Pandemics Depress the Economy, Public Health Interventions Do Not: Evidence from the 1918 Flu

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European Macro History

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The views expressed here do not necessarily represent those of the Federal Reserve Bank of New York or the Federal Reserve System

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Economics of Pandemics

- COVID-19 has sparked urgent questions about the economic effects of
  (a) Pandemics
  (b) Policy responses to pandemics

- *Theoretical* work is developing at high speed
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For the twenty-four hours ended at 10 o'clock yesterday morning, 1,450 new cases... were reported... This is the largest number of new cases reported in a single day since the disease became epidemic in New York.

In some parts of the country [the pandemic] has caused a decrease in production of approximately 50 percent.... There never has been in this country, so the experts say, so complete domination by an epidemic as has been the case with this one.

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Use variation in **mortality** and **non-pharmaceutical interventions (NPIs)** across U.S. states and cities during the 1918 Flu Pandemic to ask:

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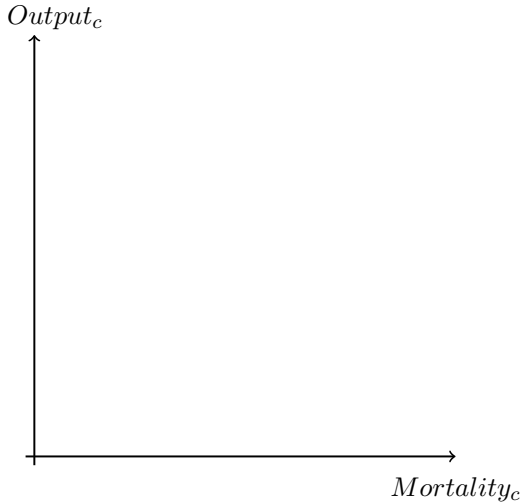
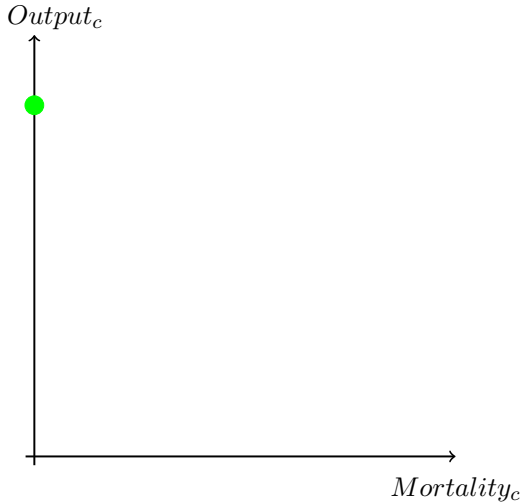
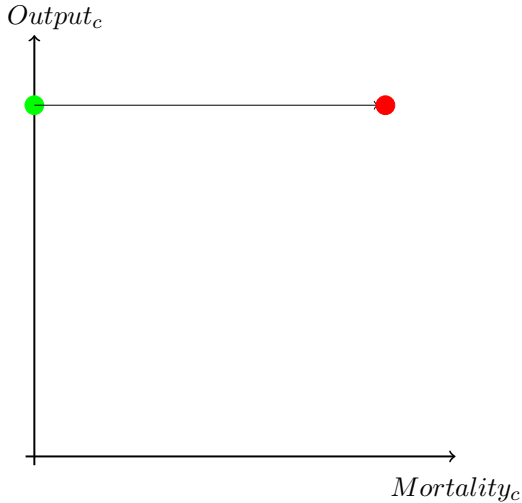
1. What are the **economic consequences of a pandemic**?

2. What are the economic **costs/merits of NPIs**?
   - NPIs implemented in 1918 resemble policies used today, including:
     - school and church closures, public gathering bans, quarantine of suspected cases, and restricted business hours
     - ...but less extensive than lockdowns and closure of non-essential businesses

