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

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[PRELIMINARY – COMMENTS WELCOME]

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Abstract

What are the economic consequences of an influenza pandemic? And given the pandemic, what are the economic costs and benefits of non-pharmaceutical interventions (NPI)? Using geographic variation in mortality during the 1918 Flu Pandemic in the U.S., we find that more exposed areas experience a sharp and persistent decline in economic activity. The estimates imply that the pandemic reduced manufacturing output by 18%. The downturn is driven by both supply and demand-side channels. Further, building on findings from the epidemiology literature establishing that NPIs decrease influenza mortality, we use variation in the timing and intensity of NPIs across U.S. cities to study their economic effects. We find that cities that intervened earlier and more aggressively do not perform worse and, if anything, grow faster after the pandemic is over. Our findings thus indicate that NPIs not only lower mortality; they also mitigate the adverse economic consequences of a pandemic.

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1 Introduction

The outbreak of the COVID-19 pandemic has sparked urgent questions about the impact of pandemics and the associated public health responses on the real economy. Policymakers are in uncharted territory, with little guidance on what the expected economic fallout will be and how the crisis should be managed. In this paper, we address two sets of questions. First, what are the real economic effects of a pandemic? Are the economic effects temporary or persistent? Second, how does the local public health response affect the economic severity of the pandemic? Do non-pharmaceutical interventions (NPIs) such as social distancing have economic costs, or do policies that slow the spread of the pandemic also reduce its economic severity?

To answer these questions, we study the economic effects of the largest influenza pandemic in U.S. history, the 1918 Flu Pandemic. For our analysis, we exploit spatial variation in both the severity of the pandemic, as well as the speed and duration of NPIs implemented to fight disease transmission. NPIs implemented in 1918 resemble many of the policies used to reduce the spread of COVID-19, including school, theaters, and church closures, public gathering and funeral bans, quarantine of suspected cases, and restricted business hours.

Our analysis yields two main insights. First, we find that areas that were more severely affected by the 1918 Flu Pandemic see a sharp and persistent decline in real economic activity. Second, we find that early and extensive NPIs have no adverse effect on local economic outcomes. On the contrary, cities that intervened earlier and more aggressively experience a relative increase in real economic activity after the pandemic. Altogether, our findings suggest that pandemics can have substantial economic costs, and NPIs can have economic merits, beyond lowering mortality.

With respect to the economic effects of the pandemic, we find that more severely affected areas experience a relative decline in manufacturing employment, manufacturing output, bank assets, and consumer durables. Our estimates imply that the 1918 Flu

Pandemic led to an 18% reduction in state manufacturing output for a state at the mean level of exposure. Exposed areas also see a rise in bank charge-offs, reflecting an increase in business and household defaults. These patterns are consistent with the notion that pandemics depress economic activity through reductions in both supply and demand (see, e.g., Eichenbaum et al., 2020). Importantly, the declines in all outcomes are persistent, and more affected areas remain depressed relative to less exposed areas from 1919 through 1923.[1]

The main concern with our empirical approach is that areas with higher exposure to the 1918 Flu Pandemic may simultaneously be more exposed to other economic shocks. However, although it was more severe in the eastern U.S., previous studies argue that the geographic spread of the pandemic was somewhat arbitrary (Brainerd and Siegler, 2003). Consistent with this, we find that severely and moderately affected areas have similar levels of population, employment, and income per capita before 1918. We also find that the results are robust to controlling for time-varying shocks that interact with a variety of local economic characteristics, including state sectoral employment composition. The effects are also similar when exploiting both city and state-level variation in influenza exposure. Further, the results are similar when using 1917 influenza mortality as an instrument for 1918 mortality. This exercise utilizes variation in the 1918 Flu driven by local predisposition to influenza outbreaks due to climate, immunological, and socioeconomic factors, which in ordinary years would not cause economic disruption. Consistent with this empirical evidence, the large economic disruption caused by the pandemic is also evident in narrative accounts from contemporaneous newspapers.[2]

Our second set of results center on the local economic impact of public NPIs. In theory, the economic effects of NPIs could be both positive or negative. All else equal, NPIs constrain social interactions and thus economic activity that relies on such interactions. However, in a pandemic, economic activity is also reduced in absence of such measures,

[1]Using data on dividend futures, Gormsen and Koijen (2020) find that expectations reflected in market prices at the onset of the COVID-19 outbreak also point to a persistent decline in real GDP.

[2]See appendix B.

as households reduce consumption and labor supply to lower the chance of becoming infected. Thus, while NPIs lower economic activity, they can solve coordination problems associated with fighting disease transmission and mitigate the pandemic-related economic disruption.

Comparing cities by the speed and aggressiveness of NPIs, we find that early and forceful NPIs do not worsen the economic downturn. On the contrary, cities that intervened earlier and more aggressively experience a relative increase in manufacturing employment, manufacturing output, and bank assets in 1919, after the end of the pandemic. The effects are economically sizable. Reacting 10 days earlier to the arrival of the pandemic in a given city increases manufacturing employment by around 5% in the post period. Likewise, implementing NPIs for an additional 50 days increases manufacturing employment by 6.5% after the pandemic.

Our findings are subject to the concern that policy responses are endogenous and may be driven by factors that are related to future economic outcomes, such as the baseline exposure of cities to flu-related mortality, as well as differences in the quality of local institutions and healthcare. This concern is somewhat mitigated by the insight from the epidemiology literature that cities that were affected in later dates appeared to have implemented NPIs sooner within their outbreak, as they were able to learn from the earlier experiences of other cities (Hatchett et al., 2007). Thus, as the flu moved from east to west, cities located further west were much faster in implementing NPIs. Importantly, we thus also show that our results are robust to controlling for time-varying shocks that are correlated with characteristics that differ between western and eastern cities, such as the exposure to agricultural shocks.

Due to the lack of higher frequency data, we cannot pinpoint the exact dynamics and mechanism through which NPIs mitigate the adverse economic consequences of the pandemic. However, the patterns we identify in the data suggest that timely and aggressive NPIs can limit the most disruptive economic effects of an influenza pandemic. The epidemiology literature finds that early public health interventions reduce peak mortality rates—flattening the curve—and cumulative mortality rates (Markel et al., 2007; Bootsma and Ferguson, 2007). Because the pandemic is highly disruptive for the local economy, these efforts can mitigate the abrupt disruptions to economic activity. As a result, the swift implementation of NPIs can also contribute to "flattening the economic curve," beyond more traditional economic policy interventions (Gourinchas, 2020).

Anecdotal evidence suggests that our results have parallels in the COVID-19 outbreak. Countries that implemented early NPIs such as Taiwan and Singapore have not only limited infection growth. They also appear to have mitigated the worst economic disruption caused by the pandemic.[3] Well-calibrated early and forceful NPIs should therefore not be seen as having major economic costs in a pandemic.

The rest of the paper is structured as follows. Section 2 discusses the historical background on the 1918 pandemic and the related literature. Section 3 describes our dataset. Sections 4 and 5 present our results on the real economic effects of the pandemic and the the economic impact of NPIs, and Section 6 offers concluding remarks.

2 Historical Background and Related Literature

The 1918 Flu Pandemic lasted from January 1918 to December 1920, and it spread worldwide. It is estimated that about 500 million people, or one-third of the world's population, became infected with the virus. The number of deaths is estimated to be at least 50 million worldwide, with about 550,000 to 675,000 occurring in the United States. The pandemic thus killed about 0.66 percent of the U.S. population. A distinct feature of the 1918-19 influenza pandemic was that it resulted in high death rates for 18-44 year old adults and healthy adults. Figure 1 shows the sharp spike in mortality from influenza and pneumonia in 1918.

The pandemic came in three different waves, starting with the first wave in spring

[3] For example, Danny Quah notes that Singapore's management of COVID-19 has avoided major disruptions to economic activity without leading to a sharp increase in infections through the use of forceful, early interventions (link to VoxEU interview).

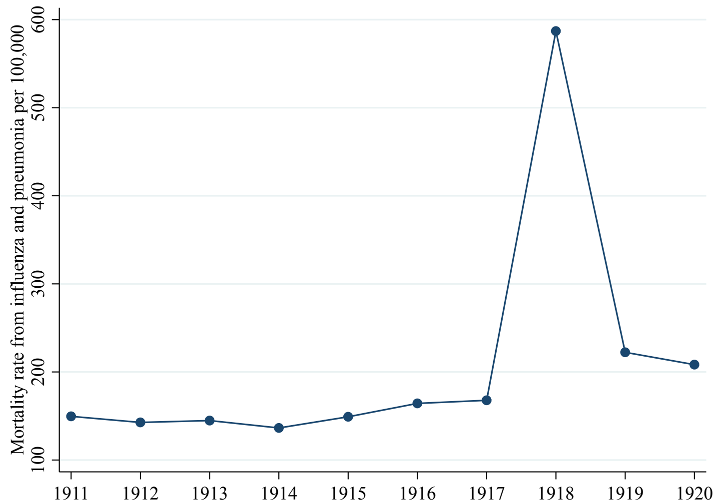


Figure 1: **U.S. mortality rate from influenza and pneumonia, 1911-1920.** Source: CDC *Mortality Statistics*

1918, a second wave in fall 1918, and a third wave in the winter of 1918 and spring of 1919. The pandemic peaked in the U.S. during the second wave in the fall of 1918. This highly fatal second wave was responsible for most of the deaths attributed to the pandemic in the U.S. The severity of the pandemic varied widely across U.S. regions, but previous research argues that regional variation in the spread and severity is somewhat arbitrary (Brainerd and Siegler, 2003).[4] In the United States, the virus was first identified in military personnel in spring 1918. Mass troop movements during the closing stages of WWI contributed to the spread of the flu in the U.S. and around the world.

The public health policy response resembles the current response in the COVID-19 pandemic in many ways. Eventually, all major cities adopted some form of non-pharmaceutical public health intervention (NPI) to promote social distancing, case isolation, and public hygiene. However, there was substantial variation across cities in the speed and aggressiveness of these measures, which we examine in section 5. The epidemiology

[4]For example, Brainerd and Siegler (2003) write: "...there is no discernible regional pattern in the severity of the epidemic.... The Northern area had the county with the highest mortality rate (Lake, 8.31), as well as the county with one of the lowest rates (Adams, 1.60).... Unlike previous epidemics which traveled on a slow east-west axis, the Spanish Lady struck in a sudden, random fashion." We find that the pandemic was stronger in the east, but there is considerable variation within longitude. We present evidence on the correlates of regional exposure to the pandemic in section 4.

literature on the 1918 Flu finds that early NPIs led to significant reductions in peak mortality and moderate, but meaningful, reductions in cumulative mortality by reducing epidemic overshoot (see, e.g., Bootsma and Ferguson, 2007; Markel et al., 2007; Hatchett et al., 2007)).

