variable, we construct a set of measures to capture the examiners' review activities. These measures, summarized in Panel B of Table 1 and described in detail in Appendix A, capture various dimensions of the patent examination process. We will describe these measures later in the paper when discussing their corresponding analyses.

2. Climatic Disaster Experience and Green Patent Review

We examine whether exposure to climatic disasters increases examiners' preference for green patents. We first conduct a regression analysis of green patent ratio. Next, we perform robustness tests and evaluate alternative explanations.

2.1 Climatic Disaster Experience and Green Patent Grant Rate

2.1.1 Baseline Results

To investigate whether examiners' exposure to climatic disasters affects their granting behavior for green patents, we estimate the following OLS regression:

$$Green\ Patent\ Ratio_{i,t} = \beta_0 + \beta_1 Disaster_{i,t-1} + FEs + \varepsilon_{it} \quad (1)$$

where the dependent variable, $Green\ Patent\ Ratio_{i,t}$, is the proportion of green patents among all patents granted by examiner *i* during year *t*, capturing the examiners' inclination towards green patents. The main independent variable, $Disaster_{i,t-1}$, is a dummy variable equal to 1 if examiner *i* experiences a climatic disaster in year *t-1*, and 0 otherwise. We include examiner and year fixed effects to control for unobserved heterogeneity across examiners and time. Standard errors are

double-clustered at the county and year levels to account for spatial and temporal correlations. If exposure to climatic disaster significantly increases an examiner's preference for green patents, we expect β_1 to be significantly positive.

Panel A of Table 2 reports the regression results, showing a significantly positive coefficient on *Disaster* across both specifications. For example, the coefficient in column (1) indicates that examiners exposed to climatic disasters increase their green patent ratio by 0.79 percentage points, or equivalent to a 9.9% increase relative to the mean (0.0079/0.08). This finding suggests that exposure to climatic disasters strengthens examiners' belief in the urgency of climate issues, leading to a greater propensity to grant green patents.

Figure 2 plots the dynamic effects of climatic disasters on examiners' green patent ratio. The results reveal a sharp increase in green patent ratio among exposed examiners in the year following the disaster, relative to their unaffected counterparts. However, this effect is transitory, dissipating after one year – consistent with a short-term behavioral response rather than a permanent shift in preferences. Crucially, Figure 2 shows no pre-trends in green patent ratios prior to the disasters, supporting the exogenous occurrence of climatic disasters and lending credibility to a causal interpretation of the estimated effects.

A potential concern with our OLS specification is the censored nature of our dependent variable. As shown in Panel B of Table 1, *Green Patent Ratio* exhibits clustering at zero, with the 25^{th} percentile equal to zero. To address this concern, we employ a Tobit model, which explicitly accounts for observations with values at boundary limits (Amemiya, 1984; Jiménez, Lopez, and Saurina, 2009; De Angelis, Grullon, and Michenaud, 2017). The Tobit regression results, presented in Panel A of Table C1 (Appendix C), show that our findings remain qualitatively and quantitatively similar.

2.1.2 Examiner Behavior or Evolving Patent Applications?

While our finding of an increase in *Green Patent Ratio* is consistent with examiners developing a stronger propensity to grant green patents after climatic disasters, it could alternatively reflect a rise in the share of green patent applications (e.g., if climatic disasters motivate firms or inventors to conduct more green innovation). However, this alternative explanation is unlikely for two reasons. First, even if the share of green patent applications increases overall, it is unlikely that this increase is concentrated among event examiners due to the random assignment of patent applications to examiners. Second, and more importantly, it takes an average of one year for patent applications to be assigned to examiners. Since *Green Patent Ratio* is based on patents granted in the year following climatic disasters, it mainly corresponds to patent applications submitted before or during the disaster years – meaning the increase is unlikely to be caused by a surge in green innovation in response to disasters.

Nevertheless, we further investigate whether climatic disasters increase the proportion of green patent applications assigned to examiners during disaster years, which would subsequently raise green patents granted in the following year. We define *Green Application Ratio* for an event examiner as the percentage of green patent applications among all patent applications assigned to that examiner during the year of a climatic disaster. Panel B of Table 2 presents the regressions of *Green Application Ratio* on *Disaster*. The coefficient on *Disaster* is statistically insignificant, indicating no increase in the proportion of green patent applications assigned to disaster-exposed examiners. This result suggests that the observed increase in green patent grants is driven by shifts in examiners' beliefs regarding climate change rather than by an increase in green patent applications assigned to these examiners.

2.1.3 Adaptation versus Mitigation Technologies

Green patents can be categorized into two groups based on their technological purpose: mitigation and adaptation. Adaptation technologies focus on helping societies cope with the adverse effects of climate change, such as flood control systems or hurricane monitoring solutions. Mitigation technologies aim to reduce or prevent climate change itself, such as methods for greenhouse gas capture and non-fossil fuel alternatives in aviation and other industries. Mitigation technologies dominate green innovation, representing approximately 92.8% of green patents.

If climatic disasters strengthen examiners' beliefs about the importance of climate change, we would expect their increased propensity to grant green patents to apply to both technology types, as disaster experience highlights the need for both adaptation and mitigation. To test this prediction, we separately analyze these two types of green patents. We define *Green Adaptation Ratio* as the percentage of green adaptation patents among all granted patents granted by an examiner in a given year. *Green Mitigation Ratio* is defined similarly using mitigation green patents. Panel C of Table 2 reports the regressions of these two measures, which shows that the climatic disaster exposure increases examiners' propensity to grant green patents for both technology types, supporting our prediction.

2.2 Additional Robustness and Placebo Tests

We conduct a series of additional robustness tests to further validate our baseline analysis. First, since our focus is climate-related green patents, our definition of green patents follows the CPC Y02 classification from the most recent OECD 2023 report. Cohen, Gurun, and Nguyen (2024) follow the classification in the OECD 2015 report (Hascic and Migotto, 2015), which includes a small number of non-climate related green patents (e.g., addressing pollution or water

scarcity).[10] We conduct a robustness test following Cohen, Gurun, and Nguyen (2024)'s broader definition of green patents, and the coefficient remains significantly positive in Panel A of Table 3 (Column (1)). In Column (2), we replace the independent variable with the non-climate-related green patent ratio, and the coefficient is almost zero and statistically insignificant. This contrast demonstrates that the significant increase in green patent ratio is driven by examiners' stronger preference for climate-related green patents induced by climatic disaster experience.

Second, the assignments of patent applications *across* art units are not random. To further filter out confounding factors at the art-unit level, we conduct a robustness test in Panel B of Table 3 by matching each disaster-exposed examiner with non-disaster-exposed examiners in the same art unit. If more than one examiner is matched, we either keep all matched examiners as the control group (Column (1)) or keep the matched examiner whose pay level is closest to the shocked examiner (Column (2)). The sample size drops sharply as this approach includes only the art units with disaster-exposed examiners. Panel B of Table 3 shows that, despite the much smaller sample size, the coefficient on *Disaster* remains almost the same as the baseline analysis.

Third, geographical proximity between patent firms and examiners may increase the chance of success in patent applications, either due to an information advantage or familiarity (Jia and Tian, 2018). If firms closer to the examiners recognize their higher tendency to grant green patents, they might file more green patent applications. Approximately 1.2% of patents in our sample are granted by examiners in the same states as applicants. We conduct a robustness test by removing applicant firms in the same state as the examiners. As shown in Panel C of Table 3, our results remain robust after this exclusion.[11]

[10] Green patents classified under our definition constitutes approximately 85% of the broader set of green patents identified using their approach.

[11] We conduct an additional robustness test by dropping the examiners residing in the headquarters county of the USPTO, and the results hold in the untabulated analysis.

Finally, we conduct a placebo test by replacing climatic disasters with other types of natural disasters. If non-climatic disasters similarly influence examiners' green patent granting behavior, our findings would reflect general disaster effects rather than specifically capturing climate change salience. In Panel D of Table 3, we repeat our baseline analysis but replace climatic disasters with other disasters (as detailed in Appendix B). The coefficients on non-climatic disasters are statistically insignificant across both specifications, highlighting that climatic disasters uniquely affect examiners' climate change beliefs and their subsequent patent review decisions.[12]

3. What Drives the Increased Propensity for Green Patents: Examiner Leniency vs. Effort

3.1 Climatic Disaster Experience and Green Patent Quality

Our findings indicate that patent examiners exhibit an increase propensity to grant green patents following exposure to climatic disasters, suggesting a shift in their attitudes toward green innovation. We investigate plausible underlying mechanisms and its implications for patent quality, exploring two competing hypotheses. On the one hand, disaster-affected examiners may apply more lenient evaluation standards for green patents due to strengthened climate change beliefs, resulting in lower-quality granted green patents (the *leniency* hypothesis). On the other hand, enhanced climate change awareness may instead motivate examiners to devote greater effort to reviewing green patent applications. Given that fast-growing green innovation often involves new concepts and technologies, insufficient examiner effort could lead to excessive or quick rejection of qualified green patents. By conducting more thorough reviews, examiners may improve both the quantity and quality of green patents (the *effort* hypothesis).

To test these competing mechanisms, we estimate Equation (1) using *Green Patent Quality*

[12] We also conduct a robustness test that excludes two less frequent climatic disaster types, wind and hail, which occur only a few times in our sample and, therefore, may be less relevant to shaping the beliefs about climate change. Panel B of Table C1 (Appendix C) shows that our results hold with this alternative classification of climatic disasters.

as the dependent variable, measured as the natural logarithm of one plus the average truncation-adjusted citation (Hall, Jaffe, and Trajtenberg, 2001) for green patents granted by each examiner annually. In Column (1) of Table 4, the coefficient on *Disaster* is significantly positive, suggesting that examiners' exposure to climatic disaster significantly increases the quality of their granted green patents by 7.4% relative to the mean (0.0222/0.30).[13]

For comparison, we examine how climatic disaster exposure affects the quality of non-green patents. We construct *Non-Green Patent Quality* as the natural logarithm of one plus the average truncation-adjusted citation of non-green patents granted by each examiner annually. Column (2) of Table 4 shows an insignificant coefficient on *Disaster*, suggesting that examiners' experience of climatic disasters has no discernible effect on the quality of non-green patents. This null effect persists when we examine *All Patent Quality* (Column (3)), defined similarly using all patents granted by the examiner. The absence of a significant change in overall patent quality is not surprising, given that green patents account for only 8% of total patents granted (Table 1). The results in Table 4 collectively support the effort hypothesis, indicating that climatic disasters motivate examiners to conduct more careful evaluations, specifically of green patent applications.