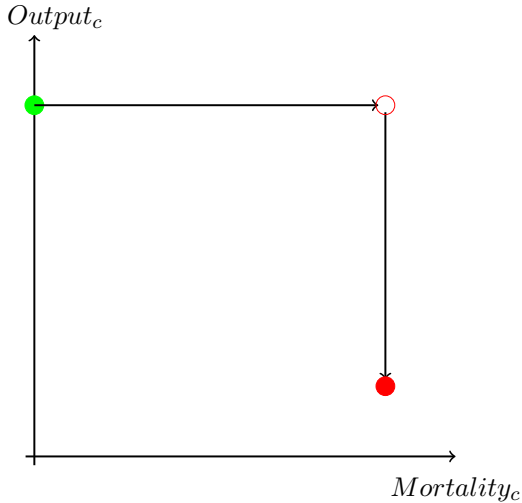

$Output_c$
$Mortality_c$



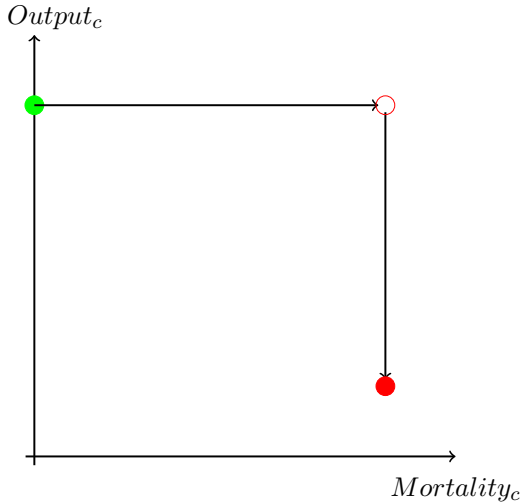
Consider a city with no pandemic



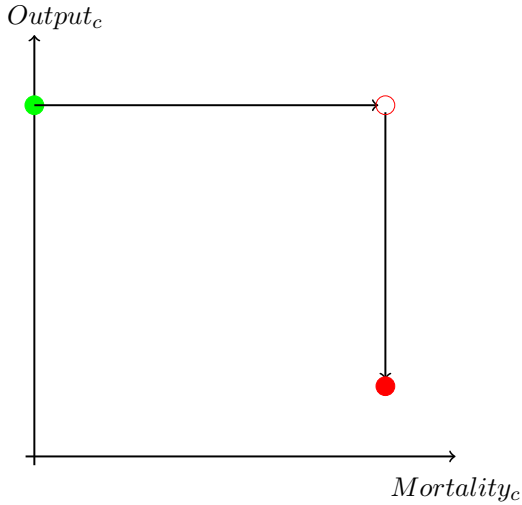
Pandemic increases illness and mortality



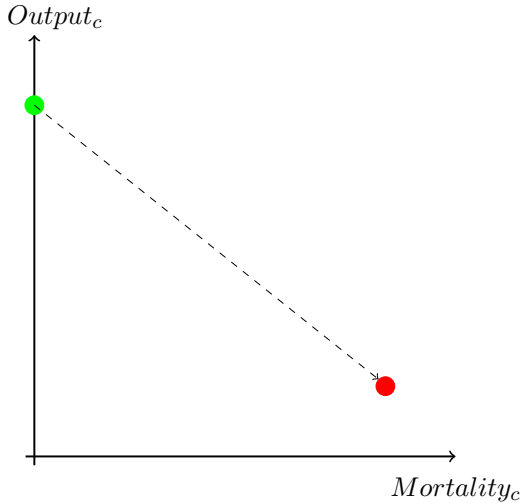
Pandemic also depresses economic activity



a) because mortality increases



b) because agents want to avoid contracting the virus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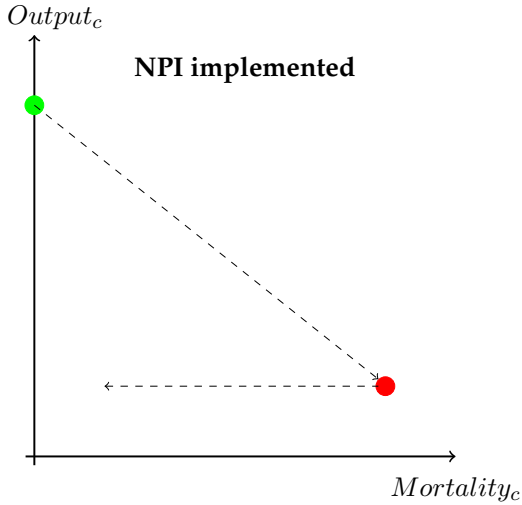
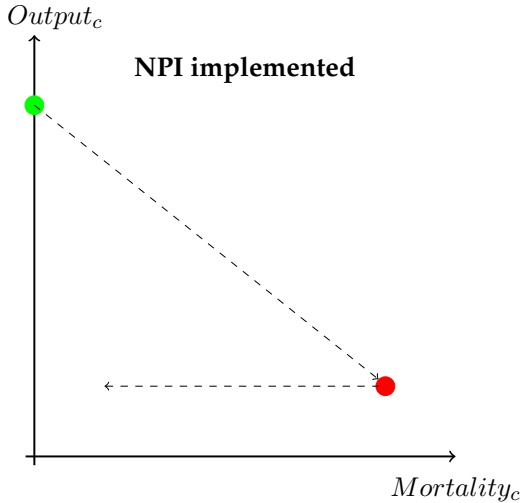
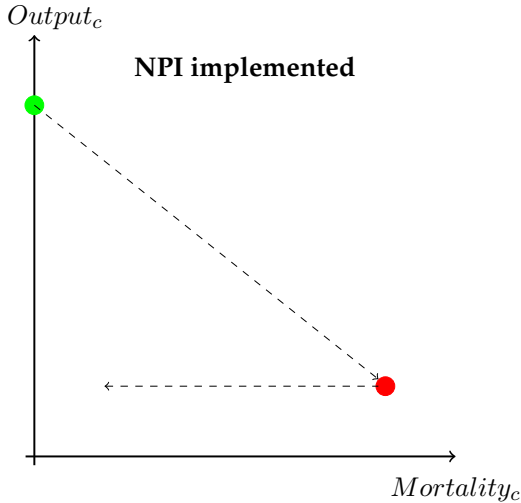