There is limited evidence on the short-run economic effects of the 1918 Flu Pandemic and resulting NPIs in the U.S. Garrett (2008) provides narrative evidence from local newspaper reports that the pandemic caused severe disruption to businesses in many sectors of the economy. Garrett (2009) finds that geographic areas with more influenza exposure saw a relative increase in wages, consistent with labor shortages. A recent study by Barro et al. (2020) uses country-level data and find that higher mortality in the 1918 flu pandemic lowered real GDP by 6-8% in the typical country.

Recent theoretical work by Eichenbaum et al. (2020) extends a canonical epidemiology model to study the interaction between economic decisions and the epidemic. Their findings suggest that people's decision to cut back on consumption and work as a response to increased disease transmission risk reduces the severity of the epidemic, as measured by total deaths. Their model suggests that containment policies require lower economic activity in order to lower mortality, while our empirical findings suggest that swift NPIs can actually lower mortality without lowering economic output in the medium term.

Several studies explore the long-run implications of the 1918 Flu. Brainerd and Siegler (2003) find that states with higher 1918 influenza mortality experience *stronger* per capita income growth in the long-run, from 1919 to 1929. Brainerd and Siegler (2003) argue this evidence is consistent with growth models in which a reduction in labor increase the capital labor ratio and subsequent growth. In contrast, using more dis-aggregated variation, Guimbeau et al. (2019) find negative effects of the 1918 flu on long-term health and productivity in São Paulo, Brazil.[5] We instead focus on the short and medium run dynamic impact of the pandemic and NPI on local real activity, but our evidence on persistent negative effects of the pandemic is consistent with Guimbeau et al. (2019).

[5] Almond (2006) finds that cohorts in utero during the pandemic displayed worse education and labor market outcomes in adulthood.

3 Data

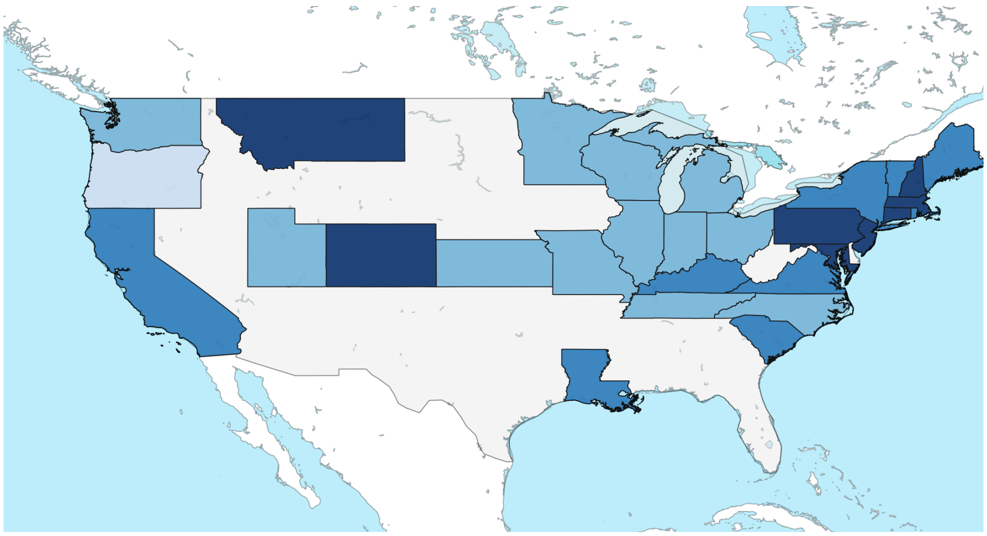
We build a regional data set for the years around the 1918 pandemic with information on influenza mortality, economic activity, bank balance sheets, and non-pharmaceutical public health interventions. We use data at both the state and city level. The analysis on the real economic effects of the pandemic in section 4 relies primarily on state-level data, as we have more outcomes of interest at the state-level. The analysis on the effects of NPIs in section 5 relies on city-level data, as public health interventions were mostly implemented in larger cities.

Influenza mortality at the state and city level are from the Center for Disease Control's (CDC) *Mortality Statistics* tables. Previous studies argue that death rates are a more accurate measure of the severity of the outbreak than case numbers, so we use death rates from influenza and pneumonia (see, e.g. Hatchett et al., 2007). Influenza mortality in 1918 is available for 30 states and 66 cities. Panel (a) of Figure 2 provides a map of state-level influenza mortality in 1918.

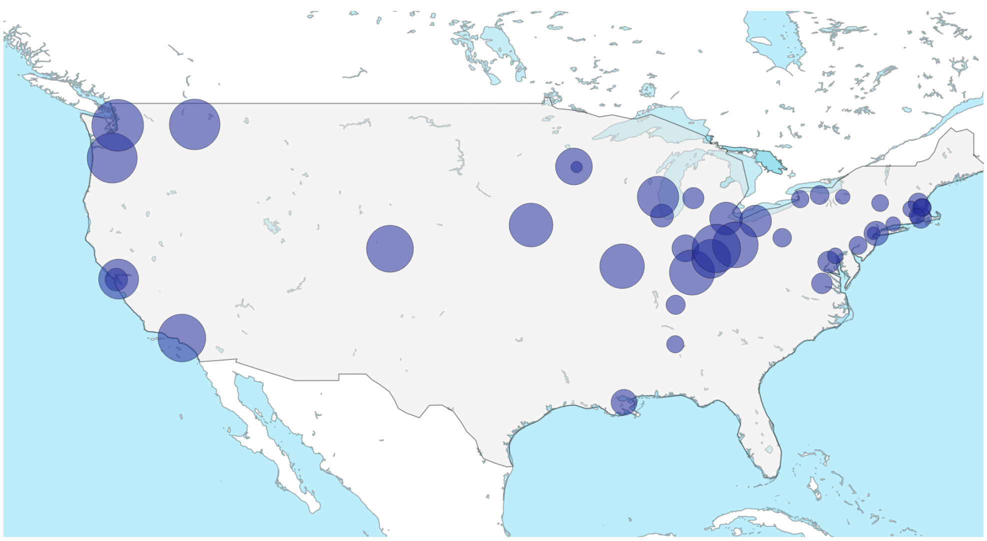
Measures of real economic activity are from a variety of sources. We digitize information on state and city-level manufacturing activity from the Census Bureau's *Statistical Abstract of the United States*, based data from the Census of Manufactures. Manufacturing data on employment and output are available in 1909 (only for states), 1914, 1919, 1921, and 1923. Annual state-level banking data are from Mark D. Flood's *Historical Statistics on U.S. Banking*, based on *Annual Reports of the Comptroller of the Currency*.[6] City-level banking data are digitized from the same source. We also digitize information on the stock of registered motor vehicles in a state from various years of the *Statistical Abstract*.

For city-level NPIs, we rely on data by Markel et al. (2007), who gather detailed information on NPIs for 43 major U.S. cities from municipal health department bulletins, local newspapers, and reports on the pandemic. NPI measures consist of school closure, public gathering bans, and isolation and quarantine. Markel et al. (2007) record information

[6]The data are available online: `http://www.flood-dalton.org/mark/research/bankdata-hist.html`.



(a) Sample of 30 states with mortality in 1918. High mortality (dark blue) - low mortality (light blue).



(b) Sample of 43 cities with NPIs in fall 1918. Radius is scaled by the number of days with NPIs in place.

Figure 2: **Geographic variation in mortality across states (panel (a)) and NPI aggressiveness across cities (panel (b)).**

on (i) the speed of the NPI response, and (ii) the number of days that NPI measures were in place. The speed of the NPI response is defined as the number of days between when the weekly excess death rate exceeds two times the baseline influenza and pneumonia death rate and the date that an NPI measure is activated. The city-level NPI measures are listed in Appendix Table A1. Panel (b) of Figure 2 provides a map of the 43 cities in our sample.

Finally, we collect variables used to control for baseline differences across states and cities. State agriculture and manufacturing employment shares, state and city population, and the urban population share are from the 1910 census. State 1910 income per capita estimates are from Lindert (1978).[7] We also use annual state-level population estimates from the Census Bureau.

4 Economic Effects of the 1918 Flu Pandemic

4.1 Conceptual issues

In this section, we examine how the 1918 influenza outbreak affects local economic activity in the short and medium-run. This raises the question: What are the channels through which the outbreak affects local economic activity? The influenza outbreak likely has meaningful effects on both the supply and demand-side of the economy (Eichenbaum et al., 2020). While disentangling the exact mechanisms is challenging, several empirical tests can nonetheless shed light on the relevant channels.[8]

On the supply side, a more severe influenza outbreak depresses labor supply through self-isolation measures from increased risk of contracting the virus, restrictions on mobility, illness, and increased mortality. Moreover, the pandemic also causes a general upheaval of ordinary economic activity. For example, efforts to limit crowds reduces the number of employees operating equipment in a manufacturing establishment and even the closure

[7] Income per capita estimates are missing for 12 states. For these states we set income to the national level.
[8] Moreover, some effects cannot be neatly classified as affecting only supply or demand.

of some business establishments. The supply-side effects should be reflected in reduced activity in all local economic sectors, including tradable sectors such as manufacturing.[9]

The influenza outbreak can also depress demand through a variety of channels. Social distancing measures reduce demand for spending on purchases requiring interpersonal contact. Current and expected future income declines from supply-side disruptions will weigh negatively on demand. Increased uncertainty about future income and employment prospects also depress current demand, especially for durable goods. Similarly, increased business uncertainty about future demand depresses business investment.

The banking system plays a potentially important role in the severity of both the decline in demand and productive capacity. Given that the pandemic itself is temporary, one should expect to see increased demand for liquidity (Holmström and Tirole, 1998). A healthy banking system can provide this liquidity, mitigating the severity of the decline in demand and production. However, if the shock leads to widespread defaults, it may stress the banking system and potentially lead to a financial crisis. In this case, bank losses may act as an important amplification mechanism through a reduction in credit availability.

4.2 Empirical specification

We estimate the dynamic impact of local exposure to the Spanish influenza using the following specification:

$$Y_{st} = \alpha_s + \tau_t + \sum_{j \neq 1918} \beta_j \, Mortality_{s,1918} \, \mathbf{1}_{j=t} + \sum_{j \neq 1918} X_s \gamma_j \mathbf{1}_{j=t} + \varepsilon_{st} \tag{1}$$

where Y_{st} is an outcome such as manufacturing employment in a local area s in year t. We estimate (1) at both the state and city level to maximize our sample size and regional variation. State-level estimates are reported below, and city-level estimates are in the appendix. We cluster standard errors at the state or city level, depending on the

[9]Supply-chain disruptions and other spillovers from more severely to less severely affected areas are also likely to play an important role in 1918-19, as they do today. Our state and city-level analysis will not fully capture these equilibrium effects.