3.2 Additional Analyses: Examiner Effort Proxies

To provide direct evidence for the effort hypothesis, we analyze how examiners' exposure to climatic disasters affects the observable proxies of examiner effort. Following Harhoff and Wagner (2009), we first measure examiner effort using the number of claims reviewed per patent, since examining patents with more claims requires a greater time investment as each claim must be thoroughly reviewed to determine the patent's legal boundaries. We construct *Green Claims* as the

[13] Note that the average truncation-adjusted citation is a continuous rather than discrete variable, which justifies log transformation. We nevertheless conduct robustness tests using a Poisson regressions, and our results remain unchanged (Table C2 of Appendix C).

average number of claims in green patents reviewed by an examiner in a given year. We further define *Non-Green Claims* and *All Claims* similarly for non-green patents and all patents granted by the examiner, respectively.

Panel A of Table 5 reports regressions of examiner effort proxies on *Disaster*. The coefficient on *Disaster* is significantly positive in the regression of *Green Claims* (Column (1)) but insignificant in the regressions of *Non-Green Claims* and *All Claims* (Columns (2) and (3)). These findings are consistent with the patent quality results (Table 4), providing further evidence that examiners increase their effort specifically for green patent reviews following disaster exposure, while maintaining their usual examination effort for other technologies.

For robustness, we consider two additional measures of examiner effort. Our second proxy examines the total number of backward citations (prior art references) that examiners require applicants to include. This measure captures examiner effort because identifying prior art demands substantial effort in searching and evaluating existing patents. We define *Green References* as the average backward citations required for green patents by an examiner in a given year. We similarly define *Non-Green References* and *All References* for non-green patents and all patents, respectively.[14] Our third effort proxy is based on patent rejections. Specifically, we examine whether examiners, when rejecting patent applications for art-based reasons, including Section 102 (lack of novelty) or Section 103 (obviousness), cite at least one prior art reference. [15] If

[14] To construct the claims- and references-based effort measures, we focus on patents without review actions before the patent grant year. This filter ensures that the backward citations do not result from reviews from earlier rounds.We also use this sample to conduct a robustness test for our baseline analysis, and our baseline findings hold in Table C3 of Appendix C.

[15] Frakes and Wasserman (2017) show that examiners can easily use non-art-based rejection, such as subject matter eligibility (Section 101 rejections) or written description (Section 112 rejections), to reject applications on the basis that the inventions are not useful, or that the application fails to satisfy the disclosure requirements. However, it is difficult to argue that the specific grounds for rejection directly correspond to examiner effort, since an application may be rejected for multiple reasons. Instead, we assess examiner effort by examining whether prior art is cited in art-based rejections, as this requires a thorough search and careful comparison between the claimed invention and existing prior art.

examiners reject green patents for art-based reasons and cite at least one prior art reference after experiencing climatic disasters, this indicates that they devote greater effort to reviewing these applications. We define Green *Rejection Effort*, for each examiner in each year, as the ratio of the number of green patent rejections based on art-based reasons that include at least one prior art citation to the total number of green patent rejections based on art-based reasons. Similarly, we define *Non-Green Rejection Effort* and *All Rejection Effort* for non-green patent rejections and all patent rejections, respectively.

Panels B and C of Table 5 present the results using the citation-based effort measure and the rejection-based effort measure, respectively. These results consistently demonstrate that examiners increase effort for green patent reviews after climatic disasters, while maintaining similar effort for non-green patent reviews. This pattern precisely mirrors the results using claims-based measure (Panel A of Table 5). Taken together, the results in Table 5 provide direct evidence supporting the effort hypothesis.

4. Climatic Disaster Experience and Examiners' Climate Change Beliefs

A key mechanism underlying our findings is that examiners' exposure to climatic disasters shapes their beliefs about climate change, which in turn influences their behavior when reviewing green patents. In this section, we examine whether exposure to climatic disasters indeed strengthens examiners' climate change beliefs.

4.1 Climatic Disaster Exposure and Examiners' Political Donations

We use examiners' political donations as a proxy for their beliefs. If exposure to climatic disasters strengthens examiners' beliefs in climate change, we expect this to be reflected in a higher likelihood of donating to the Democratic Party. This expectation aligns with the Democratic Party's emphasis on climate change-related issues and its active advocacy for ESG initiatives,

including environmental protection (Di Giuli and Kostovetsky, 2014; Bernstein et al., 2022).

We collect data on examiners' political donations from two sources. First, we use the Federal Election Commission (FEC) database, following prior studies (e.g., Hong and Kostovetsky, 2012; Di Giuli and Kostovetsky, 2014; Babenko, Fedaseyeu, and Zhang, 2020; Dasgupta et al., 2025). The FEC database provides detailed records of political contributions to federal candidates and parties since 1979, including donor names, addresses, occupations, and donation amounts. Second, we supplement the FEC data with the Database on Ideology, Money in Politics, and Elections (DIME) from Harvard University (Bonica, 2024), which covers over 130 million donation records across local, state, and federal elections. To identify patent examiners' political donations, we match their names and affiliations in the FEC database and use the DIME database to fill any gaps.

Our final sample consists of 514 examiner donations, approximately 89% of which are donated to the Democratic Party, suggesting that the majority may hold concerns about climate change.[16] Table 6 presents regressions of examiners' political donations on *Disaster*. The coefficient on Disaster is significantly positive in both models, revealing a significant increase in donations to the Democratic Party following the climatic disasters. For example, the coefficient in column (2) indicates that examiners' donations to the Democratic Party rise by 8.9% relative to the mean (04456/4.98) after experiencing climatic disasters. This finding provides evidence that exposure to climatic disasters may reshape examiners' beliefs about climate change, as reflected by a notable change in their political construction. This result is consistent with Bernard, Tzamourani, and Weber (2025), who show that individuals increase their willingness to pay (WTP) for CO_2 emission offsets after receiving relevant information.

[16] This composition is in line with Shu et al.'s (2025), who document that who document that Democratic patent examiners outnumber Republican examiners by a factor of 2.5.

4.2 Cross-Sectional Analyses

If exposure to climatic disasters strengthens examiners' beliefs about climate change, we expect this effect to be stronger among examiners who are more sensitive to environmental concerns and when the disaster experience is more salient. We test these predictions by conducting cross-sectional analyses.

4.2.1 Examiner Locations

We begin by conducting cross-sectional analyses using several examiner location characteristics that serve as proxies for examiners' sensitivity to climate change concerns. First, regions governed by the Democratic Party or states that have joined the U.S. Climate Alliance are known to prioritize climate-related issues, as evidenced by their policies and election outcomes. These areas foster an environment that emphasizes climate action, which may influence or reflect the views of examiners working there. Therefore, we construct two proxies for regional political ideology or attitudes toward climate change. The first variable, *Dem County*, is a dummy variable equal to 1 if the examiner's county is governed by the Democratic Party. The second variable, *Climate Alliance*, is a dummy variable equal to 1 if the examiner's state has joined the U.S. Climate Alliance.

Second, we examine two proxies for examiners' attention towards climate change using Google Search Volume Index (SVI) data from Google Trends. Specifically, we collect SVI data for the search term "climate change" at both the national (annual) and state-year levels.[17] Prior studies have shown that SVI effectively captures public attention (e.g., Da, Engelberg, and Gao, 2011). The index ranges from 0 to 100, with higher values indicating greater search interest. We construct two proxies for examiners' attention. The first proxy, *High Attention*, is a dummy

[17] Google search volume can be obtained from Google Trends (https://trends.google.com/trends/?geo=US). We also consider the search volume of "climate natural disaster" and "natural disaster" and the results are similar.

variable equal to 1 if the national-level SVI in the year of climatic disaster exceeds the sample median, and 0 otherwise. The second proxy, *High State Attention*, is a dummy variable equal to 1 if the SVI of the examiner's state in the disaster year is above the median of all states that year, and 0 otherwise.

Panel A of Table 7 presents the baseline regressions that include interaction terms of Disaster and the four climate-sensitivity proxies discussed above. The coefficients on these interaction terms are significantly positive across all four models. These findings suggest that climatic disasters have a more pronounced effect on examiners who exhibit greater sensitivity to climate change concerns, consistent with the posited mechanism of belief updating among examiners.

4.2.2 Salience of Climatic Disasters

Previous studies demonstrate that more salient experiences exert stronger influences on economic agents' belief formation and subsequent behaviors (e.g., Malmendier and Nagel, 2011; Gallagher, 2014; Dessaint and Matray, 2017). Building on this literature, we hypothesize that examiners exposed to more salient climatic disasters will exhibit more pronounced belief updating regarding climate change, which will consequently manifest in their evaluation of green patent applications.

To test this hypothesis, we consider four dimensions of climatic disaster damage as proxies for disaster salience. Specifically, we define *Large Loss* as a dummy variable that equals 1 if the monetary loss from a disaster is above the sample median, and 0 otherwise. We similarly construct three additional dummy variables for the duration of a disaster (*Long Duration*), whether a disaster causes fatality (*Fatality*), and whether an examiner experiences climatic disasters in two consecutive years (*Consecutive*). Panel B of Table 7 presents the baseline regressions that include interactions of *Disaster* and these salience proxies. Consistent with our prediction, we find that the

interaction terms have positive and statistically significant coefficients across all four models. These findings suggest that the impact of climatic disasters on examiner behavior is indeed magnified when disasters are more salient.

