Maternal Health and the Baby Boom

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US Baby Boom and Bust

- US total fertility rate rose from 2.12 to 3.65 between 1937 and 1960 and dropped to 1.74 in 1976

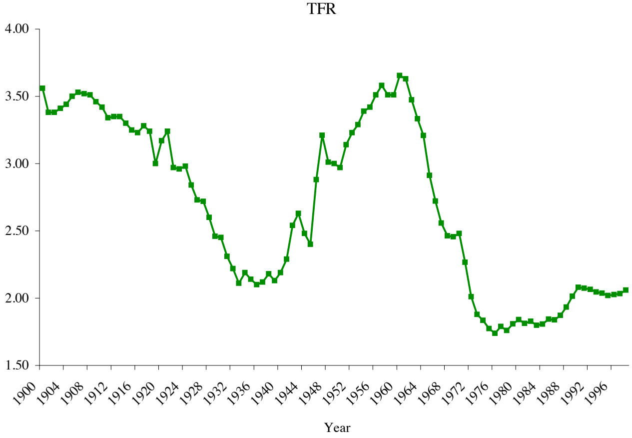

Figure: Total Fertility Rate

Existing Explanations

- Economic conditions (Easterlin, 1961)
  - Rise in "relative Income" for Great Depression and WWII generation

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  - Rise in "relative Income" for Great Depression and WWII generation
- Introduction of home appliances (Greenwood, Seshadri and Vanderbroucke, 2005)
  - Time cost of children goes down
- WWII (Doepke, Hazan and Maoz, 2007)
  - Young women face unfavorable labor market conditions due to high participation rates of older women

Maternal Health

Maternal Mortality

- Maternal mortality dropped from 51.16 to 2.87 per 10,000 live births between 1936 and 1956

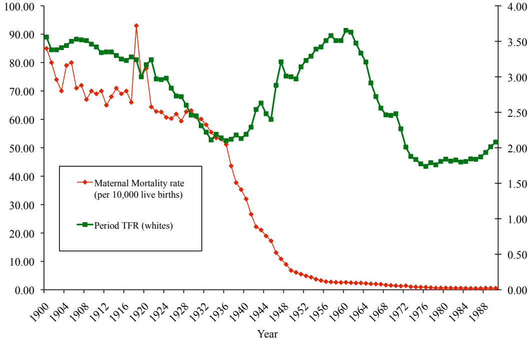

Figure: Maternal mortality and Total Fertility Rate in the U.S. 1900-1990

Source: Vital Statistics of the United States.

Maternal Health

Female Life Expectancy

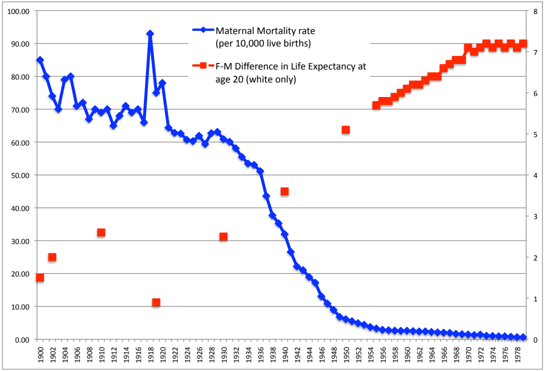

Figure: Female-male differential in life expectancy

Source: Vital Statistics of the United States

Hypothesis

- Dramatic improvement in maternal health starting in mid-1930s possible explanation for US Baby Boom and Bust

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- Mechanism
  - Decline in health burden of childbirth $\Longrightarrow$ Boom
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- Agenda:
  - Explore theoretical and empirical link between maternal and US fertility

Maternal Health and Fertility

- Theory
  - Include maternal mortality & health burden in dynamic model of fertility choice

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  - Exploit differential exposure by cohort
  - Exploit cross-state variation

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  - Exploit differential exposure by cohort
  - Exploit cross-state variation
- Findings
  - Stong positive of improved maternal health on fertility and women's educational attainment
    - Baby Boom and rise in educational attainment driven by maternal mortality drop for exposed cohorts
    - Rise in women's education necessary for Baby Bust, though Bust is harder to identify with empirical strategy

Medical Progress

Infant Mortality Decline

- Infant mortality declines from 124.48 to 9.2 per 1,000 live births between 1900 and 1990, linked to secular decline in fertility (Preston, 1978)

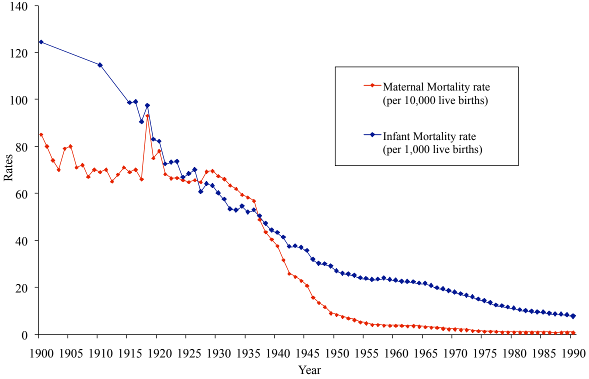

Figure: Maternal and infant mortality rates

Medical Progress and Fertility

Infant and Maternal Mortality Decline

- Infant and maternal mortality decline may jointly explain secular downward trend and medium run fluctuations in fertility

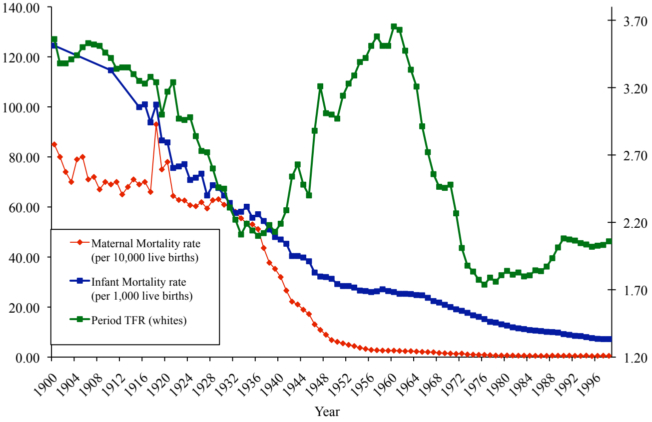

Figure: Infant and maternal mortality and fertility in the US

Medical Progress and Fertility

Integrated Approach

- Impact of medical progress
  - Rapid advances in maternal health $\Longrightarrow$ Baby Boom & Bust
  - Gradual decline in infant mortality $\Longrightarrow$ secular fertility decline

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Integrated Approach

- Impact of medical progress
  - Rapid advances in maternal health $\Longrightarrow$ Baby Boom & Bust
  - Gradual decline in infant mortality $\Longrightarrow$ secular fertility decline
- Empirical findings
  - Decline in infant mortality negatively related to fertility
  - Evidence of "reverse causation"

Literature

- Baby Booms and Busts
- Health and human capital
  - Disease eradication fertility and schooling (Bleakley 2007, Bleakley and Lange 2008)
  - Maternal mortality decline and women's schooling in Sri Lanka (Jayachandran and Lleras-Muney, 2008)
- Secular fertility decline
  - Impact of youth mortality (Preston and Haines 1991, Haines 1993)
  - Human capital (Murphy, Simon and Tamura, 2008)

