Appendix for Online Publication
Fertility and Labor Market Responses to Reductions in Mortality

Sonia Bhalotra
Atheendar Venkataramani
Selma Walther

Appendix

Table of Contents

List of Figures

List of Tables

A Data Description and Descriptive Statistics

The **mortality data** is extracted from US Vital Statistics (Grove and Hetzel 1968, Linder and Grove 1947, Ruggles, Alexander, Genadek, Goeken, Schroeder, and Sobek 2010, Bureau 1943). In particular, we combined and extended the data series collected by Grant Miller (http://www.nber.org/data/vital-statistics-deaths-historical/), and by Seema Jayachandran, Adriana Lleras-Muney, and Kimberly Smith (http://www.aeaweb.org/articles.php?doi=10.1257/app.2.2.118).

State time series data on logged state per capita income were downloaded from the Bureau of Economic Analysis website (http://www.bea.gov/regional/spi/). Data on the number of

schools, doctors, hospitals, and educational expenditures per capita were taken from Adriana Lleras-Muney's website (http://www.econ.ucla.edu/alleras/research/data.html). These data were originally collected from various volumes of the Biennial Survey of Education (schools and expenditures) and the American Medical Association's American Medical Directory (doctors and hospitals). For state per capita health expenditures, we used data collected from various reports from the US Census Bureau. (See http://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/6304?archive=ICPSR&q=6304). The state level data is matched to individual data by women's birth state.

The **main outcome variables** are constructed as follows.

- *Net total fertility* is the total number of own children living in the household. *Net childlessness* is a variable equal to one when this is zero and equal to zero otherwise.
- *Gross total fertility* is the total number of live births the woman ever had. *Gross childlessness* is a variable equal to one when this is zero and equal to zero otherwise. The number of live births was a question asked to ever-married women in the 1940 and 1950 censuses and to all women in subsequent censuses.
- The *intensive* margin of fertility for both of these measures is defined as total fertility conditional on not being childless; hence, this variable takes a missing value for childless women.
- The variable *Working* takes a value of one if the woman reports working at the time of the census and zero otherwise.
- The variable *In Labor Force* takes a value of one if the woman reports she is in the labor force at the time of the census.
- *Personal income* is the reported own income from all sources in the last year. It is available for the 1950 census and onwards.
- The *Hauser and Warren Socioeconomic Index (H-W SEI)* is a measure of occupational status based on earnings and education. It assigns a measure of prestige to each occupation. See ipums.org for a detailed explanation of its construction. It is available for the 1950 census and onwards. We also considered *occscore* from the IPUMS data and the *Duncan socioeconomic score* as outcomes, with similar results.
- *Hours worked* is the reported number of hours worked in the past week. The original data is an intervalled variable and it is converted to a continuous variable using the midpoint of each interval.
- The variable *Currently married* takes the value one if a woman is married at the time of the census and zero otherwise.
- *Ever married* is a dummy variable equal to one if a woman has been married at some point in her life and zero otherwise.

- *Age at 1st marriage* is the age at which a woman first married, only defined for women who have ever married, and not available for the 1950 census, hence making the sample size for this variable smaller than for the other outcomes.

Table A.1: Descriptive statistics: Individual characteristics in the hazard model dataset and state-level characteristics

Variable	Mean	Standard Deviation
State-level Characteristics		
$prePneumonia$	1.0918	0.1989
$preMMR$	6.2610	1.2403
$preDiarrhea$	8.1358	5.7157
$preMalaria$	34.1667	70.4349
$preCancer$	0.9674	0.3109
$preHeartDisease$	2.1483	0.6439
$preTuberculosis$	0.6284	0.3616
$ln(Income\_per\_capita)$	5.9551	0.3960
$ln(Number\_of\_schools\_per\_capita)$	0.7586	0.6491
$ln(Number\_of\_hospitals\_per\_capita)$	-2.80	0.4427
$ln(Number\_of\_doctors\_per\_capita)$	0.1246	0.2291
$ln(Education\_expend\_per\_capita)$	4.6150	0.3887
$ln(Health\_expend\_per\_capita)$	-1.2317	0.6275
$Year\_of\_birth\_registration$	1921.17	5.3726
$Year\_of\_death\_registration$	1910.681	13.478
$Literacy$	0.9760	0.0374
$Female\_LFP$	0.1971	0.0596
N	48	
Individual Characteristics in the Hazard Model Dataset		
Birth	0.0865	0.2811
$post1937$	0.5001	0.5
$Current\_birth\_order$	1.7182	1.2364
$Years\_since\_last\_birth$	6.8448	6.1723
$Birth\_year\_of\_woman$	1910.724	98.0187
N	4559108	

This table shows: In the top panel, the mean and standard deviation of state level characteristics (used as control variables in the regression estimates, where they are interacted with $post1937$ in the hazard sample and $sulfayears$ in the stock sample); In the bottom panel, outcome and control variables at the individual level in the hazard model dataset. The mortality rates from diseases are the average between 1930-1936, per 1000 population (or 1000 live births in the case of MMR), and all other state characteristics are measured in 1930, except for the year of entering the birth and death registration systems, which is simply the year when that occurred.

Table A.2: Descriptive statistics: Individual characteristics in the stock model dataset

Variable	Mean	Standard deviation	N
Net Fertility (childbearing sample)			
# Children	1.6590	1.8316	496783
# Children | Children>0	2.6118	1.6712	315548
Childless (0-1)	0.3648	0.4814	496783
$Sulfayears$	20.0	6.0626	496783
Net Fertility (completed fertility sample)			
# Children	1.9282	1.9473	239432
# Children | Children>0	2.6760	1.8060	172524
Childless (0-1)	0.2794	0.4487	496783
$Sulfayears$	14.6401	8.8397	239432
Gross Fertility (completed fertility sample)			
# Children	2.5750	2.2927	520591
# Children | Children>0	3.1660	2.1428	423423
Childless (0-1)	0.1866	0.3896	520591
$Sulfayears$	14.8679	8.6624	520591
Labor Market			
Working (0-1)	0.3510	0.4773	730498
In labor force (0-1)	0.3710	0.4831	730498
Hauser-Warren SEI	14.4093	17.181	519972
Personal income	1505.191	2817.12	307378
Hours worked	12.8097	19.1029	730498
$Sulfayears$	18.2949	7.5187	730498
Marriage Market			
Currently married (0-1)	0.7258	0.4461	496783
Ever married (0-1)	0.8499	0.3572	926552
Age at 1st marriage	21.1798	3.4153	106814
$Sulfayears$	17.5947	7.9902	926552
Age at birth			
Age at 1st birth	24.0750	4.9714	440156
Age at 2nd birth	26.7165	5.0326	316185
Age at 3rd birth	28.6299	5.0395	183840
Age at 4th birth	30.1623	4.9682	101896

Table A.3: Outcomes in Stock Model Dataset by Childlessness Status

Outcome	Childless women			Not childless women		
	Mean	St.dev.	N	Mean	St.dev.	N
Working	0.56	0.50	251652	0.24	0.43	478846
In labor force	0.59	0.49	251652	0.25	0.44	478846
H-W SEI	21.10	17.46	147691	11.76	16.33	372281
Personal income	2295.83	3328.75	88539	1185.31	2511.73	218839
Hours worked	21.06	21.05	251652	8.37	16.33	478846
Currently married	0.43	0.50	251652	0.92	0.27	478846
Ever married	0.51	0.50	251652	0.99	0.07	478846
Age at 1st marriage	21.01	5.38	50079	20.92	3.92	150534
Graduated from HS	0.25	0.44	251652	0.21	0.41	478846
Attended some college	0.12	0.32	251652	0.08	0.27	478846

This table shows the mean and standard deviation of outcomes by (net) childlessness status in the stock model dataset. All differences in means between childless and not childless women are statistically significant at the 1% level.

B Trend Breaks, Cross-State Convergence and Measurement of Child vs Adult Pneumonia

We formally test convergence in mortality rates after the introduction of sulfa drugs in 1937. Table A.4 tests for the existence of a trend break in mortality rates in 1937, captured by a linear trend interacted with a post-1937 dummy variable, and shows that high mortality states pre-1937 had larger declines in mortality rates post-1937.

Table A.4: Trend breaks and test of convergence in pneumonia mortality rates

A: Trend breaks	(1) Pneumonia all-age	(2) Pneu U5	(3) Pneu Adults
$year * post1937$	-0.0999***	-0.8059***	-0.0684***
	(0.0059)	(0.1111)	(0.0040)
$post1937$	-0.1408***	-1.0910***	-0.1500***
	(0.0240)	(0.3877)	(0.0150)
$year$	0.0192***	-0.0249	0.0325***
	(0.0042)	(0.0792)	(0.0031)
N	667	582	628
R^2	0.7573	0.7724	0.7026
B: Convergence	(4) Pneumonia all-age	(5) Pneu U5	(6) Pneu Adults
$prePneumonia_{byage} * post1937$	-0.2940***	-0.4025***	-0.4889***
	(0.0459)	(0.0394)	(0.0442)
N	667	582	624
R^2	0.8603	0.8215	0.8432

These are OLS regressions (standard errors in parentheses) at the state-year level. The dependent variables are: (1) & (4), the all-age pnuemonia mortality rate used in the baseline regressions; (2) & (5), the under-5 pneumonia mortality rate; and (3) & (6), the pneumonia mortality rate among adults 25-64. $prePneumonia_{byage}$ is the 1930-36 average state-level mortality rate from pneumonia in age groups to match the dependent variable e.g. in regression (5), this would be the 1930-36 average pneumonia mortality rate among under 5s by state. $year$ is a linear time trend and $post1937$ is a dummy variable for the years 1937 and later. All regressions also include state fixed effects, and regressions (4)-(6) also include year fixed effects. * denotes p-value<0.1, ** denotes p-value<0.05 and *** denotes p-value<0.01.

Table A.5: Relationship between timing of entry into national vital registration systems and dispersion in mortality rates

	(1) Child mortality dispersion	(2) Adult mortality dispersion
Year of entry	0.014**	-0.0019
	(0.0067)	(0.0044)
N (registration group-years)	40	40

We first calculate the dispersion of under-5 (child) and age 25-64 (adult) pneumonia mortality rates for each year of first participation in the birth and death registration systems and each calendar year. We define dispersion as the standard deviation of the observations within each group, divided by the mean mortality rate within those groups (to ensure comparability between child and adult rates). For both children and adults, we then regress dispersion against the year of entry (conditioning on calendar year fixed effects). The coefficients reflect the change in the dispersion measure for each additional year of delay (relative to 1915, the earliest year that any state entered both registration systems). * denotes p-value<0.1, ** denotes p-value<0.05 and *** denotes p-value<0.01.