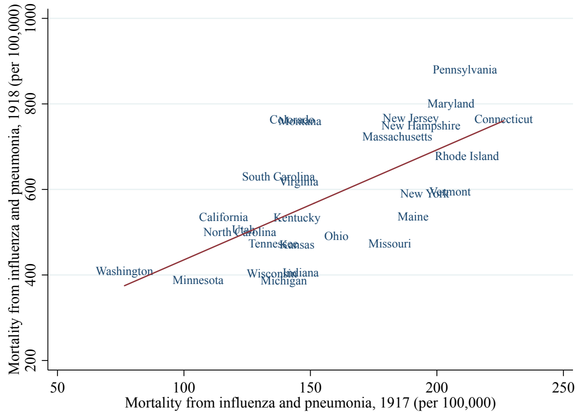
unit of observation. The sequence of coefficients β_j captures the dynamics of severely affected areas such as Pennsylvania/Philadelphia relative to mildly affected areas such as Minnesota/Minneapolis.

Our baseline measure of local exposure to the 1918 pandemic is the local mortality rate in 1918, $Mortality_{s,1918}$. The identifying assumption behind estimation of (1) is that $Mortality_{s,1918}$ is not correlated with other time-varying, regional economic shocks. While there is significant geographic variation in the severity of the pandemic, studies argue that the spread of the virus was somewhat arbitrary and that regional variation in mortality was largely orthogonal to *ex ante* economic conditions (Brainerd and Siegler, 2003). Eastern states and cities were more severely affected, as the influenza arrived from Europe and travelled from east to west.

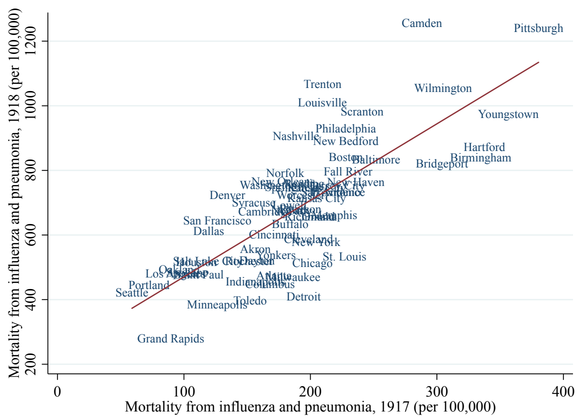
Table A3 shows that high and low $Mortality_{s,1918}$ states are broadly similar in terms of population, pre-pandemic manufacturing employment and output, and pre-pandemic income per capita. High mortality states do, however, have a smaller fraction of workers employed in the agriculture sector, a higher manufacturing share, and a higher urban share. Urban areas with greater manufacturing activity were more exposed to the flu due to higher density.

Beyond potential simultaneity between 1918 influenza mortality and economic conditions from 1918 onward, it is not obvious that $Mortality_{s,1918}$ would be correlated with other economic shocks. Nevertheless, the period 1918-1921 witnessed a variety of macroeconomic shocks, most notably the end of WWI, a large agricultural boom and bust cycle, and a severe recession in 1920-21. To account for potential differential exposure to these shocks, we control for the agriculture employment share, manufacturing employment share, urban population share, population, and income per capita, represented by X_s in (1). All controls are measured before the 1918 pandemic and are always interacted with time fixed effects to control for time-varying shocks that are correlated with baseline differences across regions.

As a supplementary identification strategy, we also instrument $Mortality_{s,1918}$ with



(a) State-level



(b) City-level

Figure 3: **Influenza mortality in 1917 predicts mortality in 1918.**

ex ante influenza exposure. A strong predictor of influenza mortality in 1918 is the influenza mortality in previous years. Figure 3 shows a strong linear relation between mortality in 1917 and 1918 across states and cities. This suggests that certain areas are more susceptible to influenza outbreaks due to a combination of climatic, socioeconomic, and immunological factors. To address any direct simultaneity between mortality in 1918 and economic conditions from 1918 onward, we therefore also use 1917 mortality as an instrument for $Mortality_{s,1918}$. This approach is similar in spirit to Palmer (2015), who exploits past regional cyclicality in house prices as an instrument for house price volatility in the 2000s housing boom and bust.

4.3 Results

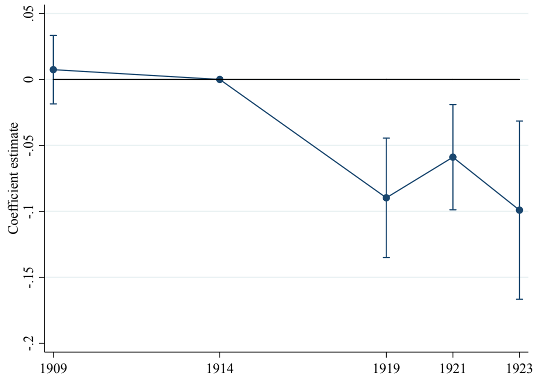
4.3.1 Manufacturing activity

Figure 4 presents the results from estimation of (1) for a variety of state-level outcomes.[10] Panels (a)-(c) show that high $Mortality_{s,1918}$ exposure leads to a significant decline in manufacturing employment and output from 1914 to 1919 census years. Both log employment and the employment-to-population ratio decline, indicating that the fall in employment is not only a direct consequence of deaths caused by the pandemic. Instead, the pandemic appears to cause broader disruption of manufacturing activity. Notably, the employment and output declines in high exposure states are persistent, and there is limited evidence of a reversal, even by 1923. Although we cannot assess pre-trends between 1914 and 1919, Figure 4(a)-(c) shows that high and low $Mortality_{s,1918}$ states had similar manufacturing activity growth from 1909 to 1914, which supports the assumption of parallel trends.

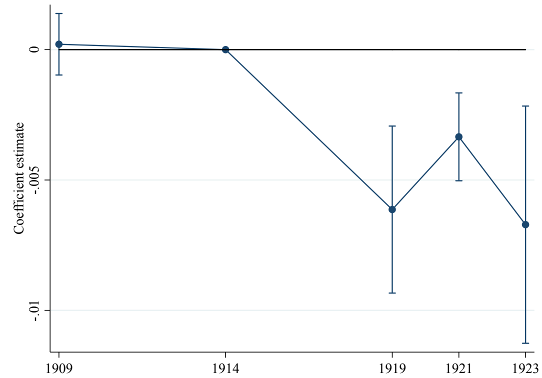
Table 1 presents the regression version of Figure 4. We collapse the time variable to years up to 1918 and years after 1918, captured by Post_t. Columns 1-3 show that the negative effect of higher influenza exposure on manufacturing activity is statistically significant in specifications both without controls (panel A), with controls (panel B), and when instrumenting $Mortality_{s,1918}$ with 1917 mortality (panel C).

In terms of magnitudes, the estimates in panel A imply that a one standard deviation increase in $Mortality_{s,1918}$ (147.7 per 100,000) leads to a 8% decline in manufacturing employment, a 0.5 percentage point fall in the employment-to-population ratio, and an 6% fall in output. The increase in mortality from the 1918 pandemic relative to 1917 mortality levels (416 per 100,000) implies a 23% fall in manufacturing employment, 1.5 percentage point reduction in manufacturing employment to population, and an 18% fall in output. Because manufacturing should be relatively insensitive to changes in local demand (Mian et al., 2020), the meaningful reduction in local manufacturing activity indicates that influenza exposure depresses the supply-side of the economy.

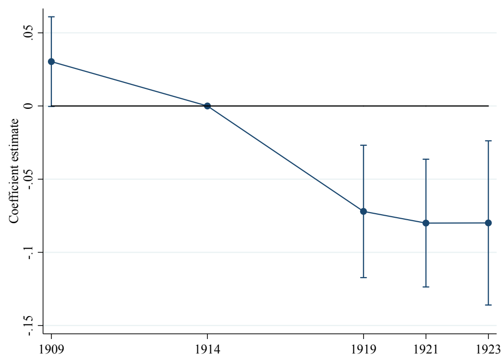
[10] Appendix Figure A1 shows that the results for manufacturing activity and bank assets are similar at the city level.



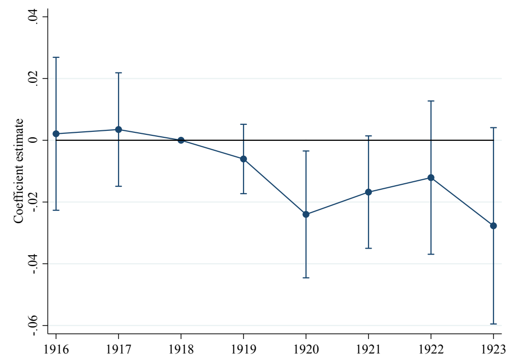
(a) Log manufacturing employment



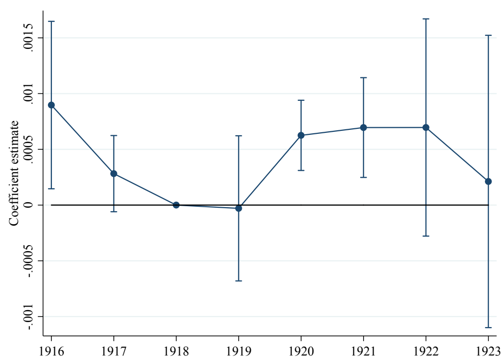
(b) Manufacturing employment to population ratio



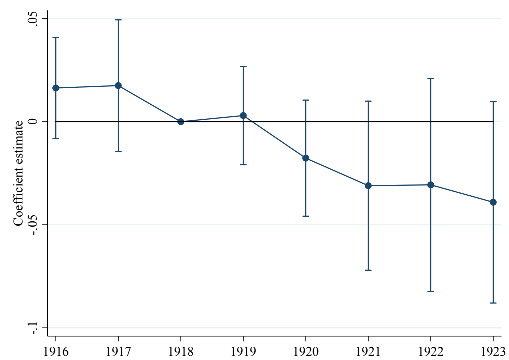
(c) Log manufacturing output



(d) Log total bank assets, all banks



(e) Losses charged-off to assets, National banks



(f) Log motor vehicle registrations

Figure 4: **Economic effects of 1918 Flu Pandemic – state-level evidence.** Results from estimating equation (1). 95% confidence bands.

4.3.2 Bank assets and losses

Figure 4 panel (d) plots the impact of state influenza exposure on total bank assets for all banks in a state, and Table 1 column 4 reports the corresponding regression estimate. The annual bank asset measure indicates that bank assets evolved in parallel in high and low $Mortality_{s,1918}$ states before 1918, consistent with parallel trends. After the influenza outbreak in the fall of 1918, high $Mortality_{s,1918}$ witness a gradual decline in bank assets in 1919 and 1920. Similar to the evidence on manufacturing activity, the reduction in bank assets is persistent. In terms of magnitudes, a one standard deviation increase in $Mortality_{s,1918}$ is associated with a 4% reduction in bank assets.

Why do bank assets decline in more in high $Mortality_{s,1918}$ areas? The decline in bank assets may simply reflect a reduction in credit demand due to falling real activity. However, bank assets may also fall due to a reduction in credit supply. If banks experience losses and raising new equity is costly, banks will need to contract their balance sheets in order to maintain sufficient capital ratios. Figure 4 panel (e) shows that National banks indeed saw an increase in losses charged off relative to assets in 1920-21, indicating an increase in non-performing loans in 1919-20.