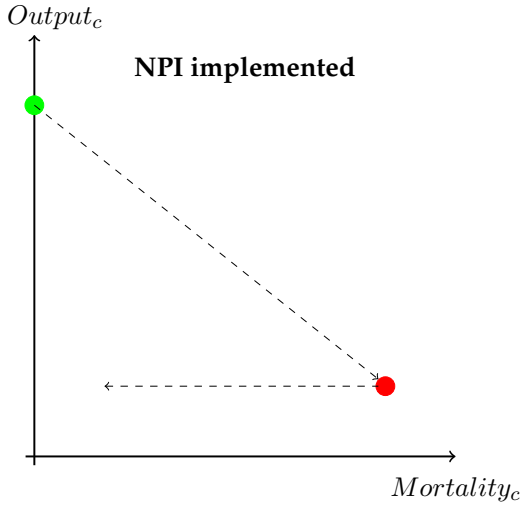
NPI reduces virus transmission, peak mortality (≈50%) and, to a lesser extent, cumulative mortality (≈10-30%)



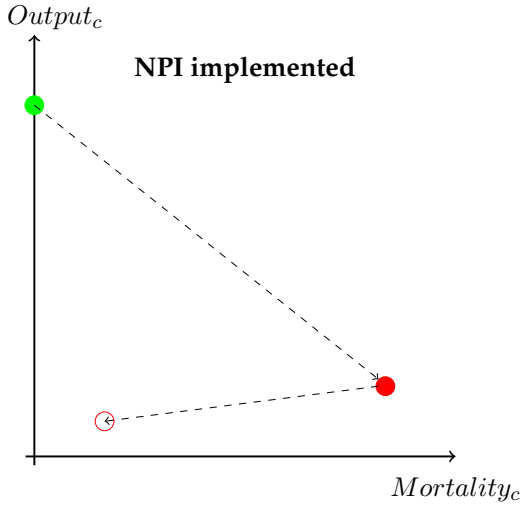
See Hatchett et al. (2007), Markel et al. (2007)



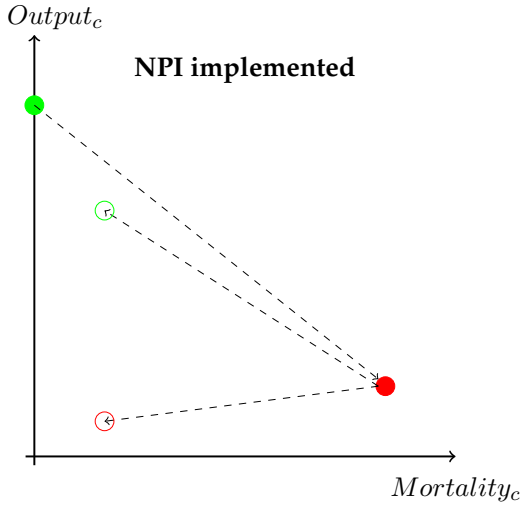
What happens to economic activity?



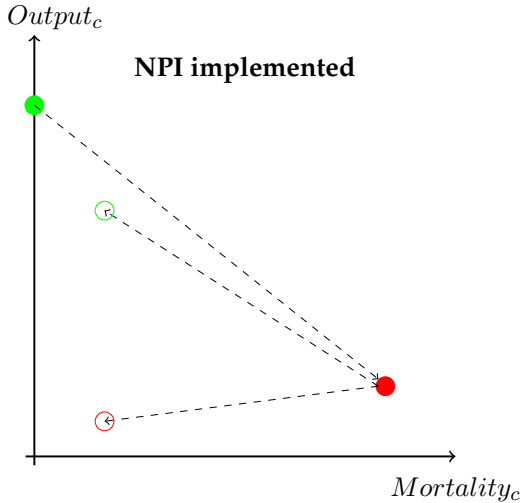
Economic effects of NPIs in a pandemic are not obvious



NPIs by themselves reduce economic activity by reducing social interactions

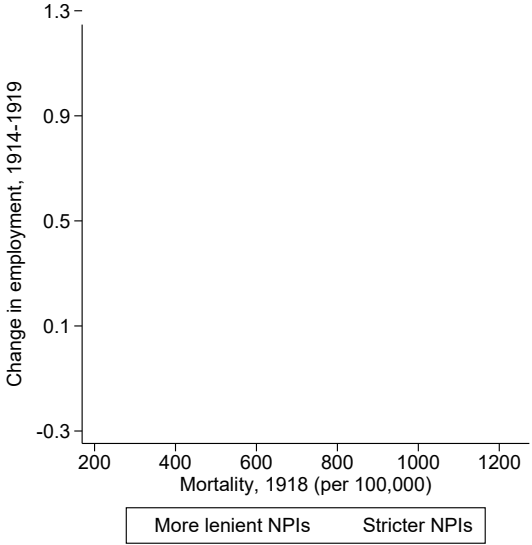


But by reducing the spread of the virus,
the original problem: mortality risk



Empirical question: Do NPIs on net decrease/increase economic activity?

Key Lessons from the 1918 Flu Pandemic in the U.S.