Table A.6: Comparing coefficients on the all-age and under-5 rate across specifications

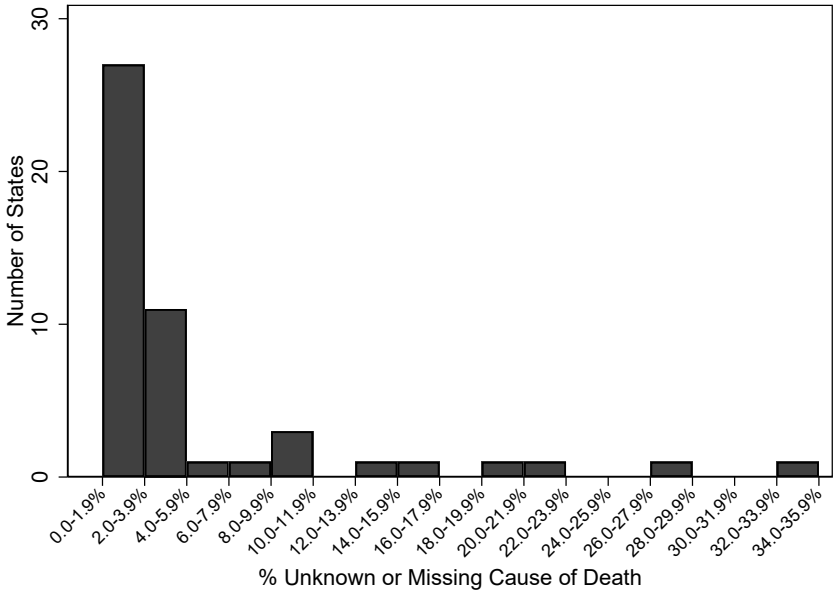
Outcome	(1) Baseline coefficient on all-age rate	(2) Coefficient on U5 rate
Birth timing model		
Birth timing	-0.0233**	-0.0006
	(0.0100)	(0.0008)
Later life outcomes model		
Childlessness	0.0089***	0.0006***
	(0.0024)	(0.0002)
Total fertility	-0.0483***	-0.0025**
	(0.0127)	(0.0010)
Working status	0.0058***	0.0003***
	(0.0017)	(0.0001)
Married status	-0.0023*	-0.0001*
	(0.0001)	(0.0001)

Column 1 is the specification in the paper using the all-age pneumonia mortality rate. Column 2 replaces this with the under-5 pneumonia mortality rate. For birth timing, the model is a logistic regression with marginal effects reported. The coefficients on all-age and under-5 mortality are not comparable in size because the mean rates are different. * denotes p-value<0.1, ** denotes p-value<0.05 and *** denotes p-value<0.01.

C Additional Tables, Figures and Robustness Checks

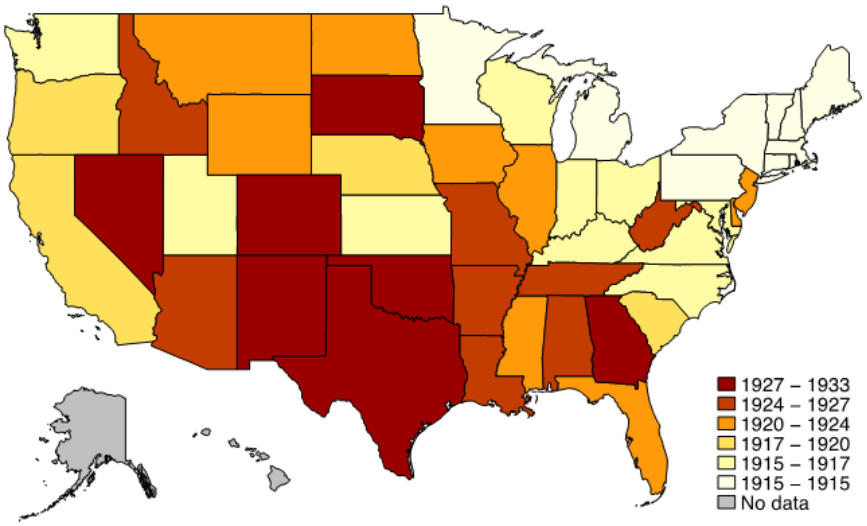
C.1 Figures

Figure A.1: Rates of missing or unknown causes of infant deaths in infant death certificates, 1940.



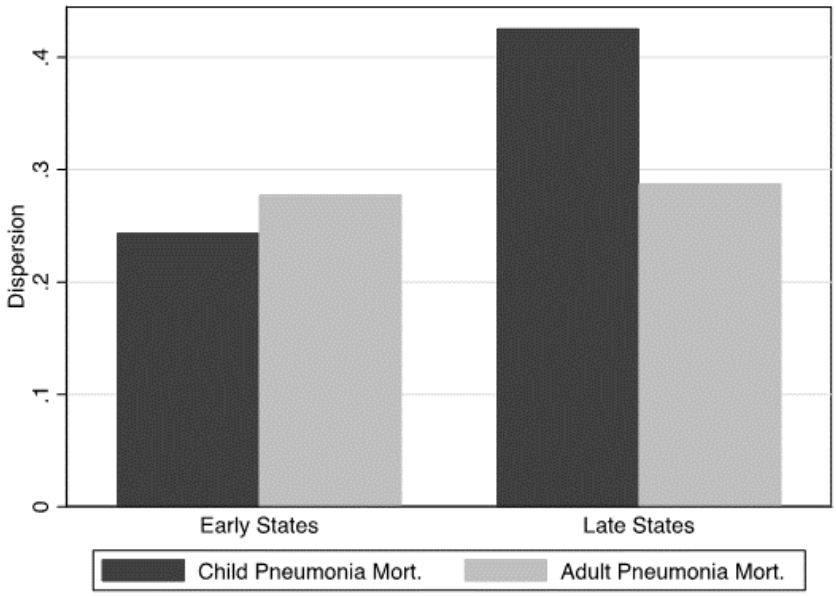
Histogram plots the number of U.S. states by share of infant death certificates in 1940 with cause of death listed as unknown or missing. 22 states had at least 2% or more infant deaths that were poorly defined or missing (10 had 8% or greater deaths listed in this manner). By comparison, for deaths across all ages - which includes adults - 15 states had at least 2% missing or ill-defined and only 3 had greater than 8% of deaths listed in this manner. Unfortunately, the data do not identify specific states. Source: Linder and Grove (1947).

Figure A.2: Map of earliest state birth and death registration system adoption year



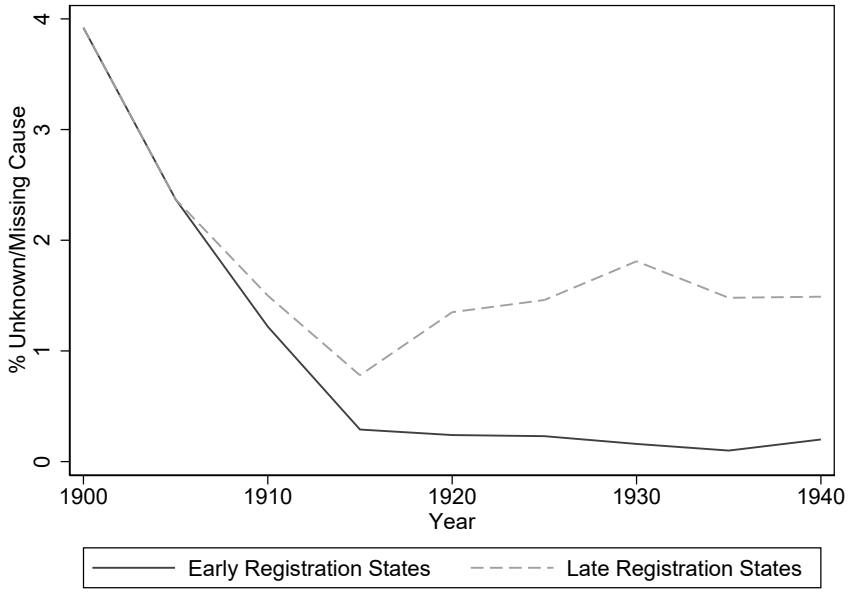
This map shows the earliest year in which a state had adopted both the birth and death registration systems.

Figure A.3: Dispersion of under-5 and adult mortality rates by registration system adoption year



This graph plots the dispersion of under-5 (child) and age 25-64 (adult) mortality rates from pneumonia over the period 1933-1936 for states that first participated in both the national birth and death registration system before and after 1920 (early and late states, respectively). We chose this period since it was after all states had entered the vital registration system and before the arrival of sulfa drugs. Dispersion was calculated as the standard deviation in mortality rates across the set of states in each of the early and late registration groups for each year in the study period. To make child and adult measures of dispersion comparable, we divided the standard deviations by the mean mortality rate for each age-registration-calendar year group.

Figure A.4: Missing or unknown causes of deaths over time, all ages, by registration entry.



Graph plots the share of all death certificates with unknown or missing causes for states that entered the death registration system by 1900 (early) and states that entered thereafter (late). Source: Linder and Grove (1947).

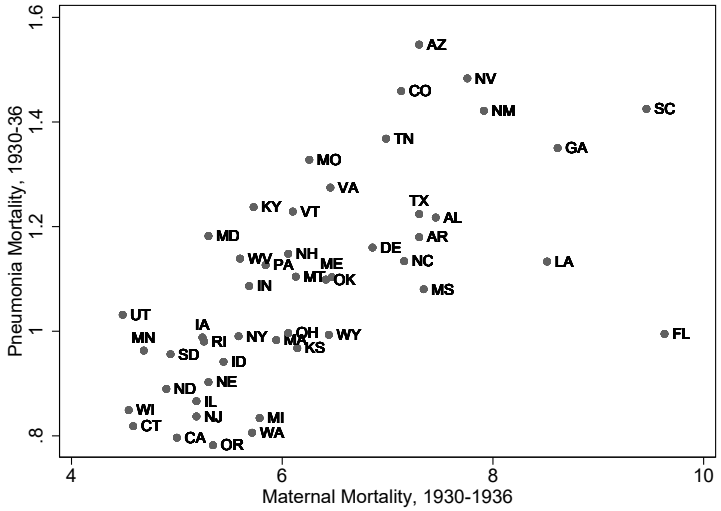
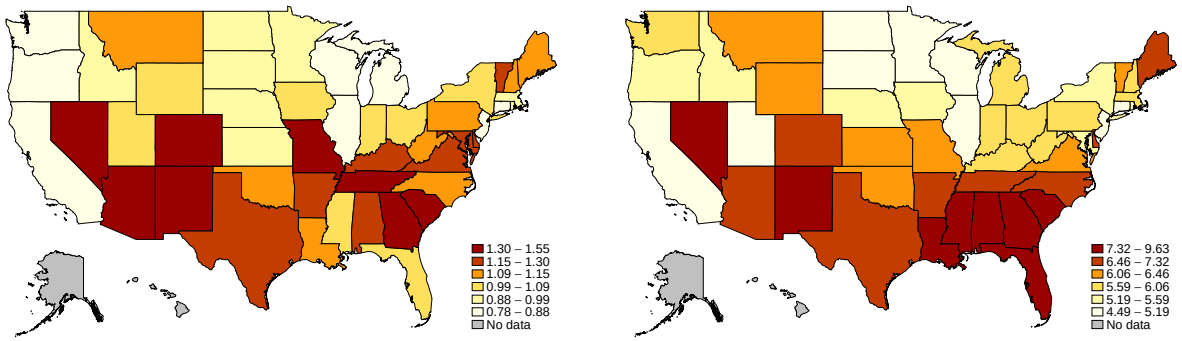


Figure A.5: Pneumonia and Maternal Mortality, United States, 1930-1936

This figure shows the relationship between the average pneumonia and maternal mortality rates in 1930-1936 across different states in the United States. Source: Vital Statistics.



(a) Pneumonia Mortality

(b) Maternal Mortality

Figure A.6: Maps showing pneumonia and maternal mortality across the U.S.

This figure displays the average state-level mortality rates between 1930-36, with shading representing discrete categories of levels of mortality rates.

Figure A.7: Articles appearing in the New York Times when sulfa drugs arrived to the U.S.

NEW DRUG SAID TO AID IN PUERPERAL FEVER; British Doctors Report Prompt Drop in Temperature and Remission of Symptoms.

Special Cable to THE NEW YORK TIMES. ();
June 06, 1936,
, Section , Page 7, Column , words

PERMISSIONS

[DISPLAYING ABSTRACT]

LONDON, June 5. -- Experiments here with the new drug commonly called prontosil, a German aniline compound, in cases of childbed fever have given exceptional results.