4.3.3 Durable spending

Figure 4 panel (f) presents the estimates of equation (1) with the log of the number of motor vehicles registered in a state as the dependent variable. This measure proxies for the stock of consumer durables owned by local households, and changes in this measure provide a proxy for durable spending. Panel (f) shows that high $Mortality_{s,1918}$ states see a gradual decline in the stock of registered vehicles, relative to low $Mortality_{s,1918}$ states. The decline in the stock suggests a fall in spending on motor vehicles in 1919 and 1920 in more affected states, indicating that the pandemic depressed local demand for durables.

Table 1: **Impact of Spanish Influenza Exposure on State Economic Activity**

	Log Man. Emp.	Man. Emp. to Pop.	Log Man. Output	Log Bank Assets	Bank Losses	Log Vehicles
Panel A: No controls						
	(1)	(2)	(3)	(4)	(5)	(6)
$Mortality_{s,1918} \times \text{Post}_t$	-0.057***	-0.0037***	-0.045**	-0.027***	0.000024	-0.028**
	(0.018)	(0.0012)	(0.018)	(0.0092)	(0.00020)	(0.013)
R^2 (within)	.28	.081	.79	.71	.13	.72
N	120	120	120	210	210	210
No of states	30	30	30	30	30	30
State and Post FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	No	No	No	No	No
Panel B: With controls × Post						
	Log Man. Emp.	Man. Emp. to Pop.	Log Man. Output	Log Bank Assets	Bank Losses	Log Vehicles
	(1)	(2)	(3)	(4)	(5)	(6)
$Mortality_{s,1918} \times \text{Post}_t$	-0.083***	-0.0054***	-0.077***	-0.014	0.00014	-0.020
	(0.021)	(0.0013)	(0.017)	(0.0085)	(0.00025)	(0.013)
R^2 (within)	.33	.099	.81	.77	.16	.74
N	120	120	120	210	210	210
No of states	30	30	30	30	30	30
State and Post FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Panel C: Instrumenting with $Mortality_{s,1917}$						
	Log Man. Emp.	Man. Emp. to Pop.	Log Man. Output	Log Bank Assets	Bank Losses	Log Vehicles
	(1)	(2)	(3)	(4)	(5)	(6)
$Mortality_{s,1918} \times \text{Post}_t$	-0.091***	-0.0050***	-0.072***	-0.028***	0.00010	-0.0053
	(0.025)	(0.0019)	(0.020)	(0.010)	(0.00025)	(0.012)
First stage F-stat (KP)	37.1	37.1	37.1	38.0	38.0	38.0
N	108	108	108	189	189	189
No of states	27	27	27	27	27	27
State and Post FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The table reports results from estimating a regression of the following form:

$$Y_{st} = \alpha_s + \beta \times Mortality_{s,1918} \times \text{Post}_t + \delta \times \text{Post}_t + \gamma \times X_s \times \text{Post}_t + \varepsilon_{st},$$

where $MORT_{s1918}$ is state mortality from influenza and pneumonia in 1918, Post_t is a dummy variable that takes the value of one after 1918. Controls in X_s are the 1910 agriculture employment share, 1910 manufacturing employment share, 1910 urban population share, 1910 income per capita, and log 1910 population. Census of Manufactures outcomes (columns 1-3) are available in 1914, 1919, 1921,and 1923. The remaining outcomes are annual from 1916 to 1922.

Standard errors clustered at the state level in parentheses; *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

5 Economic Effects of Non-pharmaceutical Public Interventions

The previous section established that the 1918 Flu Pandemic has severe adverse effects on the real economy. We next study the economic effects of NPIs that intend to slow the rise of infections and lower mortality. In theory, the net effects of NPIs on economic activity could be either positive or negative. On the one hand, NPIs constrain social interactions while they are in place, and thus necessarily depress any type of economic activity that relies on such interactions. On the other hand, because the pandemic itself has severe economic consequences, by reducing the severity of the pandemic, NPIs can mitigate the most severe economic disruptions. While an interruption of economic activity may be inevitable, this interruption can be shorter-lived and less extensive with NPIs in place that solve coordination problems.

As with our analysis the real effects in the previous section, the nature of the historical data do not allow us to identify the exact channels through which NPIs affect real economic outcomes. However, our data allow us to speak to the empirical question of whether NPIs are economically costly on net and whether there is an obvious trade-off between mortality and economic outcomes.

5.1 Identification

In order to identify the effect of NPIs, we exploit variation in the speed and aggressiveness in the implementation of NPIs across major U.S. cities. Most U.S. cities applied a wide range of NPIs in fall 1918 during the second and most deadly wave of the 1918 Flu Pandemic. The measures applied include social distancing measures such as the closure of schools, theaters, and churches, the banning of mass gatherings, but also other measures such as mandated mask wearing, case isolation, making influenza a notifiable disease, and public disinfection/hygiene measures.

The epidemiology literature has studied NPIs and their effect on local mortality in depth. Altogether, the evidence suggests that the implementation of NPIs was associated with reduced disease transmission (see, e.g., Bootsma and Ferguson, 2007; Hatchett et al., 2007; Markel et al., 2007). In particular, early interventions—measures undertaken right after the flu arrived in a location—achieved reductions in overall mortality. Even larger reductions in peak mortality were achieved by extending the epidemic for longer—i.e., by flattening the curve—and by intervening more aggressively, measured by the number of actions undertaken and the days they were in place. In an illustrative case study, Hatchett et al. (2007) study the differences in NPIs and mortality rates between Philadelphia and St. Louis. City officials in Philadelphia intervened only very late and even allowed major public gathering such as a widely attended Liberty Loan parade to take place. As a consequence, Philadelphia saw a considerable increase in flu-related mortality during fall 1918. City officials in St. Louis, in contrast, intervened swiftly, and the ultimate mortality rate was substantially lower.

For our analysis, we make use of measures on the speed and aggressiveness of NPIs constructed by Markel et al. (2007), who gather data on NPIs for 43 cities. In particular, following their approach, we measure NPIs in two ways. First, we measure how quickly an NPI was implemented by the number of days between when the city death rate exceeded twice its baseline death rate and the first day city officials enforced a local NPI. We multiply the day count by minus one so that higher values indicate a faster response and denote this measure by $NPI\,Speed_{c1918}$.[11] Second, we measure the aggressiveness of NPIs by the total number of days NPIs were in place in fall 1918, denoted by $NPI\,Days_{c18}$.

A main concern for our empirical approach is that the policy response may be endogenous. For instance, local officials may be more inclined to intervene if the local exposure to the flu is higher, which in turn may be correlated with other factors such as socio-demographic or geographic characteristics (Bootsma and Ferguson, 2007). Moreover, an alternative concern is that interventions reflect the quality of local institutions, including the local health care system. Places with better institutions may have lower costs of

[11] A positive value for $NPI\,Speed_{c1918}$ implies that a city implemented NPIs before the death rate exceeded two times its base rate. This raises an endogeneity concern. If the NPI has an immediate effect on mortality, the number of days until mortality increases will be endogenous. Note, however, that this is only the case in three cities (see Table A1 in the Appendix). All of our results are robust to excluding those cities.

intervening, as well as higher growth prospects.

There are, however, important details that suggest that the variation across cities is unrelated to economic fundamentals and is instead largely explained by city location. First, local responses were not driven by a federal response, as no coordinated pandemic plans existed.[12] Second, as discussed in Section 2, the second wave of the 1918 flu pandemic swept the country from east to west, affecting cities and states in the eastern part of the country earlier and more severely. Given the timing of the influenza wave, cities that were affected later appeared to have implemented NPIs sooner as they were able to learn from cities that were affected in the early stages of the pandemic (Hatchett et al., 2007). Consequently, the distance to the east coast seems to be best in explaining variation in NPIs across cities (see also Figure 2).The main identification concern thus becomes that differences across areas with aggressive and less aggressive NPIs are driven by a differential responses of cities in the west to the end of WWI, for instance, because they are more exposed to the agricultural boom and bust (Rajan and Ramcharan, 2015).[13]

Table A5 gives a sense of the differences between cities that were fast in implementing NPIs and have above median $NPI\,Speed_{c1918}$ and those that reacted slowly and have below-median $NPI\,Speed_{c1918}$. The above-median cities on average implemented the first NPI about 2 days after the mortality rate was twice its base level. In contrast, below-median cities only reacted on average after 13 days. Similarly, above-median cities on average had NPIs in place for 121 days, whereas below median cities only maintained NPIs for 57 days.

The table further reveals that cities which reacted faster are indeed located further west, as reflected by a lower longitude. In line with being further west, those cities have a lower mortality in 1917 and in 1918 and are located in states whose industry tends to be oriented more toward agriculture rather than manufacturing. In our regressions, we thus control for the importance of agriculture in each city's state. Reassuringly for our purposes, other than

[12]According to the CDC, in terms of national, state and local pandemic planning, no coordinated pandemic plans existed in 1918. Some cities managed to implement community mitigation measures, such as closing schools, banning public gatherings, and issuing isolation or quarantine orders, but the federal government had no centralized role in helping to plan or initiate these interventions.

[13]Yet another concern could arise from virulence of the influenza weakening over time as is suggested (Garrett, 2007).

differences in the longitude and the variation in the local industry structure, there are no observable differences across cities with different NPIs. Above-median and below-median $NPI\,Speed_{c1918}$ cities are, on average, similar in terms of population, banking sector size, and manufacturing employment.

5.2 Empirical specification

To formally study the impact of NPIs around the 1918 Flu Pandemic and to rigorously control for other local observable characteristics, we estimate a dynamic difference-in-difference equation of the form

$$Y_{ct} = \alpha_c + \tau_t + \sum_{j \neq 1918} \beta_j NPI_{c,1918} \mathbf{1}_{j=t} + \sum_{j \neq 1918} X_s \gamma_j \mathbf{1}_{j=t} + \varepsilon_{ct}, \tag{2}$$

where Y_{ct} is a city-level outcome such as the log of national banking assets, manufacturing employment, or output. NPI_{c1918} is either the speed or the aggressiveness of NPI, $NPI\,Speed_{c18}$ and $NPI\,Days_{c18}$. The set of coefficients β^j captures the relative dynamics of cities with more aggressive NPIs such as St. Louis compared to cities with weaker NPIs such as Philadelphia.

As in section 4, control variables are interacted with time dummies to allow for changes in the relation between the outcome variables and controls. We again control for the 1910 agriculture employment share, the 1910 urban population share, and the 1910 income per-capita at the state level. Moreover, at the city level we control for the log of 1910 population and the 1914 manufacturing employment to population ratio. However, unlike in our analysis on the effect of the 1918 Flu on the real economy, here we control for *past* city-level mortality as of 1917. This control captures a city's exposure to the flu in general, as well as the state of the local health care system. Note that controlling for mortality as of 1918 would not be not suitable, as it is itself driven by NPIs.