5. Real Effects: Firm-Level Greenhouse Gas Emissions

Our findings demonstrate that examiners grant higher-quality green patents following exposure to climatic disasters. In this section, we examine whether this improvement in green patent quality leads to measurable reductions in firm-level greenhouse gas (GHG) emissions.

We match patents in our sample to U.S. publicly listed firms using the patent-firm linkage file developed by Kogan, Papanikolaou, Seru, and Stoffman (2017). Our key explanatory variable, *Disaster Green Ratio*, is a measure at the firm-year level defined as the proportion of a firm's green patents granted by examiners exposed to climatic disasters in year *t-1*.[18] For our outcome variables, we obtain GHG emission data from the Trucost database. We construct two measures. The first measure, *Log(GHG Int*), is the natural logarithm of the sum of Scope 1, 2, and 3 GHG emission intensity, as provided by Trucost, over the three years from *t*. *Log(GHG Abs*) is the logarithm of the sum of Scope 1, 2, and 3 GHG emissions provided by Trucost over the three years from *t*. [19]

Our regression sample includes 481 unique publicly traded firms across 1,927 firm-years from 2012 to 2020 with available measures. Table 8 presents the summary statistics for our regression sample. *Disaster Green Ratio* has a mean of 1%, indicating that, on average, 1% of a firm's green patents granted in a given year are awarded by disaster-exposed examiners. The

[18] We require firms to have at least one green patent granted in the measurement year to calculate this variable.
[19] Scope 1 emissions refer to direct emissions from a company's own production activities. Scope 2 emissions are indirect emissions resulting from the consumption of purchased electricity, heat, or steam. Scope 3 emissions include all other indirect emissions that occur across the supply chain. GHG emission intensity is calculated as the amount of greenhouse gas emissions for each scope divided by a company's revenue.

standard deviation of *Disaster Green Ratio* is 6%, suggesting substantial variation. Additionally, *Log(GHG Abs)* has a mean of 15.39, implying that the average firm's total greenhouse gas (GHG) emissions over the three-year period amount to approximately 4.8 million tonnes of carbon dioxide equivalent.

We conduct a firm-year panel regression analysis with *Log(GHG Int*) as the dependent variable and *Disaster Green Ratio* as the independent variable. We control for firm characteristics in disaster year, including book-to-market, asset size, leverage, dividend-to-income ratio, cash holdings, R&D intensity, and stock returns. Some specifications additionally control for firms' exposure to climatic disasters.

Panel A of Table 9 presents the regression results. Consistent with our prediction, we find significantly negative coefficients for *Disaster Green Ratio*, suggesting that high-quality green patents granted by disaster-affected examiners help reduce firms' greenhouse gas emissions. In column (1), the coefficient of -0.3376 suggests that a one-standard-deviation increase in *Disaster Green Ratio* is associated with a 0.020 (0.3376*0.06) decrease in *Log(GHG Int)*, corresponding to approximately 2% (0.020/1.28) of the standard deviation. These findings indicate that green patents granted by disaster-affected examiners are not only of higher quality, but also more effective in reducing firms' GHG emissions. The observed declines in *Log(GHG Abs)* indicate that emission reductions are achieved through improvements in energy efficiency rather than cutting production.

To further validate our findings, we categorize green patents granted by disaster-affected examiners into two groups: those that are directly related to GHG emission reduction and those that are not. We then decompose *Disaster Green Ratio* into two components, where *Disaster GHG Ratio* (*Disaster NonGHG Ratio*) is defined similarly as *Disaster Green Ratio* except that the

numerator is GHG-related (non-GHG-related) green patents granted by disaster-exposed examiners.[20] Panel B of Table 9 presents regressions of these two components, in which the coefficient on *Disaster GHG Ratio* is negative and statistically significant, while that on *Disaster NonGHG Ratio* is insignificant. These contrast confirms that our main effect is specifically driven by high-quality GHG-related green patents, whereas non-GHG-related green patents show no comparable impact on emissions.

Our findings offer novel insights into the effect of green innovation on GHG emissions. While existing studies (Bolton, Kacperczyk, and Wiedemann, 2024; Hege, Pouget, and Zhang, 2024) find that green patents do not necessarily reduce firms' carbon emissions, we extend this literature by examining whether patent quality matters conditional on firms having green patents. By exploring the exogenous variation in patent quality induced by examiners' climatic-disaster exposure, we provide causal evidence that high-quality green patents significantly reduce GHG emissions.

6. Exposure to Extreme Temperature and Green Patent Review

Finally, to further validate and generalize our findings, we examine whether another major climatic anomaly, extreme temperature events, similarly influences examiners' patent review behavior. This analysis not only serves as a robustness check for our main findings, but also broadens our understanding of how climatic shocks may shape examiner decision-making.

A growing literature demonstrates that extreme heat–a salient consequence of climate change–significantly impacts human cognition, decision-making, and productivity (e.g., Graff

[20] Green patents highly related to greenhouse gas emissions are identified using CPC codes, which cover the capture, storage, sequestration, or disposal of greenhouse gases (Y02C), the reduction of greenhouse gas emissions in energy generation, transmission, or distribution (Y02E), climate change mitigation technologies in the production or processing of goods (Y02P), and climate change mitigation technologies in transportation (Y02T). Green patents not related to greenhouse gas emissions refer to all other green patents.

Zivin and Neidell, 2014; Heal and Park, 2016). Recent finance literature further shows that exposure to elevated temperatures strengthens investors' climate beliefs (Choi, Gao, and Jiang, 2020; Di Giuli, Garel, Michaely, and Romec, 2025). We follow Addoum, Ng, and Ortiz-Bobea (2020) and use daily temperature data from the PRISM Climate Group, the official climatological database of the U.S. Department of Agriculture. The PRISM dataset provides daily average, minimum, and maximum temperatures for grid cells across the continental United States.

We classify a county-day observation as experiencing an extremely hot (cold) day if the county's maximum (minimum) temperature exceeds (falls below) the 90^{th} (10^{th}) percentile of the maximum (minimum) temperature across all counties on that day. Then, we define a dummy variable at the county-year level, *Extreme Heat*, which equals one if the number of extremely hot days for a county-year is above the median of all counties in that year, and zero otherwise. Similarly, we construct *Extreme Cold* and *Extreme Temperature* dummies by using the number of extremely cold days and the total number of extremely hot and extremely cold days, respectively.

Panel A of Table 10 presents the regressions of *Green Patent Ratio* on the measures of extreme temperature experience. We find that the coefficient on *Extreme Heat* is significantly positive (Column (1)), while the coefficient on *Extreme Cold* is insignificant (Column (2)). The coefficient on *Extreme Temperature* is also significantly positive (Column (3)). These results suggest that exposure to extreme temperature increases examiners' propensity to grant green patents. Furthermore, this effect exists uniquely driven by exposure to abnormally high temperatures rather than abnormally low temperatures, likely because extreme heat is more directly associated with global warming concerns than extreme cold in the perception of examiners. In terms of economic significance, the impact of extreme temperature exposure is about 25% of

that for climatic-disaster exposure, which is expected given that climatic disasters are far more salient than abnormal temperature events.

We further examine how exposure to extreme heat affects the quality of granted green patents. Panel B of Table 10 presents regressions of patent quality measures on *Extreme Heat*, in which the coefficient on *Extreme Heat* is significantly positive in the regression of green patent quality (Column (1)). This result indicates that examiners exposed to extremely hot weather grant higher-quality green patents, a finding that is consistent with our baseline results on climatic disasters. Columns (2) and (3) further show that this effect does not extend to the quality of non-green patents or all patents, a pattern that also aligns with our previous findings on climatic disasters. Taken together, the results in Table 10 externally validate our previous findings based on climatic disasters and provide further evidence for how shocks to examiners' climate change beliefs influence their green patent reviews.

7. Conclusion

This paper has investigated the causal effect of patent examiners' climate change beliefs on their green patent review behavior and green innovation outcomes. Using granular data on U.S. patent examiners across geographic locations from 2012–2020, we leverage climatic natural disasters as plausibly exogenous shocks to examiners' climate change beliefs. We find that examiners grant significantly more green patents following local climatic disasters, with these patents showing significantly higher quality. Further analysis suggests that the effect stems from increased effort by disaster-exposed examiners during green patent reviews. These higher-quality green patents subsequently lead to greater reductions in corporate carbon emissions. We find no comparable effects for either non-green patents or non-climatic natural disasters, highlighting that examiners' climate change beliefs exclusively influence green innovation outcomes

Our study provides novel evidence on both the drivers and impacts of corporate green innovation, revealing how patent examiners' beliefs influence green innovation outcomes. These findings make important contributions to the growing literature on climate finance by showing how professional decision-makers respond to climate change and associated risks. Furthermore, our research underscores the policy relevance of salient information about climate change, providing evidence that personal exposure to environmental shocks can meaningfully change individual behavior and decision-making processes.

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Figure 1
Examiner Distribution across U.S. Counties

This figure presents an overview of patent examiner distribution in 2020. No. of examiners represents the number of examiners in each county.