Outline

- Historical backgound
- Theoretical implications for fertility choice
- Empirical analysis
- Discussion

Maternal Health in the US

Historical Background

Maternal Mortality

- Maternal mortality was the second cause of death after tuberculosis among women 15-44 in early 1930s

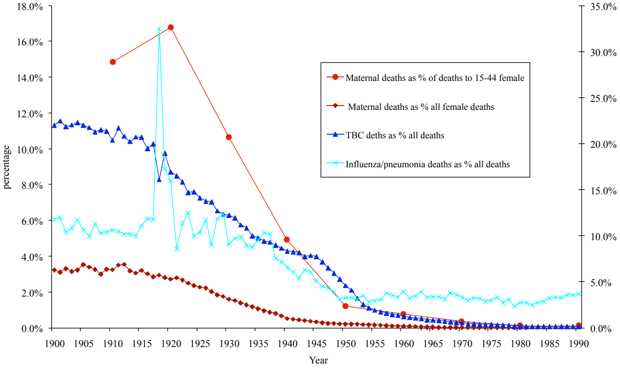


Figure: Incidence of maternal mortality

Historical Background

Maternal Mortality

- Maternal mortality in the US was high relative to other advanced countries

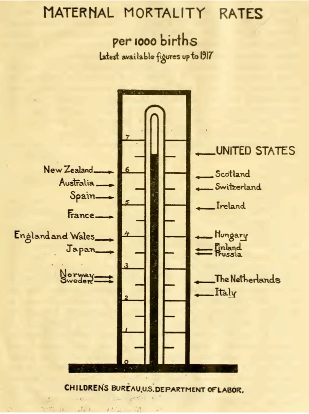


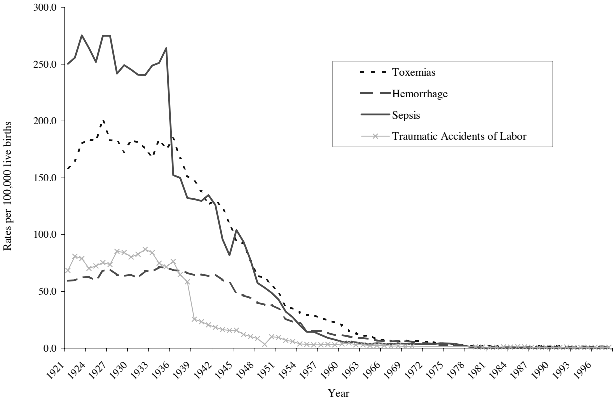
Figure: Maternal Mortality Thermometer.

Source: Eighth Annual Report of the Chief, Children's Bureau, 1920.

Historical Background

Maternal Mortality

- All causes of maternal mortality started to decline sharply in the mid-1930s



Source:Table 1 in National Center of Health Statistics, Vital Health Statistics, 1984; Series 21 No. 40

Historical Background

Maternal Morbidity

- For each maternal death, twenty cases of pregnacy-related morbidity in the late 1920s:
  - Conditions: obstetric fistulas, hypertensive disorders, chronic anaemia, infertility
  - Severe disablement (disability weights 0.10-0.43), prolonged duration/chronic
  - Years lost to disability per pregnancy: 2.5 (Albanesi and Olivetti, 2009)

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  - Severe disablement (disability weights 0.10-0.43), prolonged duration/chronic
  - Years lost to disability per pregnancy: 2.5 (Albanesi and Olivetti, 2009)
- Sharp drop (-93%) in annual rate of pregnancy-related post-partum morbidity requiring hospitalization:
  - 114.4 per 1,000 deliveries in the late 1920s (Kerr, 1933)
  - 8.1 per 1,000 deliveries in 1986-1987 (Franks et al., 1992)

Advances Maternal Health

Agencies Hail Mortality Drop In Birth Cases

Maternity Center Official Lays Trend to New Drug and Organized Campaign

By ANNE PETERSEN

A record drop in the latest maternal mortality figures for this country, and the part played in this reduction by the new chemical discovery of sulfanilamide, have given new cheer to the agencies that long and strenuously have campaigned against preventable deaths of American mothers.

Figure: The New York Times, April 9, 1939

Historical Background

Advances in Maternal Health in the US

- Medical and scientific developments
  - Prenatal care 1910s-
  - Hospitalization of childbirth 1930-
  - Standardization of obstetric practices, formal residency training, board certification 1930-
  - Advanced imaging techniques, radiology 1930s-
  - *Sulfa drugs 1936*
  - *Blood banking 1937*
  - Antibiotic effects of penicillin 1938-1942

Historical Background

Advances in Maternal Health in the US

- Government intervention
  - Expansion of death and birth registration 1850-
  - Expansion of city child health agencies 1908-
  - Children's Bureau 1912-
  - 1921-1929 Sheppard-Towner Act
  - 1933 White House Conference on Child Health Protection: "Fetal, Newborn, and Maternal Mortality Report"
  - *1935 Social Security Act, Title V, Part I*
  - 1943-1946 EMIC Program
  - 1946 Hill-Burton Act

Historical Background

Hospitalization of Childbirth

Table: Live Births by Attendant, U.S. States

	1940		1946		1954	
Percentage of total	Median	Min,Max	Median	Min,Max	Median	Min,Max
In hospital	**61**	13.9, 91.4	**89.6**	38.6, 98.9	**98**	60, 100
At home with physician	36.6	8.6, 76.7	9	1, 42.6	2	0,11
At home without physician	0.71	0.01, 49.29	0.6	0, 36.9	0	0,30
	Correlation with maternal mortality					
Percentage of total	1940		1946		1954	
In hospital	-0.31		**-0.42*** **		**-0.73*** **	
At home with physician	0.09		0.16		0.59***	
At home without physician	**0.47*** **		**0.68*** **		**0.74*** **	

*** Significant at 1% level. Source: Children's Bureau.

Historical Background
Summary

- 1936: Critical year for maternal health in the US

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- Maternal morbidity
  - 93% drop in post-partum maternal morbidity 1930-1985

Theory

Maternal Health and Fertility Choice

- Direct effects with positive impact on the demand for children
  - Maternal health burden declines
- Indirect effects with negative impact on the demand for children
  - Increased importance of utility conditional on survival
    - Incentive to invest in human capital
    - Children's opportunity cost rises

Model

- Preferences

$$\Upsilon(e,c,b,n;\mu,\varphi,\beta,U) = -v(e) + \mu\left[u(c) - h(\varphi b)\right] + \beta g(n) U$$

- $c \geq 0$ consumption, $e \geq 0$ human capital investment
  - $v(\cdot) =$ utility cost of human capital investment, $v' > 0$, $v'' \geq 0$
  - $u(\cdot) =$utility from consumption, $u' > 0$, $u'' \leq 0$

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  - $\varphi \geq 0$ health burden of each birth

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- $\mu \in (0,1]$ maternal survival probability
- $n = sb \geq 0$ number of children
  - $s \in (0,1]$ infant survival probability