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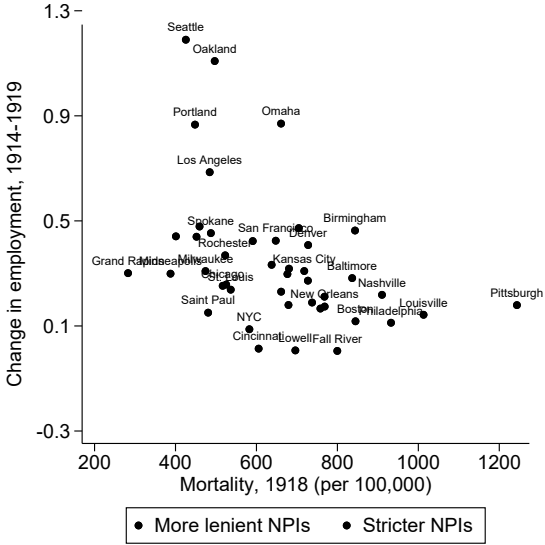

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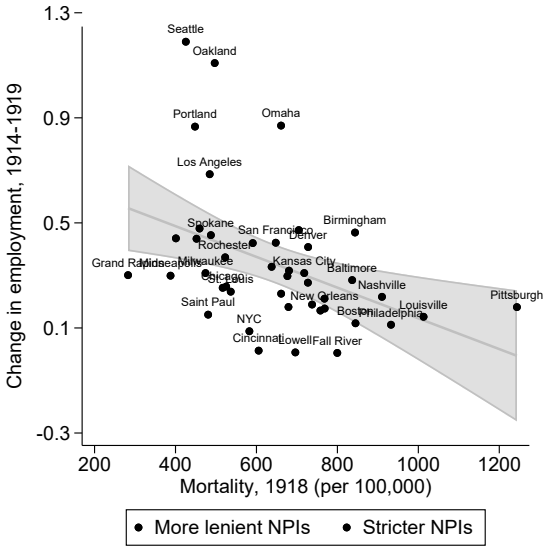

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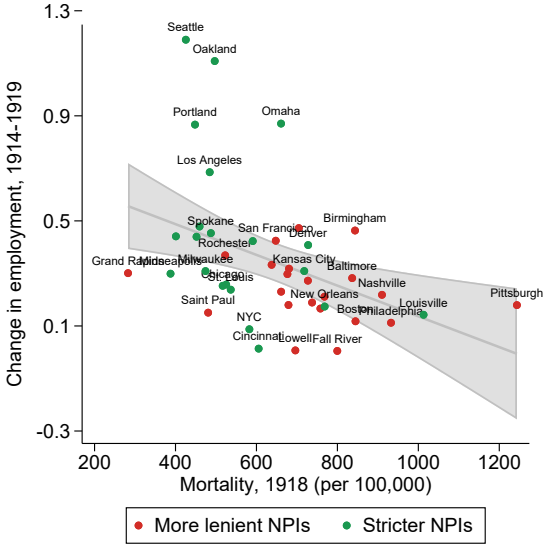

Key Results Based on 1918 Flu

1. The 1918 Flu **Pandemic depressed the economy**
   - Large in magnitude: 1-SD increase in mortality leads to an 6% relative decline in manufacturing output
   - Persistent – not V, but U or even L-shaped dynamics in regional cross-section

2. **Non-pharmaceutical health interventions (NPIs) are *not* associated with a worse economy in annual data**
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Background on the 1918 Flu Pandemic

- 1918 Flu Pandemic spread worldwide from Jan. 1918 to Dec. 1920
- Number of deaths estimated to be 50 million worldwide
  - 550,000 to 675,000 occurring in U.S. (0.66% of U.S. population)
  - Mostly during second wave in fall 1918
- Distinct feature was high death rates for 18-44 year old adults

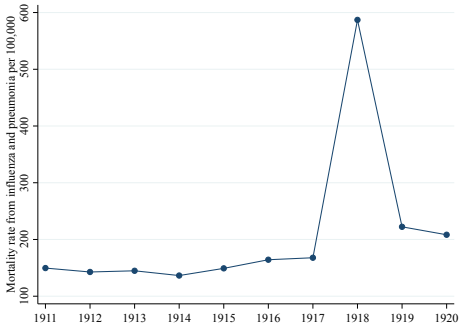

Figure: **U.S. mortality rate from influenza and pneumonia, 1911-1920.**

City and State-Level Data

- Mortality from influenza and pneumonia: Center for Disease Control's *Mortality Statistics*
- Employment and output from the *Census of Manufactures*
  - Available years: 1909, 1914, 1919, 1921, and 1923
- Higher frequency data:
  - Bi-monthly banking data from the *Annual Report of the OCC* reported in October
  - Motor vehicle registration of the *Statistical Abstract*
  - Bradstreet
- Controls on demography and socio-economic characteristics
  - *Decennial Census of 1910*, Census of Benevolent Institutions, and a variety of other sources

1. Economic Impact of the 1918 Pandemic

Empirical Strategy

1. **Baseline strategy:** Compare evolution of economic outcome Y_{st} in areas more and less severely affected by the 1918 Flu using dynamic DiD:

$$Y_{st} = \alpha_s + \tau_t + \beta_t \, Mortality_{s,1918} + X_s \gamma_j + \varepsilon_{st}$$