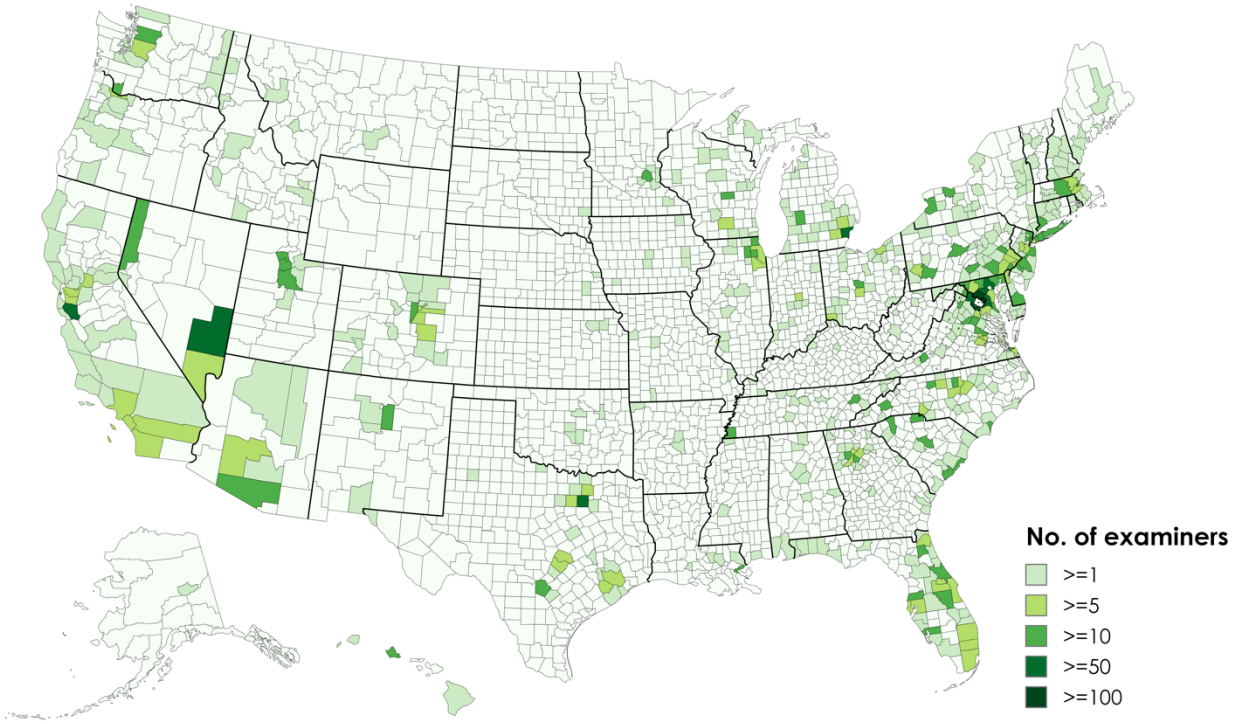


Figure 2
Climatic Disaster Experience and Examiners' Preference for Green Patents: Dynamic Effects

This figure shows the dynamic effects of climatic disasters on examiner decisions. Year 0 is the year in which the disasters occurred. Year "1" refers to the year following the year in which the disasters occurred, while Year "2+" refers to the years after Year "1". Year "-1" refers to the year before the year in which the disasters occurred, while Year "-2+" refers to the years before Year "-1". Examiner and year fixed effects are included, and standard errors are double-clustered at the county and year levels. Capped spikes indicate statistical significance at the 10% level.

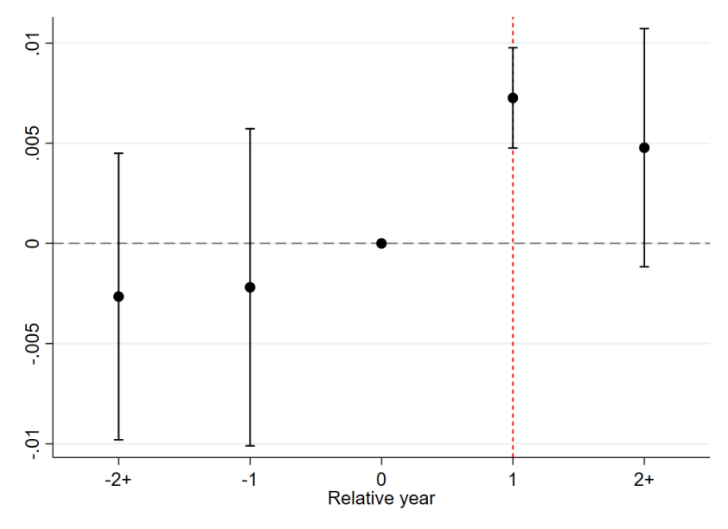


Table 1
Summary Statistics

This table shows summary statistics in our sample. Panel A reports summary statistics for climatic natural disasters in the U.S. that affected patent examiners in our sample. Reported damage is in $ 10 million adjusted to 2020 dollars. Panel B reports the summary statistics of examiner-year level variables from 2012 to 2020. *Disaster* is a dummy variable that equals one if the examiner experiences climatic disasters in the previous year, and zero otherwise. *Green Patent Ratio* is defined as the percentage of green patents granted out of all granted patents for each examiner in a given year. *Green Application Ratio* is defined as the percentage of green patent applications in all patent applications received by each examiner in a given year. *Green Adaptation Ratio* is the percentage of green patents related to technologies for adaptation to climate change in all granted patents for each examiner each year. *Green Mitigation Ratio* is the percentage of green patents related to technologies for climate change mitigation in all granted patents for each examiner each year. The baseline model includes examiner and year fixed effects. *Green Patent Quality* is defined as the logarithm of one plus the average truncated citation (Hall, Jaffe, and Trajtenberg, 2001) of green patents for each examiner in a given year. *Non-Green Patent Quality* is defined as the logarithm of one plus the average truncated citation (Hall, Jaffe, and Trajtenberg, 2001) of non-green patents for each examiner in a given year. All *Patent Quality* is defined as the logarithm of one plus the average truncated citation (Hall, Jaffe, and Trajtenberg, 2001) of all patents for each examiner in a given year. *Dem Donation (USD)* is the total annual dollar amount of donations contributed to the Democratic Party by each examiner. *Log(Dem Donation)* is the logarithm of the total annual dollar amount of donations to the Democratic Party for each examiner. *Green Claims* is defined as the average number of claims from green patents reviewed by each examiner in a given year. *Non-Green Claims* is defined as the average number of claims from non-green patents reviewed by each examiner in a given year. *All Claims* is defined as the average number of claims from all patents reviewed by each examiner in a given year. *Green References* is the average number of references to green patents cited by each examiner each year. *Non-Green References* is the average number of references to non-green patents cited by each examiner each year. *All References* is the average number of references to green patents cited by each examiner each year. *Green Rejection Effort* represents the proportion of green rejections based on 102 or 103 reasons that include at least one prior art citation, relative to the total number of such rejections by each examiner each year. *Non-Green Rejection Effort* represents the proportion of non-green rejections based on 102 or 103 reasons that include at least one prior art citation, relative to the total number of such rejections by each examiner each year. *All Rejection Effort* represents the proportion of all rejections based on 102 or 103 reasons that include at least one prior art citation, relative to the total number of such rejections by each examiner each year. *Extreme Heat* is a dummy variable that equals one if the total number of extremely hot days in a year exceeds the median of all counties for that year, and zero otherwise. *Extreme Cold* is a dummy variable that equals one if the total number of extremely cold days in a year exceeds the median of all counties for that year, and zero otherwise. *Extreme Temperature* is a dummy variable that equals one if the combined total of extremely hot and extremely cold days exceeds the median of all counties for that year, and zero otherwise. All continuous variables that are not constrained between 0 and 1 are winsorized at 1% and 99% levels. Detailed variable definitions are provided in Appendix A.

Panel A: Summary Statistics for Climatic Natural Disasters

Disasters	Average Damage ($ 10M)	Average Duration (Days)	Average Injuries & Fatalities	No. of Disasters
Flooding	245.08	2.96	6.87	23
Hurricane/Tropical Storm	264.97	2.87	4.20	15
Tornado	39.02	1.00	109.80	10
Wildfire	160.33	14.33	10.03	6
Wind	105.61	1.50	1.50	2
Hail	130.38	1.00	1.00	1

Panel B: Summary Statistics for Patent Examiners

Variable	Obs	Mean	STD	P1	P25	Med	P75	P99
Examiner-year panel								
No. of Patents	58,161	43.02	26.17	1.00	23.00	40.00	59.00	114.00
No. of Green Patents	58,161	3.79	7.99	0.00	0.00	1.00	4.00	41.00
Disaster	58,161	0.01	0.08	0.00	0.00	0.00	0.00	0.00
Green Patent Ratio	58,161	0.08	0.16	0.00	0.00	0.03	0.09	0.96
Green Application Ratio	57,191	0.09	0.16	0.00	0.00	0.03	0.10	0.93
Green Adaptation Ratio	58,161	0.01	0.03	0.00	0.00	0.00	0.00	0.15
Green Mitigation Ratio	58,161	0.08	0.16	0.00	0.00	0.02	0.08	0.96
Green Patent Quality	35,450	0.30	0.32	0.00	0.00	0.22	0.48	1.42
Non-Green Patent Quality	57,735	0.32	0.21	0.00	0.15	0.32	0.47	0.89
All Patent Quality	58,161	0.33	0.21	0.00	0.16	0.33	0.48	0.88
Dem Donation (USD)	514	311.28	598.53	0.00	38.50	120.50	300.00	3000.00
Log(Dem Donation)	458	4.98	1.37	1.61	4.13	5.02	5.77	8.02
Green Claims	22,345	16.16	6.66	3.00	12.00	16.00	20.00	42.00
Non-Green Claims	54,701	16.40	4.11	6.00	13.86	16.29	18.73	30.43
All Claims	55,459	16.39	4.03	6.00	13.88	16.25	18.67	30.08
Green References	22,345	2.86	4.02	0.00	0.33	1.50	3.67	23.00
Non-Green References	54,701	3.28	3.86	0.00	0.82	2.00	4.22	21.25
All References	55,459	3.25	3.82	0.00	0.80	2.00	4.16	21.20
Green Rejection Effort	44,117	0.88	0.24	0.00	0.86	1.00	1.00	1.00
Non-Green Rejection Effort	62,630	0.87	0.16	0.23	0.82	0.92	0.98	1.00
All Rejection Effort	62,955	0.87	0.16	0.250	0.83	0.92	0.97	1.00
Extreme Heat	58,141	0.63	0.48	0.00	0.00	1.00	1.00	1.00
Extreme Cold	58,141	0.13	0.34	0.00	0.00	0.00	0.00	1.00
Extreme Temperature	58,141	0.12	0.32	0.00	0.00	0.00	0.00	1.00

