Temperature, Unemployment and Joblessness Dynamics

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Abstract:

This paper examines the impact of temperature on unemployment, the underlying workforce dynamics driving this effect, and plausible explanations. In our baseline analysis, we combine 30 years of U.S. data from the Current Population Survey covering more than 16 million individuals together with historical temperature variation at the county level. We estimate a specification that allows us to show non-linearities in the estimated effects while controlling for time-invariant county differences, yearly trends and for state-specific seasonality. We show that colder temperatures significantly increase the probability of unemployment. This finding is robust across various sensitivity checks, including accounting for serial correlation and alternative estimation specifications. We also find that the effect of temperature on unemployment is driven by individuals who were previously working in industries with higher risk of outdoor exposure.

The impact of cold temperatures on unemployment could be driven by two distinct channels: increases in job separations or increases in unemployment duration for those who were already unemployed. Our findings show that both play a role, with cold temperatures leading to considerable increases in both job separations (inflows) and unemployment spells (outflows).

Analyzing mechanisms behind the increase in unemployment inflows and spells, we start by providing several sets of evidence showing that the impact of temperature on unemployment inflows is demand-driven. Cold temperatures considerably increase involuntary layoffs with small effects on voluntary quits. Cold temperatures also lead to a higher probability of job absences due to weather disruptions for employed workers, minimal changes in the probability of work absences due to illness when temperatures are cold. Lastly, we show that the impact of cold temperatures is more pronounced in industries with lower levels of unionization, suggesting a role for bargaining power.

We also provide evidence showing that the impact of temperature on unemployment duration is likely driven by reduced labor demand, rather than by changes in labor supply. To do so we combine our historical temperature variation with two additional sources of data: the American Time Use survey and the Bureau of Labor Statistics Job Openings and Labor Turnover survey

dataset. We find that cold temperatures do not change the time that individuals spend on job search activities or in job interviews, but rather that cold temperature leads to fewer job openings making it more difficult for unemployed workers to find employment.

In what follows is a detailed set of slides documenting the data sources, econometric methods and results.

DATA and EMPIRICAL MODEL

- Data:
  - NOAA
  - CPS
    - Individuals aged between 18 and 65
    - From 1994 to 2023 □ 30 years of US data
    - Sample of roughly 16 million observations
  - ATUS
  - BLS Job Openings and Labor Turnover Survey

DATA and EMPIRICAL MODEL

- $$U_{icsmy} = \sum_{T=1}^{7} \beta_T Temp_{Tcsmy} + \delta_c + \delta_y + \delta_{sm} + \epsilon_{icsmy}$$

- Dependent variable:
  - U_{icsmy}: Unemployment status of worker *i* living in county *c* (in State *s*) during month *m* of year *y*

- $Temp_{Tcsmy}$: Share of days with temperature falling in interval T over the last three months prior *m*
  - Seven temperature intervals T (in Celsius): <=5; 5-10; 10-15; 15-20; 20-25; 25-30; >=30

DATA and EMPIRICAL MODEL

- $$U_{icsmy} = \sum_{T=1}^{7} \beta_T Temp_{Tcsmy} + \delta_c + \delta_y + \delta_{sm} + \epsilon_{icsmy}$$

- Set of FEs:
  - δ_c: County FE ➔ Keep constant 'historical' differences in temperatures constant btw counties
  - δ_y: Year FE ➔ Macro-trend in temperature constant (e.g. global warming)
  - δ_{sm}: State*Month FE ➔ Keep state-specific seasonality constant

- So what are β_T capturing? (or what is the variation left?)
  - Changes in temperatures at the county*month level net of:
    - 'Historical' county differences
    - Not of shared macro-trends
    - Net of state-specific seasonality only

DATA and EMPIRICAL MODEL

- $$U_{icsmy} = \sum_{T=1}^{7} \beta_T Temp_{Tcsmy} + \delta_c + \delta_y + \delta_{sm} + \epsilon_{icsmy}$$

- Additional pieces of info:
  - Exogenous individual covariates (i.e. gender, age, age^2)
  - Cluster SE at county level