YOUNG ROOSEVELT SAVED BY NEW DRUG; Doctor Used Prontylin in Fight on Streptococcus Infection of the Throat. CONDITION ONCE SERIOUS But Youth, in Boston Hospital, Gains Steadily -- Fiancee, Reassured, Leaves Bedside. YOUNG ROOSEVELT SAVED BY NEW DRUG

Special to THE NEW YORK TIMES. ();
December 17, 1936,
, Section , Page 1, Column , words

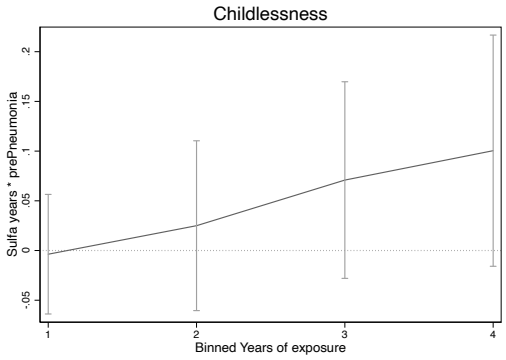
PERMISSIONS

[DISPLAYING ABSTRACT]

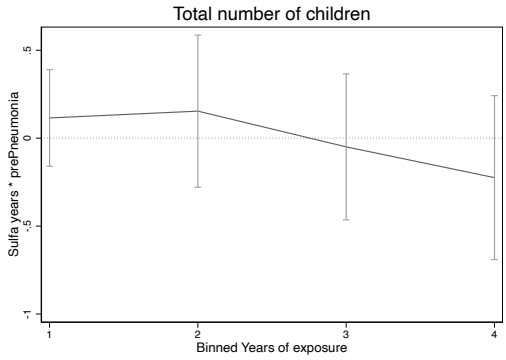
BOSTON, Dec. 16. -- Franklin D. Roosevelt Jr. faced death from a throat infection last week, it was disclosed tonight by his personal physician, Dr. George Loring Tobey Jr., at the Phillips House of the Massachusetts General Hospital, where young Roosevelt is a patient.

Figure A.8: Event Study: Stock fertility, labor market and marriage outcomes as a function of years of exposure bins

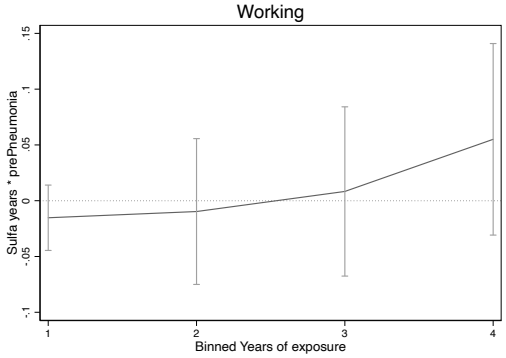
(a) Childlessness



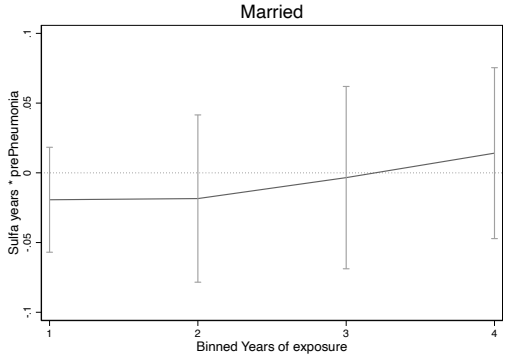
(b) Total Fertility



(c) Working

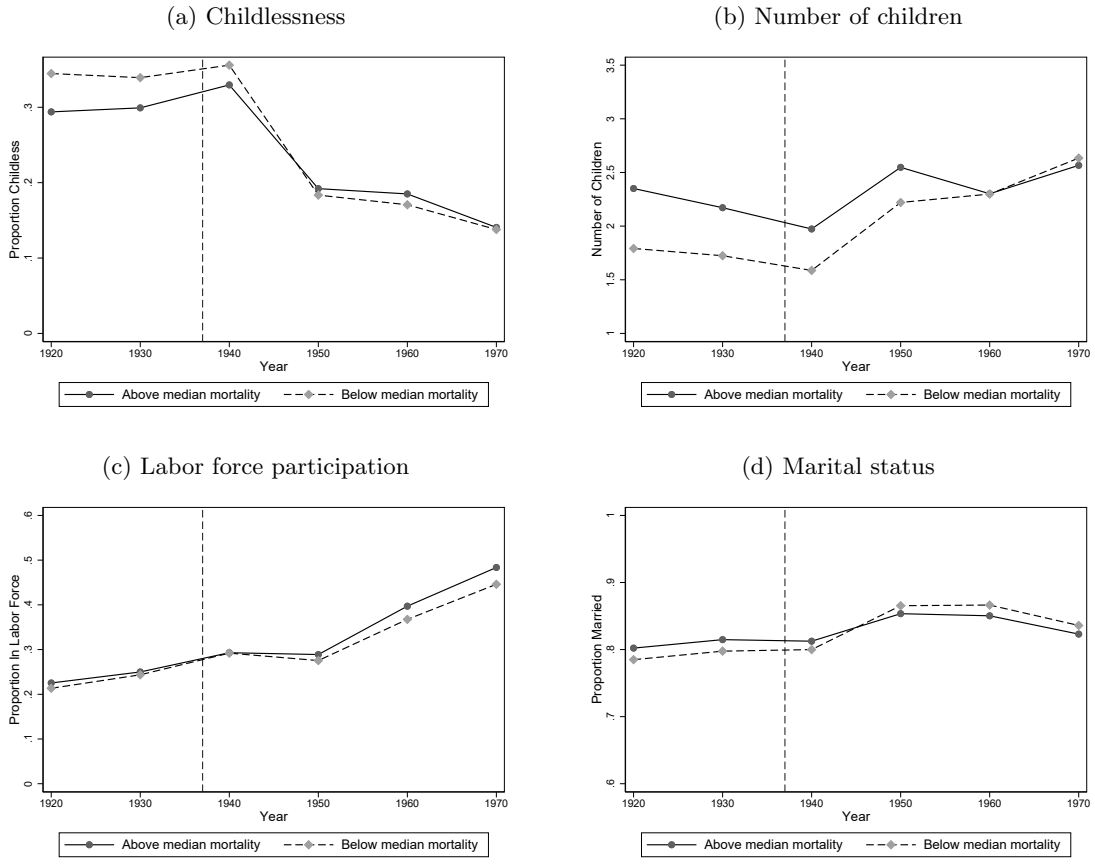


(d) Married



This figure displays the coefficients and 95% confidence intervals around these coefficients on the variable $prePneumonia * sulfayear_bins$, where $sulfayear_bins$ are five dummy variables for years of exposure to sulfa drugs. The bins are 0 years, 1-8 years, 9-16 years, 17-24 years and 25 years. The base (omitted) case is 0 years, the unexposed.

Figure A.9: Nonparametric Patterns of Outcomes by Above/Below Median Pneumonia Mortality



These figures show the average state-level outcomes of women in above and below median pneumonia mortality states in each census year, where this is defined based on average pneumonia mortality rates in 1930-36. Fertility outcomes are defined based on net fertility. The sample includes all women aged 30-40 at the time of the census. The dashed line shows the year 1937, when sulfa drugs were introduced to the US.

C.2 Tables

C.2.1 Women's mortality rates and Census region x Cohort FEs check

Table A.7: Fertility outcomes - Women's mortality rates and census region x cohort FEs

	(1)	(2)	(3)	(4)	(5)	(6)
		Net Fertility			Gross Fertility	
A: Women's mortality rates	# Children	# Children | Children>0	Childless	# Children	# Children | Children>0	Childless
$prePneumonia * sulfayears$	-0.0438**	-0.0370***	0.0072**	-0.0229	-0.0214	0.0020*
	(0.0175)	(0.0134)	(0.0030)	(0.0159)	(0.0142)	(0.0012)
N	494316	313910	494316	518832	421898	518832
B: Census region x Cohort FEs						
$prePneumonia * sulfayears$	-0.0309**	-0.0259***	0.0047*	-0.0057	-0.0057	0.0009
	(0.0125)	(0.0091)	(0.0025)	(0.0103)	(0.0101)	(0.0008)
N	494437	313981	494437	518933	421983	518933

See the notes to Table 3 for a description of variables and sampling. The robustness checks are described in Section 3.4. Panel A removes malaria, heart disease, cancer and tuberculosis all-sex all-age mortality, replacing it with women's all-age mortality from these diseases, as well as women's over-2s diarrhea mortality (the baseline already includes diarrhea mortality among under 2s). Panel B adds census region x cohort fixed effects to the baseline regressions in Table 3. * denotes p-value<0.1, ** denotes p-value<0.05 and *** denotes p-value<0.01.

Table A.8: Labor market outcomes - Women's mortality rates and census region x cohort FEs

A: Women's mortality rates	(1) Working	(2) In labor force	(3) H-W SEI	(4) Personal income	(5) Hours worked
$prePneumonia * sulfayears$	0.0057***	0.0054***	0.1880**	5.7052	0.2320***
	(0.0019)	(0.0020)	(0.0891)	(15.7238)	(0.0791)
N	727239	727239	517746	306209	727239
B: Census region x Cohort FEs					
$prePneumonia * sulfayears$	0.0038***	0.0037***	0.1190**	18.9336	0.1630***
	(0.0007)	(0.0007)	(0.0555)	(16.7793)	(0.0300)
N	727398	727398	517857	306280	727398

See the notes to Table 5 for a description of variables and sampling. The robustness checks are described in Section 3.4. Panel A removes malaria, heart disease, cancer and tuberculosis all-sex all-age mortality, replacing it with women's all-age mortality from these diseases, as well as women's over-2s diarrhea mortality (the baseline already includes diarrhea mortality among under 2s). Panel B adds census region x cohort fixed effects to the baseline regressions in Table 5. * denotes p-value<0.1, ** denotes p-value<0.05 and *** denotes p-value<0.01.

Table A.9: Marriage market outcomes - Women's mortality rates and census region x cohort checks

A: Women's mortality rates	(1) Currently married	(2) Ever married	(3) Age at 1st marriage
$prePneumonia * sulfayears$	-0.0013	-0.0022	0.0089
	(0.0015)	(0.0013)	(0.0192)
N	494316	727239	116588
B: Census region x Cohort FEs			
$prePneumonia * sulfayears$	-0.0007	-0.0020*	0.0196
	(0.0011)	(0.0010)	(0.0234)
N	494437	727398	116632

See the notes to Table 5 for a description of variables and sampling. The robustness checks are described in Section 3.4. Panel A removes malaria, heart disease, cancer and tuberculosis all-sex all-age mortality, replacing it with women's all-age mortality from these diseases, as well as women's over-2s diarrhea mortality (the baseline already includes diarrhea mortality among under 2s). Panel B adds census region x cohort fixed effects to the baseline regressions in Table 5. * denotes p-value<0.1, ** denotes p-value<0.05 and *** denotes p-value<0.01.

C.2.2 Sensitivity to controls

Table A.10: Sensitivity of main estimates to the inclusion of controls

	(1) # Children	(2) # Children | Children>0	(3) Childless	(4) Working	(5) Currently married
			A: With basic controls only		
$prePneumonia * sulfayears$	-0.0782***	-0.0863***	0.0060**	0.0018	-0.0007
	(0.0213)	(0.0203)	(0.0029)	(0.0017)	(0.0017)
N	496783	315548	496783	730498	496783
			B: Adding state-cohort controls		
$prePneumonia * sulfayears$	-0.0483***	-0.0345***	0.0089***	0.0058***	-0.0023*
	(0.0127)	(0.0117)	(0.0024)	(0.0017)	(0.0012)
N	494437	313981	494437	727398	494437

See the notes to Tables 3 and 5 for variable definitions and sampling. Regressions in Panel A include individual birth state, birth year, race and education fixed effects, and Panel B adds state level mortality rates for maternal mortality, malaria, heart disease, cancer, tuberculosis and diarrhea among the under 2s, income and public services, literacy, female labor force participation, and the year of state birth and death registration, all interacted with $sulfayears$. * denotes p-value<0.1, ** denotes p-value<0.05 and *** denotes p-value<0.01.