Table 2

Climatic Disaster Experience and Examiners' Preference for Green Patents

This table presents examiner-year level regressions of examiners' preference for green patents on climatic disaster exposures. *Disaster* is a dummy variable that equals one if the examiner experiences climatic disasters in the previous year, and zero otherwise. Panel A shows the baseline results. *Green Patent Ratio* is defined as the percentage of green patents granted out of all granted patents for each examiner in a given year. Panel B presents the results of climatic disasters on examiners' approval rate. *Green Application Ratio* is defined as the percentage of green patent applications in all patent applications received by each examiner in a given year. Panel C shows the impact on different green patent categories. *Green Adaptation Ratio* is the percentage of green patents related to technologies for adaptation to climate change in all granted patents for each examiner each year. *Green Mitigation Ratio* is the percentage of green patents related to technologies for climate change mitigation in all granted patents for each examiner each year. The baseline model includes examiner and year fixed effects. Standard errors are double-clustered at the county and year levels, and reported in parentheses. The sample period is from 2012 to 2020. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Regressions of Green Patent Ratio

	Dependent Variable: Green Patent Ratio	
	(1)	(2)
Disaster	0.0079***	0.0079***
	(0.0020)	(0.0024)
Examiner FE	Yes	Yes
Year FE	Yes	Yes
Cluster	County, Year	County
# Obs.	58,161	58,161
Adj. R^2	0.852	0.852

Panel B: Regressions of Green Applications Ratio

	Dependent Variable: Green Application Ratio	
	(1)	(2)
Disaster	0.0002	0.0002
	(0.0030)	(0.0031)
Examiner FE	Yes	Yes
Year FE	Yes	Yes
Cluster	County, Year	County
# Obs.	57,191	57,191
Adj. R^2	0.883	0.883

Panel C: Climate Change Adaptation Patents vs. Mitigation Patents

	Green Adaptation Ratio	Green Mitigation Ratio
	(1)	(2)
Disaster	0.0014*	0.0062***
	(0.0008)	(0.0014)
Examiner FE	Yes	Yes
Year FE	Yes	Yes
# Obs.	58,161	58,161
Adj. R^2	0.547	0.864

Table 3
Robustness Tests and Placebo Tests

This table shows the results of robustness and placebo tests. Panel A presents examiner-year level regressions of examiners' tendency for green patents on climatic disaster exposures, based on an alternative green patent classification. *Disaster* is a dummy variable that equals one if the examiner experiences climatic disasters in the previous year, and zero otherwise. *Green Patent Ratio(OECD15)* is the percentage of green patents identified by the OECD 2015 classification in all granted patents for each examiner each year. *Non-Climate-Related Green Patent Ratio* is the percentage of green patents that fall within the OECD 2015 classification but do not include the CPC Y02 classification in all granted patents for each examiner each year, where these green patents are all non-climate-change related. Panel B presents examiner-year level regressions of examiners' tendency for green patents on climatic disaster exposures using matched samples. *Green Patent Ratio* is the percentage of green patents granted in all granted patents for each examiner in a given year. Column (1) uses a sample with matched examiners of the same art units, while column (2) uses a sample that only keeps one matched examiner whose pay level is closest to the shocked examiner. In Panel C, we exclude patents filed by companies located in the same state as the examiners. Panel D presents examiner-year level regressions of examiners' tendency for green patents on non-climatic disaster exposures. *Non-climatic Disaster* is a dummy variable that equals one if the examiner experiences non-climatic disasters in the previous year, and zero otherwise. The baseline model includes examiner and year fixed effects. Standard errors are double-clustered at the county and year levels, and reported in parentheses. The sample period is from 2012 to 2020. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Alternative Classification of Green Patents

	Green Patent Ratio (OECD15)	Non-Climate-Related Green Patent Ratio
	(1)	(2)
Disaster	0.0074***	-0.0006
	(0.0018)	(0.0010)
Examiner FE	Yes	Yes
Year FE	Yes	Yes
# Obs.	58,161	58,161
Adj. R^2	0.868	0.819

Panel B: Matched Examiners within Art Units

	Dependent Variable: Green Patent Ratio	
	Art unit matching	
	1:m	1:1
	(1)	(2)
Disaster	0.0076***	0.0077***
	(0.0016)	(0.0015)
Examiner FE	Yes	Yes
Year FE	Yes	Yes
# Obs.	9,402	3,128
Adj. R^2	0.827	0.865

Panel C: Excluding Firms in the Same State as Examiners

	Dependent Variable: Green Patent Ratio	
	(1)	(2)
Disaster	0.0081***	0.0081***
	(0.0017)	(0.0025)
Examiner FE	Yes	Yes
Year FE	Yes	Yes
Cluster	County, Year	County
# Obs.	58,142	58,142
Adj. R^2	0.851	0.851

Panel D: Placebo Test Using Non-Climatic Disasters

	Dependent Variable: Green Patent Ratio	
	(1)	(2)
Non-Climatic Disaster	0.0003	0.0003
	(0.0017)	(0.0019)
Examiner FE	Yes	Yes
Year FE	Yes	Yes
Cluster	County, Year	County
# Obs.	58,161	58,161
Adj. R^2	0.852	0.852

Table 4
Climatic Disaster Experience and Quality of Green Patents

This table presents examiner-year level regressions of green patent quality on climatic disaster exposures. *Green Patent Quality* is defined as the logarithm of one plus the average truncated citation (Hall, Jaffe, and Trajtenberg, 2001) of green patents for each examiner in a given year. *Non-Green Patent Quality* is defined as the logarithm of one plus the average truncated citation (Hall, Jaffe, and Trajtenberg, 2001) of non-green patents for each examiner in a given year. *All Patent Quality* is defined as the logarithm of one plus the average truncated citation (Hall, Jaffe, and Trajtenberg, 2001) of all patents for each examiner in a given year. *Disaster* is a dummy variable that equals one if the examiner experiences climatic disasters in the previous year, and zero otherwise. Examiner and year fixed effects are included. Standard errors are double-clustered at the county and year levels, and are reported in parentheses. The sample period is from 2012 to 2020. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Green Patent Quality	Non-Green Patent Quality	All Patent Quality
	(1)	(2)	(3)
Disaster	0.0222**	-0.0034	-0.0013
	(0.0111)	(0.0061)	(0.0060)
Examiner FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
# Obs.	35,450	57,735	58,161
Adj. R^2	0.322	0.661	0.677

Table 5

Climatic Disaster Experience and Examiners' Efforts in Green Patent Reviews

This table presents examiner-year level regressions of examiners' efforts for green patents on climatic disaster exposures. *Disaster* is a dummy variable that equals one if the examiner experiences climatic disasters in the previous year, and zero otherwise. In Panel A, we focus on the data related to patent claims. *Green Claims* is defined as the average number of claims from green patents reviewed by each examiner in a given year. *Non-Green Claims* is defined as the average number of claims from non-green patents reviewed by each examiner in a given year. *All Claims* is defined as the average number of claims from all patents reviewed by each examiner in a given year. In Panel B, we focus on the data related to patent references. *Green References* is the average number of references to green patents cited by each examiner each year. *Non-Green References* is the average number of references to non-green patents cited by each examiner each year. *All References* is the average number of references to green patents cited by each examiner each year. In panel C, we focus on the sample with all the rejection applications. *Green Rejection Effort* represents the proportion of green rejections based on 102 or 103 reasons that include at least one prior art citation, relative to the total number of such rejections by each examiner each year. *Non-Green Rejection Effort* represents the proportion of non-green rejections based on 102 or 103 reasons that include at least one prior art citation, relative to the total number of such rejections by each examiner each year. *All Rejection Effort* represents the proportion of all rejections based on 102 or 103 reasons that include at least one prior art citation, relative to the total number of such rejections by each examiner each year. Examiner and year fixed effects are included. Standard errors are double-clustered at the county and year levels, and are reported in parentheses. The sample period is from 2012 to 2020. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Claims of Patents Reviewed by Examiners

	Green Claims	Non-green Claims	All Claims
	(1)	(2)	(3)
Disaster	1.1476***	0.0292	0.2098
	(0.3576)	(0.1628)	(0.1809)
Examiner FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
# Obs.	22,345	54,701	55,459
Adj. R^2	0.176	0.320	0.330

Panel B: References Cited by Examiners in the Review Process

	Green References	Non-green References	All References
	(1)	(2)	(3)
Disaster	0.3124**	-0.0990	-0.0294
	(0.1414)	(0.0762)	(0.0400)
Examiner FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
# Obs.	22,345	54,701	55,459
Adj. R^2	0.584	0.744	0.749

Panel C: Examiners' Rejection Effort

	Green Rejection Effort	Non-green Rejection Effort	All Rejection Effort
	(1)	(2)	(3)
Disaster	0.0296**	0.0033	0.0036
	(0.0142)	(0.0068)	(0.0065)
Examiner FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
# Obs.	44,117	62,630	62,955
Adj. R^2	0.329	0.649	0.659

Table 6
Climatic Disaster Experience and Examiners' Political Donations

This table presents examiner-year level regressions of examiners' political donations on climatic disaster exposures. *Dem Donation (USD)* is the total annual dollar amount of donations contributed to the Democratic Party by each examiner. *Log(Dem Donation)* is the logarithm of the total annual dollar amount of donations to the Democratic Party for each examiner. *Disaster* is a dummy variable that equals one if the examiner experiences climatic disasters in the previous year, and zero otherwise. Examiner and year fixed effects are included. Standard errors are double-clustered at the county and year levels, and are reported in parentheses. The sample period is from 2012 to 2020. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Dem Donation (USD)	Log(Dem Donation)
	(1)	(2)
Disaster	204.8644***	0.4456***
	(52.1659)	(0.1156)
Examiner FE	Yes	Yes
Year FE	Yes	Yes
# Obs.	514	458
Adj. R^2	0.238	0.495