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- $g(\cdot) =$Barro-Becker dynastic discount factor, $g' > 0$, $g'' \leq 0$
  - $\beta \in (0, 1)$, $U > 0$ average child's utility

Model

- Key health parameters
  - φ health burden of each birth
  - μ maternal survival probability
  - s infant survival probability

Model

- Budget constraint:

$$c = (1 + \varepsilon e)w$$

  - $\varepsilon \geq 0$ returns to human capital, $w \geq 0$ base income

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- Timing
  - Stage 1: Human capital choice (e)
  - Stage 2: Fertility choice (b)

Comparative Statics

Decline in the health burden

- Impact on fertility only:

$$\frac{\partial b}{\partial \varphi} < 0$$

  - Magnitude of b response positively related to initial φ and μ, negatively related to s, U
- Maternal health burden declines ($\varphi \downarrow$) $\Longrightarrow$ demand for children rises

Comparative Statics

Drop in maternal mortality

- Must occur at Stage 1 to affect decision problem
- Impact on human capital investment:

$$\frac{\partial e}{\partial \mu} \geq 0$$

  - Mechanism: Positive effect of human capital on mother's consumption

Comparative Statics

Drop in maternal mortality

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$$\frac{\partial e}{\partial \mu} \geq 0$$

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- Impact on fertility:

$$\frac{\partial b}{\partial \mu} \leq 0$$

  - Mechanism: Negative effect of births on utility conditional on survival, due to health burden

- Maternal motality drop ($\mu \uparrow$) $\Longrightarrow$ Human capital rises and demand for children falls

Theory

Summary of predictions

- Effect of advances in maternal health
  - Exposure during childbearing years (Stage 2):
    - Positive fertility response
  - Exposure prior to childbearing years (Stage 1):
    - Positive human capital response
    - Ambiguous fertility response: Likely positive at low fertility, high burden

Comparative Statics

Drop in infant mortality

- Impact on fertility only
- $\frac{\partial b}{\partial s} \leq 0$ if and only if intertemporal substitution of children in dynastic discount factor smaller than 1

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Drop in infant mortality

- Impact on fertility only
- $\frac{\partial b}{\partial s} \leq 0$ if and only if intertemporal substitution of children in dynastic discount factor smaller than 1
- Typical dependency on curvature of utility from children (Wolpin 1993, Doepke 2005)

Theory

Generalization

- Predictions confirmed with:
    - Mother enjoys direct utility from children conditional on survival
    - Utility cost of health burden borne irrespective of maternal survival
    - Children's utility depends positively on maternal survival

Theory

Generalization

- Introducing *complementarities* between human capital investment and fertility choice
- Channels:
  - Probability of survival depends on the number of births: $\mu(b)$, with $\mu' < 0$ and $\mu'' \geq 0$
  - Endogenous labor force participation $p \in [0,1]$
    - Budget constraint: $c = (1 + \varepsilon e) w p$
    - Disutility from health burden and labor force participation: $h(\varphi b + p)$

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    - Disutility from health burden and labor force participation: $h(\varphi b + p)$
- Predictions: Drop in maternal health burden causes fertility to rise *only if* not anticipated
  - Otherwise, human capital rises and fertility may decline
    - Decline in fertility more likely with higher returns to human capital

Empirical Analysis

Empirical Analysis

Approach

- Goal: Study impact of advances in maternal health on fertility and women's human capital
- Approach:
  - Maternal mortality used as proxy for maternal health
  - Maternal mortality drop treated as quasi-experiment
  - Difference-in-difference estimation strategy:
    - Exposure varies by cohort and by state
    - Cross-state variation interpreted as exogenous

Cross-state Variation in Maternal Mortality

MMR*					
(per 10,000 live births)					
Levels			Change		
	Mean	Min, Max		Mean %	Min, Max
1930	70.68	49, 114			
1940	38.06	18.3, 68.8	1940-1930	-46	-61.5, -10.1
1950	8.81	1.8, 26.9	1950-1940	-78.5	-52.6,-16.5
1960	3.68	1.2, 10.6	1960-1950	-50.7	-25.6, 4.6
1970	2.14	0.4, 7.2	1970-1960	-35.0	-9.4, 1.4

* Aggregate mortality rates.

Empirical Analysis
Data

- Demographic and state level data from IPUMS of Decennial Census of the U.S. (1930-1990)
  - Sample: White married women with children living in in non-farm households
- Maternal and infant mortality rates by states from Vital Statistics of the U.S.
- State per capita personal income: BEA Regional Economic Accounts

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- State per capita personal income: BEA Regional Economic Accounts
- State level controls on payments of federal funds for maternal and infant health, maternal health clinics, live births by attendant, general and maternity hospitals
  - Newly digitized data from Children's Bureau publications and JAMA's Hospital Service in the U.S.

Empirical Analysis

Concepts

- Completed fertility measure: Children Ever Born at age 32-39
- Differential exposure to maternal mortality drop by stage of the life cycle
  - Expected MM: Average in state at age 18 (beginning of adult life)
  - Concurrent MM: Average at age 20-31 (during childbearing years)
- Education measures:
  - Main: Male-female differential in college graduation
  - Additional: High school/college graduation rate, years of schooling

Empirical Analysis
Estimation

- Baseline regression equation:

$$\Delta Y_{sc} = \alpha_o + \alpha_1 \Delta MMR_{sc} + \alpha_2 \Delta X_{sc} + \alpha_3 Z_{s\bar{c}} + \alpha_4 Z_s + \varepsilon_s$$

- $\Delta Y_{sc} = Y_{sc} - Y_{s\bar{c}}$ difference in outcome Y for state s between cohorts c and $\bar{c}$
- ΔMMR_{sc} drop in maternal mortality across cohorts
  - Coefficient of interest: α_1

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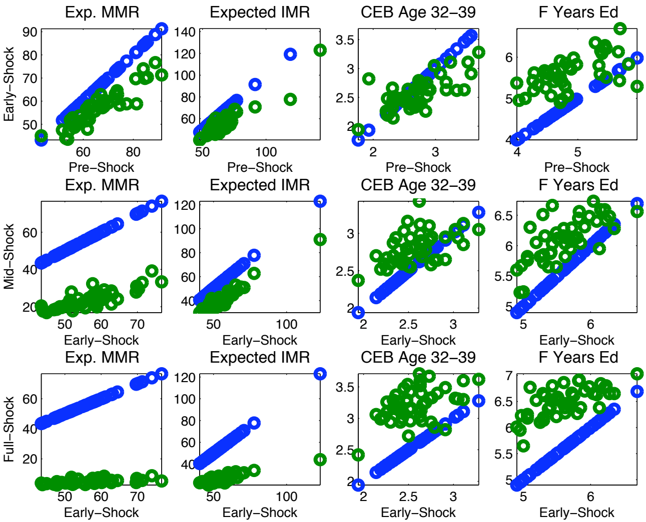
  - Coefficient of interest: α_1
- ΔX_{sc} change in state-level controls, X
- $Z_{s\bar{c}}$ state controls for older cohort
- Z_s state-level controls invariant across cohorts