C.2.3 New Deal, WW2, Dust Bowl and Mean reversion checks

Table A.11: Fertility outcomes - New Deal, WW2, Dust Bowl and Mean reversion checks

	(1)	(2)	(3)	(4)	(5)	(6)
		Net Fertility			Gross Fertility	
A: New Deal	# Children	# Children | Children>0	Childless	# Children	# Children | Children>0	Childless
$prePneumonia * sulfayears$	-0.0417***	-0.0316**	0.0074***	-0.0210	-0.0186	0.0020*
	(0.0140)	(0.0125)	(0.0024)	(0.0134)	(0.0119)	(0.0010)
N	494437	313981	494437	518933	421983	518933
B: WW2						
$prePneumonia * sulfayears$	-0.0442*	-0.0218	0.0113***	-0.0172	-0.0150	0.0020**
	(0.0235)	(0.0189)	(0.0039)	(0.0115)	(0.0103)	(0.0009)
N	317789	230684	317789	518832	421898	518832
C: Dust Bowl						
$prePneumonia * sulfayears$	-0.0499***	-0.0358***	0.0092***	-0.0267**	-0.0233**	0.0025**
	(0.0127)	(0.0123)	(0.0022)	(0.0117)	(0.0105)	(0.0010)
N	444734	280263	444734	463435	376022	463435
D: Mean reversion						
$prePneumonia * sulfayears$	-0.0570***	-0.0416***	0.0106***	-0.0234*	-0.0197	0.0021**
	(0.0123)	(0.0124)	(0.0020)	(0.0130)	(0.0118)	(0.0009)
N	494437	313981	494437	518933	421983	518933

See notes to Table 3 for definitions of outcomes. The robustness checks are described in Section 3.4. * denotes p-value<0.1, ** denotes p-value<0.05 and *** denotes p-value<0.01.

Table A.12: Labor outcomes - New Deal, WW2, Dust Bowl and Mean reversion checks

A: New Deal	(1) Working	(2) In labor force	(3) H-W SEI	(4) Personal income	(5) Hours worked
$prePneumonia * sulfayears$	0.0055***	0.0051***	0.3308**	29.8135***	0.2295***
	(0.0016)	(0.0017)	(0.1472)	(10.2308)	(0.0637)
N	727398	727398	247015	306280	727398
B: WW2					
$prePneumonia * sulfayears$	0.0070***	0.0066***	0.3695***	14.5503	0.2931***
	(0.0017)	(0.0017)	(0.1293)	(14.5801)	(0.0533)
N	517746	517746	246952	306209	517746
C: Dust Bowl					
$prePneumonia * sulfayears$	0.0057***	0.0053***	0.3128*	1.7650	0.2395***
	(0.0017)	(0.0018)	(0.1627)	(14.9465)	(0.0639)
N	654187	654187	223428	274954	654187
D: Mean reversion					
$prePneumonia * sulfayears$	0.0059***	0.0053***			
	(0.0017)	(0.0017)			
N	727398	727398			

See notes to Table 5 for definitions of outcomes. The robustness checks are described in Section 3.4. * denotes p-value<0.1, ** denotes p-value<0.05 and *** denotes p-value<0.01.

Table A.13: Marriage market outcomes - New Deal, WW2, Dust Bowl and Mean reversion checks

A: New Deal	(1) Currently married	(2) Ever married	(3) Age at 1st marriage
$prePneumonia * sulfayears$	-0.0020	-0.0024*	0.0152
	(0.0013)	(0.0012)	(0.0245)
N	494437	727398	116632
B: WW2			
$prePneumonia * sulfayears$	-0.0051**	-0.0042***	-0.2328
	(0.0025)	(0.0014)	(0.2526)
N	317789	517746	81854
C: Dust Bowl			
$prePneumonia * sulfayears$	-0.0023*	-0.0031**	-0.0071
	(0.0012)	(0.0012)	(0.0260)
N	444734	654187	103929
D: Mean reversion			
$prePneumonia * sulfayears$	-0.0023*	-0.0031**	0.0157
	(0.0012)	(0.0012)	(0.0233)
N	494437	727398	116632

See notes to Table 5 for definitions of outcomes. The robustness checks are described in Section 3.4. * denotes p-value<0.1, ** denotes p-value<0.05 and *** denotes p-value<0.01.

C.2.4 Education outcomes

Table A.14: Education as a function of sulfa exposure - women aged 15-25 in 1937

	(1) Some College	(2) High School graduate	(3) HS dropout	(4) Some College	(5) High School graduate	(6) HS dropout
	Aged 21-40 at census interview			Aged 40 or older at census interview		
$prePneumonia * treated\_educ$	-0.0113	0.0541**	-0.0428	0.0012	0.0502	-0.0514
	(0.0108)	(0.0264)	(0.0265)	(0.0168)	(0.0347)	(0.0318)
N	199161	199161	199161	186067	186067	186067

The dependent variables are dummy variables for the highest level of education achieved by the woman. *treated_educ* takes the value one if a woman was 20 or under in 1937, and the value zero if she was 21 or older. The sample is further restricted to woman aged at least 21 at the time of census enumeration so that they had completed their education. *prePneumonia* is the average state-level pneumonia mortality rate between 1930-36. These are OLS regressions with standard errors (in parentheses) clustered at the state of birth level. Our dataset is a cross-section of fertility outcomes of women aged 15-25 in 1937 and 21-40 at the time of the census for columns 1-3 and at least 40 for columns 4-6, born in the United States and resident in their birth state at the time of the census. The cohorts in this table were born in the years 1912-1922 and are drawn from the 1940, 1950, 1960 and 1970 US decennial population censuses. Regressions include individual birth state, birth year, race and education fixed effects, as well as state level mortality rates for maternal mortality, malaria, heart disease, cancer, tuberculosis and diarrhea among the under 2s, income and public services, literacy, female labor force participation, and the year of state birth and death registration, all interacted with $sulfayears$. * denotes p-value<0.1, ** denotes p-value<0.05 and *** denotes p-value<0.01.

C.2.5 Occupation structure and Adult mortality rates checks

Table A.15: Fertility outcomes - occupation structure and adult mortality checks

	(1)	(2)	(3)	(4)	(5)	(6)
		Net Fertility			Gross Fertility	
A: Occupation structure	# Children	# Children | Children>0	Childless	# Children	# Children | Children>0	Childless
$prePneumonia * sulfayears$	-0.0366**	-0.0267**	0.0065**	-0.0046	-0.0019	0.0016*
	(0.0139)	(0.0126)	(0.0026)	(0.0110)	(0.0104)	(0.0009)
N	494316	313910	494316	518832	421898	518832
B: Adult mortality rates						
$prePneumonia * sulfayears$	-0.0495**	-0.0318*	0.0097***	-0.0222	-0.0197	0.0029**
	(0.0193)	(0.0175)	(0.0032)	(0.0205)	(0.0191)	(0.0013)
N	494316	313910	494316	518832	421898	518832

See notes to Table 3 for definitions of outcomes. The robustness checks are described in Section 3.4. * denotes p-value<0.1, ** denotes p-value<0.05 and *** denotes p-value<0.01.

Table A.16: Labor market outcomes - occupation structure and adult mortality checks

A: Occupation structure	(1) Working	(2) In labor force	(3) H-W SEI	(4) Personal income	(5) Hours worked
$prePneumonia * sulfayears$	0.0039**	0.0035**	0.1976**	2.3577	0.1673***
	(0.0015)	(0.0016)	(0.0841)	(15.2636)	(0.0570)
N	727239	727239	517746	306209	727239
B: Adult mortality rates					
$prePneumonia * sulfayears$	0.0071***	0.0070***	0.2527**	15.0101	0.2964***
	(0.0022)	(0.0022)	(0.0990)	(20.5246)	(0.0814)
N	727239	727239	517746	306209	727239

See notes to Table 5 for definitions of outcomes. The robustness checks are described in Section 3.4. * denotes p-value<0.1, ** denotes p-value<0.05 and *** denotes p-value<0.01.

Table A.17: Marriage market outcomes - occupation structure and adult mortality checks

A: Occupation structure	(1) Currently married	(2) Ever married	(3) Age at 1st marriage
$prePneumonia * sulfayears$	-0.0025***	-0.0037***	0.0070
	(0.0009)	(0.0009)	(0.0279)
N	494316	727239	116588
B: Adult mortality rates			
$prePneumonia * sulfayears$	-0.0016	-0.0026	0.0189
	(0.0017)	(0.0015)	(0.0264)
N	494316	727239	116588

See notes to Table 5 for definitions of outcomes. The robustness checks are described in Section 3.4. * denotes p-value<0.1, ** denotes p-value<0.05 and *** denotes p-value<0.01.

C.2.6 Placebo test, Age of conception and Mountain/South states checks

Table A.18: Probability of birth - Age of conception and Mountain/South states checks

	(1) Age<10	(2) Conception year	(3) Excl mountain Birth	(4) Excl deep south
$prePneumonia * post1937$	-0.0161**	-0.0263***	-0.0299**	-0.0065
	(0.0078)	(0.0101)	(0.0129)	(0.0058)
N	2810044	4035785	4414170	3941672

See notes to Table 1 for a description of the baseline regression. The robustness checks in each column is described in detail in Section 3.4. For column (1), only potential births between 1940-43 are included from the 1950 census. * denotes p-value<0.1, ** denotes p-value<0.05 and *** denotes p-value<0.01.

Table A.19: Fertility outcomes - Placebo test, Age of conception and Mountain/South states checks

	(1)	(2)	(3)	(4)	(5)	(6)
		Net Fertility			Gross Fertility	
A: Placebo	# Children	# Children | Children>0	Childless	# Children	# Children | Children>0	Childless
$prePneumonia * sulfayears$	-0.2112	-0.3751	-0.0170			
	(0.2053)	(0.2319)	(0.0323)			
N	61918	42447	61918			
B: Excl. 10 and older						
$prePneumonia * sulfayears$	-0.0227**	-0.0174**	0.0074**			
	(0.0085)	(0.0078)	(0.0029)			
N	494437	236499	494437			
C: Excl Mountain West						
$prePneumonia * sulfayears$	-0.0.0417**	-0.0329**	0.0072***	-0.0225	-0.0196	0.0016
	(0.0155)	(0.0138)	(0.0026)	(0.0156)	(0.0142)	(0.0011)
N	483852	306588	483852	509656	413931	509656
D: Excl Deep South						
$prePneumonia * sulfayears$	-0.0395**	-0.0311**	0.0077**	-0.0104	-0.0107	0.0016
	(0.0157)	(0.0134)	(0.0030)	(0.0130)	(0.0121)	(0.0011)
N	435017	274490	435017	464042	376270	464042

The variables and specification are described in the notes to Table 3 and the robustness checks are described in Section 3.4. For Panel A, our dataset is a cross-section of fertility outcomes of women aged 6-44 in 1897, with outcomes drawn from the 1910-1930 censuses. For other panels, our dataset is a cross-section of outcomes of women aged 6-44 in 1937 and 18-40 at census (columns 1-3) or at least 40 (columns 4-6), born in the U.S. and resident in their birth state at census. The cohorts in this table were born in 1900-1931 (columns 1-3) and 1893-1931 (columns 4-6) and are drawn from the 1940-1970 US decennial population censuses. * denotes p-value<0.1, ** denotes p-value<0.05 and *** denotes p-value<0.01.