Table 7

Climatic Disaster Experience and Green Patent Review: Cross-Sectional Analyses

This table presents the results from the cross-sectional analysis. *Green Patent Ratio* is defined as the percentage of green patents granted in all granted patents for each examiner in a given year. *Disaster* is a dummy variable that equals one if the examiner experiences climatic disasters in the previous year, and zero otherwise. Panel A is based on the role of regional-level characteristics. *Dem County* is a dummy variable that equals one if the county where the examiner is located is governed by the Democratic Party in the previous year, and zero otherwise. *Disaster* × *Dem County* is an interaction term between *Disaster* and *Dem County*. *Climate Alliance* is a dummy variable that equals one if the state where the examiner is located has joined the United States Climate Alliance in the previous year, and zero otherwise. *Disaster* × *Climate Alliance* is an interaction term between *Disaster* and *Climate Alliance*. *High Attention* is a dummy variable that equals one if the total Google search volume in the previous year is higher than the median, and zero otherwise. *Disaster* × *High Attention* is an interaction term between *Disaster* and *High Attention*. *High State Attention* is a dummy variable that equals one if the state's Google search volume in the previous year is higher than the median of all states for that year, and zero otherwise. *Disaster*× *High State Attention* is an interaction term between *Disaster* and *High State Attention*. Panel B is based on the role of disaster-level characteristics. *Large Loss* is a dummy variable that equals one if the monetary loss of a disaster is above the median, and zero otherwise. *Disaster* × *Large Loss* is an interaction term between *Disaster* and *Large Loss*. *Long Duration* is a dummy variable that equals one if the total duration of the corresponding disasters is higher than the median, and zero otherwise. *Disaster* × *Long Duration* is an interaction term between *Disaster* and *Long Duration*. *Fatality* is a dummy variable that equals one if the corresponding disasters have caused the fatality, and zero otherwise. *Disaster* × *Fatality* is an interaction term between *Disaster* and *Fatality*. *Consecutive* is a dummy variable that equals one if the examiners experience climatic disasters in the previous two consecutive years, and zero otherwise. *Disaster* × *Consecutive* is an interaction term between *Disaster* and *Consecutive*. Examiner and year fixed effects are included. Standard errors are double-clustered at the county and year levels, and are reported in parentheses. The sample period is from 2012 to 2020. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Regional-level Characteristics

	Dependent Variable: Green Patent Ratio			
	(1)	(2)	(3)	(4)
Disaster	0.0048**	0.0067***	0.0015	0.0071***
	(0.0022)	(0.0017)	(0.0013)	(0.0017)
Dem County	0.0001			
	(0.0001)			
Disaster × Dem County	0.0021**			
	(0.0009)			
Climate Alliance		-0.0013		
		(0.0009)		
Disaster × Climate Alliance		0.0101***		
		(0.0028)		
Disaster × High Attention			0.0086***	
			(0.0017)	
High State Attention				-0.0004
				(0.0009)
Disaster × High State Attention				0.0048**
				(0.0021)
Examiner FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
# Obs.	58,161	58,161	58,161	58,161
Adj. R^2	0.852	0.852	0.852	0.852

Panel B: Disaster-level Characteristics

	Dependent Variable: Green Patent Ratio			
	(1)	(2)	(3)	(4)
Disaster	0.0051***	0.0058***	-0.0015	0.0069***
	(0.0008)	(0.0022)	(0.0044)	(0.0015)
Disaster × Large Loss	0.0074*			
	(0.0039)			
Disaster × Long Duration		0.0090**		
		(0.0057)		
Disaster × Fatality			0.0115**	
			(0.0052)	
Disaster × Consecutive				0.0108**
				(0.0051)
Examiner FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
# Obs.	58,161	58,161	58,161	54,815
Adj. R^2	0.852	0.852	0.852	0.857

Table 8
Summary Statistics for the Firm Regression Sample

This table shows the statistics for firm-year level variables in our sample. *Disaster Green Ratio* is, for each firm, the percentage of green patents granted by examiners who experienced the disaster in the previous year. *Disaster GHG Ratio* is, for each firm, the percentage of green patents (highly related to greenhouse gas emissions) granted by examiners who experienced a disaster in the previous year. *Disaster NonGHG Ratio* is, for each firm, the percentage of green patents (not related to greenhouse gas emissions) granted by examiners who experienced a disaster in the previous year. *Log(GHG Int*) is the logarithm of the sum of Scope 1 greenhouse gas emission intensity, Scope 2 greenhouse gas emission intensity, and Scope 3 greenhouse gas emission intensity provided by the Trucost database over the three years. *Log(GHG Abs*) is the logarithm of the sum of Scope 1 greenhouse gas emissions, Scope 2 greenhouse gas emissions, and Scope 3 greenhouse gas emissions provided by the Trucost database over the three years. *Firm Disaster* is a dummy variable that equals one if the county where the firm's headquarters is located experienced a climatic disaster in the previous year, and zero otherwise. *Book-to-market* is the difference between common equity and preferred stock capital divided by the equity market value at the end of the previous year. *Return* is the annual return calculated by accumulating the monthly return in the previous year. *Log(Assets)* is the logarithm of total assets at the end of the previous year. *Div/Inc* is dividends at the end of the year divided by net income at the end of the year. *Leverage* is long-term debt plus current liabilities divided by total assets in US dollars (millions) at the end of the previous year. *Cash Holding* is the ratio of current assets to total assets at the end of the previous year. *RD Intensity* is the R&D expense scaled by total assets at the end of the previous year. The sample period is from 2012 to 2020. All continuous variables that are not constrained between 0 and 1 are winsorized at the 1% and 99% levels. Detailed variable definitions are provided in Appendix A.

Variable	Obs	Mean	STD	P1	P25	Med	P75	P99
Firm-year panel								
Disaster Green Ratio	1,927	0.01	0.06	0.00	0.00	0.00	0.00	0.20
Disaster GHG Ratio	1,927	0.00	0.04	0.00	0.00	0.00	0.00	0.10
Disaster NonGHG Ratio	1,927	0.00	0.04	0.00	0.00	0.00	0.00	0.10
Log(GHG Int)	1,927	7.03	1.22	4.76	6.03	6.95	7.69	10.34
Log(GHG Abs)	1,927	15.39	2.52	8.11	13.90	15.55	17.10	20.76
Book-to-market	1,927	0.37	0.28	0.01	0.19	0.31	0.48	1.46
Returns	1,927	0.16	0.41	-0.67	-0.08	0.13	0.34	1.91
Log(Assets)	1,927	8.73	2.04	4.05	7.39	8.66	10.22	12.87
Div/Inc	1,927	0.26	0.51	-1.35	0.00	0.16	0.39	3.14
Leverage	1,927	0.24	0.16	0.00	0.12	0.23	0.34	0.62
Cash Holding	1,927	0.23	0.21	0.00	0.07	0.16	0.32	0.93
RD Intensity	1,927	0.08	0.10	0.00	0.02	0.04	0.10	0.53
Firm Disaster	1,927	0.03	0.18	0.00	0.00	0.00	0.00	1.00

Table 9

Climatic-Disaster Exposure, Patent Quality, and Corporate Greenhouse Gas Emissions

This table presents firm-year level regressions of greenhouse gas emissions on selected green patents by event examiners. Panel A shows the impact of selected green patents by event examiners. *Disaster Green Ratio* is, for each firm, the percentage of green patents granted by examiners who experienced the disaster in the previous year. *Log(GHG Int*) is the logarithm of the sum of Scope 1 greenhouse gas emission intensity, Scope 2 greenhouse gas emission intensity, and Scope 3 greenhouse gas emission intensity provided by the Trucost database over the three years. *Log(GHG Abs*) is the logarithm of the sum of Scope 1 greenhouse gas emissions, Scope 2 greenhouse gas emissions, and Scope 3 greenhouse gas emissions provided by the Trucost database over the three years. In Panel B, the selected green patents are divided into two categories: those that are highly related to greenhouse gas emissions and those that are not. *Disaster GHG Ratio* is, for each firm, the percentage of green patents (highly related to greenhouse gas emissions) granted by examiners who experienced a disaster in the previous year. *Disaster NonGHG Ratio* is, for each firm, the percentage of green patents (not related to greenhouse gas emissions) granted by examiners who experienced a disaster in the previous year. We control firm-level variables, including *Book-to-market*, *Log(Assets)*, *Div/Inc, Leverage*, *Cash Holding*, *RD Intensity*, *Return*, and *Firm Disaster*. Industry, county, and year fixed effects are included. Standard errors are double-clustered at the county and year levels, and are reported in parentheses. The sample period is from 2012 to 2020. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Detailed variable definitions are provided in Appendix A.