A. BASELINE RESULTS: effect of temperature on unemployment

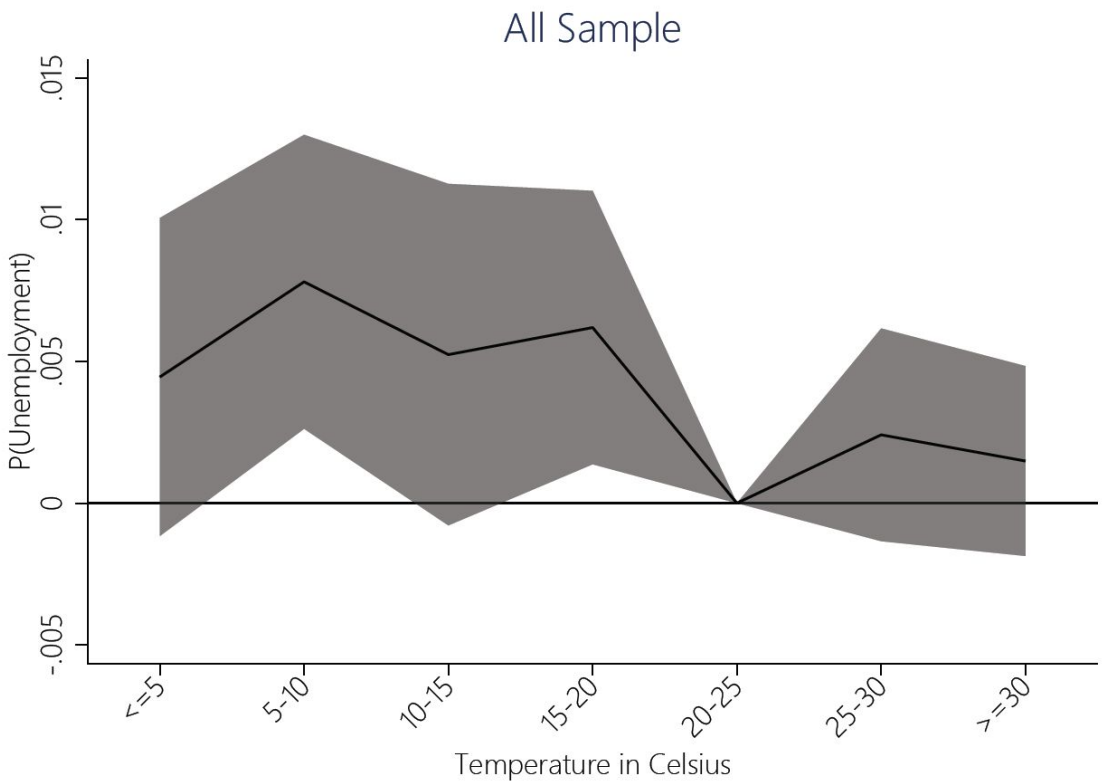
- A.1 Baseline results
- A.2 Robustness checks
- A.3 Who bears the burden?

A. BASELINE RESULTS: effect of temperature on unemployment

- A.1 Baseline results
- A.2 Robustness checks
- A.3 Who bears the burden?

A.1 Baseline results: Does temperature affect U?

A. Baseline results: yes, it does!



A cold temperature effect

In terms of magnitude:

- A one sd rise in the share of days spent btw 5 to 10 degrees Celsius = rise of 0.10 pp in unemployment probability (around 2.7% of average incidence) □ Non negligeable while not being implausible

A. BASELINE RESULTS: effect of temperature on unemployment

What's working:

- A.1 Baseline results
- **A.2 Robustness checks**
- A.3 Who bears the burden?

A.2 ROBUSTNESS CHECKS

- We estimate a set of sensitivity checks where we:
  - Account for serial correlation (see **Appendix 1**)
  - Use other time horizons for temperature (e.g. 1 month, 6 months)
  - Use different set of individual controls
  - Use different set of FE
  - Use different estimation techniques

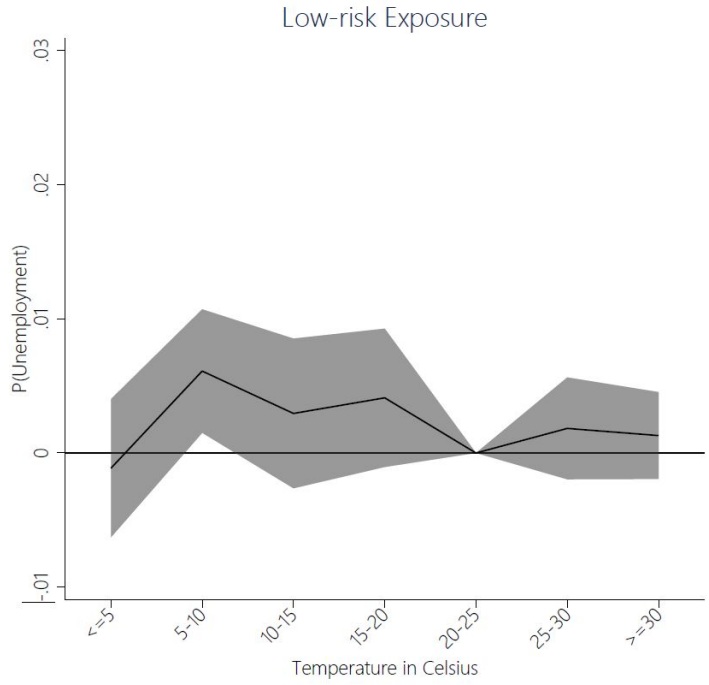
A. BASELINE RESULTS: effect of temperature on unemployment

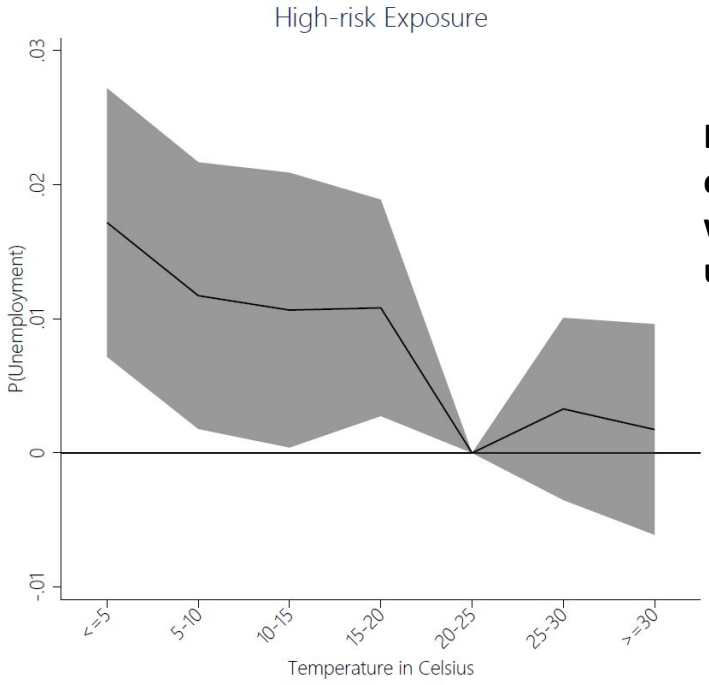
What's working:

- A.1 Baseline results
- A.2 Robustness checks
- **A.3 Who bears the burden?**

A.3 Understanding our baseline results: Who bears the burden?

We compare high-risk to low-risk exposure to temperature (industry level)





Exactly what we would expect if temperatures were responsible for unemployment:

- All effect driven by high-risk exposure (extreme cold: +0.017 vs -0.001)
  - From now on: all the results will be on high-risk exposure workers except when explicitly indicated

A. BASELINE RESULTS: SUMMARY

- **Cold temperatures increase unemployment**
  - Results robust to several sensitivity checks, such as serial correlation and specification choice

- **Effect driven by high-risk exposure industries**

B. Understanding our baseline results

- **B.1 How does temperature increase unemployment?**

- **B.1 Understanding our baseline results: How does temperature increase unemployment?**

A change in the temperature T affects the law of motion of unemployment as follows:

$$\frac{\partial A_W(T)}{\partial T}\cdot\frac{\partial d(T)}{\partial A_W(T)}+\frac{\partial A_B(T)}{\partial T}\cdot\frac{\partial d(T)}{\partial A_B(T)}+\frac{\partial F(T)}{\partial T}\cdot\frac{\partial q(T)}{\partial F(T)}-\left[\frac{\partial \mu(T)}{\partial T}f(U_t,V_t)+\mu(T)\frac{\partial f(U_t,V_t)}{\partial V_t}\cdot\frac{\partial V_t}{\partial T}\right]$$

Job destruction | Quits | Matching Efficiency and Vacancies

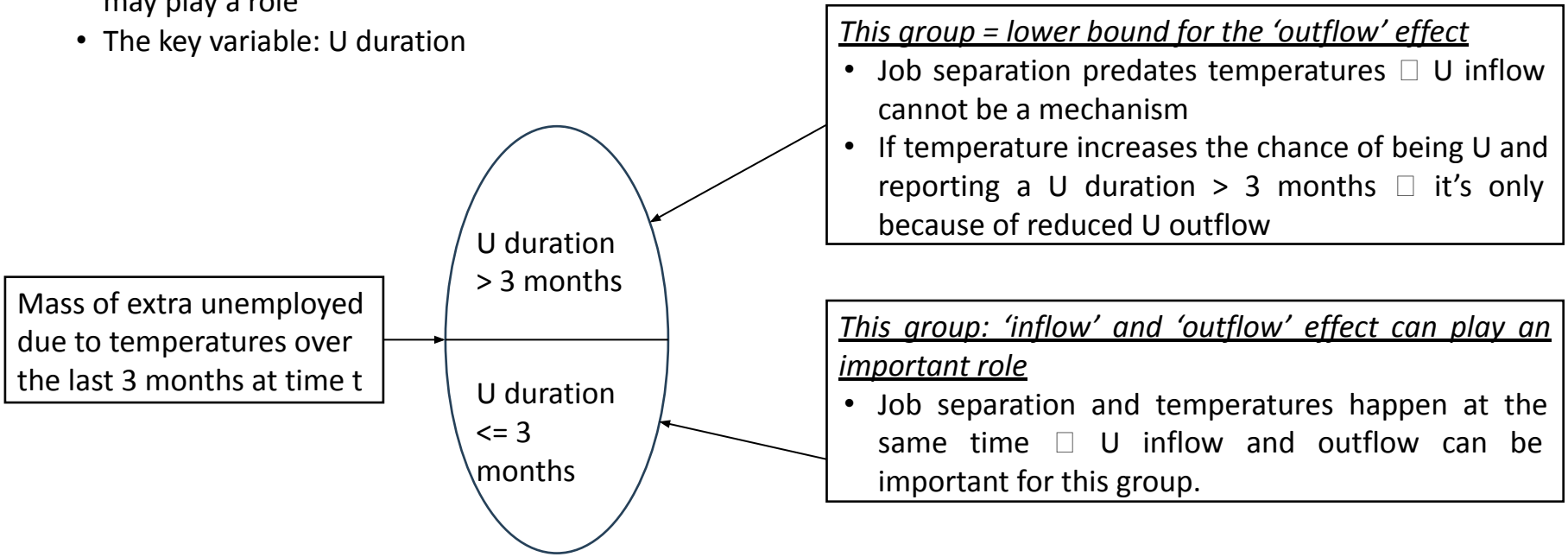
Unemployment inflow
Entry into U

Unemployment outflow
Longer U spells

- **B.1 Understanding our baseline results: How does temperature increase unemployment?**