Table: Cohort Definition and Summary Statistics

	Pre-Shock	*Early-Shock*	*Mid-Shock*	*Full-Shock*	*Post-Shock*
Born	1901-08	1911-18	1921-28	1931-38	1941-1948
Age [22-29] in	1930	1940	1950	1960	1970
Exposure	None	Partial drop in concurrent MM	Partial drop in expected MM; Concurrent MM < expected	Full drop in expected MM; Concurrent MM ~ expected	
Maternal mortality per 10,000 live births					
Expected	63.19	56.65	23.78	4.85	2.35
Concurrent	60.03	33.24	8.61	2.68	1.42
Fertility					
Children Ever Born	2.71	2.57	2.80	3.22	2.42
College Graduation Rate					
Female	0.05	0.06	0.10	0.10	0.18
M-F Differential	0.03	0.05	0.11	0.12	0.11

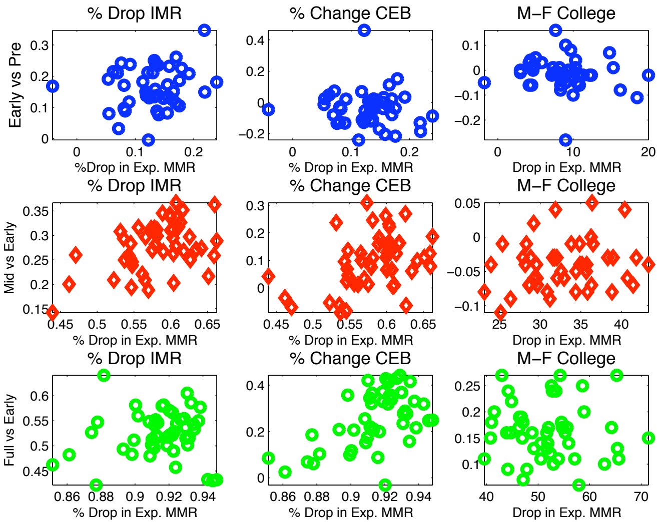
Experimental Cohort Comparisons

Descriptive Analysis



Experimental Cohort Comparisons

Relation with Expected Maternal Mortality Drop



Estimation

Issues

- Positive correlation between expected MM and fertility for older cohorts $\Longrightarrow$ Possible downward bias in estimated coefficient for fertility since
  - MM drops by more in states with initially high MM
  - Fertility rises by less in states with initially high fertility

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Issues

- Positive correlation between expected MM and fertility for older cohorts $\Longrightarrow$ Possible downward bias in estimated coefficient for fertility since
  - MM drops by more in states with initially high MM
  - Fertility rises by less in states with initially high fertility
- Negative correlation between education and maternal mortality for early-shock and later cohorts $\Longrightarrow$ Possible downward bias in estimated coefficient for education since
  - male-female differential in education is higher and drops by less in states with initially high education

Estimation

Cross-state variation in maternal mortality

- Initial cross-state variation in MM and fertility and cross-state variation in magnitude of drop interpreted as exogenous

Estimation

Cross-state variation in maternal mortality

- Initial cross-state variation in MM and fertility and cross-state variation in magnitude of drop interpreted as exogenous
- Include controls to address possible joint endogeneity for MM drop and change in fertility:
  - Access to funds for government programs for maternal and infant health
  - Diffusion of home appliances
  - World War II mobilization (Early-shock and Mid-Shock cohorts)

Impact of MM Drop on Fertility

Early-shock vs Pre-shock comparison

- Expected MM: Drops by 10% $\Longrightarrow$ Placebo
  - No effect of MM drop on change in fertility
- Concurrent MM: Drops by 45%, late in life cycle and only for high MM states
  - No significant impact on fertility
- Early-shock cohort considered last 'untreated'

Impact of MM Drop on Fertility

Mid-Shock vs Early-shock comparison

- Expected MM: Drops by 58%, still high relative to modern values
  - No significant effect on fertility change

Impact of MM Drop on Fertility

Mid-Shock vs Early-shock comparison

- Expected MM: Drops by 58%, still high relative to modern values
  - No significant effect on fertility change
- Concurrent MM: Drops by 74%, close to modern values
  - Positive and significant effect of MM drop on change in fertility $\Longrightarrow \alpha_1 \in (0.88, 0.90)$
  - Predicted fertility change +60%, actual +9%

Concurrent MM, Mid-shock

Concurrent MMR and completed fertility: Mid-shock vs Early-shock comparison

Dependent Variable is Percentage Change in Completed 1	2	3	4	5
%Drop Concurrent MMR	0.9013**	0.8794**	0.8328*	0.8067*	0.8910*
Concurent MMR	-0.0089***	-0.0087***	-0.0081**	-0.0078**	-0.0065**
Per Capita Personal Income		0	0	0	0
%Change:					
Per Capita Personal Income	0.1463	0.1577	0.0494	-0.0587	-0.2191
Share White			0.1385	0.1725	0.0916
Share Farm			-0.0567	-0.0307	-0.0131
Share Foreign Born			-0.0607	-0.024	-0.0341
Share Health Sector			0.0067	-0.0064	0.0097
Share Public Sector			-0.0793	-0.0415	-0.041
Unemployment Rate				-0.0195	-0.0299
Share High School Graduates				-0.1293	-0.1359
Female FT Hourly Wage					0.0367
Male FT Hourly Wage					0.1885
Constant	-0.2527	-0.2532	-0.1735	-0.0353	-0.1638
Observations	49	49	49	49	49
Adj R-squared	0.367	0.353	0.324	0.321	0.308

Notes: Robust standard errors in brackets. Mid-shock cohort, born in 1921-28. Early-shock cohort, born in 1911-18. In columns 1-5 and 7 the dependent variable is computed for the sample of white married women with children, not living in institutional quarters and not living in farms.
*Significance at 10% level. **Significance at 5% level. ***Significance at 1% level.

Impact of MM Drop on Fertility

Full-shock vs Early-shock comparison

- Expected MM: Drops by 92%
  - Positive and significant effect of MM drop on change in fertility $\Longrightarrow \alpha_1 \in (0.34, 0.62)$
  - Predicted fertility change 31-57%, actual 25.3%

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- Expected MM: Drops by 92%
  - Positive and significant effect of MM drop on change in fertility $\implies \alpha_1 \in (0.34, 0.62)$
  - Predicted fertility change 31-57%, actual 25.3%
- Concurrent MM: Similar to expected MM
  - No effect on fertility change for any specification