Panel A: High-quality green patents

	Log(GHG Int)		Log(GHG Abs)	
	(1)	(2)	(3)	(4)
Disaster Green Ratio	-0.3376***	-0.3383***	-0.5450***	-0.5485***
	(0.0802)	(0.1127)	(0.1957)	(0.1984)
Firm Disaster		0.0065		0.0317
		(0.1263)		(0.1575)
Control	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
County FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
# Obs.	1,927	1,927	1,927	1,927
Adj. R^2	0.742	0.742	0.898	0.898

Panel B: High-quality green patents related to greenhouse gas emission

	Dependent Variable: Log(GHG Int)					
	(1)	(2)	(3)	(4)	(5)	(6)
Disaster GHG Ratio	-0.7549***	-0.7575***			-0.7567***	-0.7593***
	(0.2744)	(0.2554)			(0.2889)	(0.2738)
Disaster NonGHG Ratio			-0.0490	-0.0491	0.0173	0.0173
			(0.2273)	(0.2275)	(0.2310)	(0.2342)
Firm Disaster		0.0112		0.0016		0.0112
		(0.1244)		(0.1267)		(0.1245)
Control	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
# Obs.	1,927	1,927	1,927	1,927	1,927	1,927
Adj. R^2	0.742	0.742	0.741	0.741	0.742	0.742

Table 10
Extreme Temperature Exposure and Green Patent Review

This table presents examiner-year level regressions for green patent review on extreme temperature exposures. Panel A presents regressions of *Green Patent Ratio*, and Panel B presents regressions of *Patent Quality*, both on measures of extreme temperature experience. *Green Patent Ratio* is the percentage of green patents granted out of all granted patents for each examiner in a given year. *Extreme Heat* is a dummy variable that equals one if the total number of extremely hot days in a year exceeds the median of all counties for that year, and zero otherwise. *Extreme Cold* is a dummy variable that equals one if the total number of extremely cold days in a year exceeds the median of all counties for that year, and zero otherwise. *Extreme Temperature* is a dummy variable that equals one if the combined total of extremely hot and extremely cold days exceeds the median of all counties for that year, and zero otherwise. *Green Patent Quality* is defined as the logarithm of one plus the average truncated citation (Hall, Jaffe, and Trajtenberg, 2001) of green patents for each examiner in a given year. *Non-Green Patent Quality* is defined as the logarithm of one plus the average truncated citation (Hall, Jaffe, and Trajtenberg, 2001) of non-green patents for each examiner in a given year. *All Patent Quality* is defined as the logarithm of one plus the average truncated citation (Hall, Jaffe, and Trajtenberg, 2001) of all patents for each examiner in a given year. Examiner and year fixed effects are included. Standard errors are double-clustered at the county and year levels, and are reported in parentheses. The sample period is from 2012 to 2020. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Green Patent Ratio

	Dependent Variable: Green Patent Ratio		
	(1)	(2)	(3)
Extreme Heat	0.0022***		
	(0.0006)		
Extreme Cold		-0.0011	
		(0.0010)	
Extreme Temperature			0.0029***
			(0.0008)
Examiner FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
# Obs.	58,141	58,141	58,141
Adj. R^2	0.852	0.852	0.852

Panel B: Green Patent Quality

	Green Patent Quality	Non-Green Patent Quality	All Patent Quality
	(1)	(2)	(3)
Extreme Heat	0.0138**	0.0026	0.0024
	(0.0066)	(0.0021)	(0.0020)
Examiner FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
# Obs.	35,436	57,715	58,141
Adj. R^2	0.322	0.660	0.677

Appendix A: Variable Definitions

Variables	Definitions
Examiner-year level	
Disaster	Disaster is a dummy variable, which equals one if the examiner experiences climatic disasters in the previous year, and zero otherwise.
Green Patent Ratio	Green Patent Ratio is the percentage of green patents granted in all granted patents for each examiner in a given year.
Green Application Ratio	Green Application Ratio is defined as the percentage of green patent applications received by the examiner, in all patent applications received by the examiner in the previous year.
Green Adaptation Ratio	Green Adaptation Ratio is the percentage of green patents related to technologies for adaptation to climate change in all granted patents for each examiner each year.
Green Mitigation Ratio	Green Mitigation Ratio is the percentage of green patents related to technologies for climate change mitigation in all granted patents for each examiner each year.
Green Patent Ratio (OECD15)	Green Patent Ratio (OECD15) is the percentage of green patents identified by the OECD 2015 classification in all granted patents for each examiner each year.
Non-Climate-Related Green Patent Ratio	Non-Climate-Related Green Patent Ratio is the percentage of green patents that fall within the OECD 2015 classification but do not include the OECD 2023 classification in all granted patents for each examiner each year.
Non-Climatic Disaster	Non-Climatic Disaster is a dummy variable that equals one if the examiner experiences non-climatic disasters in the previous year, and zero otherwise.
Green Patent Quality	Green Patent Quality is defined as the logarithm of one plus the average truncated citation (Hall, Jaffe, and Trajtenberg, 2001) of green patents for each examiner in a given year.
Non-Green Patent Quality	Non-Green Patent Quality is defined as the logarithm of one plus the average truncated citation (Hall, Jaffe, and Trajtenberg, 2001) of non-green patents for each examiner in a given year.
All Patent Quality	All Patent Quality is defined as the logarithm of one plus the average truncated citation (Hall, Jaffe, and Trajtenberg, 2001) of all patents for each examiner in a given year.
Dem Donation (USD)	Dem Donation (USD) is the total annual dollar amount of donations contributed to the Democratic Party by each examiner.
Log(Dem Donation)	Log(Dem Donation) is the logarithm of the total annual dollar amount of donations to the Democratic Party for each examiner.
Green Claims	Green Claims is defined as the average number of claims from green patents reviewed by each examiner in a given year.
Non-Green Claims	Non-Green Claims is defined as the average number of claims from non-green patents reviewed by each examiner in a given year.
All Claims	All Claims is defined as the average number of claims from all patents reviewed by each examiner in a given year.
Green References	Green References is the average number of references to green patents cited by each examiner each year.
Non-Green References	Non-Green References is the average number of references to non-green patents cited by each examiner each year.

All References	All References is the average number of references to green patents cited by each examiner each year.
Green Rejection Effort	Green Rejection Effort represents the proportion of green rejections based on 102 or 103 reasons that include at least one prior art citation, relative to the total number of such rejections by each examiner each year.
Non-Green Rejection Effort	Non-Green Rejection Effort represents the proportion of non-green rejections based on 102 or 103 reasons that include at least one prior art citation, relative to the total number of such rejections by each examiner each year.
All Rejection Effort	All Rejection Effort represents the proportion of all rejections based on 102 or 103 reasons that include at least one prior art citation, relative to the total number of such rejections by each examiner each year.
Dem County	Dem County is a dummy variable that equals one if the county where the examiner is located is governed by the Democratic Party, and zero otherwise.
Climate Alliance	Climate Alliance is a dummy variable that equals one if the state where the examiner is located has joined the United States Climate Alliance and zero otherwise.
High Attention	High Attention is a dummy variable that equals one if the total Google search volume in one year is higher than the median, and zero otherwise.
High State Attention	High State Attention is a dummy variable that equals one if the state's Google search volume in one year is higher than the median of all states this year, and zero otherwise.
Large Loss	Large Loss is a dummy variable, which equals one if the monetary loss of a disaster is above the median, and zero otherwise.
Long Duration	Long Duration is a dummy variable that equals one if the total duration of the disasters is higher than the median duration of all disasters, and zero otherwise.
Fatality	Fatality is a dummy variable that equals one if the disaster has caused the fatality, and zero otherwise.
Consecutive	Consecutive is a dummy variable that equals one if the examiners experience climatic disasters in two consecutive years, and zero otherwise.
Extreme Heat	Extreme Heat is a dummy variable that equals one if the total number of days in a year when the maximum temperature in the examiner's county exceeds the 90^{th} percentile across all counties is greater than the median of all counties for that year, and zero otherwise.
Extreme Cold	Extreme Cold is a dummy variable that equals one if the total number of days in a year when the minimum temperature in the examiner's county is below the 10^{th} percentile across all counties is greater than the median of all counties for that year, and zero otherwise.
Extreme Temperature	Extreme Temperature is a dummy variable that equals one if the total number of days when the maximum temperature in the examiner's county exceeds the 90^{th} percentile plus the total number of days when the minimum temperature falls below the 10^{th} percentile across all counties is greater than the median of all counties for that year, and zero otherwise.

Firm-year level	
Disaster Green Ratio	Disaster Green Ratio is, for each firm, the percentage of green patents granted by examiners who experienced the disaster in the previous year.
Disaster GHG Ratio	Disaster GHG Ratio is, for each firm, the percentage of green patents (highly related to greenhouse gas emissions) granted by examiners who experienced a disaster in the previous year.
Disaster NonGHG Ratio	Disaster NonGHG Ratio is, for each firm, the percentage of green patents (not related to greenhouse gas emissions) granted by examiners who experienced a disaster in the previous year.
Log(GHG Int)	Log(GHG Int) is the logarithm of the sum of Scope 1 greenhouse gas emission intensity, Scope 2 greenhouse gas emission intensity, and Scope 3 greenhouse gas emission intensity provided by the Trucost database over the three years.
Log(GHG Abs)	Log(GHG Abs) is the logarithm of the sum of Scope 1 greenhouse gas emissions, Scope 2 greenhouse gas emissions, and Scope 3 greenhouse gas emissions provided by the Trucost database over the three years.
Firm Disaster	Firm Disaster is a dummy variable that equals one if the county where the firm's headquarters is located experienced a climatic disaster in the previous year, and zero otherwise.
Book-to-market	Book-to-market is the difference between common equity and preferred stock capital divided by the equity market value at the end of the previous year.
Return	Return is the annual return calculated by accumulating the monthly return in the previous year.
Log(Assets)	Log(Assets) is the logarithm of total assets at the end of the previous year.
Div/Inc	Div/Inc is dividends at the end of the year divided by net income at the end of the year.
Leverage	Leverage is long-term debt plus current liabilities divided by total assets in US dollars (millions) at the end of the previous year.
Cash Holding	Cash Holding is the ratio of current assets to total assets at the end of the previous year.
RD Intensity	RD Intensity is the R&D expense scaled by total assets at the end of the previous year.

Appendix B: Classification of Climatic Natural Disasters

(not to be published)

This appendix provides details for our classification of climatic natural disasters. The Spatial Hazard and Loss Database for the United States (SHELDUS) includes 18 types of natural disasters. In our study, we focus on identifying natural disasters more closely linked to climate change, referred to as *climatic disasters*. The Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (2022) highlights extreme climate events, including flooding, drought, wind, tornadoes, and storms (including thunderstorms, hail, and hurricanes/tropical storms).[21] Additionally, Alok, Kumar, and Wermers (2020) and Kim, Wang, and Wu (2022) provide broader definitions of climatic disasters based on SHELDUS, though their categorizations differ slightly.

