

Influenza Pandemics, Air Pollution, and the Introduction of Medicaid

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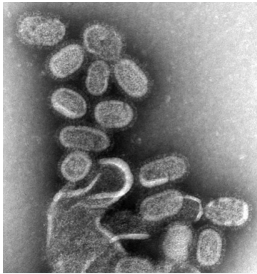
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- Health care saves lives
 - Currie and Gruber (1996), Goodman-Bacon (2018)
 - BUT its value may be more salient during severe health shocks
- Influenza pandemics are severe health shocks
 - Air pollution increases the severity of infectious disease Clay et al. (2018), Hanlon (2019)
- Our research question: Does access to health care reduce the deadly effects of severe health shocks?

- Using county level data for 1950-1979 on infant mortality we find:
 - Higher coal capacity increased pandemic severity in the 1957-1958 and 1968-1969 pandemics
 - The implementation of Medicaid in 1966 and 1967 in high AFDC eligible states *fully offset* the adverse effect of coal capacity during the 1968-1969 pandemic
 - Increased access to health care saved about **600** infant lives during the 1968-1969 pandemic

Pandemics and Air Pollution

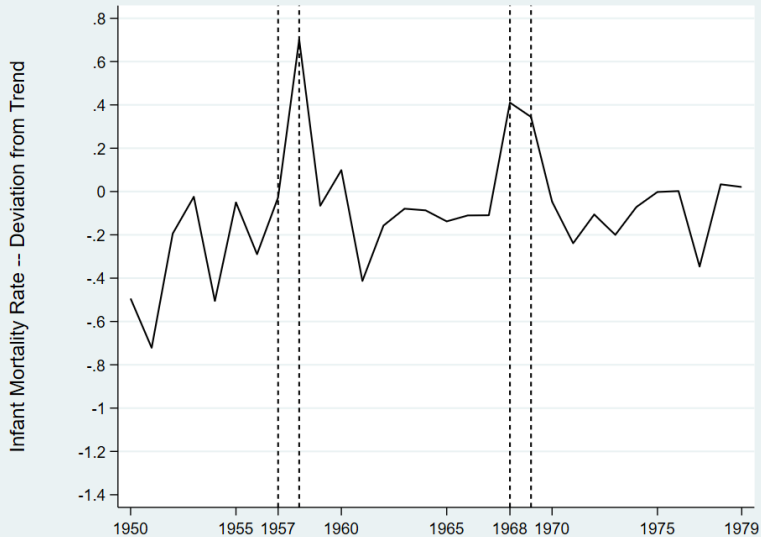
- Major pandemics in 1957-1958 and in 1968-1969
- Air pollution induces county level variation in the severity of pandemics



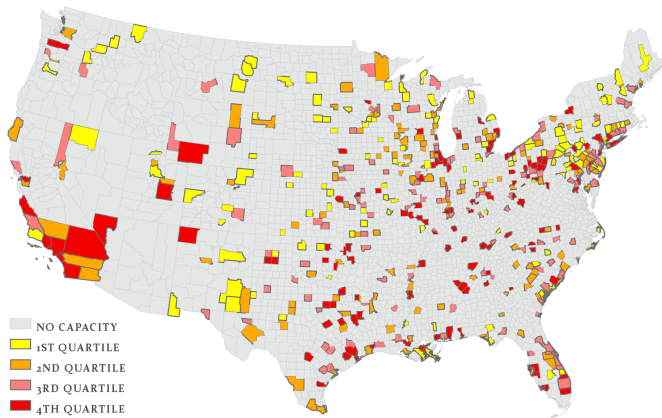
Influenza virus, magnified approximately 100,000 times