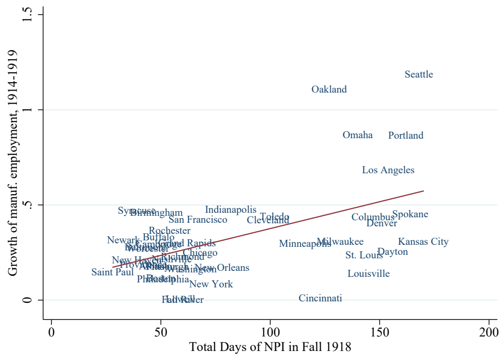
5.3 Results

5.3.1 Manufacturing activity

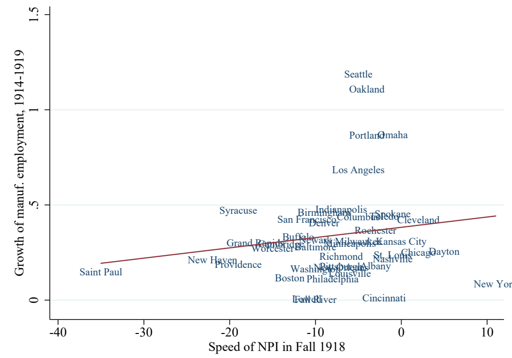
We begin by studying the correlation between NPIs and growth in local manufacturing activity. Panels (a)-(d) of Figure 5 show city-level scatterplots with linear fits of the growth in manufacturing employment and output between 1914 and 1919 against our two NPI measures, $NPI\ Speed_{c18}$ and $NPI\ Days_{c18}$. All panels reveal a positive correlation between growth in real economic activity and NPIs. These patterns suggest that NPIs increase economic activity, rather than reducing it.

Figure 6 presents the results from estimating Equation (2) for various outcomes, allowing us study the dynamics of the effect more explicitly. Panels (a) and (b) of Figure 6 show that there is an increase in manufacturing employment between 1914 and 1919 in higher values of both NPI measures. The estimates are statistically significant for all years, and the effect persists through 1923. In terms of magnitudes, a one standard deviation increase in the speed of the NPI (8 days) is associated with 4% higher employment after the pandemic has passed. A one standard deviation increase in the duration of NPIs (46 days) leads to an around 6% higher level of employment. Both effects are statistically significant, as shown in Table 2. Table 2 also reveals that the estimates are similar with and without controls.

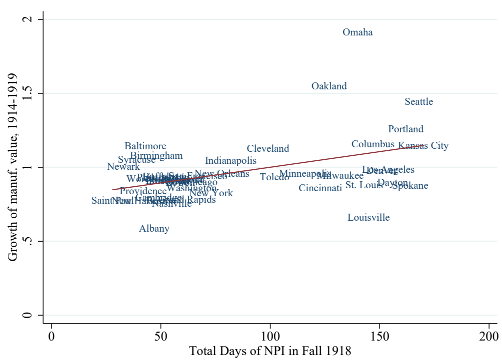
Figure 6 panels (c)-(d) show that the effects are similar for manufacturing output. A one standard deviation increase in the speed of NPI implementation increases output by around 5%. Likewise, a one standard deviation increase in the days of of NPIs in place increases output by approximately 7%. Altogether, this evidence suggests that cities that implemented NPIs earlier and more aggressively experienced more economic activity in the aftermath of the 1918 Flu Pandemic.



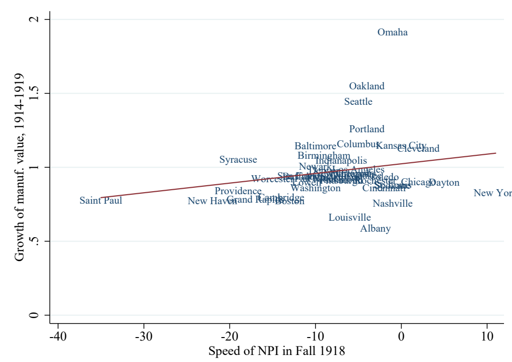
(a) Growth of city-level employment from 1914 to 1919 by the number of days with NPIs in fall 1918.



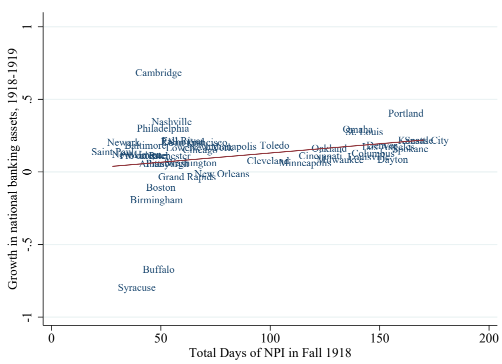
(b) Growth of city-level employment from 1914 to 1919 by the speed NPI implementation in fall 1918.



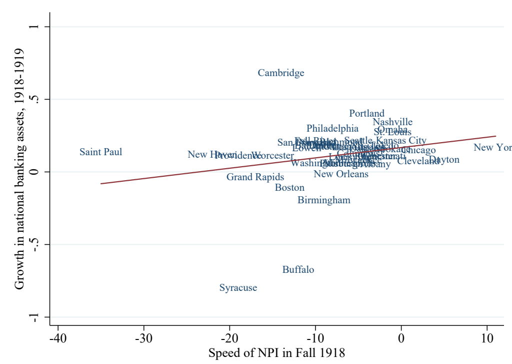
(c) Growth of city-level manufacturing output from 1914 to 1919 by the number of days with NPI's in fall 1918.



(d) Growth of city-level manufacturing output from 1914 to 1919 by the speed NPI implementation in fall 1918.

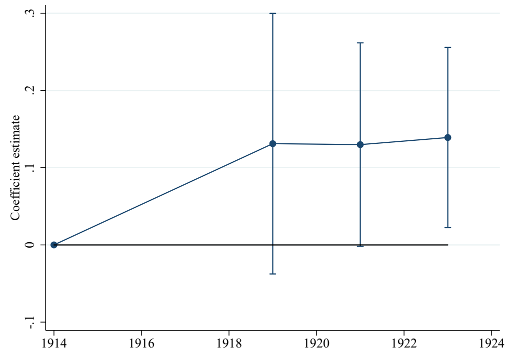


(e) Growth of city-level national bank assets from October 1918 to October 1919 by the number of days with NPIs in fall 1918.

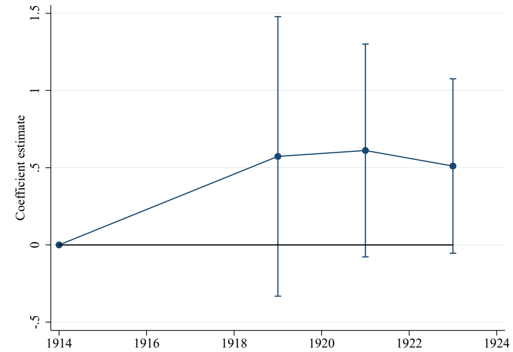


(f) Growth of city-level national bank assets from October 1918 to October 1919 by the speed of NPI implementation in fall 1918.

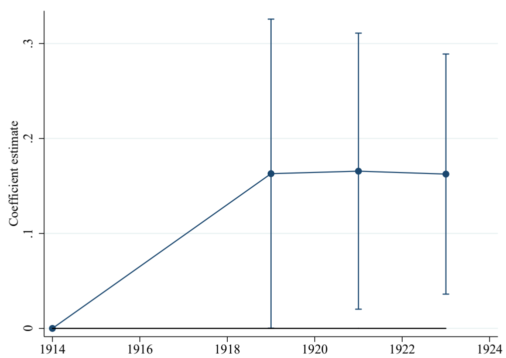
Figure 5: **Correlating city-level banking and manufacturing outcomes with the speed and length of non-pharmaceutical interventions in fall 1918.**



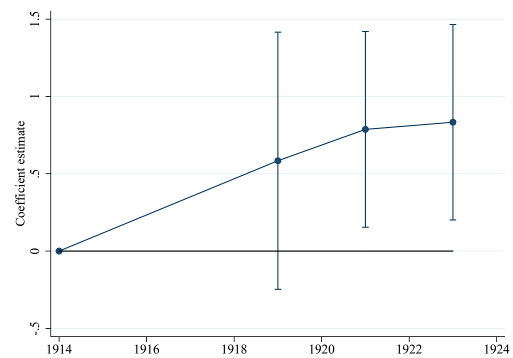
(a) Duration of NPIs and log manufacturing employment.



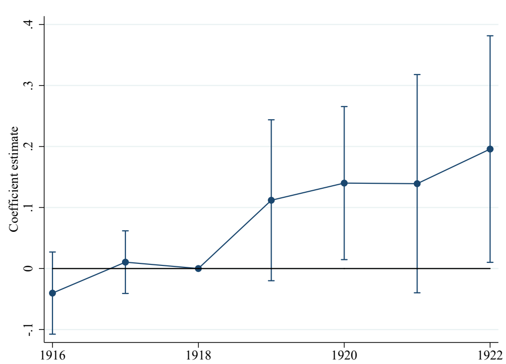
(b) Speed of NPI and log manufacturing employment.



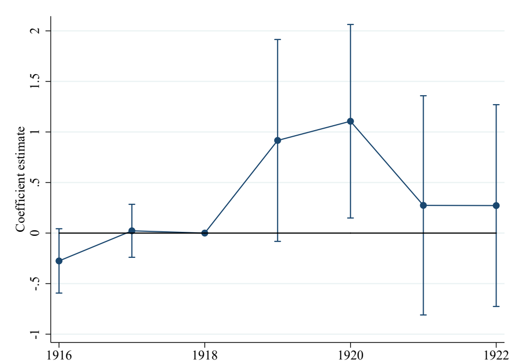
(c) Duration of NPIs and log of manufacturing output.



(d) Speed of NPI and log manufacturing output.



(e) Duration of NPIs and log national banking assets.



(f) Speed of NPI and log national banking assets.

Figure 6: **The effects of non-pharmaceutical interventions in fall 1918 on city-level banking and manufacturing outcomes.** Results from estimating Equation (2). 95% confidence bands.

5.3.2 Bank assets

Next, we study the effect of NPIs on local banking outcomes. Studying banking outcomes is informative, as they are correlated with real economic activity and available at a higher frequency than the employment data. Panels (e) and (f) of Figure 5 show scatterplots with linear fits the two NPIs measures and the growth in national bank assets from 1918 to 1919. Both panels reveal a positive correlation between growth in banking assets after the pandemic and the NPI measures. Both a quicker reaction and a longer implementation of NPI are associated with more growth in local national banking assets from early fall 1918 to 1919.

As with manufacturing activity outcomes, we also estimate Equation (2) with annual city-level bank assets as the dependent variable. The results are presented in panels (e) and (f) of Figure 6. Local banking sector assets follow similar trends across cities with different NPIs before the 1918 pandemic. In the year after the 1918 Flu Pandemic, there is an uptick in banking assets in cities with early and longer interventions after 1918. The effect is statistically significant and economically sizable. A one standard deviation increase in the number of days of NPIs in place induces an around 7.5% larger local banking sector after 1918. These results support our findings on manufacturing outcomes for higher-frequency data that allow us to control for pre-trends more thoroughly.