Table A.20: Labor market outcomes - Placebo test, Age of conception and Mountain/South states checks

A: Placebo	(1) Working	(2) In labor force	(3) H-W SEI	(4) Personal income	(5) Hours worked
$prePneumonia * sulfayears$	0.0102	0.0211			
	(0.0388)	(0.0435)			
N	54852	54842			
B: Excl Mountain West					
$prePneumonia * sulfayears$	0.0065***	0.0062***	0.2163***	35.0206***	0.2744***
	(0.0014)	(0.0014)	(0.0538)	(12.7874)	(0.0460)
N	712693	712693	507062	300013	712693
C: Excl Deep South					
$prePneumonia * sulfayears$	0.0056***	0.0052***	0.1668	-15.0912	0.2047***
	(0.0018)	(0.0018)	(0.1032)	(16.5964)	(0.0683)
N	642475	642475	459065	274429	642475

The variables and specification are described in the notes to Table 5 and the robustness checks are described in Section 3.4. For Panel A, our dataset is a cross-section of fertility outcomes of women aged 6-44 in 1897, with outcomes drawn from the 1910-1930 censuses. For other panels, our dataset is a cross-section of outcomes of women aged 6-44 in 1937 and 18-40 at census (columns 1-3) or at least 40 (columns 4-6), born in the U.S. and resident in their birth state at census. The cohorts in this table were born in 1900-1931 (columns 1-3) and 1893-1931 (columns 4-6) and are drawn from the 1940-1970 US decennial population censuses. * denotes p-value<0.1, ** denotes p-value<0.05 and *** denotes p-value<0.01.

Table A.21: Marriage market outcomes - Placebo test, Age of conception and Mountain/South states checks

A: Placebo	(1) Currently married	(2) Ever married	(3) Age at 1st marriage
$prePneumonia * sulfayears$	0.0003	-0.0018	-0.2592***
	(0.0326)	(0.0024)	(0.0112)
N	61918	135524	7625
B: Excl Mountain West			
$prePneumonia * sulfayears$	-0.0022	-0.0028**	-0.0274
	(0.0014)	(0.0011)	(0.0177)
N	483852	904574	302364
C: Excl Deep South			
$prePneumonia * sulfayears$	-0.0023	-0.0022	-0.0187
	(0.0014)	(0.0013)	(0.0152)
N	435017	817174	274187

The variables and specification are described in the notes to Table 5 and the robustness checks are described in Section 3.4. For Panel A, our dataset is a cross-section of fertility outcomes of women aged 6-44 in 1897, with outcomes drawn from the 1910-1930 censuses. For other panels, our dataset is a cross-section of outcomes of women aged 6-44 in 1937 and 18-40 at census (columns 1-3) or at least 40 (columns 4-6), born in the U.S. and resident in their birth state at census. The cohorts in this table were born in 1900-1931 (columns 1-3) and 1893-1931 (columns 4-6) and are drawn from the 1940-1970 US decennial population censuses. * denotes p-value<0.1, ** denotes p-value<0.05 and *** denotes p-value<0.01.

C.2.7 Migration checks

Table A.22: Fertility outcomes - Migration checks

	(1)	(2)	(3)	(4)	(5)	(6)
		Net Fertility			Gross Fertility	
	# Children	# Children | Children>0	Childless	# Children	# Children | Children>0	Childless
A: Incl Migrants						
$prePneumonia * sulfayears$	-0.0253***	-0.0159*	0.0052***	-0.0145	-0.0145	0.0012
	(0.0083)	(0.0087)	(0.0016)	(0.0105)	(0.0095)	(0.0007)
N	828558	548080	828558	955497	780370	955497
B: 2SLS Migrants						
$prePneumonia * sulfayears$	-0.0408***	-0.0300**	0.0080***	-0.0262	-0.0255	0.0023*
	(0.0127)	(0.0141)	(0.0024)	(0.0171)	(0.0158)	(0.0012)
N	809989	533144	809989	880951	718855	880951

The dependent variables are described in the notes to Table 3 and the robustness checks are described in Section 3.4. * denotes p-value<0.1, ** denotes p-value<0.05 and *** denotes p-value<0.01.

Table A.23: Labor market outcomes - Migration checks

	(1)	(2)	(3)	(4)	(5)
A: Incl Migrants					
$prePneumonia * sulfayears$	0.0033***	0.0030**	0.1496**	-21.0175	0.1214***
	(0.0012)	(0.0012)	(0.0693)	(16.5351)	(0.0449)
N	1264807	1264807	980312	673706	1264807
B: 2SLS Migrants					
$prePneumonia * sulfayears$	0.0045**	0.0040**	0.2290**	-34.3413	0.1612**
	(0.0018)	(0.0019)	(0.1049)	(23.9145)	(0.0676)
N	1222295	1222295	939159	633897	1222295

T The dependent variables are described in the notes to Table 5 and the robustness checks are described in Section 3.4. * denotes p-value<0.1, ** denotes p-value<0.05 and *** denotes p-value<0.01.

Table A.24: Marriage market outcomes - Migration checks

	(1)	(2)	(3)
A: Incl Migrants			
$prePneumonia * sulfayears$	-0.0004	-0.0009*	-0.0132
	(0.0009)	(0.0005)	(0.0132)
N	828558	1592612	595742
B: 2SLS Migrants			
$prePneumonia * sulfayears$	-0.0008	-0.0017**	-0.0214
	(0.0014)	(0.0008)	(0.0219)
N	809989	1527667	587994

The dependent variables are described in the notes to Table 5 and the robustness checks are described in Section 3.4. * denotes p-value<0.1, ** denotes p-value<0.05 and *** denotes p-value<0.01.

C.2.8 Linear pre-trends check and Binary DiD

Table A.25: Probability of birth - Migration checks and Migration as a function of sulfa exposure

	(1) Birth - Migrants	(2) Birth - 2SLS Migrants	(3) Pr(in migrant sample)	(4) Migrated between 1935-40
$prePneumonia * post1937$	-0.0219**	-0.0386*		
	(0.0102)	(0.0211)		
$prePneumonia * sulfayears$			0.0020	-0.0045
			(0.0031)	(0.0072)
N	6349665	6319430	1122827	56722

columns 1 and 2: See notes to Table 1 for a description of the baseline regression. The robustness checks in each column is described in detail in Section 3.4. columns 3 and 4: The dependent variable in column 3 is a dummy variable that equals one if a woman's census state is different from her birth state, and zero otherwise. The dependent variable in column 4 equals one if a woman reported in the 1940 census that she has migrated in the last 5 years, and equals zero if she reported that she did not migrate. The cohorts in this sample were born in the years 1893-1931 and are drawn from the 1940, 1950, 1960 and 1970 US decennial population censuses (column 3) and the 1940 US decennial population census (column 4). Regressions include individual birth state, birth year, race and education fixed effects, as well as state level mortality rates for maternal mortality, malaria, heart disease, cancer, tuberculosis and diarrhea among the under 2s, income and public services, literacy, female labor force participation, and the year of state birth and death registration, all interacted with $sulfayears$. * denotes p-value<0.1, ** denotes p-value<0.05 and *** denotes p-value<0.01.

Table A.26: Linear trends in birth probability in above and below median mortality states, 1930-1936

	(1)	(2)
	Birth	
$AboveMedPneu * trend$	-0.0001	-0.0001
	(0.0002)	(0.0003)
N	2230331	2230331

The dependent variable is a dummy variable that equals one if a woman gave birth in that year, and zero otherwise. The variable *trend* is a linear time trend. *AboveMedPneu* is a dummy variable that equals one if a state had an above median average value of *prePneumonia* in 1930-1936 and zero otherwise. These are Logistic regressions with standard errors (in parentheses) clustered at the state of birth level. Our dataset is a panel of woman-year birth outcomes for women aged 15 to 40 in the period 1930-1936, born in the United States, resident in their birth state at the time of the census. The cohorts in this table were born in the years 1893-1928 and are drawn from the 1940 and 1950 US decennial population censuses. Regression (1) includes while Regression (2) omits a dummy variable for above median average *preMMR* in 1930-1936, interacted with *trend*. Both regressions include individual birth state, birth year, race, and education, child birth order, time since last birth and year and census region*year fixed effects, as well as state level mortality rates for malaria, heart disease, cancer, tuberculosis and diarrhea among the under 2s, income and public services, literacy, female labor force participation, and the year of state birth and death registration, all interacted with *post*1937. * denotes p-value<0.1, ** denotes p-value<0.05 and *** denotes p-value<0.01.

Table A.27: Binary DiD estimates of the effect of sulfa exposure on fertility, labor and marriage market outcomes

A: Fertility	(1)	(2)	(3)	(4)	(5)	(6)
		Net Fertility			Gross Fertility	
	# Children	# Children | Children>0	Childless	# Children	# Children | Children>0	Childless
$prePneumonia * treated$	-0.8565***	-0.7925**	0.1386**	-0.4930	-0.5562	0.0325
	(0.3830)	(0.3472)	(0.0676)	(0.3667)	(0.3502)	(0.0253)
N	279899	182808	279899	163036	137303	163036

B: Labor market	(1)	(2)	(3)	(4)	(5)
	Working	In labor force	H-W SEI	Personal inc.	Hours worked
$prePneumonia * treated$	0.1339**	2.3366***	-3303.3419***	-0.0440	4.5693
	(0.0588)	(0.0597)	(0.5128)	(64.3696)	(2.4842)
N	279899	279899	245681	168344	279899

C: Marriage market	(1)	(2)	(3)
	Curr. married	Ever marr.	Age at 1st marr.
$prePneumonia * treated$	-0.0440	-0.0998**	0.3031
	(0.0398)	(0.0376)	(0.6092)
N	279899	279899	86390

treated is a variable that equals one if a woman was exposed to sulfa drugs for her entire fertile period, and equals zero if a woman was exposed for no years. Women exposed for only some years are excluded from these regressions. Panel A: The dataset is a cross-section of fertility outcomes of women aged 6-15 or 40-44 in 1937 and 18-50 at the time of the census for columns 1-3 and at least 40 for columns 4-6, born in the United States and resident in their birth state at the time of the census. Panel B: The dataset is a cross-section of labor outcomes of women aged 6-15 or 40-44 in 1937 and 18-50 at the time of the census, born in the United States and resident in their birth state at the time of the census. Panel C: The dataset is a cross-section of marriage outcomes of women aged 6-15 or 40-44 in 1937 and 18-50 at the time of the census, born in the United States and resident in their birth state at the time of the census. * denotes p-value<0.1, ** denotes p-value<0.05 and *** denotes p-value<0.01.

C.3 Additional Robustness Checks

C.3.1 Alternative sample definitions

First, we show that our stock model results are not sensitive to sample definitions. We reestimate the net fertility results for 18-36 year olds at the time of the census (a child born to a woman aged 18 would leave home at 36, hence this measure minimises underreporting of children who have left home). These results are in Panel A of Table A.28. All the results are statistically significant and the magnitudes are comparable to those in the main text. Panel B complements this analysis by presenting results for gross uncompleted fertility; that is, gross fertility for 18-40 year olds. The coefficients are comparable in magnitude to the main text, although they are not precisely estimated; this is likely driven by the fact that the gross fertility question was only asked to ever married women in the 1940 and 1950 censuses, and 95% of the sample in these regressions comes from these two censuses. As the main results suggest that fertility and marriage decisions are intertwined, restricting the sample to ever married women leads to a select sample of women.

In Table A.29, we show that the labor supply results are robust to using a sample of 18-40 year olds and 18-60 year olds; as with the fertility results, the coefficients have the largest magnitudes for the youngest sample. This Table also shows robustness to widening the marriage market sample.