Expected MM, Full-shock

Expected MMR and Completed Fertility: Full-Shock vs. Early-Shock Cohort

Dependent Variable is Percentage Change in Completed Fertility

		1	2	3	4	5	6	7
	%Drop Expected MMR	**.6170*****	**.4984****	**0.4778****	**0.4464****	**0.3368***	**0.6670***	**0.5184****
	Expected MMR	-0.0023***	-0.0020**	-0.0016**	-0.0015**	-0.0008	-0.0045***	-0.0013*
	Per Capita Personal Income		0	0.0000*	0.0000*	0	0	0.0000*
%Change:	Per Capita Personal Income	-0.1445	0.0242	0.2619*	0.3048**	0.1794	0.0807	0.3234**
	Share White				0.7123***	0.8242***	1.1309***	0.5146
	Share Farm			0.0983**	0.1149**	0.1519***	0.0101	0.1287***
	Share Foreign Born			-0.0822**	-0.0688**	-0.0740**	-0.1068**	-0.0755**
	Share Health Sector			-0.0346	-0.0324	-0.042	0.0118	-0.0497
	Share Public Sector			-0.1209**	-0.0731	-0.0341	-0.0827	-0.0951
	Unemployment Rate				-0.0151	-0.0093		
	Share High School				-0.1538*	-0.2667**		
	Female FT Hourly Wage					-0.0963		
	Male FT Hourly Wage					0.4383**		
	Constant	-0.1452	-0.2056	-0.247	-0.2002	-0.1729	-0.1403	-0.285
	Observations	49	49	49	49	49	49	48
	Adj R-squared	0.425	0.449	0.642	0.647	0.684	0.424	0.651

Notes: Robust standard errors in brackets. Full-shock cohort, born in 1931-38. Early-shock cohort, born in 1911-18. In columns 1-5 and 7 the dependent variable is computed for the sample of white married women with children, not living in institutional quarters and not living in farms. In column 6 the sample includes only women born-in-state. In columns 1-6 sample excludes Alaska and Hawaii, in column 7 DC is also excluded from the sample. *Significance at 10% level. **Significance at 5% level. ***Significance at 1% level.

Expected MM, Full-shock: Robustness

Expected MMR and Completed Fertility: Full-Shock vs. Early-Shock Cohort, Robustness

	Dependent Variable is Percentage Change in Completed Fertility						
	1	2	3	4	5	6	7
% Drop Expected MMR	**0.4578****	**0.3432***	**0.5176****	**0.3784****	**0.3337***	**0.3500****	**0.4719****
Share of Dwellings with Refrigerators	0.1821**	0.131					
% Drop Concurrent IMR			0.1252				
Literacy				-0.0052			
Date Suffrage Accepted				0.0001			
Sheppard-Towner Act per capita payments				0.2743**			
Social Security Act per capita payments				-0.0682**			
WWII Mobilization Rates					0.0537	0.2316	
% Nonwhite 1940					-0.1153		
% Farmers 1940					-0.0454		
% Births to Servicemen1943							0.0002
Constant	-0.3697*	-0.2718	-0.3116	-0.3124	-0.1715	-0.314	-0.2491
Additional controls	{1}	{1,2}	{1}	{1}	{1}	{1}	{1}
Observations	49	49	49	49	47	47	49
Adj R-squared	0.681	0.699	0.638	0.704	0.684	0.695	0.634

Notes: Robust standard errors in brackets. Full-shock cohort, born in 1931-38. Early-shock cohort, born in 1911-18. The dependent variable is computed for the sample of white married women with children, not living in institutional quarters and not living in farms. Controls: 1= 1950's expected MMR and per-capita personal income, percentage change in: per-capita personal income, share white, share farm, share foreign born, share working in health and in the public sector, 2= 1 + percentage change in unemployment rate, share high school graduate, male and female full-time real hourly wage. In columns 1-4 and 7 the sample excludes Alaska and Hawaii. In columns 5-6 Nevada and DC are also excluded from the sample because of missing information on mobilization rates.
*Significance at 10% level. **Significance at 5% level. ***Significance at 1% level.

Gender Differential in College

- Negative and sizable impact of expected MM drop on male-female differentials in college graduation rate for Mid-shock vs Early-shock comparison
  - Baseline coefficient implies M-F differential should drop from 5% to -4%
  - Significant in percentage specification, magnitude robust to controls

Gender Differential in College

- Negative and sizable impact of expected MM drop on male-female differentials in college graduation rate for Mid-shock vs Early-shock comparison
  - Baseline coefficient implies M-F differential should drop from 5% to -4%
  - Significant in percentage specification, magnitude robust to controls
- Negative and sizable impact of expected MM drop on male-female differentials in college graduation rate for Full-shock vs Early-shock comparison
  - Baseline coefficient implies M-F differential should drop from 5% to -5%
  - Significant in levels specification, magnitude robust to controls

Education, Mid-shock

Expected MMR and Male-Female College Graduation Differential: Mid-Shock vs. Early-Shock Cohort					
Dependent variable is % change in male-female college graduation rate					
	1	2	3	5	6
%Drop Expected MMR	-2.9320**	-2.7469**	-3.2374	-4.4337*	-2.9593
Per Capita Personal Income					-0.0004
%Change					
Per Capita Personal Income		-2.4099**	-0.3707	0.1726	-0.3524
Share White					-1.6079
Share Farm					-1.8257**
Share Health Sector					0.2474
Share Public Sector					0.4541
Share textile					0.0927
Share agricolture					3.0937*
Unemployment Rate					0.0663
Female FT Hourly Wage					-0.4231
Male FT Hourly Wage					2.52
Male college Mid-shock		-10.2575***			
College graduation rate			-0.5484		
WWII Mobilization Rate				-3.387	-11.8433
Share White Early-shock				-0.6427	0.5763
Share Farm Early-shock				-0.5616	-1.1415
Years schooling Early-shock				0.0943	0.6257**
Constant	2.0926***	3.6451***	2.3866*	3.9765	3.9013
Observations	49	49	49	47	44
R-squared	0.074	0.421	0.076	0.121	0.367
Adj R-squared	0.0547	0.382	0.0149	-0.0104	-0.0086

Education, Full-shock

Expected MMR and Male-Female College Differential: Full-Shock vs. Early-Shock Cohort
Dependent variable is the change in M-F differential in college graduation rate

	1	2	3	4	5
Level Drop Expected MMR	-0.0017*	-0.0017*	-0.0015*	-0.0014*	-0.0002
Per Capita Personal Income Change					-0.0000**
Per Capita Personal Income		0	0	0	0
Share White					-0.5057***
Share Farm					0.2319
Share Health Sector					-0.8956
Share Public Sector					0.4432
Share textile					-0.2955
Share agricolture					-0.2617
Unemployment Rate					0.1207
Female FT Hourly Wage					0.0308
Male FT Hourly Wage					0.015
College 1940			0.5762		
Male college 1940				0.4063	
Constant	0.0784***	0.0804*	0.0469	0.0523*	0.0869
Observations	49	49	49	49	49
R-squared	0.058	0.058	0.222	0.201	0.601
Adj R-squared	0.0379	0.0171	0.17	0.148	0.468

Post-Shock Cohort

- Born 1941-1949, Age 22-29 in 1970
- Fertility:
  - Positive relation with expected MM drop in comparison with Early-shock cohort, not robust
  - No relation with expected MM drop in comparison with Full-shock cohort

Post-Shock Cohort

- Born 1941-1949, Age 22-29 in 1970
- Fertility:
  - Positive relation with expected MM drop in comparison with Early-shock cohort, not robust
  - No relation with expected MM drop in comparison with Full-shock cohort
- Education:
  - Negative relation with expected MM drop on male-female differential in college graduation rate in comparison with Early-shock and Full-shock cohorts
  - Baseline coefficient implies M-F differential should drop from 5% to -5%