6 Conclusion

This paper examines the impact of 1918 Flu pandemic and resulting non-pharmaceutical interventions on real economic activity. Using variation across U.S. states and cities, we deliver two key messages. First, the pandemic leads to a sharp and persistent fall in real economic activity. We find negative effects on manufacturing activity, the stock of durable goods, and bank assets, which suggests that the pandemic depresses economic activity through both supply and demand-side effects. Second, cities that implemented more rapid and forceful non-pharmaceutical health interventions do not experience worse downturns.

Table 2: **The Effects of Non-pharmaceutical interventions on Local Banking, Employment, and Output.**

Panel A: Manufacturing Employment

	Log Manuf. Emp			
	(1)	(2)	(3)	(4)
$NPI\ Speed_{c1918} \times \text{Post}_t$	0.580*	0.565*		
	(0.338)	(0.325)		
$NPI\ Days_{c1918} \times \text{Post}_t$			0.263***	0.133**
			(0.059)	(0.058)
R^2 (Within)	.27	.39	.34	.39
N	172	172	172	172
No of Cities	43	43	43	43

Panel B: Manufacturing Output

	Log Manuf. Output			
	(1)	(2)	(3)	(4)
$NPI\ Speed_{c1918} \times \text{Post}_t$	0.686**	0.735**		
	(0.312)	(0.301)		
$NPI\ Days_{c1918} \times \text{Post}_t$			0.204***	0.164***
			(0.062)	(0.058)
R^2 (Within)	.81	.82	.82	.82
N	172	172	172	172
No of Cities	43	43	43	43

Panel C: Banking Outcomes

	Log National Bank Assets			
	(1)	(2)	(3)	(4)
$NPI\ Speed_{c1918} \times \text{Post}_t$	0.440	0.729		
	(0.492)	(0.494)		
$NPI\ Days_{c1918} \times \text{Post}_t$			0.142*	0.157**
			(0.072)	(0.073)
R^2 (Within)	.16	.23	.18	.24
N	299	299	299	299
No of Cities	43	43	43	43
Time FE	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes
Controls	No	Yes	No	Yes

Notes: This table reports results from estimating a regression of the following form:

$$Y_{ct} = \alpha_c + \tau_t + \beta \times NPI_{c1918} \times \text{Post}_t + \gamma \times X_t \times \text{Post}_t + \epsilon_{ct},$$

where $NPI_{c,1918}$ measures either the speed of the total days of NPI and Post_{18} is dummy that takes the value after 1918. X_s consists of the 1910 agriculture employment share, the 1910 urban population share, and the 1910 income per capita at the state level, and the log of 1910 population and the share of manufacturing in 1914 of the total population at the city level.
Standard errors clustered at the city level in parentheses; *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

In contrast, evidence on manufacturing activity and bank assets suggests that the economy performed better in areas with more aggressive NPIs after the pandemic.

Altogether, our evidence implies that pandemics are highly disruptive for economic activity. However, timely measures that can mitigate the severity of the pandemic can reduce the severity of the persistent economic downturn. That is, NPIs can reduce mortality while at the same time being economically beneficial.

Finally, when interpreting our findings, there several important caveats to keep in mind. First, our analysis is limited to data on 30 states and 43 to 66 cities. Second, data on manufacturing activity is not available in all years, so we cannot carefully examine pre-trends between 1914 and 1919 for the manufacturing activity outcomes. Third, the economic environment toward the end of 1918 was unusual due to the end of WWI. Fourth, while there are important economic lessons from the 1918 Flu for today's COVID-19 pandemic, we stress the limits of external validity. Estimates suggest that 1918 Flu was more deadly than COVID-19, especially for prime-age workers, which also suggests more severe economic impacts of the 1918 Flu. The complex nature of modern global supply chains, the larger role of services, and improvements in communication technology are mechanisms we cannot capture in our analysis, but these are important factors for understanding the macroeconomic effects of COVID-19.

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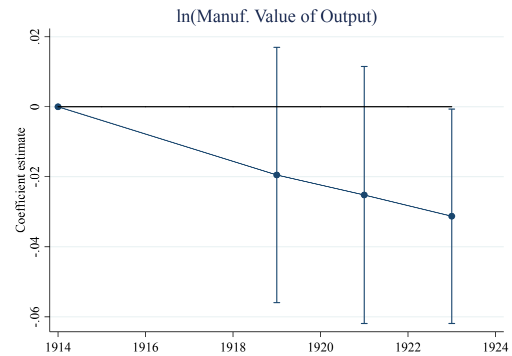
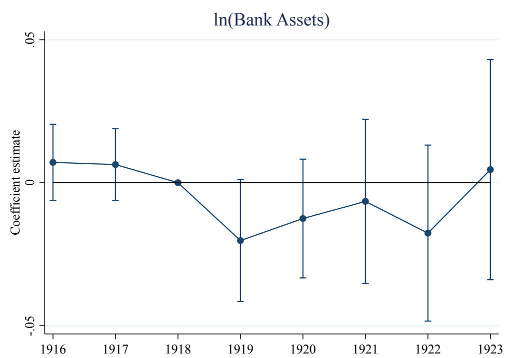
A Supplementary Figures and Tables

(a) Log manufacturing employment

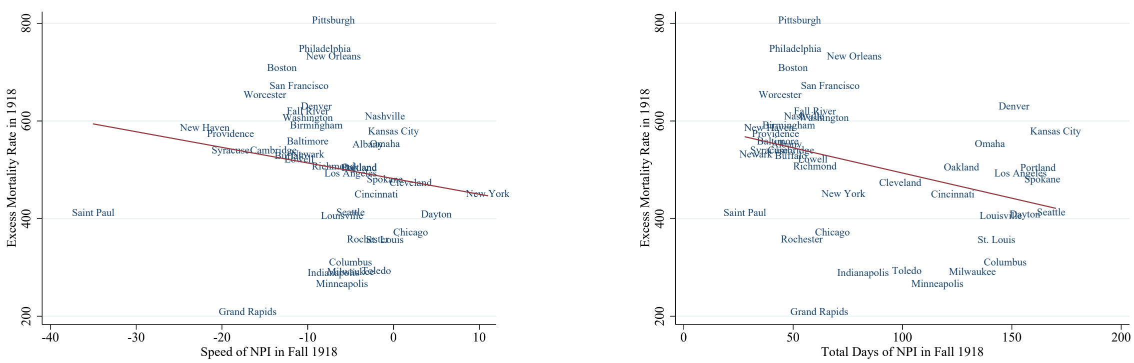


(b) Log manufacturing output



(c) Log total assets, National banks

Figure A1: **Economic effects of the 1918 Flu Pandemic – city-level evidence.** Results from estimating equation (1). 95% confidence bands.



(a) Excess mortality and speed of NPIs.

(b) Excess mortality and total number of days of NPI.

Figure A2: **City-level Excess Mortality and NPIs during fall 1918.** Notes: This figures correlates the excess pneumonia and influenza related mortality (through 24 week average mortality) with the speed of NPI implementation and the total number of days of NPIs in place during fall 1918. Data are taken from Markel et al. (2007).

Table A1: **Non-pharmaceutical Health Interventions (NPI) in 43 cities during Fall 1918** (Markel et al., 2007).

City	State	First Case	Mortality Acc. Date	Response Date	$NPI\ Speed_{c18}$	$NPI\ Days_{c18}$	$MORT_{c1917}$	$MORT_{c1918}$
Albany	New York	Sep/27/1919	Oct/06/1919	Oct/09/1919	-3	47	187.4	679.1
Baltimore	Maryland	Sep/18/1919	Sep/29/1919	Oct/09/1919	-10	43	251.9	836.5
Birmingham	Alabama	Sep/24/1919	Sep/30/1919	Oct/09/1919	-9	48	334.7	843.6
Boston	Massachusetts	Sep/04/1919	Sep/12/1919	Sep/25/1919	-13	50	228	844.7
Buffalo	New York	Sep/24/1919	Sep/28/1919	Oct/10/1919	-12	49	184	637.5
Cambridge	Massachusetts	Sep/04/1919	Sep/11/1919	Sep/25/1919	-14	49	164.2	676.5
Chicago	Illinois	Sep/17/1919	Sep/28/1919	Sep/26/1919	2	68	201.7	516.6
Cincinnati	Ohio	Sep/24/1919	Oct/04/1919	Oct/06/1919	-2	123	171.3	605.4
Cleveland	Ohio	Sep/20/1919	Oct/07/1919	Oct/05/1919	2	99	198.5	590.9
Columbus	Ohio	Sep/20/1919	Oct/06/1919	Oct/11/1919	-5	147	168.1	451.9
Dayton	Ohio	Sep/20/1919	Oct/05/1919	Sep/30/1919	5	156	157.8	525.2
Denver	Colorado	Sep/17/1919	Sep/27/1919	Oct/06/1919	-9	151	134.4	727.7
Fall River	Massachusetts	Sep/09/1919	Sep/16/1919	Sep/26/1919	-10	60	229.7	799.7
Grand Rapids	Michigan	Sep/23/1919	Oct/02/1919	Oct/19/1919	-17	62	89.6	282.7
Indianapolis	Indiana	Sep/22/1919	Sep/30/1919	Oct/07/1919	-7	82	156.6	459.4
Kansas City	Missouri	Sep/20/1919	Sep/26/1919	Sep/26/1919	0	170	205	718.1
Los Angeles	California	Sep/27/1919	Oct/06/1919	Oct/11/1919	-5	154	93.3	484.5
Louisville	Kentucky	Sep/13/1919	Oct/01/1919	Oct/07/1919	-6	145	209.5	1012.9
Lowell	Massachusetts	Sep/09/1919	Sep/16/1919	Sep/27/1919	-11	59	183.6	696.1
Milwaukee	Wisconsin	Sep/14/1919	Oct/06/1919	Oct/11/1919	-5	132	186.3	474.1
Minneapolis	Minnesota	Sep/21/1919	Oct/06/1919	Oct/12/1919	-6	116	126.3	387.7
Nashville	Tennessee	Sep/21/1919	Oct/06/1919	Oct/07/1919	-1	55	188.6	910.2
New Haven	Connecticut	Sep/14/1919	Sep/23/1919	Oct/15/1919	-22	39	236	768
New Orleans	Louisiana	Sep/10/1919	Oct/01/1919	Oct/08/1919	-7	78	178.5	768.6
New York	New York	Sep/05/1919	Sep/29/1919	Sep/18/1919	11	73	204.5	582.5
Newark	New Jersey	Sep/06/1919	Sep/30/1919	Oct/10/1919	-10	33	184	680.4
Oakland	California	Oct/01/1919	Oct/08/1919	Oct/12/1919	-4	127	96.3	496.9
Omaha	Nebraska	Sep/18/1919	Oct/04/1919	Oct/05/1919	-1	140	207.1	660.8
Philadelphia	Pennsylvania	Aug/27/1919	Sep/25/1919	Oct/03/1919	-8	51	228	932.5
Pittsburgh	Pennsylvania	Sep/04/1919	Sep/27/1919	Oct/04/1919	-7	53	380.4	1243.6
Portland	Oregon	Oct/02/1919	Oct/07/1919	Oct/11/1919	-4	162	72.4	448.2
Providence	Rhode Island	Sep/08/1919	Sep/17/1919	Oct/06/1919	-19	42	221.7	737.4
Richmond	Virginia	Sep/21/1919	Sep/29/1919	Oct/06/1919	-7	60	199.5	661
Rochester	New York	Sep/22/1919	Oct/06/1919	Oct/09/1919	-3	54	151.7	522.7
Saint Paul	Minnesota	Sep/21/1919	Oct/02/1919	Nov/06/1919	-35	28	112	480.6
San Francisco	California	Sep/24/1919	Oct/07/1919	Oct/18/1919	-11	67	126.4	647.7
Seattle	Washington	Sep/24/1919	Oct/01/1919	Oct/06/1919	-5	168	58.9	425.5
Spokane	Washington	Sep/28/1919	Oct/09/1919	Oct/10/1919	-1	164	102.5	487.4
St. Louis	Missouri	Sep/23/1919	Oct/07/1919	Oct/08/1919	-1	143	227	536.5
Syracuse	New York	Sep/12/1919	Sep/18/1919	Oct/07/1919	-19	39	155.2	704.6
Toledo	Ohio	Sep/21/1919	Oct/13/1919	Oct/15/1919	-2	102	152.4	401
Washington	District of Columbia	Sep/11/1919	Sep/23/1919	Oct/03/1919	-10	64	166.8	758
Worcester	Massachusetts	Sep/09/1919	Sep/12/1919	Sep/27/1919	-15	44	192.3	727.1