C.3.2 Outliers

Next, we reestimate the main results but excluding New Mexico, which was shown to be an outlier state in Figure 8. The hazard model results are in column (1) of Table A.31, while the stock model results are in Panel A of Tables A.32 (fertility) and A.33-A.34 (labor and marriage markets). The exclusion of New Mexico does not change the results in a substantive way.

C.3.3 OLS and Woman Fixed Effects

In order to verify that our results are similar in a simpler estimation model, we estimate the hazard model using OLS (Table A.31). In the same table, to control for time invariant unobserved factors at the woman level that affect birth probability and potentially are also correlated with mortality rates, we estimate the hazard model with woman fixed effects. The coefficients are similar to the main results in Table 1, but they are less precisely estimated.

C.3.4 Multiple hypothesis testing

Finally, in Panel C of Table A.33, we adjust the standard errors from the main results (Table 5) for multiple hypothesis testing. (We do not adjust the standard errors for fertility because these variables are all defined based on one originating variable.) In particular, we implement the procedure described in Aker, Boumnijel, McClelland, and Tierney 2014, which adjusts standard

errors to take into account correlation between outcomes. The formula for the adjusted p-values is

$$\begin{aligned} p^{new} &= 1-(1-p^{old})^{A} \\ A &= (1-c)^{\#outcomes}, \end{aligned}$$

where c is the average correlation between all other outcomes in the group. As we only consider two marriage market outcomes, this formula can only be implemented for the labor market outcomes. The adjusted standard errors do not change the significance of the results in a substantive way.

Table A.28: Fertility as a function of sulfa exposure: Alternative samples

	(1) # Children	(2) # Children | Children >0	(3) Childless
A: Net fertility, 18-36 year old women			
$prePneumonia * sulfayears$	-0.0408***	-0.0297**	0.0089***
	(0.0119)	(0.0130)	(0.0029)
N	393720	234416	393720
B: Gross fertility, 18-40 year old women			
$prePneumonia * sulfayears$	-0.0288	-0.0275	0.0029
	(0.0201)	(0.0205)	(0.0029)
N	170537	138760	170537

The dependent variables are the total number of children (column 1), the total number of children conditional on having at least one (column 2) and a dummy variable that equals one if the woman has zero children and zero otherwise (column 3). $prePneumonia * sulfayears$ is the average state-level pneumonia mortality rate between 1930-36, interacted with the number of fertile years (aged 15-40) that a woman was exposed to sulfa drugs. These are OLS regressions with standard errors (in parentheses) clustered at the state of birth level. Regressions include individual birth state, birth year, race and education fixed effects, as well as state level mortality rates for maternal mortality, malaria, heart disease, cancer, tuberculosis and diarrhea among the under 2s, income and public services, literacy, female labor force participation, and the year of state birth and death registration, all interacted with $sulfayears$. Panel A: Definitions based on net fertility. The dataset is a cross-section of fertility outcomes of women aged 6-44 in 1937 and 18-36 at census enumeration, born in the United States and resident in their birth state at the time of the census. The cohorts were born in the years 1904-1931 and are drawn from the 1940, 1950, 1960 and 1970 US decennial population censuses. Panel B: Definitions based on gross fertility. The dataset is a cross-section of fertility outcomes of women aged 6-44 in 1937 and 18-40 at the time of the census, born in the United States and resident in their birth state at the time of the census. The cohorts were born in the years 1900-1931 and are drawn from the 1940, 1950, 1960 and 1970 US decennial population censuses. * denotes p-value<0.1, ** denotes p-value<0.05 and *** denotes p-value<0.01.

Table A.29: Labor market outcomes as a function of sulfa exposure: Alternative samples

	(1) Working	(2) In labor force	(3) H-W SEI	(4) Personal income	(5) Hours worked
A: 18 to 40 year old women					
$prePneumonia * sulfayears$	0.0074**	0.0064*	0.2727*	-5.3710	0.3561***
	(0.0025)	(0.0026)	(0.1351)	(12.0006)	(0.0878)
N	494437	494437	317867	152468	494437
B: 18 to 60 year old women					
$prePneumonia * sulfayears$	0.0043**	0.0040**	0.1481*	-9.0074	0.1775**
	(0.0015)	(0.0015)	(0.0570)	(11.9414)	(0.0518)
N	922769	922769	713228	482383	922769

The dependent variables are: (1) a dummy variable equal to one if the woman reports working at the time of the census and zero otherwise; (2) a dummy variable equal to one if the woman is in the labor force and zero otherwise; (3) the Hauser-Warren Socioeconomic Index, based on occupation; (4) the US Dollar amount of personal earnings in the past year; (5) hours worked in the last week, where intervalled data is converted to a continuous measure using the midpoint of each interval. $prePneumonia * sulfayears$ is the average state-level pneumonia mortality rate between 1930-36, interacted with the number of fertile years (aged 15-40) that a woman was exposed to sulfa drugs. These are OLS regressions with standard errors (in parentheses) clustered at the state of birth level. Our dataset is a cross-section of labor and marriage outcomes of women aged 6-44 in 1937, born in the United States and resident in their birth state at the time of the census, with age at census restrictions shown above the relevant columns in the table. The cohorts in this table were born in the years 1900-1931 (Panel A) or 1893-1931 (Panel B) and are drawn from the 1940, 1950, 1960 and 1970 US decennial population censuses. Regressions include individual birth state, birth year, race and education fixed effects, as well as state level mortality rates for maternal mortality, malaria, heart disease, cancer, tuberculosis and diarrhea among the under 2s, income and public services, literacy, female labor force participation, and the year of state birth and death registration, all interacted with $sulfayears$. * denotes p-value<0.1, ** denotes p-value<0.05 and *** denotes p-value<0.01.

Table A.30: Marriage market outcomes as a function of sulfa exposure: Alternative samples

	(1) Currently married	(2) Ever married	(3) Age at 1st marriage
A: 18 to 50 year old women			
$prePneumonia * sulfayears$	-0.0013	-0.0032**	-0.0170
	(0.0011)	(0.0012)	(0.0152)
N	727398	727398	181562
B: 18 to 60 year old women			
$prePneumonia * sulfayears$	-0.0005	-0.0025**	-0.0294*
	(0.0011)	(0.0011)	(0.0155)
N	922769	922769	309077

The dependent variables are: (1) a dummy variable equal to one if the woman is married at the time of the census and zero otherwise; (2) a dummy variable equal to one if the woman has ever married in her lifetime and zero otherwise; (3) age at first marriage, only defined for ever married women. $prePneumonia * sulfayears$ is the average state-level pneumonia mortality rate between 1930-36, interacted with the number of fertile years (aged 15-40) that a woman was exposed to sulfa drugs. These are OLS regressions with standard errors (in parentheses) clustered at the state of birth level. Our dataset is a cross-section of marriage outcomes of women aged 6-44 in 1937, born in the United States and resident in their birth state at the time of the census, with age at census restrictions shown above the relevant columns in the table. The cohorts in this table were born in the years 1893-1931 and are drawn from the 1940, 1950, 1960 and 1970 US decennial population censuses. Regressions include individual birth state, birth year, race and education fixed effects, as well as state level mortality rates for maternal mortality, malaria, heart disease, cancer, tuberculosis and diarrhea among the under 2s, income and public services, literacy, female labor force participation, and the year of state birth and death registration, all interacted with $sulfayears$. * denotes p-value<0.1, ** denotes p-value<0.05 and *** denotes p-value<0.01.

Table A.31: Probability of birth as a function of sulfa exposure: Additional robustness checks

	(1) - Excl. New Mexico	(2) - Pneu only Birth	(3) - OLS	(4) - OLS+WFE
$prePneumonia * post1937$	-0.0241**	-0.0158*	-0.0253*	-0.0185
	(0.0104)	(0.0084)	(0.0134)	(0.0209)
N	4485763	4499588	4499792	4499792

See notes to Table 1 for a description of the baseline regression. column (4) adds woman fixed effects. columns (3) and (4) are estimated using OLS. * denotes p-value<0.1, ** denotes p-value<0.05 and *** denotes p-value<0.01.

Table A.32: Net and gross fertility as a function of sulfa exposure: Additional robustness checks

	(1)	(2)	(3)	(4)	(5)	(6)
		Net Fertility			Gross Fertility	
A: Excl. New Mexico	# Children	# Children | Children>0	Childless	# Children	# Children | Children>0	Childless
$prePneumonia * sulfayears$	-0.0474***	-0.0341***	0.0088***	-0.0207*	-0.0184*	0.0021**
	(0.0124)	(0.0117)	(0.0023)	(0.0119)	(0.0107)	(0.0009)
N	492776	312786	492776	517651	420859	517651
B: Pneu only						
$prePneumonia * sulfayears$	-0.0397***	-0.0324***	0.0067**	-0.0192*	-0.0179*	0.0021**
	(0.0131)	(0.0097)	(0.0027)	(0.0100)	(0.0093)	(0.0009)
N	494437	313981	494437	518933	421983	518933

Net fertility is defined by the number of own children living in the household and gross fertility is defined by the number of live births. The dependent variables are the total number of children (columns 1 and 4), the total number of children conditional on having at least one (columns 2 and 5) and a dummy variable that equals one if the woman has zero children and zero otherwise (columns 3 and 6). $prePneumonia * sulfayears$ is the average state-level pneumonia mortality rate between 1930-36, interacted with the number of fertile years (aged 15-40) that a woman was exposed to sulfa drugs. These are OLS regressions with standard errors (in parentheses) clustered at the state of birth level. Our dataset is a cross-section of fertility outcomes of women aged 6-44 in 1937 and 18-40 at the time of the census for columns 1-3 and at least 40 for columns 4-6, born in the United States and resident in their birth state at the time of the census. The cohorts in this table were born in the years 1900-1931 (columns 1-3) and 1893-1931 (columns 4-6) and are drawn from the 1940, 1950, 1960 and 1970 US decennial population censuses. Regressions include individual birth state, birth year, race and education fixed effects, as well as state level mortality rates for maternal mortality (not in Panel B), malaria, heart disease, cancer, tuberculosis and diarrhea among the under 2s, income and public services, literacy, female labor force participation, and the year of state birth and death registration, all interacted with $sulfayears$. * denotes p-value<0.1, ** denotes p-value<0.05 and *** denotes p-value<0.01.

Table A.33: Labor market outcomes as a function of sulfa exposure: Additional robustness checks

A: Excl. New Mexico	(1) Working	(2) In labor force	(3) H-W SEI	(4) Personal income	(5) Hours worked
$prePneumonia * sulfayears$	0.0058***	0.0055***	0.1970**	7.9247	0.2419***
	(0.0017)	(0.0018)	(0.0750)	(15.3758)	(0.0634)
N	725118	725118	516184	305575	725118
B: Pneu only					
$prePneumonia * sulfayears$	0.0040**	0.0036*	0.2000**	7.0433	0.1642*
	(0.0017)	(0.0018)	(0.0753)	(13.2783)	(0.0662)
N	727398	727398	517857	306280	727398
C: Mult. Hypothesis					
$prePneumonia * sulfayears$	0.0058***	0.0055***	0.1991**	7.7366	0.2421***
	(0.0018)	(0.0019)	(0.0857)	(54.9474)	(0.0675)
N	727398	727398	517857	306451	727398

The dependent variables are: (1) a dummy variable equal to one if the woman reports working at the time of the census and zero otherwise; (2) a dummy variable equal to one if the woman is in the labor force and zero otherwise; (3) the Hauser-Warren Socioeconomic Index, based on occupation; (4) the US Dollar amount of personal earnings in the past year; (5) hours worked in the past week, where intervalled data is converted to a continuous measure using the midpoint of each interval. $prePneumonia * sulfayears$ is the average state-level pneumonia mortality rate between 1930-36, interacted with the number of fertile years (aged 15-40) that a woman was exposed to sulfa drugs. These are OLS regressions with standard errors (in parentheses) clustered at the state of birth level (and adjusted for multiple hypothesis testing in Panel C). Our dataset is a cross-section of labor outcomes of women aged 6-44 in 1937 and 18-50 at the time of the census, born in the United States and resident in their birth state at the time of the census. The cohorts in this table were born in the years 1893-1931 and are drawn from the 1940, 1950, 1960 and 1970 US decennial population censuses. Regressions include individual birth state, birth year, race and education fixed effects, as well as state level mortality rates for maternal mortality (not in Panel B), malaria, heart disease, cancer, tuberculosis and diarrhea among the under 2s, income and public services, literacy, female labor force participation, and the year of state birth and death registration, all interacted with $sulfayears$. * denotes p-value<0.1, ** denotes p-value<0.05 and *** denotes p-value<0.01.