Fertility, Post-shock

Expected MMR and Completed Fertility: Post-Shock vs. Early-Shock Cohort
Dependent Variable is Percentage

	1	2	3	4	5
%Drop Expected MMR	0.2975**	0.2747*	0.144	0.1801	0.1528
Expected MMR	-0.0015***	-0.0015**	-0.0018**	-0.0017**	-0.0015**
Per Capita Personal Income		0	0	0	0
%Change:					
Per Capita Personal Income	-0.1523**	-0.0574	-0.1174	-0.1035	-0.2479
Share White			0.2327*	0.2982**	0.3910**
Share Farm			-0.0237	-0.043	-0.0392
Share Foreign Born			-0.007	0.0039	0.01
Share Health Sector			-0.0129	0.0078	0.0217
Share Public Sector			-0.1098**	-0.0788	-0.0652
Unemployment Rate				0.0106	-0.0005
Share High School Graduates				-0.1248	-0.1762
Female FT Hourly Wage					-0.0296
Male FT Hourly Wage					0.4884
Constant	-0.0716	-0.113	0.0348	0.0136	0.0028
Observations	49	49	49	49	49
Adj R-squared	0.346	0.343	0.392	0.378	0.407

Notes: Robust standard errors in brackets. Post-shock cohort, born in 1941-48. Early-shock cohort, born in 1911-18. In columns 1-5 and 7 the dependent variable is computed for the sample of white married women with children, not living in institutional quarters and not living in farms. In column 6 the sample is further restricted to women born-in-state. In columns 1-6 sample excludes Alaska and Hawaii, in column 7 DC is also excluded from the sample. *Significance at 10% level. **Significance at 5% level. ***Significance at 1% level.

Education, Post-shock

Expected MMR and M-F College Graduation Differential: Post-Shock vs. Early-Shock and Full-Shock Cohort

Dependent Variable is Level Change in M-F College Graduation Differential

	1	2	3	4	5	6	7
% Drop Expected MMR	-2.0462*	-1.724	-1.4435	-1.7384	-2.7138**	-2.0327*	-2.4000**
Per Capita Personal Income					0		-0.0001
% Change							
Per Capita Personal Income		0.603	-0.0535	0.6598	-0.8096	0.1813	-0.4234
Share White					3.1044		0.1694
Share Farm					-0.4522		-1.388
Share Health Sector					0.1098		0.0576
Share Public Sector					-0.5143		-0.2961
Share Textile					-0.0709		-0.0348
Share Agriculture					0.362		1.4587*
Unemployment Rate					0.1562		0.3368
Female FT Hourly Wage					1.097		1.1096
Male FT Hourly Wage					-2.4706		-1.1461
Share Male College 1950			-2.5342***				
Share of 18-64 Population with College				0.3544			
WWII Mobilization Rates						0.6771	-3.1168
Share White 1940						0.2653	0.2707
Share Men Farm 1940						-0.0507	0.028
Constant	1.3083*	0.9394	1.2070*	0.9113	2.4337**	0.9291	2.2739
Observations	49	49	49	49	45	47	44
R-squared	0.075	0.108	0.287	0.108	0.31	0.099	0.407
Adj R-squared	0.055	0.0688	0.24	0.049	0.0508	-0.0106	0.0548

Notes: Robust standard errors in brackets. Early-shock cohort, born in 1911-18. Full-shock cohort, born in 1931-38. Post-shock cohort, born in 1941-48. In all columns the dependent variable is computed for the sample of white married women, not living in institutional quarters and not living in farms. In columns 1-4 the sample excludes Alaska and Hawaii. *Significance at 10% level. **Significance at 5% level. ***Significance at 1% level.

Impact of Infant Mortality Decline

Table: Cohort Definition and Summary Statistics

	Pre-Shock	*Early-Shock*	*Mid-Shock*	*Full-Shock*
Born	1901-08	1911-18	1921-28	1931-38
Age [22-29] in Year	1930	1940	1950	1960
Exposure	None	Partial reduction in concurrent MM	Partial reduction in expected MM; Concurrent MM < expected	Full reduction in expected MM; Concurrent MM ~ expected
Infant mortality per 1,000 live births				
Expected	63.52	55.26	39.99	25.98
Concurrent	59.91	44.69	29.19	23.3

Impact of Infant Mortality on Fertility

Estimation Issues

- Gradual decline in IM implies all cohorts are partially exposed
- Possible "reverse causation" captured by concurrent IM estimates $\Longrightarrow$ Maternal depletion causes IM to rise with fertility
  - Only expected IM estimates isolate direct causation

Impact of Infant Mortality on Fertility
Estimation Issues

- Gradual decline in IM implies all cohorts are partially exposed
- Possible "reverse causation" captured by concurrent IM estimates $\Longrightarrow$ Maternal depletion causes IM to rise with fertility
  - Only expected IM estimates isolate direct causation
- Positive correlation between expected/concurrent infant mortality and fertility for all cohorts $\Longrightarrow$ Possible upward bias in estimated coefficient for fertility since
  - IM drops by more in states with initially high IM
  - Fertility rises by less in states with initially high fertility

Impact of Infant Mortality on Fertility

Findings

- Early-shock vs Pre-Shock comparison delivers strongest results for both expected and concurrent IM
  - Baseline coefficient implies -11.7% change in fertility for expected IM regression, actual is -5.17%

Impact of Infant Mortality on Fertility

Findings

- Early-shock vs Pre-Shock comparison delivers strongest results for both expected and concurrent IM
  - Baseline coefficient implies -11.7% change in fertility for expected IM regression, actual is -5.17%
- Strong estimated impact of expected and concurrent IM drop for all other comparisons
  - Baseline coefficient implies -18.4% change in fertility, actual is 3.3%
- Role of concurrent IM may reflect reverse causation

Early-shock vs Pre-Shock

IMR and Completed Fertility: Early-Shock vs. Pre-Shock Cohort

	Dependent Variable is Percentage Change in Completed Fertility					
	Expected IMR			*Concurrent IMR*		
	1	2	3	4	5	6
%Drop IMR	-0.9034**	-0.9751***	-0.8838***	-1.0896**	-1.4545***	-1.3752***
Per Capita Personal Income	0.0001***	0.0000*	0.0000*	0.0001***	0.0001**	0.0001**
%Change:						
Per Capita Personal Income	0.1096	0.0398	0.0744	0.1159	0.0198	0.0557
Share White		-0.0234	-0.5057		-0.4746	-0.7269
Share Farm		-0.1957	-0.2042		0.1633	0.1279
Share Foreign Born		-0.2906**	-0.2557**		-0.1981*	-0.2176*
Share Health Sector		-0.0287	-0.016			-0.0336
Share Public Sector		-0.0069	-0.0173			-0.0019
Unemployment Rate			0.1084			0.0958
Share High School Graduates			0.1134			0.0824
Female FT Hourly Wage			-0.083			-0.0245
Male FT Hourly Wage			0.5893*			0.3911
Constant	-0.1856*	-0.2353*	-0.3333*	-0.0994	0.0325	-0.0355
Observations	47	47	47	49	49	49
Adj R-squared	0.335	0.328	0.343	0.309	0.38	0.355

Notes: Robust standard errors in brackets. Early-shock cohort, born in 1911-18. Pre-shock cohort, born in 1901-08. In all columns the dependent variable is computed for the sample of white married women with children, not living in institutional quarters and not living in farms. In all columns the sample excludes Alaska and Hawaii. In columns 1 to 3 the sample also excludes South Dakota and Texas since expected MMR cannot be computed for the pre-shock cohort. *Significance at 10% level. **Significance at 5% level. ***Significance at 1% level.