Notes: This table list all 43 cities used in Markel et al. (2007) for which NPI data are available. NPIs are measures such as the closure of schools and churches, the banning of mass gatherings, but also other measures such as mandated mask wearing, case isolation, and public disinfection/hygiene measures. The table reports our two main measures for $NPISpeed$ and $NPIDays$. The former is measured as the difference between the response date and the mortality acceleration date which is the day the mortality rate exceeds twice its base. The later counts the total number of days NPIs were in place. Markel et al. (2007).

Table A2: **Summary Statistics**

	N	Mean	Std. dev.	10th	90th
A: State-level					
Influenza mortality, 1918 ($MORT_{s1918}$)	30	575.99	147.67	398.05	768.55
Influenza mortality, 1917	27	159.84	37.87	115.70	211.10
Agr. empl. share, 1910	30	30.00	17.03	8.46	53.70
Manuf. empl. share, 1910	30	30.30	12.02	16.89	50.01
Urban share, 1910	30	46.97	20.31	21.65	77.64
Income per capita, 1910	30	792.13	208.39	454.50	1,023.50
Log population, 1910	30	1,432.21	87.74	1,291.09	1,546.58
Log manuf. empl.	120	1,179.49	112.92	1,030.19	1,340.02
Manuf. empl. to pop.	120	8.33	4.98	3.13	16.54
Log manuf. output	120	1,350.48	118.12	1,202.81	1,516.31
Log total assets, all banks	210	1,338.06	106.43	1,218.71	1,492.42
Bank losses, National banks	210	0.56	0.30	0.26	0.96
Log registered vehicles	210	1,174.25	99.54	1,043.15	1,307.52
B: City-level					
Influenza mortality, 1918 ($MORT_{s1918}$)	66	686.92	203.03	451.90	977.80
Influenza mortality, 1918	66	191.40	65.03	109.90	288.20
Speed of NPI	43	-7.35	7.84	-17.00	0.00
Total days of NPI	43	88.28	46.43	42.00	156.00
Manuf. empl. in 1914 to 1910 pop.	66	14.13	7.74	5.24	24.62
Log city population, 1910	66	1,215.93	84.62	1,137.84	1,323.30
Log manuf. empl.	264	1,020.22	97.47	905.64	1,137.03
Log manuf. output	264	1,197.20	107.74	1,067.23	1,332.15
Log total assets, National banks	460	1,794.49	120.64	1,669.55	1,950.76

Notes: The table reports summary statistics for the state and city-level data sets. Influenza mortality is measured per 100,000. Shares and logged variables are multiplied by 100. Manufacturing variables are measures in 1914, 1919, 1921, and 1923. Banking variables are annual from 1916 to 1922.

Table A3: **Comparison of Low and High Influenza Mortality States**

	Below Median $MORT_{1918}$		Above Median $MORT_{1918}$		Difference	
	Mean	Std	Mean	Std	Diff	t-stat
Population, 1910 (in th)	2400.20	1397.04	2296.27	2657.98	-103.93	-0.13
Manuf. empl., 1914 (in th)	162.00	157.58	263.79	333.98	101.79	1.07
Manuf. output, 1914 (in th)	628403	631563	846339	1125138	217936	0.65
Mortality, 1917	134.56	26.47	180.07	33.56	45.51	3.83
Agr. empl. share, 1910	37.19	13.35	22.81	17.65	-14.38	-2.52
Manuf. empl. share, 1910	24.88	7.02	35.72	13.68	10.85	2.73
Urban share, 1910	39.76	13.50	54.18	23.68	14.41	2.05
Income per capita, 1910	762.87	213.16	821.40	206.60	58.53	0.76

Notes: This table compares state-level characteristics for states with below and above-median $Mortality_{s,1918}$.

Table A4: **Impact of 1918 Influenza Exposure on City-Level Economic Activity**

Panel A: No controls			
	Log Man. Emp.	Log Man. Output	Log Bank Assets
	(1)	(2)	(3)
$MORT_{1918} \times$ Post	-0.033***	-0.023**	-0.0011
	(0.012)	(0.010)	(0.0082)
R^2 (within)	.28	.79	.26
N	264	264	460
No of cities	66	66	66
City and Post FE	Yes	Yes	Yes
Controls	No	No	No

Panel B: With controls × Post			
	Log Man. Emp.	Log Man. Output	Log Bank Assets
	(1)	(2)	(3)
$MORT_{1918} \times$ Post	-0.024	-0.025*	-0.019*
	(0.015)	(0.015)	(0.011)
R^2 (within)	.30	.80	.30
N	264	264	460
No of cities	66	66	66
City and Post FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes

Panel C: Instrumenting with $MORT_{1917}$			
	Log Man. Emp.	Log Man. Output	Log Bank Assets
	(1)	(2)	(3)
$MORT_{1918} \times$ Post	-0.045**	-0.034*	-0.036***
	(0.018)	(0.018)	(0.011)
First stage F-stat (KP)	88.9	88.9	89.8
N	264	264	460
No of cities	66	66	66
City and Post FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes

Notes: The table reports results from estimating a regression of the following form:

$$Y_{ct} = \alpha_c + \beta \times Mortality_{c,1918} \times \text{Post}_t + \delta \times \text{Post}_t + \gamma \times X_c \times \text{Post}_t + \epsilon_{ct},$$

where $MORT_{c1918}$ is city mortality from influenza and pneumonia in 1918, Post_t is a dummy variable that takes the value of one after 1918. Controls in X_c are the 1910 state agriculture employment share, 1914 city manufacturing to population ratio, 1910 state urban population share, 1910 state income per capita, and log 1910 city population. Census of Manufactures outcomes (columns 1-2) are available in 1914, 1919, 1921 and 1923. National bank assets in column 3 are annual from 1916 to 1922.

Table A5: **Comparison of Cities with Fast and Slow Implementation of NPIs.**

	Below median $NPISpeed_{c18}$		Above median $NPISpeed_{c18}$		Difference	
	Mean	Std	Mean	Std	Diff	t-stat
Longitude	-81.156	12.700	-93.686	16.465	-12.531	-2.786
Speed of NPHI	-12.818	6.558	-1.619	4.080	11.199	6.754
Total Days of NPHI	56.864	24.940	121.190	40.630	64.327	6.224
Influenza mortatlity, 1917	197.159	67.136	160.314	49.905	-36.845	-2.048
Influenza mortatlity, 1918	723.359	184.207	567.529	158.752	-155.831	-2.975
Log city population, 1910	12.403	0.726	12.542	0.977	0.139	0.527
Manuf. empl. in 1914 to 1910 pop	0.143	0.072	0.112	0.053	-0.031	-1.616
Log manuf. employment, 1914	10.319	0.797	10.229	1.266	-0.090	-0.278
Log manuf. output, 1914	11.499	0.812	11.645	1.244	0.146	0.453
Log total assets, National Banks, 1917	18.151	1.134	18.395	1.228	0.244	0.651
Per-capita income in 1910, state-level	877.636	211.433	883.190	181.598	5.554	0.093
Agr. empl. share in 1910, state-level	19.002	17.859	27.035	12.768	8.034	1.702

Notes: This table reports differences in city-level and state-level characteristics for the 43 cities with NPIs. The sample is split into cities with above median and below median speed of NPI implementation measured by the days between the first day an NPI is implemented and the day mortality exceeds twice its average.

B Historical Newspaper Articles

This section contains excerpts of newspaper articles contemporaneous to the 1918 Influenza pandemic, documenting the real effects of the pandemic in trade and production, as well as the timeline of policy interventions.

B.1 Real effects

"Holland's Letter: Effect Of Influenza on Loan and Output—Reasons For and Against Imposing a Stamp Tax." *Wall Street Journal*, Oct 24, 1918, p. 2. At a private and informal meeting last week of some of these who are of important in the world of finance and banking, the suggestion was made that a communication be sent to Secretary of the Treasury McAdoo that he wold be justified in extending to another week the campaign for the sale of the Fourth Liberty Loan bonds. ...

One reason alone influenced those who suggested a recommendation of this kind to Secretary McAdoo. That was the prevalence of the grippe or influenza, which had seriously interfered with the sale of the bonds. ...

The effect of the influenza epidemic was not exclusively felt, by the loan, however. In some parts of the country it has caused a decrease in production of approximately 50% and almost everywhere it has occasioned more or less falling off.

The loss of trade which the retail merchants throughout the country have met with has been very large. The impairment of efficiency has also been noticeable. 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. ...

"Influenza Checks Trade: Less Doing In Retail Shops As Illness and Caution Cut Down the Crowds." *Wall Street Journal*, Oct 25, 1918, p. 10. Widespread epidemic of influenza has caused serious inroads on the retail merchandise trade during the current month.

Heads of large organizations report that not only has sickness cut down the shopping crowds, but in many cities the health authorities have shut down the stores.

The chain store companies have felt the effect of the sickness not a little, for in addition to the smaller business done a number of their employees are sick. . . .

"5 Theatres Close Tonight: Theatrical Depression Attributed In Large." *New York Times*, Oct 12, 1918, p. 13. Theatrical Depression Attributed in Large Part to Influenza Scare.

An unprecedented theatrical depression, which managers attribute in large part to the influenza scare, resulted in sudden decisions yesterday to close five playhouses tonight. . . . In all, more than a dozen local theatres will be dark next week.