A. More inflow or less outflow? Using U duration to tease out the effects

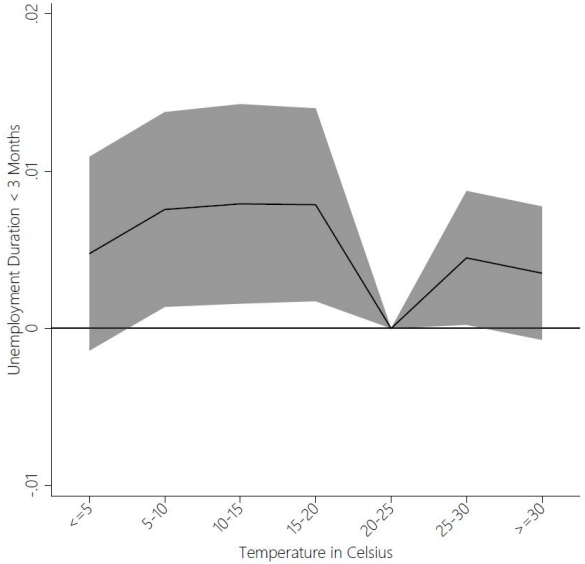
- It is difficult/near impossible to clearly separate the two type of flows…
- …but we can use a series of evidence to help us gauge the extent to which inflows and outflows may play a role
- The key variable: U duration

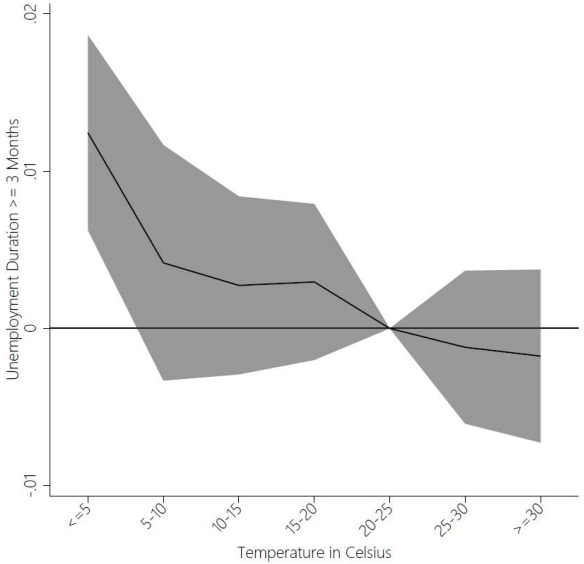


- **B.1 Understanding our baseline results: How does temperature increase unemployment?**

  A. More inflow or less outflow? Using U duration to tease out the effects

  - Coming back to CPS: recent vs less recent U which kind of U does temperature predict?





Important effects of temperature for both recent and less recent unemployment

Both U inflows and outflows potentially play an important role

About gauging effect sizes :

Less-recent unemployment graph can be used to gauge the lower bound of the effect of temperature on U outflow

C. Mechanisms

- **C.1 Mechanisms behind why temperature increases unemployment inflows**

- **C.2 Mechanisms behind why temperature increases unemployment outflows**

C. Mechanisms

- **C.1 Mechanisms behind why temperature increases unemployment inflows**

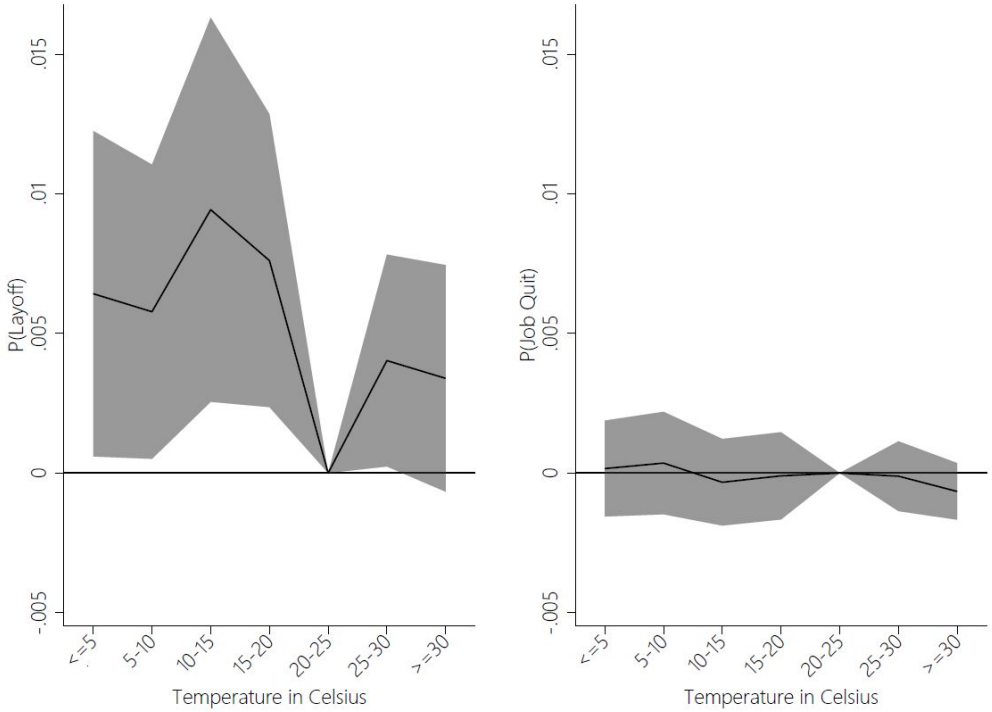
- C.2 Mechanisms behind why temperature increases unemployment outflows

- **C.1 Mechanisms behind why temperature increases unemployment inflows**

U inflow – involuntary or voluntary?