Mid-shock vs Pre-Shock

IMR and Completed Fertility: Mid-Shock vs. Pre-Shock Cohort

	Dependent Variable is Percentage Change in Completed Fertility					
	Expected IMR			*Concurrent IMR*		
	1	2	3	4	5	6
%Drop IMR	-0.3586**	-0.5397***	-0.6329***	-0.6241***	-0.7061***	-0.7755***
Per Capita Personal Income	0.0001***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000**
%Change:						
Per Capita Personal Income	0.3613**	0.3309**	0.3316*	0.2716**	0.2579*	0.2372
Share White		0.0022	0.1492		0.0693	0.1125
Share Farm		0.0804*	0.0538		0.0395	0.0143
Share Foreign Born		-0.0434	-0.049		-0.0301	-0.0526
Share Health Sector		-0.0774**	-0.062		-0.0949***	-0.0810**
Share Public Sector		-0.0652	-0.0819		-0.0452	-0.0493
Unemployment Rate			-0.0532			-0.0165
Share High School Graduates			-0.0663			-0.0393
Female FT Hourly Wage			0.1174			0.0692
Male FT Hourly Wage			0.0207			0.162
Constant	-0.2397**	-0.0628	-0.1222	-0.0628	0.0916	0.0117
Observations	47	47	47	49	49	49
Adj R-squared	0.391	0.459	0.417	0.449	0.473	0.433

Notes: Robust standard errors in brackets. Mid-shock cohort, born in 1921-28. Pre-shock cohort, born in 1901-08. In all columns the dependent variable is computed for the sample of white married women with children, not living in institutional quarters and not living in farms. In all columns the sample excludes Alaska and Hawaii. In columns 1 to 3 the sample also excludes South Dakota and Texas since expected MMR cannot be computed for the pre-shock cohort. *Significance at 10% level. **Significance at 5% level. ***Significance at 1% level.

Full-shock vs Pre-Shock

IMR and Completed Fertility: Full-Shock vs. Pre-Shock Cohort

	Dependent Variable is Percentage Change in Completed Fertility					
	Expected IMR			*Concurrent IMR*		
	1	2	3	4	5	6
%Drop IMR	-0.5014**	-0.5996***	-0.7928***	-0.4639***	-0.5254***	-0.6060**
Per Capita Personal Income	0	0.0000***	0	0	0.0000*	0
%Change:						
Per Capita Personal Income	-0.0951	0.2176	0.1556	-0.0927	0.1543	0.0627
Share White		0.2472	0.2599		0.1437	0.1631
Share Farm		0.0105	-0.018		-0.0313	-0.0249
Share Foreign Born		-0.1112**	-0.1344***		-0.0824*	-0.0924*
Share Health Sector		-0.1467***	-0.1285***		-0.1276***	-0.1213**
Share Public Sector		-0.0868*	-0.0799*		-0.0858*	-0.0797*
Unemployment Rate			-0.0622			-0.0162
Share High School Graduates			-0.0263			0.0063
Female FT Hourly Wage			0.0339			-0.1476
Male FT Hourly Wage			0.2194			0.2554
Constant	0.1673	0.13	0.0947	0.1678	0.1398	0.1808
Observations	47	47	47	49	49	49
Adj R-squared	0.478	0.643	0.616	0.479	0.576	0.539

Notes: Robust standard errors in brackets. Full-shock cohort, born in 1931-38. Pre-shock cohort, born in 1901-08. In all columns the dependent variable is computed for the sample of white married women with children, not living in institutional quarters and not living in farms. In all columns the sample excludes Alaska and Hawaii. In columns 1 to 3 the sample also excludes South Dakota and Texas since expected MMR cannot be computed for the pre-shock cohort. *Significance at 10% level. **Significance at 5% level. ***Significance at 1% level.

Discussion

Contributions

- First analysis of impact of improved maternal health on fertility and women's educational attainment in U.S.
  - Broadly consistent with simple theory of fertility choice
- Suggests medical progress as possible integrated explanation for *both* secular decline and Baby Boom in U.S. fertility
  - association with Baby Bust tenuous

Ongoing work

- Formal analysis of determinants of maternal mortality drop across states
  - Government education and insurance programs
  - Development of private health insurance
  - Cultural factors i.e. attitude towards women's economic and political rights, ethnic composition & religion
- International analysis
  - Compilation of historical dataset on maternal mortality and fertility for broad set of countries
  - Empirical and theoretical study

Broader Implications

- Advances in maternal health lead to temporary rise in fertility and permanent rise in women's human capital
- Advances in maternal health accounts for large fraction of rise in female LFP between 1930-1960 in the U.S. (Albanesi and Olivetti, 2009a)
  - Improved maternal health alone increases income per capita by 50% based on simulations

Broader Implications

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- Advances in maternal health accounts for large fraction of rise in female LFP between 1930-1960 in the U.S. (Albanesi and Olivetti, 2009a)
  - Improved maternal health alone increases income per capita by 50% based on simulations
- Implications: Advances in maternal health weaken tight link between fertility decline and rising living standards

Expected MM, Early-shock

Expected MMR and Completed Fertility: Early-Shock vs. Pre-Shock Cohort

	Dependent Variable is Percentage Change in Completed Fertility						
	1	2	3	4	5	6	7
%Drop Expected MMR	-0.1521	-0.4619	-0.3939	-0.5182	-0.4425	-0.6611	-0.401
Expected MMR	0.001	0.003	0.0042	0.0031	0.0026	0.0132	0.0043
Per Capita Personal Income		0.0001**	0	0	0	0.0001	0
%Change:							
Per Capita Personal Income	-0.0798	0.1962	0.1256	0.2041	0.1786	0.2205	0.1196
Share White			-1.0532	-0.9683	-1.1388	-5.7380**	-0.9834
Share Farm			-0.002	-0.1036	-0.0841	-0.53	0.0499
Share Foreign Born			-0.2014	-0.1484	-0.1485	-0.5978*	-0.2006
Share Health Sector			0.0018	0.0106	0.0212	0.0373	0.0005
Share Public Sector			0.0381	0.0005	0.0058	0.1875	0.0422
Unemployment Rate				0.1745	0.1655		
Share High School Graduates				-0.0163	0.0278		
Female FT Hourly Wage					-0.0383		
Male FT Hourly Wage					0.4707		
Constant	-0.0353	-0.5354**	-0.6162*	-0.4711*	-0.5442*	-1.6329*	-0.6026*
Observations	47	47	47	47	47	47	46
Adj R-squared	0.042	0.211	0.287	0.349	0.375	0.429	0.263

Notes: Robust standard errors in brackets. Early-shock cohort, born in 1911-18. Pre-shock cohort, born in 1901-08. In columns 1-5 and 7 the dependent variable is computed for the sample of white married women with children, not living in institutional quarters and not living in farms. In column 6 the sample includes only women born-in-state. In columns 1-6 sample excludes Alaska, Hawaii as well as South Dakota and Texas since expected MMR cannot be computed for the pre-shock cohort. In column 7 DC is also excluded from the sample. *Significance at 10% level. **Significance at 5% level. ***Significance at 1% level.