   - 1918 Flu Exposure = $Mortality_{s,1918}$
   - Include controls (X_s) to account for time-varying shocks that interact with
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Result 1: The Pandemic Depresses the Economy – Manufacturing Outcomes

Difference-in-differences

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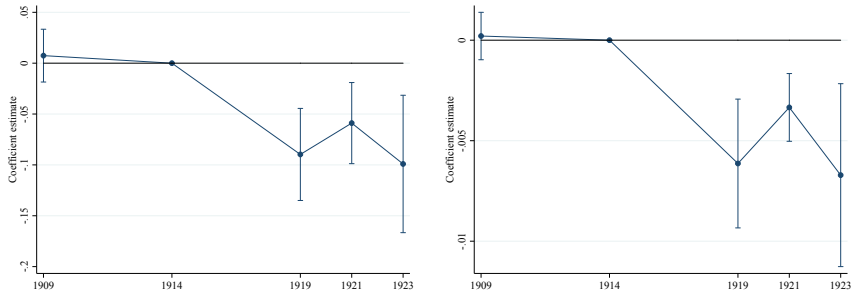


(a) Log of manufacturing employment

(b) Manufacturing employment to population ratio

- One standard deviation increase (150 per 100,000) in $Mortality_{s,1918} \Rightarrow 6\%$ fall in manufacturing employment

IV Strategy: Distance to Military Camps

- WWI military camps important clusters and vectors of infection
- City-level instrument based on inverse distance to military camps

$$Z_c = \sum_j \frac{\ln(camp\ size_j)}{\ln(dist_{c,j})}$$

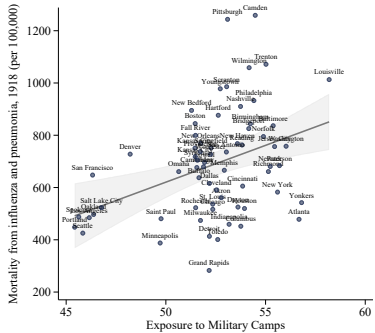
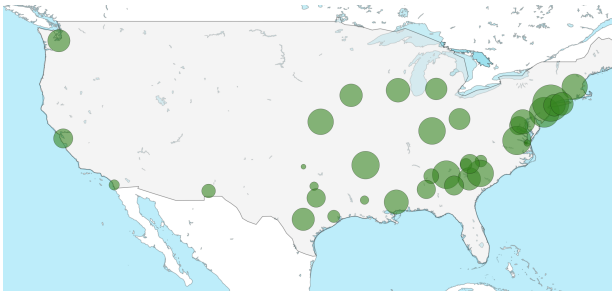


Figure: **First stage of military camp distance instrument**

IV Strategy: Distance to Military Camps

- Troops lived in close quarters, leading to rapid spread within camps, and troop movements disseminated virus across camps and to nearby cities
- Most camps established during 1917; no obvious spatial relation to war production



1918 Flu Pandemic

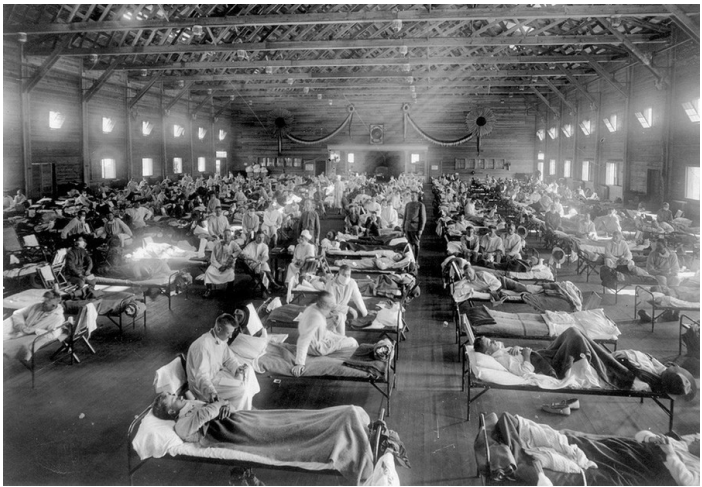
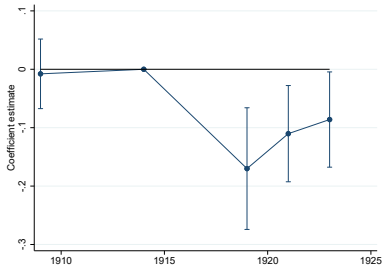


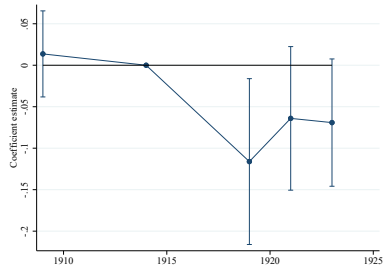
Figure: Emergency hospital near Fort Riley, Kansas in 1918. Source: National Museum of Health/AP

Military Camp IV Results

$$Y_{ct} = \alpha_c + \tau_t + \beta_j \widehat{Mortality}_{s,1918} + X_c\gamma_j + \varepsilon_{ct}$$



