

# The Salience of Climate Change and Green Patents Review

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## Research Question

How does **climate change** affect **patent examiners' beliefs** and, in turn, their review process of **green patent** applications?

## Climate Change in the US

- Climate change has been increasingly severe in recent years, which has led to many climatic natural disasters.
- Climatic natural disasters are disaster events related to climate change, such as hurricanes, droughts, and floods.



## Motivation

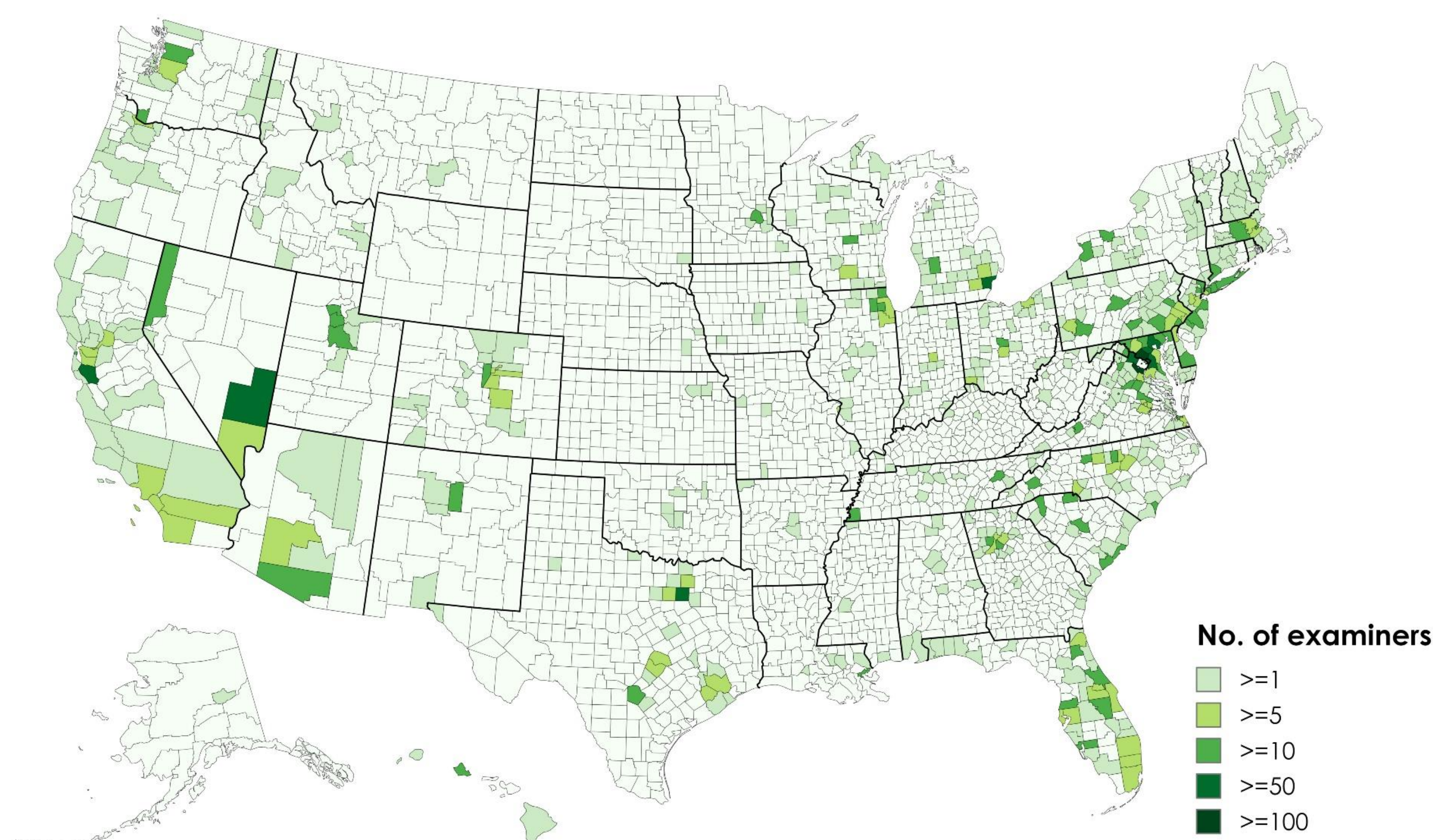
- Climate change, evidenced by climatic natural disasters, has resulted in significant economic costs and high mortality, drawing widespread attention and concern.
- Innovations, particularly green innovations related to climate change, are pivotal in addressing climate change and advancing social sustainability.
- Existing literature offers little about what determines the success of green innovations.
- Patent examiners are gatekeepers of the innovation system and significantly influence which inventions ultimately receive legal protection and market access.