"Textile Trade Hit By Spanish Influenza: Many Mills Closed And Others Working Partially—Retail Business Hurt." *Wall Street Journal*, Oct 21, 1918, p. 6. Both the wholesale and retail trades have been hit badly by the Spanish influenza epidemic. Mill production is being curtailed, and even Government business is held up. A great many mills throughout the country have either completely ceased operations or kept only a small fraction of their machinery working. Consequently, deliveries have been held up in many lines. Retailers report that the disease has hurt their fall business, but it is hoped particularly among New York merchants that when the epidemic wanes they will quickly catch upon lagging sales. . . .

"Anthracite Output Affected By Influenza: Collieries Shut Down As ." *Wall Street Journal*, Oct 12, 1918, p. 9. Effect of the influenza epidemic in current anthracite production is substantial . . . Around Minersville, Pa., where the ravages of the disease are said to have been probably as severe as in any part of the region, one entire colliery was shut down, but the washery of this particular company resumed working before the close of the week.

“Copper Shortage Is Acute: Influenza At Refineries And Smelters Further Reduces Output Already Curtailed by Labor Scarcity.” *Wall Street Journal*, Oct 25, 1918, p. 6. Scarcity of copper is acute. Even the United States Government is not at present obtaining its full quota of metal, according to interests conversant with the situation. With Government orders unfilled, there is, of course, no surplus available for the outside trade.

Increased curtailment of production is due largely to influenza at the refineries and smelters. With the country’s output already seriously impaired by labor shortages, a condition which is believed not likely to improve during the war, incapacitation of a large percentage of employees at nearly all the producing plants is resulting in a contraction in the copper supply which is expected to be more severe than was experienced during the worst months of the labor strikes in 1917.

“Corporation Bonds Comparatively Low: Present Average Price Over Eleven Points Under High Price Reached Since Stock Exchange Reopened.” *Wall Street Journal*, Jan 22, 1919, p. 5. High Point Recorded January 18, 1917, and Low Since September 28, 1918—Influenza Epidemic an Influence in Decline of Railroad Bonds Which Are Usually Bought Heavily by Life Insurance Companies

. . . Several other factors which have tended to unsettle the bond market will be removed in the near future. The influenza epidemic, which caused heavy claims on life insurance companies, thus temporarily putting them out of the market for high-grade railroad bonds, is an example.

“Drug Markets Affected By Spanish Influenza: Big Demand For Camphor Causes Advance in Wholesale and Retail Prices—Aspirin, Rhinitis and Quinine Taken in Big Quantities.” *Wall Street Journal*, Oct 21, 1918, p. 6. The countrywide epidemic of Spanish influenza has had considerable influence on the drug markets and the demand for camphor, aspirin, quinine and many disinfectants has been unprecedented. . . .

"Influenza Impedes Ship Production: About 6,500 Workers Are Ill At Fall River and Hog Island—Other Yards Affected." *New York Times*, Oct 3, 1918, Special. The epidemic of Spanish influenza has put 10 per cent of the shipyard workers in the Fall River district and at least 8 per cent of those at Hog Island, Philadelphia, temporarily on the ineffective list and is seriously interfering with rapid ship construction. Practically all of the yards as far south as Baltimore are affected to some degree, and extraordinary steps are being take in to fight the disease. At Hog Island and other large plants some of the administration buildings have been converted into hospitals.

B.2 Public health intervention

"Drastic Steps Taken To Fight Influenza Here: Health Board Issues 4 P.M. Closing Orders for All Stores Except Food and Drug Shops. Hours for Factories Fixed. Plan, in Effect Today, to Reduce Crowding in Transportation Lines in Rush Periods. Time Table for Theatres. Radical Regulations Necessary to Prevent Shutting City Up Tight, Says Dr. Copeland." *New York Times*, Oct 5, 1918, p. 1. In order to prevent the complete shutdown of industry and amusement in this city to check the spread of Spanish influenza, Health Commissioner Copeland, by proclamation, yesterday ordered a change in the hours for opening stores, theatres and other places of business.

The Department is of the opinion that the greatest sources of spread of the disease are crowded subway and elevated trains and cars on the surface lines and the purpose of the order is to diminish the "peak" load in the evenings and mornings on these lines by distributing the travelers over a greater space of time. This will reduce crowding to a minimum.

Dr. Copeland's action was taken after a statement made by Surgeon General Blue, Chief of the Public Health Service in Washington, was called to his attention, in which Dr. Blue advocated the closing of churches, schools, theatres and public institutions in every community where the epidemic has been developed. Dr Blue said:

“There is no way to put a nationwide closing order into effect, as this is a matter which is up to the individual communities. In some States the State Board of Health has this power, but in many others it is a matter of municipal regulation. I hope that those having the proper authority will close all public gathering places if their community is threatened with the epidemic. This will do much toward checking the spread of the disease”

. . . One of the decisions reached is to close all stores other than those dealing exclusively in food or drugs at 4 o’clock in the afternoon. . . .

All moving picture houses and theatres outside of a certain district are considered community houses and are held to draw their patronage from within walking distance. There was debate on the proposition to close the schools and churches and other places of assemblage, but it was decided against it at this time. . . .

“The Spanish Influenza.” *New York Times*, Oct 7, 1918, p. 12. Under adverse conditions the health authorities of American communities are now grappling with an epidemic that they do not understand very well. But they understand it well enough to know that it spreads rapidly where people are crowded together in railway trains, in theatres and places of amusement, in stores and factories and schools. In some cities and towns where the influenza seems to be malignant the schools and many places of amusement have been closed. Pennsylvania, taking a serious view of the hazards of the disease, because it is raging in the shipyards and increasing ominously elsewhere, has taken drastic measures to protect the public health. The sale of liquor has been generally prohibited in Philadelphia, the courts stand adjourned, Liberty Loan meetings have been abandoned, public assemblies of all kinds have been forbidden, the theatres are not allowed to give performances, and it is recommended that the churches hold no services. In some other parts of Pennsylvania the authorities have gone further, closing churches and Sunday schools. Football games have been canceled. In localities in New Jersey the public schools have been closed. This is the case in Omaha and other Western cities. In Oswego, where about 15 per cent of the population is down with influenza, the Health Board has acted vigorously. . . .

New York City has thus far escaped lightly compared with Boston, which has had 100,000 cases, and with Philadelphia, where the total two days ago was 20,000. Up to yesterday only 8,000 cases had been reported in this city of about 6,000,000 people, according to the Health Department, although there are perhaps many cases still unreported. It seems providential that there have been so few cases in our congested districts, and generally in a population that packs the transportation lines. But unless our health authorities are vigilant and practical, there may soon be another story to tell. The precautionary and restrictive regulations adopted by the Department of Health are at best tentative. It is a question whether the schools should not be temporarily closed, as in other places. As business must go on, if not as usual, it was advisable to vary the opening and closing hours of business establishments to regulate the "rush hours" on transportation lines. The opening time of theatres has been changed with a similar purpose. It is evident that the Health Department hesitates to be strenuous, because, as Dr. Copeland says, "this community is not striken with the epidemic".

But it may be if only half measures at taken. A stitch in time saves nine. THe closing of the schools is a debatable question. Dr. Copeland's reasons for keeping them open are not altogether convincing. . . .

"Delays In Reports Swell Grip Figures: 1,450 New Cases Recorded, Largest Number for a Single Day Since Epidemic Began. Newark Officials Clash. Mayor Raises Closing Bank OVer Head of the State Board of Health." *New York Times*, Oct 24, 1918, p. 12. For the twenty-four hours ended at 10 o'clock yesterday morning, 1,450 new cases of Spanish influenza were reported to the Board of Health. This is the largest number of new cases reported in a single day since the disease became epidemic in New York.

. . . Major Gillen of Newark, and the New Jersey State Board of Health yesterday began a controversy over the authority of the city officials in ordering the raising of the closing order on schools, theatres, saloons, soda fountains and churches after the State Board had ruled that all should be closed until it lifted the ban. A meeting of the State Board will be held in Trenton today to consider measures compelling the Newark City Government to enforce the rule. The Newark City Commission also will hold a meeting to discuss whether it has jurisdiction upon health superior to that of the State Board.

... After being held twenty-four hours in Quarantine for examination and fumigation the Holland-America liner Nieuw Amsterdam was permitted to leave for the pier to land her 900 passengers yesterday. The health officers at Quarantine said there had been fifty cases of Spanish influenza on the voyage from Holland, but only twelve passengers in the second cabin were still confined to their berths when the steamship reached port on Tuesday. ...

"Major Closes Theatres, Schools and Churches. Sudden Spread of Spanish Influenza Forces City Officials to Take Drastic Steps. 25 Flu Cases in Seattle Reported." *The Seattle star*, October 05, 1918, p. 1. All churches, schools, theatres and places of assemblage were ordered closed by proclamation of Mayor Hanson at noon Saturday, to check the spread of the Spanish influenza.

Police officers were immediately send to the motion picture houses to enforce the order.

At 2 p.m. policemen had served notice on all the downtown theatres, including movie houses, and the had close their doors.

While latitude was given to officers in orders to close all other assemblages in buildings.

No church services will be permitted Sunday.

"We will enforce the order to the letter," Mayor Hanson declared. "The chief of police has been given orders. Dance halls were ordered closed last night. No private dances must be held. Persons spitting on sidewalks or in street cars are to be immediately places under arrest."

His order followed consultation with Health Commissioner McBride, who reported that there were 25 civilian cases on record at noon.

New cases are being reported every few minutes.

There has been one civilian death. . . .

"Halls and Churches to be Flu Hospitals." *The Seattle star*, October 07, 1918, p. 1. *Don't be grumbler*

Don't grumble because you can't see a movie or play a game of billiards—or because the schools and churches closed.

The health of the city is more important than all else. An ounce of prevention now is worth a thousand cures. In Boston, influenza has taken a toll of thousands. We do not want to court that situation here.

Preparations were under way Monday by Mayor Hanson and municipal health authorities to transform Seattle's big public dance halls, and churches if necessary, into emergency hospitals to care for Spanish influenza cases if the epidemic is not checked.

This action was decided upon as a preparatory measure, supplementing the order of Saturday that closed schools, theatres, motion picture houses, pool halls, and all indoor assemblages. . . .

"We don't know how long it will be necessary to enforce the general closing order," said Mayor Hanson Monday. "I have not made any predictions, and cannot make any. We have received citywide co-operation with practically everyone affected except school authorities, who objected."

"Not Ready to Lift the Influenza Ban." *The Seattle star*, October 23, 1918, p. 3. Twelve influenza and pneumonia cases have been reported in Seattle to the health department withint he last 24 hours, while 194 new cases were reported Wednesday morning. Five deaths occurred late Tuesday night and Wednesday morning. . . .

Wednesday, Dr. J. S. McBride, city health commissioner, announces that the crest of the epidemic has been passed, but that great caution must be observed by every individual for some time yet. He has not announced when the ban will be lifted.