(a) IV-DD: Log manufacturing employment



(b) IV-DD: Log manufacturing value

Additional Results and Possible Channels

- Results robust to instrumenting with mortality in 1917, capturing baseline influenza exposure (Palmer, 2015)
- Other robustness checks
  - Controls for past growth (1909 to 1914), region-by-time fixed effects
  - WWI mortality
  - Public health institutions: number of doctors, nurses, and beds per capita
- Challenging to disentangle exact channels, but possible channels include:
  - Short-term:
    - Contraction in labor supply, spending, disruption, illness/mortality
  - Medium-term:
    - Propagation of short term shock via weaker balance sheets, production linkages…
    - Depressed natural rate and lower investment (Jorda et al 2020)
    - Mortality and morbidity (bronchitis, drowsiness, encephalitis lethargica) lowering productivity and human capital (Almond 2006, Karlsson et al 2013, Guimbeau et al 2019)

2. Economic Impact of Non-Pharmaceutical Interventions (NPIs)

Non-Pharmaceutical Interventions in the 1918 Flu Pandemic

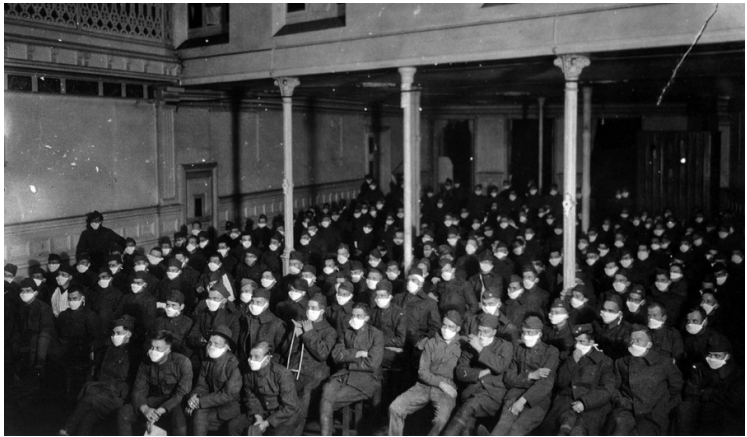


Figure: New York Health Board on masks: **“Better ridiculous than dead.”**

Non-Pharmaceutical Interventions in Fall 1918

- No coordinated federal response to Pandemic
- Implementation of NPIs at the discretion of local city officials
- Examples of NPIs implemented during fall 1918:
  - School, theater, and church closures
  - Public gathering bans (Liberty Loan parades, funerals, etc.)
  - Case isolation
  - Mandatory face-masks
  - Average of about 4 weeks (range 1-10 weeks)

- City-level NPI_{1918} measures for 43 U.S. cities from Markel et al (2007):
  1. $NPI\ Speed_{1918}$ = Number of days between NPIs are activated and when the weekly excess death rate exceeds two times the baseline death rate (mean=7.5 days)
  2. $NPI\ Intensity_{1918}$ = Cumulative days on which 3 key NPIs were activated (mean=38)

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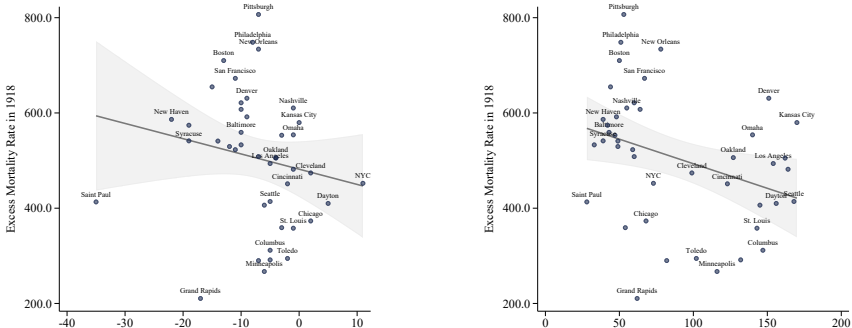
Non-Pharmaceutical Interventions Reduce Mortality



(a) Speed of NPIs

(b) Intensity of NPIs

- Large reduction in weekly peak mortality (≈50%)
- Modest reductions in cumulative mortality (≈10-30%) due to second waves (Hatchett et al 2007, Markel et al 2007, Bootsma and Ferguson 2007)
  - Reduction in peak may have limited epidemic overshoot

Identification Challenges

$$Y_{ct} = \alpha_c + \tau_t + \beta_t NPI_{c,1918} + \gamma_t X_s + \varepsilon_{ct},$$

1. $NPI\ Speed_{c1918}$
2. $NPI\ Intensity_{c1918}$

- Key concern: NPIs are endogenous!
- Possible unobserved selection: NPI more likely in cities with
  - ... better local health care system, governance, or economic prospects

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→ What is the source of variation in NPIs?