We apply our approach and assess whether the extra recent U caused by temperatures is supply- or demand-driven:

- Layoff vs Job quits

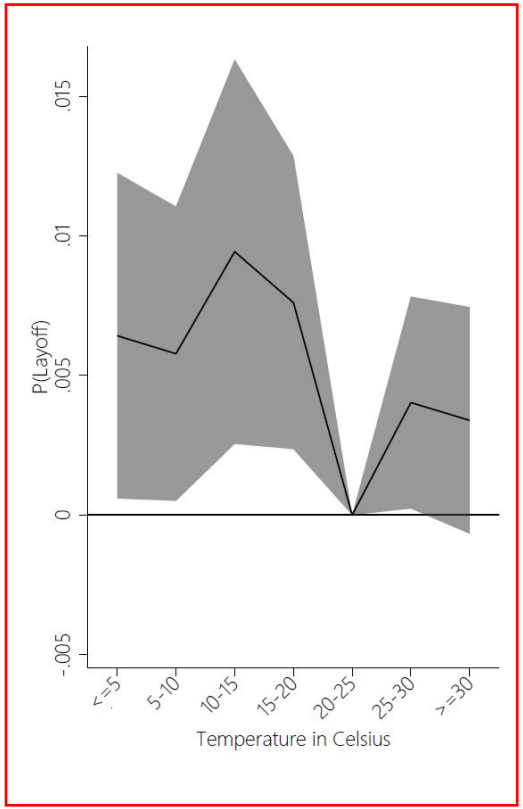


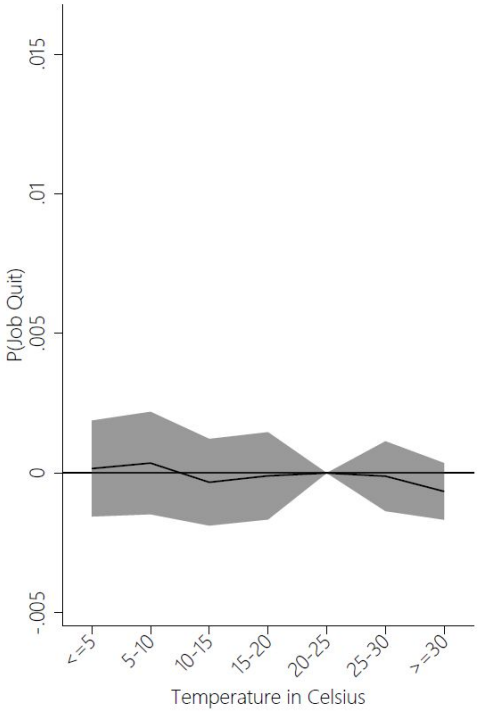
- **More recent layoff when cold weather**

• C.1 Mechanisms behind why temperature increases unemployment inflows

U inflow – involuntary or voluntary?

Effect of temperature on U occurs mainly through involuntary U → evidence supporting that effect is demand-driven





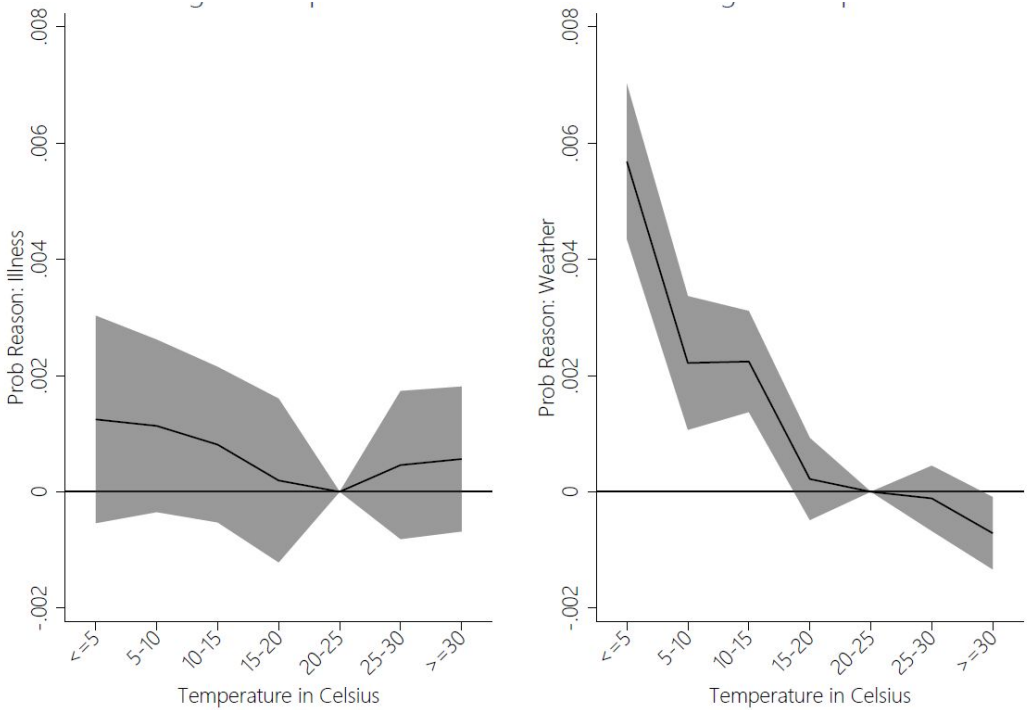
Focus on layoff

• C.1 Mechanisms behind why temperature increases unemployment inflows

Effect of temperature on U inflow is demand driven – but why?