Pandemics



Coal Capacity



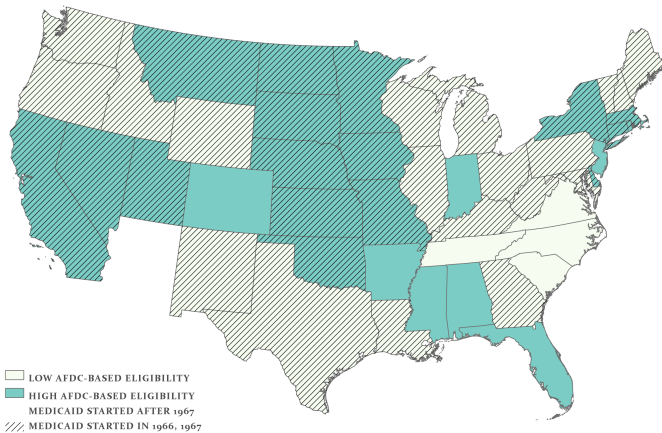
Coal Capacity and Air Pollution

	(1)	(2)	(3)	(4)
	TSP	TSP	TSP	TSP
Coal Capacity (100 MW)	0.242** (0.097)	0.281*** (0.095)	0.281*** (0.096)	0.245** (0.096)
Adjusted R^2	0.838	0.844	0.847	0.850
Counties	544	544	544	544
County-Year Obs	6141	6141	6141	6141
State-by-Year FE, County FE	Y	Y	Y	Y
Temperature, Precipitation	Y	Y	Y	Y
ManufacturingEmp		Y	Y	Y
Transportation			Y	Y
Socioeconomic				Y



- Medicaid is a federal program that is established in 1965 to improve the health of the poor
 - Medicaid is implemented in 37 states in 1966 and 1967
 - Expands access to care for children and pregnant women
 - There is cross-state variation in AFDC, which is closely tied to eligibility for Medicaid
 - Goodman-Bacon (2018) shows that the introduction of Medicaid reduces infant and child mortality
- Pregnant women and their unborn children are particularly vulnerable to influenza

Medicaid



- Main outcome: county-level infant mortality per 1,000 live births from Bailey et al. (2018): ICPSR 36603
- Proxy for air pollution: coal-fired electricity generating capacity from Clay et al. (2016, 2019)
- Indicators for access to Medicaid health insurance from Goodman-Bacon (2018)
- Controls for temperature, precipitation, transportation, economic activity, health care infrastructure, and demographic variables

$$\begin{aligned}IMR_{ct} = & \beta_1 Coal_{ct} + \beta_2 (Coal_{ct} \times Post1965_{st}) \\ & + \beta_3 (Coal_{ct} \times HighAFDC_s) + \beta_4 (Coal_{ct} \times Post1965_{st} \times HighAFDC_s) \\ & + \beta_5 (Coal_{ct} \times Pand57_t) + \beta_6 (Coal_{ct} \times Pand68_t) \\ & + \beta_7 (Coal_{ct} \times Pand57_t \times HighAFDC_s) + \beta_8 (Coal_{ct} \times Pand68_t \times HighAFDC_s) \\ & + \eta_c + \lambda_{st} + \psi X_{ct} + \theta_t Z_{c,baseline} + \epsilon_{ct},\end{aligned}$$

- IMR_{ct} denotes county infant mortality rate per 1,000 live births
- $CoalCap_{ct}$ denotes county coal-fired electricity generating capacity
- $Post1965_s$ and $HighAFDC_s$ are dummies for after 1965 and if the AFDC rate is above the median
- $Pand57_t$ and $Pand68_t$ are dummies that reflect pandemic years 1957-58 and 1968-69
- Controls include county fixed effects (η_c), state-by-year fixed effects (λ_{st}), climatic variables (X_{ct}), and differential trends in baseline economic and demographic county characteristics ($Z_{c,baseline}$)

Main Results, Positive Coal Capacity

	(1)	(2)	(3)	(4)
	IMR	IMR	IMR	IMR
				Med1966-67
Coal Capacity (100 MW)	0.093*** (0.033)	0.091*** (0.033)	0.064*** (0.024)	0.056** (0.024)
Post 1965 x Coal	-0.041** (0.018)	-0.042** (0.017)	-0.040** (0.019)	-0.046** (0.021)
AFDC x Coal	-0.053 (0.042)	-0.058 (0.041)	-0.028 (0.034)	-0.010 (0.034)
Post 1965 x AFDC x Coal	0.026 (0.027)	0.036 (0.026)	0.024 (0.027)	0.024 (0.028)
P 1957-58 x Coal		0.072*** (0.027)	0.073*** (0.028)	0.071** (0.028)
P 1957-58 x AFDC x Coal		-0.026 (0.033)	-0.027 (0.034)	-0.021 (0.035)
P 1968-69 x Coal		0.057*** (0.019)	0.061*** (0.020)	0.063*** (0.020)
P 1968-69 x AFDC x Coal		-0.078*** (0.021)	-0.078*** (0.022)	-0.083*** (0.022)
Adjusted R ²	0.750	0.751	0.758	0.758
Counties	666	666	666	506
County-Year Obs	19980	19980	19980	15180
State-by-Year, County FE	Y	Y	Y	Y
Temperature and Precipitation	Y	Y	Y	Y
IMRbase, MfgEmp	Y	Y	Y	Y
Transportation			Y	Y
Health Infrastructure			Y	Y
Socioeconomic			Y	Y