Building on previous studies and classifications generated with the assistance of ChatGPT, we identify 10 climate-related disaster types: drought, flooding, coastal, heat, hurricane/tropical storm, severe thunderstorm, wildfire, wind, tornado, and hail. We exclude the remaining 8 disaster types: fog, avalanche, landslide, lightning, winter weather, earthquake, tsunamis/seiche, and volcanic, as these are either not directly linked to climate change or are geologically driven. Figure B1 presents ChatGPT's classification process, while Table B1 draws on existing scientific research to detail the relationships between the six selected climatic disaster types in our final sample and climate change, providing a solid foundation for our classification and analysis. Overall, these references collectively support our classification of events in the sample as climatic natural disasters and establish their connection to climate change. This ensures that our analysis is grounded in established scientific and empirical research, thereby strengthening the validity of our findings.

[21] See https://www.ipcc.ch/report/ar6/wg2/.

Figure B1
Climatic Disasters Classified by ChatGPT

This figure demonstrates how ChatGPT classifies climatic disasters that are highly related to climate change.

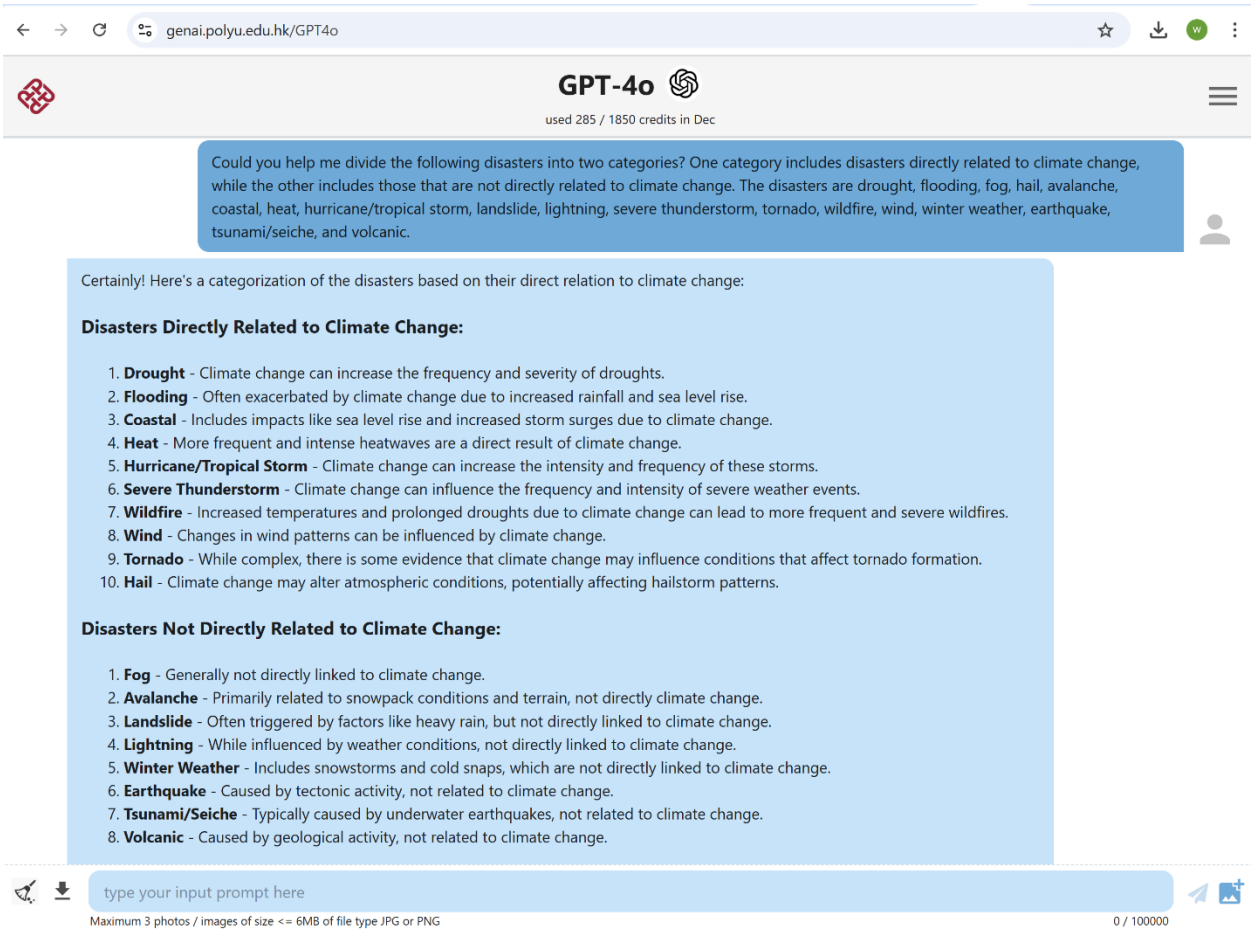


Table B1
Supporting Evidence for Climatic Natural Disasters

Disasters	Relation to Climate Change
Flooding	Climate change increases flooding by raising the frequency and intensity of heavy precipitation and altering temperatures across the region. (Mallakpour and Villarini, 2015; Alifu, Hirabayashi, Imada, and Shiogama, 2022)
Hurricane/ Tropical Storm	Climate changes, such as higher sea-surface temperatures, increased atmospheric moisture, and changes in large-scale circulation, can influence factors like intensity, size, landfall angle, translation speed, and sea level, thereby contributing to hurricanes and tropical storms. (Hassanzadeh et al., 2020; Strauss et al., 2021)
Tornado	Climate change plays a significant role in modulating the annual frequency of tornadoes. In a warming climate, the frequency of environments favorable to tornadoes is expected to increase, particularly in spring, due to a rise in high wind shear values in the lowest 1 km of the atmosphere. (Brooks, Carbin, and Marsh, 2014; Nouri, Devineni, Were, and Khanbilvardi, 2021)
Wildfire	Climate changes, such as increased global temperatures, accelerate the water cycle, leading to more intense rainfall events, more severe and widespread droughts, regional humidity variations, and sea surface temperature fluctuations, which in turn increase wildfire. For example, these changes dry out vegetation, making it more flammable, and create conditions that are more favorable for wildfires, thereby increasing their frequency and severity. (Jolly et al., 2015; Gutierrez et al, 2021.)
Wind	Climate change can influence wind-related natural disasters by altering variables directly linked to wind generation and propagation. For instance, increasing greenhouse gas concentrations can intensify winds that promote upwelling. This intensification is more noticeable at higher latitudes, consistent with the warming patterns associated with climate change, leading to more severe wind events. (Sydeman et al., 2014; Lobeto, Menendez, and Losada, 2021)
Hail	Climate change, such as global warming, affects low-level moisture, convective instability, microphysical processes, and vertical wind shear. These changes create conditions that increase the frequency and severity of hail by enhancing the atmospheric environment necessary for hail formation and growth. (Allen, 2017; Raupach et al., 2021)

Appendix B References

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Appendix C: Additional Results

(not to be published)

Table C1
Climatic Disaster Experience and Green Patent Review: Additional Tests

This table presents examiner-year level regressions of examiners' perference for green patents on climatic disaster exposures. *Green Patent Ratio* is the percentage of green patents granted out of all granted patents for each examiner in a given year. *Disaster* is a dummy variable that equals one if the examiner experiences climatic disasters in the previous year, and zero otherwise. In panel A, we run the regression using the Tobit model, including county and year fixed effects. In panel B, we exclude certain climate disasters, such as hail and wind events, as they may be less directly associated with climate change compared to other climatic disasters in our sample. The baseline model includes examiner and year fixed effects. Standard errors are double-clustered at the county and year levels for the baseline model, and are reported in parentheses. The sample period is from 2012 to 2020. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Tobit Model

	Dependent Variable: Green Patent Ratio	
	(1)	(2)
Disaster	0.0202***	0.0202***
	(0.0071)	(0.0074)
County FE	Yes	Yes
Year FE	Yes	Yes
Cluster	County, Year	County
# Obs.	58,161	58,161
Pseudo R^2	0.112	0.112

Panel B: Alternative Definition of Climatic Disasters

	Dependent Variable: Green Patent Ratio	
	(1)	(2)
Disaster	0.0084***	0.0084***
	(0.0019)	(0.0024)
Examiner FE	Yes	Yes
Year FE	Yes	Yes
Cluster	County, Year	County
# Obs.	58,161	58,161
Adj. R^2	0.852	0.852

Table C2
Climatic Disaster Experience and Green Patent Quality: Poisson Regressions

This table presents examiner-year level Poisson regressions of green patent quality on climatic disaster exposures. *Green Patent Quality* is the average number of citations received by green patents for each examiner in a given year. *Non-Green Patent Quality* is the average number of citations received by non-green patents for each examiner in a given year. *All Patent Quality* is the average number of citations received by all patents for each examiner in a given year. *Disaster* is a dummy variable that equals one if the examiner experiences climatic disasters in the previous year, and zero otherwise. Examiner and year fixed effects are included. Standard errors are double-clustered at the county and year levels, and are reported in parentheses. The sample period is from 2012 to 2020. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Green Patent Quality	Non-Green Patent Quality	All Patent Quality
	(1)	(2)	(3)
Disaster	0.1961***	0.0032	0.0231
	(0.0723)	(0.0501)	(0.0459)
Examiner FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
# Obs.	35,450	57,735	58,161
Pseudo R^2	0.471	0.499	0.500

Table C3

Climatic Disaster Experience and Green Patent Review: Patents without Prior Actions

This table presents examiner-year level regressions of examiners' tendency for green patents on climatic disaster exposures. *Green Patent Ratio* is the percentage of green patents granted out of all granted patents for each examiner in a given year. *Disaster* is a dummy variable that equals one if the examiner experiences climatic disasters in the previous year, and zero otherwise. Here, we use the same sample as in Table 5. The baseline model includes examiner and year fixed effects. Standard errors are double-clustered at the county and year levels, and are reported in parentheses. The sample period is from 2012 to 2020. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable: Green Patent Ratio	
	(1)	(2)
Disaster	0.0091***	0.0091***
	(0.0022)	(0.0029)
Examiner FE	Yes	Yes
Year FE	Yes	Yes
Cluster	County, Year	County
# Obs.	55,682	55,682
Adj. R^2	0.874	0.874