Why layoffs happen? □ some insights from why workers have been recently absent

Workers are less productive → $\frac{\partial A_W(T)}{\partial T} \cdot \frac{\partial d(T)}{\partial A_W(T)} + \frac{\partial A_B(T)}{\partial T} \cdot \frac{\partial d(T)}{\partial A_B(T)}$ ← Firms are disrupted

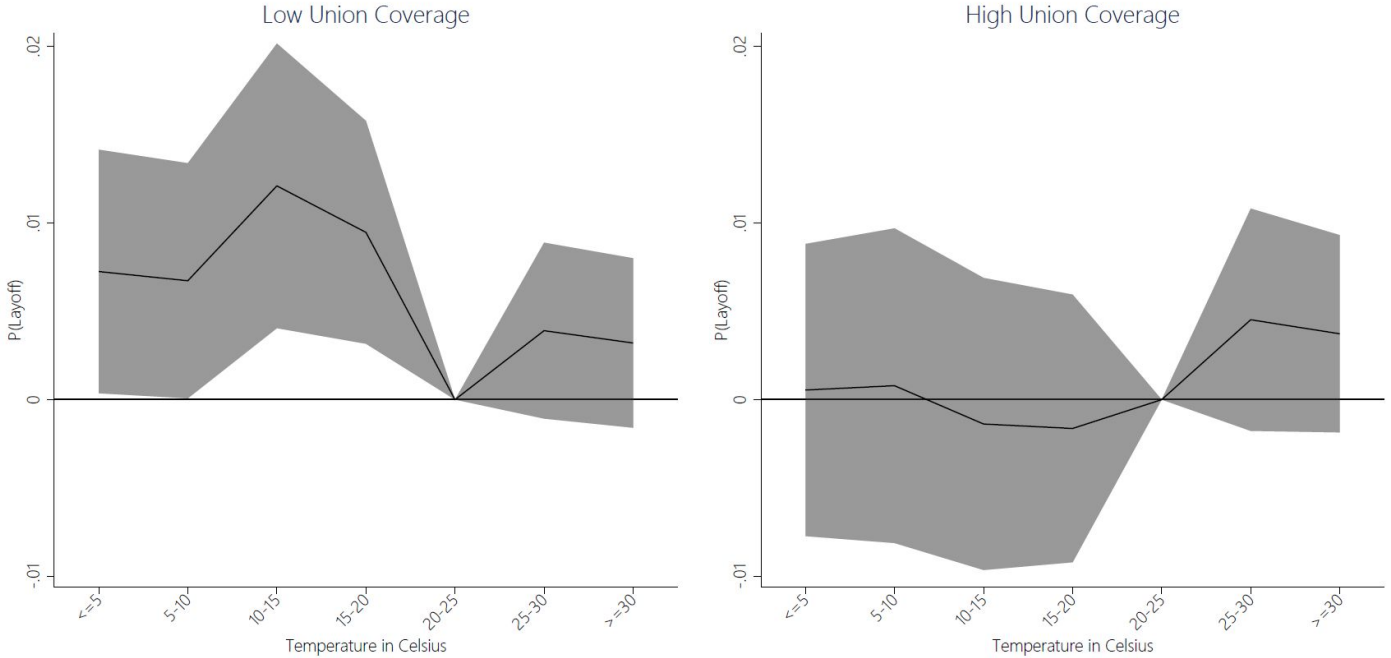


Cold temperature:

- Disrupt business
- Not significant effect on illness (proxy for productivity here)

- **C.1 Mechanisms behind why temperature increases unemployment inflows**

U inflow – is it really demand driven?

