Climate-Induced Labor Risk and Firm Investments in Automation

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Abstract

- I study whether and how firms adapt to climate-induced labor risk through automation.
- I construct a text-based measure of automation investments at the firm-year level.
- I find that firms with a more climate-exposed workforce invest more in automation when
  - ✓ Facing adverse long-term climate conditions.
  - ✓ Are financially unconstrained.
- After automation adoption, climate-exposed firms
  - ✓ Have smaller employment and employee health insurance buffers.
  - ✓ Enjoy better operating performance under short-term climate shocks.

Motivation

- Climate-exposed workers suffer losses in working hours, productivity and safety (e.g., Graff-Zivin and Neidell, 2014; Somanathan et al., 2021).
- Firms employ a "labor adaptation" strategy including having more employees and greater employee insurance costs, but it is ineffective under climate surprises (Xiao, 2022).
- Firms may resort to capital adaptation, especially, automation investments that substitute labor.

Data

- **Sample period: 2000-2018.**
- Material news and events from KeyDevelopment.
- Plant information from NETS Establishment.
- Work-related injuries and illness from OSHA.
- Firm-level employee benefits from Form 5500.
- Daily weather data from NOAA.

Measuring Firm Investments in Automation

- **Substance**: 2.7 million items of material news and events.
- **Methodology**: word embedding and keyword discovery algorithms.
- **Automation investment intensity (`Auto_Inv`)**: the percentage of automation keywords in an investment disclosure item averaged over all items in a firm-year.

Figure 1:Validating Auto_Inv using Industry Robots Shipment

Industry	Raw Score: Industrial Robot Density	*Capex**100	*Auto_Inv*
Agriculture, forestry, and fishing	0.20	2.57	0.25
Auto and other transportation manufacturing	29.30	4.27	0.68
Chemical manufacturing	6.00	19.31	0.42
Construction	0.10	3.16	0.34
Education	0.10	4.03	0.00
Food and beverage manufacturing	3.10	5.79	0.23
Metal and electrical/electronic manufacturing	4.70	3.68	0.89
Textile manufacturing	0.30	23.43	0.32
Mining and quarrying	0.50	4.03	0.29
Utilities	0.40	3.96	0.32
Wood and paper manufacturing	1.00	7.59	0.39
Correlation with Industrial Robot Density		-0.07	0.54

Empirical Findings

Table 1: Workforce Climate Exposure and Automation Investments

$$Y_{it} = \alpha_i + \mu_{jt} + \beta X_{\texttt{it-1}} + \theta \texttt{Firm\_Climate\_Exp}_{\texttt{it-1}} + \epsilon_{ijt} \quad (1)$$

- **`Firm_Climate_Exp`**: the employment-weighted average of occupation-level climate exposure.

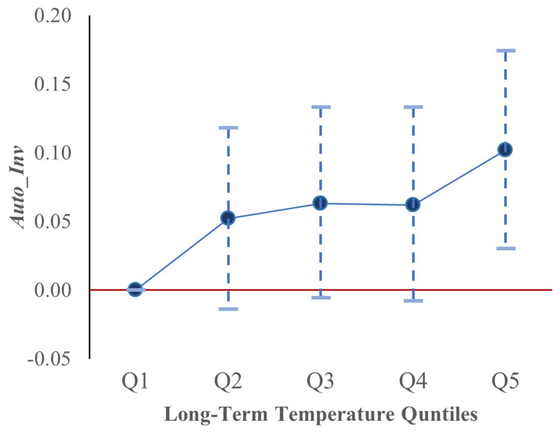
DV	Automation Investment Intensity: Main	Robustness			*Capex**100
	Auto_Inv	*Auto_News*	D_{Auto_inv}	*Auto_Inv: Climate-Raled*	
	(1)	(2)	(3)	(4)	(5)
Firm_Climate_Exp	-0.011	-0.188	-0.005	-0.008	0.091
	(-0.43)	(-0.52)	(-0.94)	(-0.34)	(0.61)
N	41,642	41,642	41,642	41,642	41,534
R^2	0.432	0.404	0.270	0.452	0.720
Adjusted R^2	0.329	0.295	0.136	0.352	0.668

✓More climate-exposed firms do not invest more in capital/automation.