Cities in the west learned from cities in the east

- Flu arrives (red dot)
- NPI implemented (green dot; dot size by NPI intensity)

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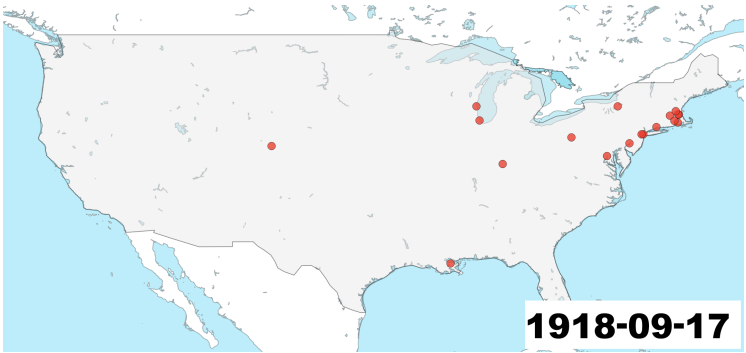

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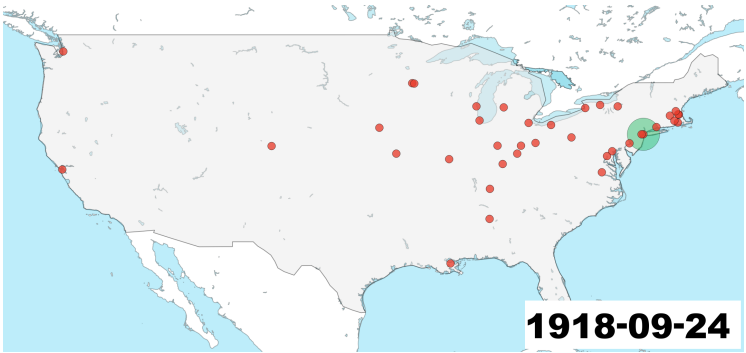

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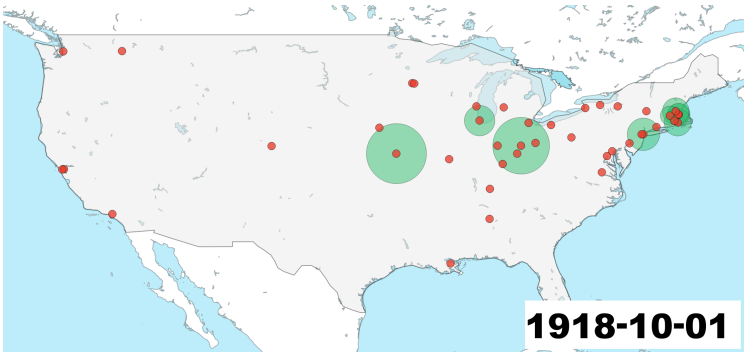
Cities in the west learned from cities in the east



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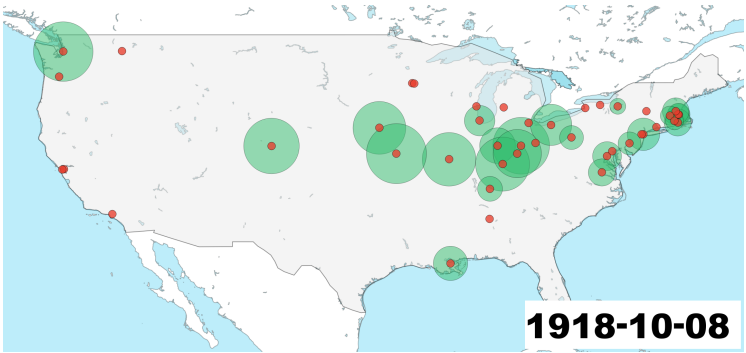

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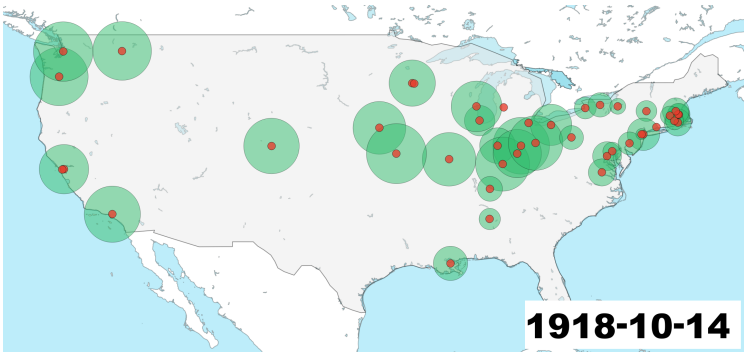

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Variation in NPIs not exclusively driven by east vs. west

Twin Cities: Minneapolis vs. St. Paul

- Officials in Minneapolis moved quickly, closed schools, churches, theaters and pool halls early October
- Across the river, St. Paul remained largely open into November, as its leaders were confident they had the epidemic under control
- The St. Paul Pioneer Press: ***In Heaven's Name Do Something!***
- Both cities, relative to the worst-hit parts of the country, escaped steep death tolls
- Mortality in Minneapolis was lower than in St. Paul, and economy emerged stronger, too

Several other examples!