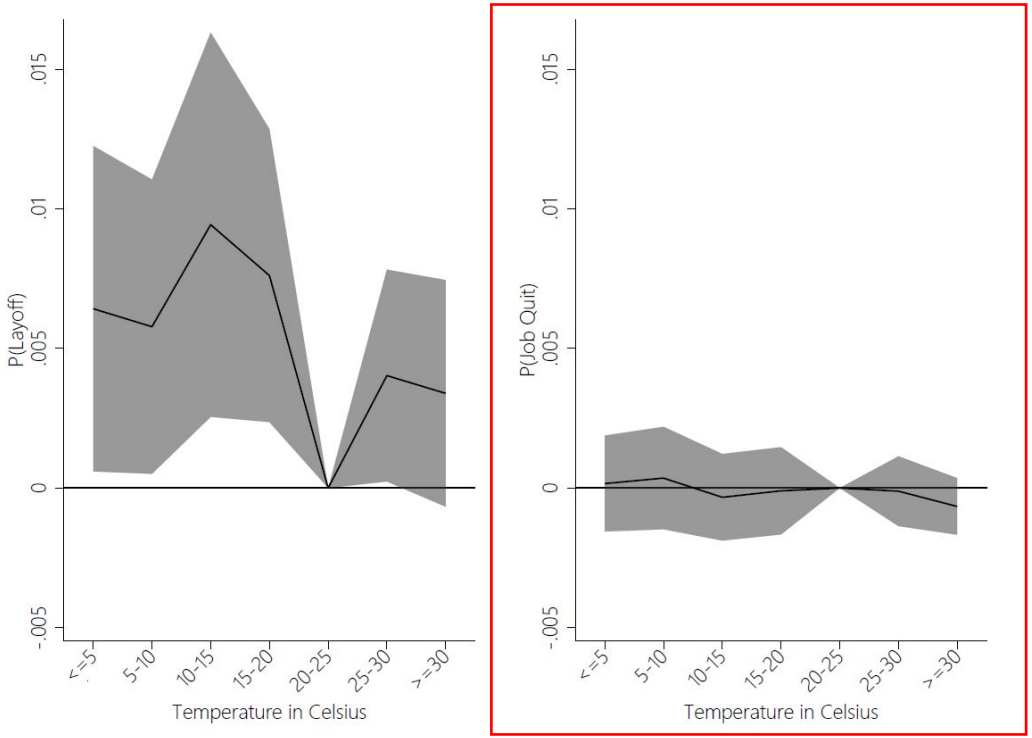


- We investigate whether effects are larger for high-risk workers working in industries more vs less unionized effect is higher for high-risk workers in less unionized industries effect of temperature on U inflows seems to be demand driven

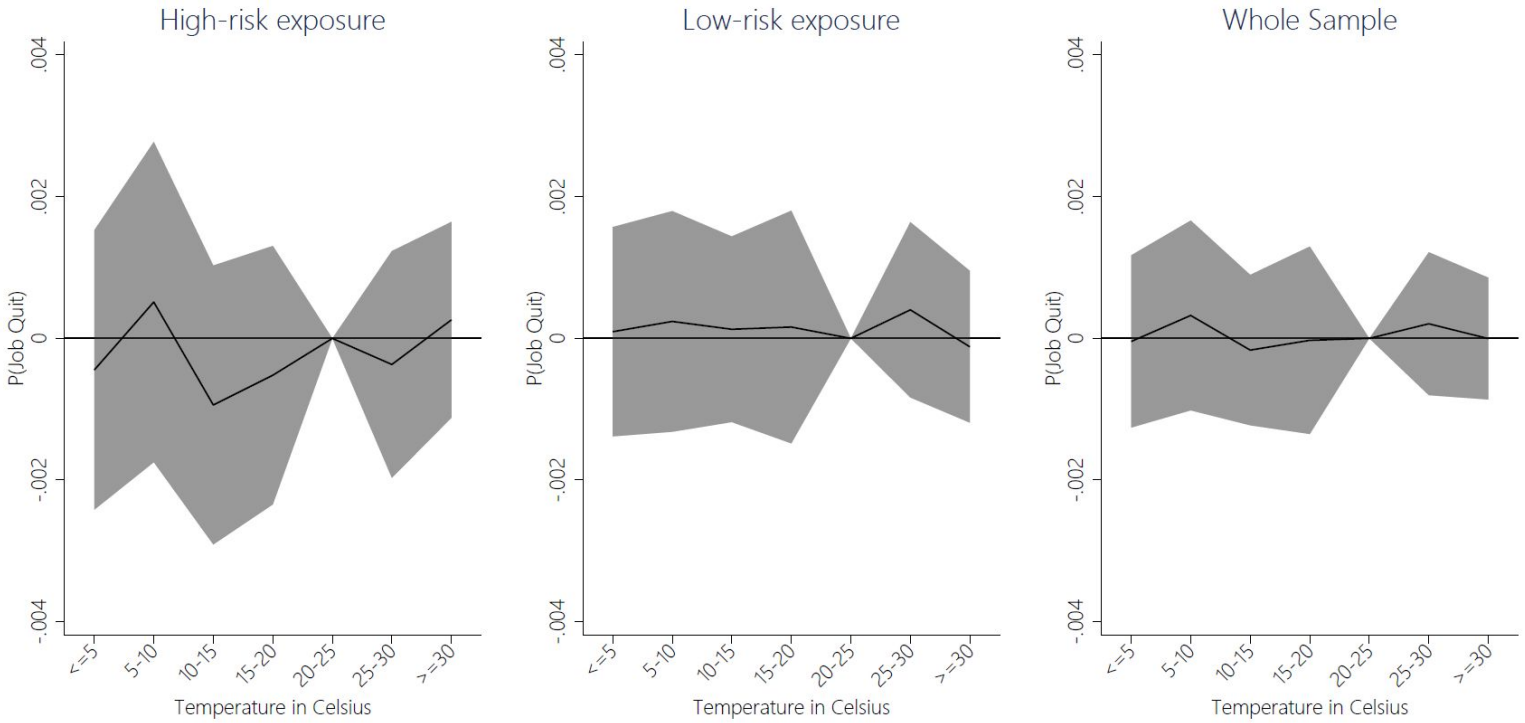
- **C.1 Mechanisms behind why temperature increases unemployment inflows**