Main Results, All Counties

	(1)	(2)	(3)	(4)
	IMR	IMR	IMR	IMR
				Med1966-67
Coal Capacity (100 MW)	0.082*** (0.026)	0.080*** (0.026)	0.055** (0.022)	0.047** (0.022)
Post 1965 x Coal	-0.039** (0.016)	-0.039*** (0.015)	-0.041** (0.016)	-0.040** (0.017)
AFDC x Coal	-0.015 (0.038)	-0.021 (0.037)	-0.005 (0.034)	0.014 (0.035)
Post 1965 x AFDC x Coal	0.015 (0.028)	0.024 (0.028)	0.018 (0.027)	0.008 (0.027)
P 1957-58 x Coal		0.059** (0.025)	0.059** (0.025)	0.057** (0.025)
P 1957-58 x AFDC x Coal		-0.008 (0.028)	-0.004 (0.028)	-0.001 (0.029)
P 1968-69 x Coal		0.043*** (0.016)	0.047*** (0.016)	0.045*** (0.016)
P 1968-69 x AFDC x Coal		-0.057*** (0.019)	-0.057*** (0.019)	-0.055*** (0.020)
Adjusted R^2	0.628	0.628	0.632	0.605
Countries	2741	2741	2741	2068
County-Year Obs	82230	82230	82230	62040
State-by-Year, County FE	Y	Y	Y	Y
Temperature and Precipitation	Y	Y	Y	Y
IMRbase, MfgEmp	Y	Y	Y	Y
Transportation			Y	Y
Health Infrastructure			Y	Y
Socioeconomic			Y	Y

- Higher coal capacity exacerbated pandemic severity
 - 1957-58 pandemic: about 530 additional infant deaths
 - 1968-69 pandemic: about 860 additional infant deaths
- The implementation of Medicaid in 1966 and 1967 in high AFDC eligible states *fully offset* the adverse effect of coal capacity during the 1968-1969 pandemic
- Increased access to health care saved about 600 infant lives during the 1968-1969 pandemic

- Age: Birth vs. Older Ages
- Race: Whites vs. Non-whites
 - Non-whites have higher Medicaid eligibility than whites (Goodman-Bacon 2018)
- Medical expenditure: overall and by type of expenditure
 - Dummy for above or below median medical expenditure per capita in 1967
- Other social programs such as Head Start and food stamps
 - Dummy for above or below median participation rates

Mechanisms, Age

	(1)	(2)	(3)	(4)	(5)
	Day 1	Day 2-27	Day28-Y1	Y1	Y1
					Med66-67
Coal Capacity (100 MW)	0.004 (0.016)	0.001 (0.013)	-0.017 (0.011)	-0.026 (0.023)	-0.034 (0.024)
Post 1965 x Coal	-0.022* (0.012)	0.010 (0.009)	0.022* (0.011)	0.019 (0.019)	0.020 (0.019)
AFDC x Coal	-0.013 (0.023)	0.005 (0.019)	0.016 (0.017)	0.014 (0.033)	0.018 (0.036)
Post 1965 x AFDC x Coal	0.011 (0.016)	-0.005 (0.011)	-0.020 (0.015)	-0.023 (0.027)	-0.019 (0.028)
P 1968-69 x Coal	0.027** (0.012)	0.006 (0.008)	0.008 (0.007)	0.033** (0.015)	0.032** (0.016)
P 1968-69 x AFDC x Coal	-0.040*** (0.014)	-0.017* (0.010)	-0.005 (0.009)	-0.054*** (0.017)	-0.058*** (0.017)
Adjusted R^2	0.658	0.538	0.667	0.751	0.749
Counties	665	665	665	665	505
County-Year Obs	11970	11970	11970	11970	9090
State-by-Year, County FE	Y	Y	Y	Y	Y
Temperature and Precipitation	Y	Y	Y	Y	Y
IMRbase, MfgEmp	Y	Y	Y	Y	Y
Transportation	Y	Y	Y	Y	Y
Health Infrastructure	Y	Y	Y	Y	Y
Socioeconomic	Y	Y	Y	Y	Y