Table A.34: Marriage market outcomes as a function of sulfa exposure: Additional robustness checks

A: Excl. New Mexico	(1) Currently married	(2) Ever married	(3) Age at 1st marriage
$prePneumonia * sulfayears$	-0.0023*	-0.0032**	0.0010
	(0.0012)	(0.0012)	(0.0242)
N	492776	725118	116261
B: Pneu only			
$prePneumonia * sulfayears$	-0.0008	-0.0018	0.0154
	(0.0013)	(0.0013)	(0.0203)
N	494437	727398	116632
C: Mult. Hypothesis			
$prePneumonia * sulfayears$	-0.0023	-0.0032**	0.0021
	(0.0016)	(0.0014)	(0.0652)
N	494437	727398	116632

The dependent variables are: (1) a dummy variable equal to one if the woman is married at the time of the census and zero otherwise; (2) a dummy variable equal to one if the woman has ever married in her lifetime and zero otherwise; (3) the age at fist marriage, only defined for ever married women. $prePneumonia * sulfayears$ is the average state-level pneumonia mortality rate between 1930-36, interacted with the number of fertile years (aged 15-40) that a woman was exposed to sulfa drugs. These are OLS regressions with standard errors (in parentheses) clustered at the state of birth level (and adjusted for multiple hypothesis testing in Panel C). Our dataset is a cross-section of labor and marriage outcomes of women aged 6-44 in 1937 and 18-40 at the time of the census for columns 1 and 3, 18-50 for column 2, born in the United States and resident in their birth state at the time of the census. The cohorts in this table were born in the years 1900-1931 (1893-1931 for column 2) and are drawn from the 1940, 1950, 1960 and 1970 US decennial population censuses. Regressions include individual birth state, birth year, race and education fixed effects, as well as state level mortality rates for maternal mortality (not in Panel B), malaria, heart disease, cancer, tuberculosis and diarrhea among the under 2s, income and public services, literacy, female labor force participation, and the year of state birth and death registration, all interacted with $sulfayears$. * denotes p-value<0.1, ** denotes p-value<0.05 and *** denotes p-value<0.01.

D A Model of Fertility and Labor Market Choices

D.1 Proofs

Proof of Proposition 1

Proof. We solve the woman's problem by backward induction. At $t = 2$, if the woman has a surviving child at this date, then Assumption (4) implies that her optimal strategy is not to get pregnant ($a_2 = 0$). Her continuation utility in this case (ignoring her exogenous endowment, which does not affect optimal decisions) is simply $V_1(A)$. If she does not have a surviving child, her continuation value is

$$\max\{y_2, (1-\lambda) V_1(A)\},$$

since she can choose to either get pregnant or work for wage y_2. At $t = 1$, it is therefore optimal to get pregnant ($a_1 = 1$) if and only if

$$\lambda \max\{0, (1-\lambda) V_1(A)\} + (1-\lambda) V_1(A) \quad \geq \quad E[\max\{y_2, (1-\lambda) V_1(A)\} | a_1 = 0] \tag{11}$$

For any $A < \underline{A}$, where $\underline{A}$ is defined implicitly by $V_1(\underline{A}) = 0$, the inequality in (11) cannot hold because

$$(1-\lambda) V_1(A) < 0 \leq E[y_2 | a_1 = 0].$$

This establishes point 1 in the proposition. Next, for any $A \geq \underline{A}$, we can use the facts that $y_2 = Y$ with probability p, and $y_2 = 0$ otherwise, to reduce (11) to

$$(1+\lambda)(1-\lambda) V_1(A) \geq p \max\{Y, (1-\lambda) V_1(A)\} + (1-p)(1-\lambda) V_1(A). \tag{12}$$

As a function of A, the left-hand side has slope $(1-\lambda^2) V_1'(A)$, while the right-hand side has slope less than $(1-\lambda) V_1'(A)$. Since $V_1(0) < 0$ and $\lim_{A\to\infty} V_1(A) = \infty$, there must be a unique solution $A = \bar{A}(\lambda)$ such that (12) holds if and only if $A \geq \bar{A}(\lambda)$. We conjecture and verify that this solution satisfies $0 < (1-\lambda) V_1\left(\bar{A}(\lambda)\right) < Y$. If this conjecture is correct, then part 2 of the proposition follows, because it implies that pregnancy at date 2 after working at date 1 is optimal if and only if the woman has not been promoted. Solving (12) then yields $V_1\left(\bar{A}(\lambda)\right) = \frac{pY}{(p+\lambda)(1-\lambda)}$, which clearly satisfies our conjecture and also establishes part 3 of the proposition. ■

Proof of Proposition 2

Proof. This result follows by evaluating the probability of childlessness for each of the three cases governing the optimal policy in Proposition 1. In case 1 (no fertility), the probability is clearly 1. In case 2 (delayed fertility), the woman is childless either if i) she is promoted, which occurs with probability p, or if ii) she is not promoted, gets pregnant and fails to have a surviving child, which occurs with probability $(1-p)\lambda$. Hence, the probability of childlessness in case 2 is $p + (1-p)\lambda$. In case 3 (early fertility), the woman is childless if both she gets pregnant twice but has no surviving

child, which occurs with probability λ^2. Combining these probabilities with the probability mass of women in each case, and summing across cases, yields equation (7). ■

Proof of Proposition 3

Proof. The first point in the proposition follows by observing that $\underline{A}$ is the implicit solution on $V_1(\underline{A}) = 0$. Since the definition of $V_1(A)$ in (15) does depend on λ, it follows that $\underline{A}$ is also independent of λ. aFor the second point, the definition of $\bar{A}(\lambda)$ can be alternatively written as

$$pY = (p+\lambda)(1-\lambda) V_1\left(\bar{A}(\lambda)\right).$$

By the implicit function theorem, we have

$$0 = (1-p-2\lambda) V_1\left(\bar{A}(\lambda)\right) + (p+\lambda)(1-\lambda) V_1'\left(\bar{A}(\lambda)\right) \frac{\partial \bar{A}(\lambda)}{\partial \lambda},$$

Applying the envelope theorem to (15), we obtain $V_1'\left(\bar{A}(\lambda)\right) = u(1, e_1^\star) > 0$, where $e_1^\star$ denotes the optimal choice of e in problem (15) when $n = 1$. Hence, we find that $\frac{\partial \bar{A}(\lambda)}{\partial \lambda} < 0$ if and only if $1 - p - 2\lambda > 0$, which is equivalent to (8). ■

Proof of Proposition 4

Proof. This result follows by totally differentiating Equation (7) with respect to λ. ■

D.2 Price effects

In this appendix, we consider comparative statics with respect to child health shocks that affect both the rate λ of child mortality and the prices $\boldsymbol{\tau} = (\tau_q, \tau_e)$ of child quantity and quality, respectively. In turn, prices affect the surplus associated with having n children. We make this dependence explicit:

$$V_n(A; \boldsymbol{\tau}) = \max_e \{A \cdot u(n, e) - n(\tau_q + \tau_e e)\}$$

Moreover, making the dependence of suprlus on prices and λ explicit, the value of $A = \bar{A}(\lambda; \boldsymbol{\tau})$, at which women are indifferent between early and delayer fertility is now implicitly defined by

$$(p+\lambda)(1-\lambda) V_1\left(\bar{A}(\lambda; \boldsymbol{\tau}); \boldsymbol{\tau}\right) = pY \tag{13}$$

As in the paper, we focus on conditions under which $\frac{d\bar{A}}{d\lambda} < 0$, so that a positive shock (a decline in λ) encourages delay. To analyze indirect effects of health shocks through prices, we model prices as a function $\boldsymbol{\tau}(\lambda)$ and consider changes in λ. We assume that this function is twice differentiable for all $\lambda \in [0, 1]$. We assume that surplus continues to satisfy our parametric assumption that $V_1(A; \boldsymbol{\tau}(\lambda)) < V_2(A; \boldsymbol{\tau}(\lambda))$ for all $\lambda \in [0, 1]$.

The total derivative of interest is now given by[52]

$$\frac{d\bar{A}\left(\lambda;\boldsymbol{\tau}\left(\lambda\right)\right)}{d\lambda}=\frac{\partial\bar{A}\left(\lambda\right)}{\partial\lambda}+\frac{\partial\bar{A}\left(\lambda\right)}{\partial\boldsymbol{\tau}}\cdot\frac{\partial\boldsymbol{\tau}\left(\lambda\right)}{\partial\lambda}.$$

We derive a sufficient condition under which the behavioral effect encourages delay in response to a decline in λ:

Proposition 5 *There exists a threshold $K>0$ such that $\lambda\leq\frac{K-p}{2}$ implies $\frac{d\bar{A}(\lambda;\boldsymbol{\tau}(\lambda))}{d\lambda}<0$.*

Intuitively, a decline in λ has two distinct effects on the marginal cost of delay. First, it reduces the marginal probabilityof childlessness due to delay, as long as λ is not too large. Second, there is a counterveiling effect if the decline in λ lowers prices, which raises the surplus from having children and encourages early fertility. However, the price effect affects the marginal cost of delay in proportion to the marginal probability $(p+\lambda)(1-\lambda)$, and is therefore dominated when p and λ is sufficiently small.

Proof of Proposition 5

Proof. Taking logs of Equation (13) and using the implicit function theorem, we have

$$\frac{\partial\log V_1\left(\bar{A}\left(\lambda;\boldsymbol{\tau}\left(\lambda\right)\right);\boldsymbol{\tau}\left(\lambda\right)\right)}{\partial A}\frac{d\bar{A}\left(\lambda;\boldsymbol{\tau}\left(\lambda\right)\right)}{d\lambda}=-\left[\frac{1-p-2\lambda}{\left(p+\lambda\right)\left(1-\lambda\right)}+J\left(\lambda\right)\right] \tag{14}$$

with

$$J\left(\lambda\right)=\frac{\partial\log V_1\left(\bar{A}\left(\lambda;\boldsymbol{\tau}\left(\lambda\right)\right);\boldsymbol{\tau}\left(\lambda\right)\right)}{\partial\boldsymbol{\tau}}\cdot\frac{\partial\boldsymbol{\tau}\left(\lambda\right)}{\partial\lambda}.$$

We have assumed that women's utility and $\boldsymbol{\tau}\left(\lambda\right)$ are twice differentiable, so that the function $J\left(\lambda\right)$ is continuous in $\lambda\in[0,1]$. We can therefore define the lower bound $B=\inf_{\lambda\in[0,1]}J\left(\lambda\right)$, which is independent of p and λ. Now assume that $p+2\lambda\leq K$, so that we have

$$\frac{1-p-2\lambda}{\left(p+\lambda\right)\left(1-\lambda\right)}+J\left(\lambda\right)\geq\frac{1-K}{K}+B.$$

We can find a sufficiently small $K>0$ such that the right-hand side of this expression is strictly positive. Combining with Equation (14), and noting that $\frac{\partial\log V_1}{\partial A}>0$, we find that $\frac{d\bar{A}}{d\lambda}<0$ for sufficiently small K, which completes the proof. ■

D.3 General dynamics

This appendix presents a version of our model with general dynamics. There is a unit measure of women whose life cycles consists of T periods $t\in\{1,2,...,T\}$. Women's utility is $U=A\cdot u\left(n,e\right)+c$, as in the baseline model.