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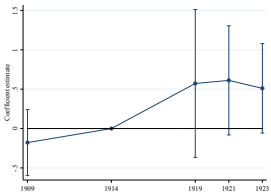
Controls

$$Y_{ct} = \alpha_c + \tau_t + \beta_t NPI_{c,1918} + \gamma_t X_s + \varepsilon_{ct},$$

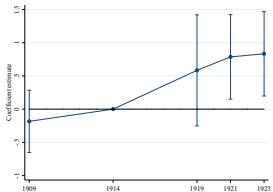
→ Include controls X_s to capture east-west differences that may interact, e.g., with end of WW1:

- Industry structure (agriculture, manufacturing)
- Income
- Public spending (total and health)
- Past mortality
- City-density
- WWI mortality
- Export intensity
- …

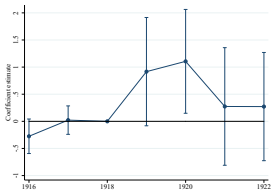
Result 2: NPIs Do Not Depress Economic Activity – *Speed of NPI*



(a) Log of manuf. employment



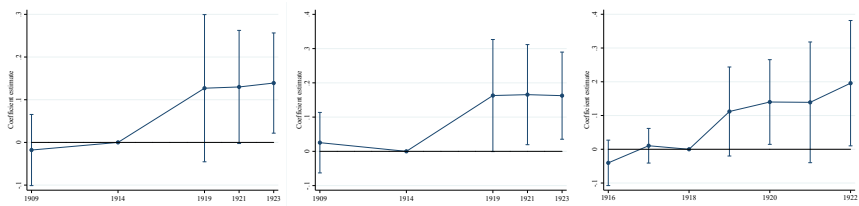
(b) Log of manuf. output



(c) Log of banking assets

$$Y_{ct} = \alpha_c + \tau_t + \beta_t NPI\ Speed_{c,1918} + \gamma_t X_s + \varepsilon_{ct},$$

Result 2: NPIs Do Not Depress Economic Activity – *Intensity of NPI*



(a) Log of manuf. employment (b) Log of manuf. output (c) Log of banking assets

$$Y_{ct} = \alpha_c + \tau_t + \beta_t NPI\ Intensity_{c,1918} + \gamma_t X_s + \varepsilon_{ct},$$

- One standard deviation increase in $NPI\ Intensity_{c1918}$ (46 days) $\Rightarrow$ 6% higher employment following pandemic

Robustness

Results are robust to a variety of tests:

- Control for longitude
- Region-time fixed effects
- Controls for city-level public health spending
- WWI related controls: City export intensity controls and WWI mortality
- Excluding California, Oregon, and Washington

Robustness checks show: *effect never becomes negative*

⇒ Absence of a negative effect implies there is no trade-off between mortality and economic activity in annual data

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Why Might NPIs Not Be Economically Costly?

- Direct effect: NPIs restrict social interactions and thus depress ordinary economic activity
  - Households **cannot** consume or work
- However, the pandemic *itself* also disrupts the economy
  - Households do not want to consume or work if they risk contracting the virus
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  - Moderate NPIs that lowering peak mortality can limit largest economic disruptions (Bodenstein et al 2020)
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The Economic Costs and Merits of NPIs

Assume reduced form relationship:

$$Y_c = f(NPI_c, Pandemic_c(NPI_c))$$

Net effect of NPI is sum of direct and indirect effects:

$$\underbrace{\frac{dY_c}{dNPI_c}}_{\text{Net}} = \underbrace{\frac{\partial f}{\partial NPI}}_{<0} + \underbrace{\frac{\partial f}{\partial Pandemic_c}}_{<0} \times \underbrace{\frac{dPandemic_c}{dNPI}}_{>0}$$

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The economic costs and merits of NPIs: External validity?

What are the estimates today?

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Conclusion

Key Findings:

1. 1918 Flu Pandemic led to large economic costs in more exposed regions
2. NPIs were not associated with worse economic performance in annual data

- Caveats:
  - Data limitations
  - Unusual economic environment at the end of WWI
  - Caution with extrapolating to 2020

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→ **1918 Flu Pandemic suggests its not a given that there is tradeoff between public health interventions and the economy**

Thank you for your attention!

Fast and Slow NPI Cities Similar on Economic Observables

- Cities that were quick in implementing NPIs are comparable to slow NPI cities in terms of population and economic structure…

	Below median $NPI\ Speed_{c18}$		Above median $NPI\ Speed_{c18}$		Difference	
	Mean	Std	Mean	Std	Diff	t-stat
$NPI\ Speed_{c1918}$	-12.8	6.6	-1.6	4.1	11.2	6.754
$NPI\ Intensity_{c1918}$	56.9	24.9	121.2	40.6	64.3	6.224
Longitude	-81.2	12.7	-93.7	16.5	-12.5	-2.786
Log city population, 1910	12.4	0.726	12.5	1.0	0.1	0.527
Log manuf. employment, 1914	10.3	0.8	10.2	1.3	-0.1	-0.278
Per-capita income in 1910, state-level	877.6	211.4	883.2	181.6	5.6	0.093
Manuf. empl. in 1914 to 1910 pop	14.3	7.2	11.2	5.3	-3.1	-1.616
Agr. empl. share in 1910, state-level	19.0	17.9	27.0	12.8	8.0	1.702