Mechanisms, Race

Dep Var: IMR	(1)	(2)	(3)	(4)
	White	White Med 1966-67	Non-white	Non-white Med 1966-67
Coal Capacity (100 MW)	0.009 (0.026)	0.001 (0.027)	0.033 (0.076)	0.064 (0.077)
Post 1965 x Coal	-0.035* (0.020)	-0.032 (0.020)	0.031 (0.063)	0.014 (0.064)
AFDC x Coal	-0.007 (0.034)	-0.007 (0.035)	-0.059 (0.104)	0.043 (0.110)
Post 1965 x AFDC x Coal	0.024 (0.026)	0.027 (0.025)	-0.042 (0.076)	-0.052 (0.076)
P 1968-69 x Coal	0.023 (0.014)	0.025* (0.015)	0.049 (0.052)	0.055 (0.053)
P 1968-69 x AFDC x Coal	-0.039** (0.016)	-0.045*** (0.016)	-0.082 (0.058)	-0.104* (0.059)
Adjusted R^2	0.650	0.682	0.597	0.604
Counties	665	505	665	505
County-Year Obs	9432	6900	8859	6392
State-by-Year, County FE	Y	Y	Y	Y
Temperature and Precipitation	Y	Y	Y	Y
IMRbase, MfgEmp	Y	Y	Y	Y
Transportation	Y	Y	Y	Y
Health Infrastructure	Y	Y	Y	Y
Socioeconomic	Y	Y	Y	Y

Mechanisms, Medical Expenditure

	(1)	(2)	(3)	(4)
Dep Var: IMR	All Exp	Rx Drugs	MD	Hospital
Coal Capacity (100 MW)	0.045*** (0.016)	0.046*** (0.015)	0.047*** (0.016)	0.045*** (0.016)
Post 1965 x Coal	-0.016 (0.020)	-0.012 (0.017)	-0.020 (0.019)	-0.016 (0.020)
Post 1965 x Exp x Coal	-0.011 (0.020)	-0.021 (0.018)	-0.007 (0.020)	-0.011 (0.020)
P 1957-58 x Coal	0.131* (0.078)	0.071** (0.032)	0.128* (0.069)	0.133* (0.077)
P 1957-58 x Exp x Coal	-0.079 (0.081)	-0.017 (0.040)	-0.085 (0.073)	-0.082 (0.081)
P 1968-69 x Coal	0.103** (0.048)	0.048** (0.023)	0.103*** (0.040)	0.104** (0.048)
P 1968-69 x Exp x Coal	-0.102** (0.048)	-0.050** (0.024)	-0.106*** (0.040)	-0.103** (0.048)
Adjusted R^2	0.758	0.758	0.758	0.758
Counties	666	666	666	666
County-Year Obs	19980	19980	19980	19980
State-by-Year, County FE	Y	Y	Y	Y
Temperature, Precip	Y	Y	Y	Y
IMRbase, MfgEmp	Y	Y	Y	Y
Transportation	Y	Y	Y	Y
Health Infrastructure	Y	Y	Y	Y
Socioeconomic	Y	Y	Y	Y

Mechanisms, Other Social Programs

	(1)
	IMR
...	
P 1957-58 x Coal	0.069** (0.028)
P 1957-58 x AFDC x Coal	-0.031 (0.033)
P 1957-58 x HeadStart x Coal	0.085 (0.070)
P 1957-58 x FoodStamp x Coal	-0.036 (0.033)
P 1968-69 x Coal	0.072*** (0.025)
P 1968-69 x AFDC x Coal	-0.087*** (0.026)
P 1968-69 x HeadStart x Coal	0.061 (0.048)
P 1968-69 x FoodStamp x Coal	-0.038 (0.030)
Adjusted R^2	0.758
Counties	666
County-Year Obs	19980
State-by-Year FE, County FE	Y
Temperature and Precipitation	Y
IMR base, Mfg Emp	Y
Transportation	Y
Health Infrastructure	Y
Socioeconomic	Y

- Flu pandemics are important negative health shocks
- Health care access helped address the consequences of health shocks
- Introduction of Medicaid *fully offset* the additional adverse effects of coal capacity during the 1968-1969 pandemic, saving **600** additional infant lives during the pandemic
- This analysis presents new policy-relevant evidence on the roles that air pollution and access to medical care may play during pandemics