Interacting with Temperatures

$$Y_{it} = \alpha_i + \mu_{jt} + \beta X_{\texttt{it-1}} + \theta \texttt{Firm\_Climate\_Exp}_{\texttt{it-1}} + \omega \texttt{Firm\_Climate\_Exp}_{\texttt{it-1}} * \Sigma D_{\texttt{Firm\_Lt\_Temp}_{it}} + \epsilon_{ijt} \quad (2)$$

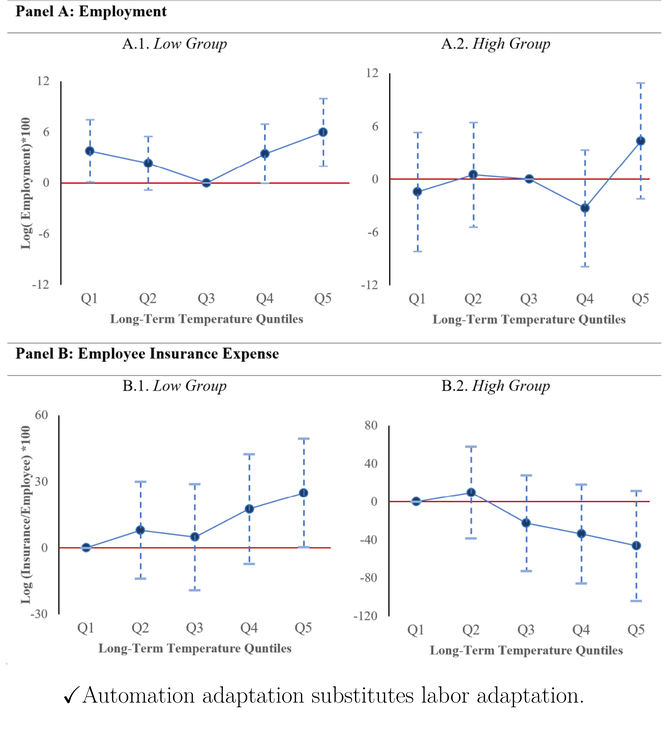
- **`Firm_Lt_Temp`**: the 20-year moving average of county-level temperatures weighted by firm employment in a given county.



✓Climate-exposed firms respond to long-term adverse climate trends through automation investments, suggesting the long-term benefits of investment offset the short-term spending.

Labor Adaptation After Automation

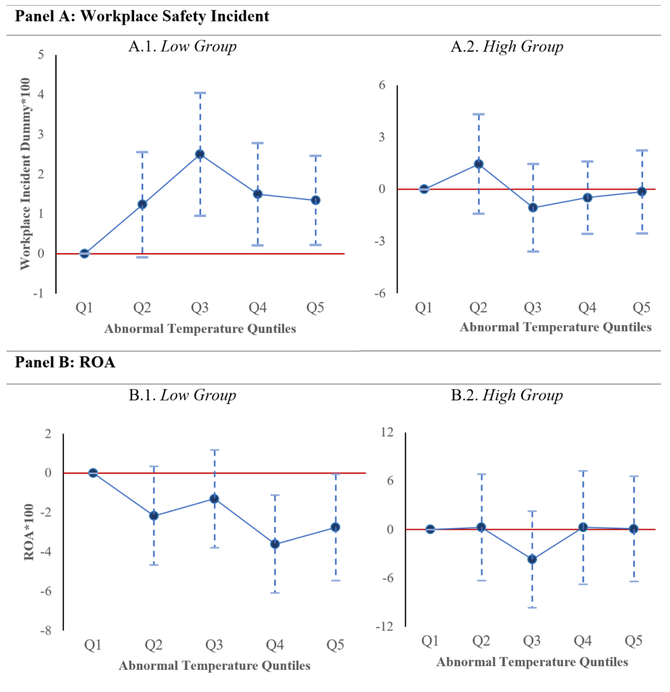
- **High Group**: lagged automation investments in the top 30%.



✓Automation adaptation substitutes labor adaptation.

Operating Performance After Automation

- **`Firm_Ab_Temp`**: the average of abnormal temperatures (difference between the county annual and 20-year moving average) weighted by firm employment in a given county.



✓Automation helps mitigate climate-induced risk effectively.

Other Findings

- Only financially unconstrained firms expand automation investments in response to increasing climate-induced labor risk.
- Following the passage of the 2005 California Heat Standard that aims to reduce heat stress in the workplace, climate-exposed firms invest more in automation.
- The automation news of climate-exposed firms sees positive stock market responses.
- Results are robust using various alternative textual-based proxies for automation investments.

Reference

- Graff Zivin, Joshua, and Matthew Neidell, 2014, Temperature and the allocation of time: Implications for climate change, *Journal of Labor Economics* 32, 1-26.
- Somanathan, E., Rohini Somanathan, Anant Sudarshan, and Meenu Tewari, 2021, The impact of temperature on productivity and labor supply: Evidence from Indian manufacturing, *Journal of Political Economy* 129, 1797-1827.
- Xiao, Rachel J., 2022, Climate risk in the workplace: Labor market consequences and firm performance, Georgia State University.

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