## Main Findings

- Using a large sample of patent examiners in the U.S. from 2012 to 2020, we exploit geographical variations of examiner locations and use climatic natural disasters as shocks to beliefs about climate change.
  - Patent examiners grant more green patents following the experience of climatic natural disasters.
  - Disaster experience leads to an increase in the quality of green patents granted by event examiners. The effects of climatic disaster experience are muted on non-green patent reviews.
  - Further analysis shows evidence that examiners devote greater effort and are more diligent in reviewing green patent applications after experiencing climatic disasters.

## Data

- Examiners and patents: the U.S. Patent & Trademark Office (USPTO) and PatentsView.
- All patent examiners in the U.S. from 2012 to 2020: 8,408 unique examiners.
- Classify patents in the CPC Y02 classification as green patents that are more related to climate change.
- Select climatic natural disasters in the U.S. from the Spatial Hazard and Loss Database for the United States (SHELDUS) Database.



## Climate Change and Green Patent Issuance

- We estimate the following DID regression

$$Green\ Patent\ Ratio_{i,t} = \alpha + \beta Disaster_{i,t-1} + FE_s + \varepsilon_{i,t}$$

- $Green\ Patent\ Ratio_{i,t}$ : Percentage of green patents in all patents granted by examiner  $i$  in year  $t$ .
- $Disaster_{i,t-1}$ : Dummy variable which equals one if the examiner  $i$  experiences climatic disasters in year  $t-1$ , and zero otherwise.
- Following climatic natural disasters,  $Green\ Patent\ Ratio$  for the event examiners increases by 10% relative to the mean (0.0079/0.08).

	Dependent Variable: Green Patent Ratio			
	(1)	(2)	(3)	(4)
Disaster	<b>0.0079***</b> (0.0020)	0.0079*** (0.0024)	0.0121*** (0.0035)	0.0077*** (0.0025)
Examiner FE	Yes	Yes	No	Yes
County FE	No	No	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Cluster	County, Year	County	County, Year	County, Year
# Obs.	58,161	58,161	58,161	58,161
Adj. R <sup>2</sup>	0.852	0.852	0.043	0.852

## Disaster Experience and Green Patent Quality

- $Green\ Patent\ Quality$ : Logarithm of one plus the average number of truncation-adjusted citations received by green patents for an examiner in a year (Hall, Jaffe, and Trajtenberg, 2001).
- Disaster experience increases  $Green\ Patent\ Quality$  by 0.0222, or a 7% increase from the mean (0.0222/0.30).
- This effect is muted for non-green patents.

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

## Disaster Experience and Examiner Effort

- $Green\ Examiner\ Citation$ : Average number of citations referred by an examiner in green patent reviews in a year. We focus on the subsample of patent reviews that have no prior decisions.
- $Green\ Seriousness$ : Average of green rejection citation for the green patent rejections that include 102 or 103 rejections for an examiner-year.  $Green\ Rejection\ Citation$ : Equal to one if at least one prior art citation is referenced in 102 or 103 rejections for green patents, and zero otherwise.
- Examiners exert more effort on green patent reviews following disaster experiences.

Variable	Citations cited by examiners			Application rejected by examiners		
	Green Examiner Citation	Non-green Examiner Citation	All Examiner Citation	Green Seriousness	Non-green Seriousness	All Seriousness
Disaster	<b>0.3246**</b> (0.1313)	-0.0957 (0.0780)	-0.0253 (0.0403)	<b>0.0296**</b> (0.0142)	0.0033 (0.0068)	0.0036 (0.0065)
Examiner FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
# Obs.	22,412	54,719	55,476	44,117	62,630	62,955
Adj. R <sup>2</sup>	0.584	0.744	0.749	0.329	0.649	0.659

## Cross-Section Analyses

- The effect of disaster experience on green patent approval is stronger among:
  - States where people pay higher attention to climate change, as proxied by Google Search Volume Index.
  - More salient disasters, as proxied by damage, duration, and consecutive disasters.
  - More senior examiners, as proxied by compensation and tenure.

## Robustness Tests

- Rule Out the Possibility of An Increase in Green Applications
- Rule Out the Possibility of Location Advantage
- Match examiners with similar characteristics: Tech units and pay.
- Alternative green patent classifications: OECD's IPC classification.
- Two types of green patents: Climate change adaptation & climate change mitigation.
- Placebo test: Non-climatic disasters.