Concurrent MM, Early-shock

Concurrent MMR and Completed Fertility: Early-Shock vs. Pre-Shock Cohort

	Dependent Variable is Percentage Change in Completed Fertility							
	1	2	3	4	5	6	7	8
% Drop Concurrent MMR	0.0763	-0.5569	-0.5985	-0.5449	-0.3304	-0.3493	-0.225	-0.5787
% Drop Concurrent IMR	-0.8224**	-1.2703***	-1.1112***	-1.2929***	-1.5968***	-1.0771***	-1.1707***	-1.2839***
% Change Share Dwellings with Refrigerators				0.0233				
Literacy					-0.527			
Date Suffrage Accepted					0.0002***			
Sheppard-Towner Act per capita payments					-0.05			
Social Security Act per capita payments					0.0739			
WWII Mobilization Rates						-0.6628	-0.1639	
% Nonwhite 1940							0.3847	
% Farmers 1940							-0.0804	
% Births to Servicemen1943								0.0008
Constant	0.2955*	0.0008	-0.0092	-0.0273	0.189	0.3019	0.1532	0.0213
Additional controls	{1}	{1,2}	{1,2,3}	{1,2}	{1,2}	{1,2}	{1,2}	{1,2}
Observations	49	49	49	49	49	47	47	49
Adj R-squared	0.0557	0.407	0.369	0.395	0.445	0.209	0.232	0.394

Notes: Robust standard errors in brackets. Early-shock cohort, born in 1911-18. Pre-shock cohort, born in 1901-08. The dependent variable is computed for the sample of white married women with children, not living in institutional quarters and not living in farms. Controls: 1= 1940's expected MMR and percentage change in per-capita personal income; 2=1+1940's per-capita personal income, percentage change in: share white, share farm, share foreign born, share working in health and in the public sector; 3= 2 + percentage change in unemployment rate, share high school graduate, male and female full-time real hourly wage. In columns 1-4 and 7 the sample excludes Alaska and Hawaii. In columns 5-6 Nevada and DC are also excluded from the sample because of missing information on mobilization rates. *Significance at 10% level. **Significance at 5% level. ***Significance at 1% level.

Concurrent MM, Mid-shock: Robustness

Concurrent MMR and Completed Fertility: Mid-Shock vs. Early-Shock Cohort, Robustness

	Dependent Variable is Percentage Change in Completed Fertility					
	1	2	3	4	5	6
% Drop Concurrent MMR	0.9175*	0.8916*	0.8330*	0.4556	0.5612	0.8295*
Share of Dwellings with Refrigerators	0.1703	0.0258				
% Drop Concurrent IMR			0.0026			
Literacy				0.7187		
Date Suffrage Accepted				-0.0001		
Sheppard-Towner Act per capita payments				0.2946		
Social Security Act per capita payments				-0.1606**		
WWII Mobilization Rates					0.2919	
% Nonwhite 1940						
% Farmers 1940						
% Births to Servicemen1943						-0.0004
Constant	-0.3043	-0.1734	-0.1743	-0.5291	-0.3148	-0.1736
Additional controls	{1}	{1,2}	{1}	{1}	{1}	{1}
Observations	49	49	49	49	47	49
Adj R-squared	0.327	0.288	0.306	0.382	0.353	0.307

Notes: Robust standard errors in brackets. Mid-shock cohort, born in 1921-28. Early-shock cohort, born in 1911-18. In columns 1-5 and 7 the dependent variable is computed for the sample of white married women with children, not living in institutional quarters and not living in farms. *Significance at 10% level. **Significance at 5% level. ***Significance at 1% level.

Maternal Mortality and Fertility for Non-Whites

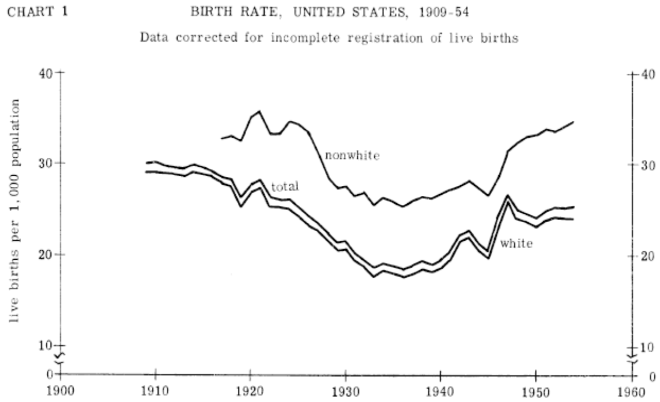

Figure: Source: Children's Bureau Pub. 42, 1954

Maternal Mortality and Fertility for Non-Whites

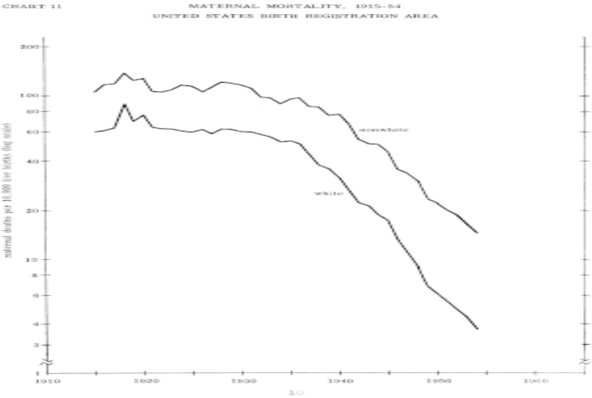

Figure: Source: Children's Bureau Pub. 42, 1954

Maternal Mortality and Fertility for Non-Whites

Live births by attendant

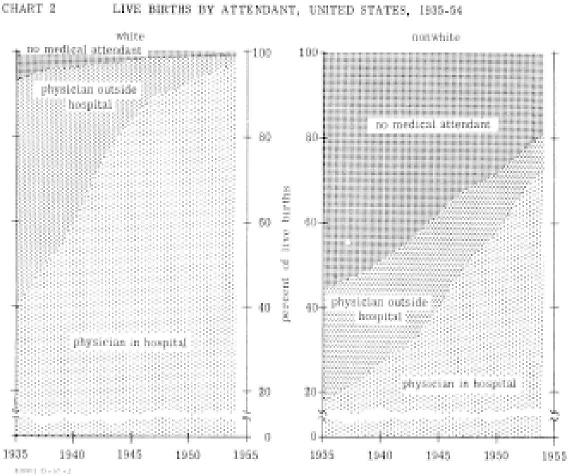

Figure: Source: Children's Bureau Pub. 42, 1954