More insights about U inflow

We now come back to voluntary U



- **C.1 Mechanisms behind why temperature increases unemployment inflows**



No effect on job quits

C. Understanding Mechanisms behind increase in U inflows and outflows

- C.1 Mechanisms behind why temperature increases unemployment inflows

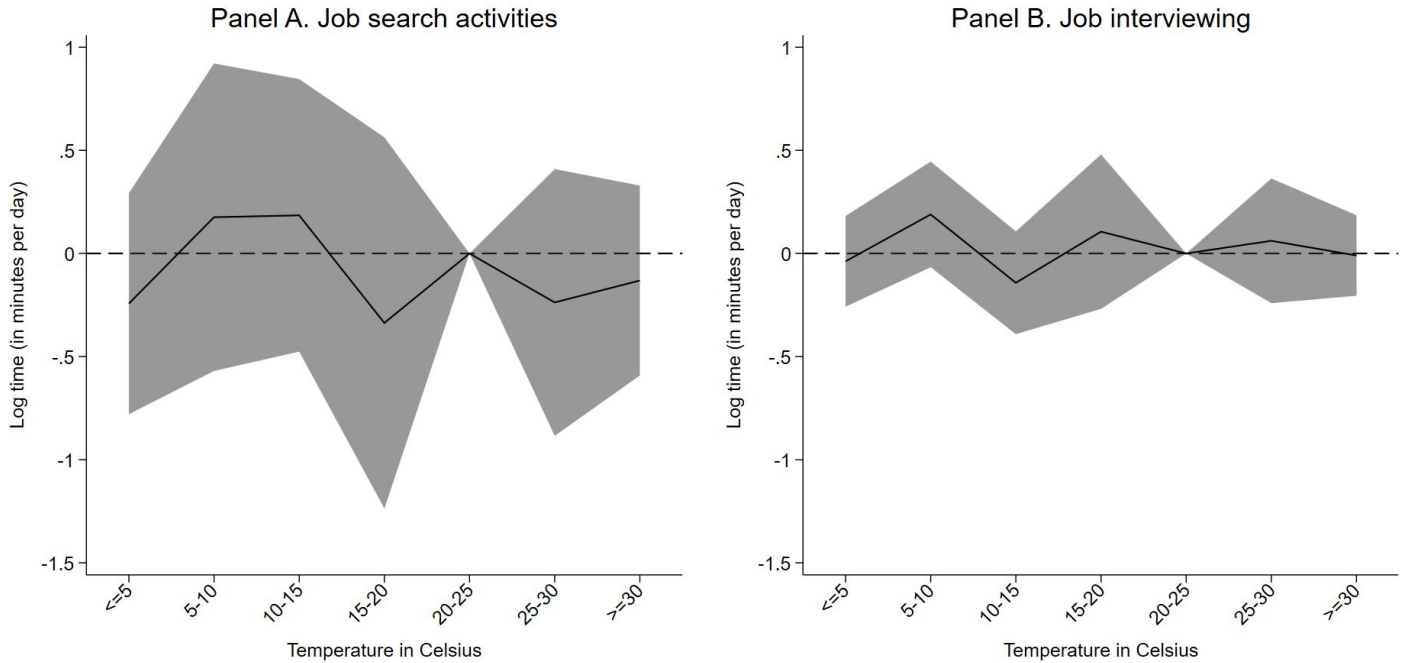
- **C.2 Mechanisms behind why temperature increases unemployment outflows**

• C.2 Mechanisms behind why temperature increases unemployment outflows

Exploring the role of labor supply:

Use data coming from ATUS:

- ***Data about job search behavior***



- Exposure to different temperature conditions does not seem to change job search behavior:
  - No effect on time spent on job search activities
  - No effect on time spent on job interviews

• C.2 Mechanisms behind why temperature increases unemployment outflows

Exploring the role of labor demand:

Use data coming from BLS Job Openings and Labor Turnover Survey:

- ***Time series about job openings*** **at the State level: monthly data from 2000 to 2024**

	Log Job Openings
% days max temp < 10	-0.007*
	(0.004)
% days max temp > 25	0.003
	(0.004)
Year dummies	Yes
State dummies	Yes
Observations	13499

- Cold temperatures:
  - Reduce job openings labor demand side seems to be important behind the increase in U outflows brought by cold temperatures

- Ideas of any other dataset we can use for this analysis?

CONCLUSIONS

- We find a net-of-seasonality relationship btw temperature and U
  - Cold temperature ↑ U
  - Effect is robust to a set of sensitivity checks

- We provide evidence to understand our baseline results:
  - Who drives the effect? Baseline results driven by high-risk workers
  - How does it happen? U ↑ both through an ↑ in U inflows and an ↓ in U outflows

- We provide evidence on mechanisms behind the increase in U inflows and U outflows:
  - U inflows:
    - Cold temperatures mainly ↑ layoffs → effect demand driven
    - Cold temperatures ↑ production disruption (i.e. absences due to weather) rather than ↓ workers' productivity (i.e. absences due to illness are unchanged)
    - Effect on layoffs ↑ when unionization ↓ → demand driven
  - U outflows:
    - Labor supply: Exposure to different temperature conditions does not change job search behavior
    - Labor demand: Cold temperatures ↓ job openings

APPENDIX

- **Appendix 1: Accounting for serial correlation**

Appendix 1. Accounting for serial correlation

Talking about the **causal effect of temperature over the last three months** may be risky:

- Point estimates may be biased by serial correlation in temperature not only the effect of temperatures over the last three months but we may also pick up the effect of less recent temperatures

Solution: controlling for past temperature and see whether results change

Looks OK threat of serial correlation in temperature addressed

Note for us: produce an estimate of this serial correlation for the paper