[52] We write $\frac{\partial\bar{A}(\lambda)}{\partial\boldsymbol{\tau}}$ for the derivative with respect to both prices, and $\frac{\partial\boldsymbol{\tau}(\lambda)}{\partial\lambda}$ for the vector of derivatives of both prices with respect to λ. Both are vectors with two elements, and we denote their inner product by $\frac{\partial\bar{A}(\lambda)}{\partial\boldsymbol{\tau}}\cdot\frac{\partial\boldsymbol{\tau}(\lambda)}{\partial\lambda}$.

At dates $t = 1, 2, ..., T-1$, each woman chooses whether to get pregnant, denoted $a_t = 1$, or to work, denoted $a_t = 0$. If she chooses $a_t = 1$, she has a surviving child with probability $(1 - \lambda)$, where λ is the rate of child mortality. If she works, she earns wages y_t per period. Her wages are intialized at $y_1 = 0$. If she works at date t and earns $y_t = 0$, there are two possibilities. With probability p, she is promoted, in which case her wage rises to $y_s = Y > 0$ for all subsequent periods $s > t$ until her first pregnancy. With probability $1 - p$, she is not promoted, and her wage remains at $y_{t+1} = 0$ for the next period. If she woman gets pregnant at t, then her wage falls to $y_s = 0$ for all periods $s \geq t$. This is a generalization of the stochastic process in our baseline model, which captures the "job then family" pattern of the sulfa drug era.

At the final date $t = T$, the woman's fertility is complete, and she takes as given the final number of her surviving children $n \in \{0, 1, ..., T-1\}$. As in the baseline model, we define the surplus she obtains at this date as

$$V_n = \max_e \left\{ A \cdot u(n, e) - n(\tau_q + \tau_e e) \right\}. \tag{15}$$

We assume that this surplus is concave in n. We write $n^\star = \arg\max_{n \geq 0} V_n$ for the surplus-maximizing number of children, assuming that $0 < n^\star < \infty$, and $V^\star = \max_{n \geq 0} V_n$ for the maximized surplus.

We write the woman's dynamic optimization problem in recursive form. The relevant state variables are i) the current date t, ii) an indicator $\ell \in \{0, 1\}$ for whether the woman is still in the labor market, iii) her current wage y (which is always zero when $\ell = 0$), and iv) her current number of children n (which is always zero when $\ell = 1$). Suppose the woman chooses action $a_t = a \in \{0, 1\}$ at date t and faces state variables (t, ℓ, y, n). The state variables at date $t + 1$, denoted $(t + 1, \ell', y', n)$, are governed by the following laws of motion:

$$\begin{aligned}
\ell' &= \ell(1 - a) \\
y' &= \begin{cases} \ell(1 - a)\, y, & \text{w.pr. } 1 - p, \\ \ell(1 - a)\, Y, & \text{w.pr. } p \end{cases} \\
n' &= \begin{cases} n + a, & \text{w.pr. } 1 - \lambda, \\ n, & \text{w.pr. } \lambda \end{cases}
\end{aligned}$$

The initial values for these state variables at date 0 are given by $t = 0$, $\ell = 1$, and $y = n = 0$.

We define her continuation surplus, that is, her maximized utility in excess of consuming her current wealth, by $\mathcal{V}(t, \ell, y, n)$. This value must satisfy the Bellman equation

$$\mathcal{V}(t, \ell, y, n) = \max_{a \in \{0,1\}} E\left[(1 - a)\, y + \mathcal{V}\left(t + 1, \ell', y', n'\right) \middle| a \right] \tag{16}$$

with terminal condition

$$\mathcal{V}(T, \ell, y, n) = V_n. \tag{17}$$

We now characterize the solution. Notice that whenever $\ell = 0$ at any date, we must also have $y = 0$, because women who have left the labor market cannot earn wages. Whenever $\ell = 1$, we must have $n = 0$, because working women cannot have children. Hence, we can restrict the state space to the following three regions:

1. The woman has left the labor market, so that $\ell = 0$ and $y = 0$.
2. The woman is in the labor market with high income, so that $\ell = 1$, $y = Y$ and $n = 0$.
3. The woman is in the labor market with low income, so that $\ell = 1$, $y = 0$ and $n = 0$.

In the following proposition, we present a general closed-form solution to the Bellman equation for each region:

Proposition 6 *The solution to the Bellman equation (16) with terminal condition (17) is as follows:*

1. *For a woman who has left the labor market, we have*

$$\mathcal{V}(t,0,0,n) = \begin{cases} \sum_{k=0}^{T-t} \begin{pmatrix} T-t \\ k \end{pmatrix} (1-\lambda)^n \lambda^{T-t-n} \max\{V_{n+k}, V^\star\}, & n < n^\star, \\ V_n, & n \geq n^\star \end{cases} \tag{18}$$

2. *For a woman who is in the labor market with high income $y = Y$, we have*

$$\mathcal{V}(t,1,Y,0) = \begin{cases} (t_H^\star - t)\, Y + v_{t_H^\star}, & t < t_H^\star, \\ \mathcal{V}(t,0,0,0), & t \geq t_H^\star \end{cases} \tag{19}$$

   where $t_H^\star$ is the lowest integer t that satisfies

$$\mathcal{V}(t,0,0,0) \geq Y + \mathcal{V}(t+1,0,0,0) \tag{20}$$

3. *For a woman who is in the labor market with low income $y = 0$, we have the recursion*

$$\mathcal{V}(t,1,0,0) = \begin{cases} p\mathcal{V}(t+1,1,Y,0) + (1-p)\,\mathcal{V}(t,1,0,0), & t < t_L^\star, \\ \mathcal{V}(t,0,0,0), & t \geq t_L^\star, \end{cases} \tag{21}$$

   where $t_L^\star \leq t_H^\star$ is the lowest integer t that satisfies

$$\mathcal{V}(t,0,0,0) \geq p\mathcal{V}(t+1,1,Y,0) + (1-p)\,\mathcal{V}(t+1,0,0,0) \tag{22}$$

The intuition is as follows. For point 1, a woman who has left the labor market optimally gets pregnant if and only if she has not reached the surplus-maximizing number of children $n^\star$. Her

continuation value is therefore is the expectation of the maximal surplus she can achieve in $T-t$ trials of pregnancy. Evaluating the associated (binomial) probabilities yields Equation (18). For point 2, we guess and verify that a woman with high income chooses a cutoff rule, and gets pregnant after a threshold date $t_H^\star$. The intuition for this cutoff strategy is that, because the surplus V_n is concave in n, the marginal cost of delaying fertility by one more period is increasing over time, while the marginal benefit is fixed at the current wage Y. For point 3, we guess and verify that a woman with low income also chooses a cutoff rule.

This proposition immediately yields the woman's optimal policy:

Corollary 1 *The woman's optimal policy is as follows:*

1. *A woman who has left the labor market chooses to get pregnant ($a=1$) if and only if $n<n^\star$.*
2. *A woman who is in the labor market with high income chooses $a=1$ if and only if $t\geq t_H^\star$.*
3. *A woman who is in the labor market with high income chooses $a=1$ if and only if $t\geq t_L^\star$, where $t_L^\star\leq t_H^\star$.*

Next, we evaluate the effect of changes in the child mortality rate λ on the woman's strategy. For comparison with the baseline model, we concentrate on extensive margin effects. We characterize the effects on λ on the optimal timing of fertility among women who have not been promoted.[53]

Proposition 7 *Assume that $n^\star\leq 1$. If the rate λ of child mortality satisfies*

$$\lambda<\frac{1-p}{2}, \tag{23}$$

then the threshold $t_L^\star$ that determine the optimal timing of fertility is decreasing in λ. Conversely, a decline in λ encourages women who have not been promoted to delay their fertility. Moreover, a woman who is indifferent between starting her fertility and waiting at $t=t_L^\star$ will choose $t=t_L^\star+1$ after a marginal decline in λ.

We conclude that a decline in λ leads to delay across the board, i.e., regardless of the initial optimal choice of fertility, under the same upper bound on λ as in the baseline model.

Proof of Proposition 6 **Proof.** We derive the expression for value function in point 1 directly by characterizing the woman's optimal behavior. Then, we verify that the conjectured solutions in points 2 and 3 satisfy the Bellman equation.

Point 1: For a woman who has left the labor market, it is clearly optimal to get pregnant if and only if $n<n^\star$. Hence, if $n\geq n^\star$ at date t, the woman does not get pregnant at any date $s\geq t$, and enjoys surpus V_n at the final date. If $n<n^\star$ at date t, we can model the woman's potential number of live births as a latent binomial random variable with $T-t$ trials and success probability

[53] An equivalent result for women who have been promoted is available, as long as these women optimally get pregnant at least once, with $t_H^\star<T$. Promoted women who never get pregnant ($t_H^\star=T$) may switch to trying once ($t_H^\star=T-1$) after a decline in λ.

$1-\lambda$. If the number of successes k is such that $n+k \leq n^{\star}$, then she optimally gets pregnant at every date $s \geq t$ and enjoys final surplus V_{n+k}. Otherwise, she optimally gets pregnant until $n = n^{\star}$. Evaluating her expected utility under there probabilities yields the desired expression.

Point 2: Define the sequence

$$v_t = \mathcal{V}(t,0,0,0),\ 0 \leq t \leq T,$$

as the expected surplus of a woman who begins her fertility at date t. Notice point that v_t is the expected value of $\max\left\{V_{k(t)}, V^{\star}\right\}$, where $k(t)$ is a binomial random variable with $T-t$ trials and success probability $1-\lambda$. Since $\max\{V_k, V^{\star}\}$ is increasing in k, the expectation $v_t = E\left[\max\left\{V_{k(t)}, V^{\star}\right\}\right]$ is increasing in the number of trials and therefore decreasing in t.

Moreover, consider the increments $z_t \equiv v_{t-1} - v_t$. We have

$$z_t = (1-\lambda)\sum_{k=0}^{T-t}\begin{pmatrix} T-t \\ k \end{pmatrix}(1-\lambda)^k \lambda^{T-t-k}\left(\max\{V_{k+1}, V^{\star}\} - \max\{V_k, V^{\star}\}\right)$$

Therefore z_t is the expected value of

$$u_{k(t)} = \max\left\{V_{k(T)+1}, V^{\star}\right\} - \max\left\{V_{k(t)}, V^{\star}\right\},$$

Since surplus is concave, u_k is a decreasing sequence. Therefore, the expectation $z_t = E\left[u_{k(t)}\right]$ is decreasing in the number of trials and therefore increasing in t. From this result, it follows that there exists a unique period $t_H^{\star}$ such that (20) holds if and only if $t \geq t_H^{\star}$.

We are now ready to verify that our conjectured solution $\mathcal{V}(t,1,Y,0)$ satisfies the Bellman equation. First, suppose that $t \geq t_H^{\star} \Leftrightarrow v_t \geq Y + v_{t+1}$. Then the right-hand side of the Bellman equation is

$$\begin{aligned}\max\{v_t, Y + v_{t+1}\} &= v_t \\ &= \mathcal{V}(t,1,Y,0)\end{aligned}$$

as required. Second, suppose $t < t_H^{\star} \Leftrightarrow v_t < Y + v_{t+1}$. Then the right-hand side of the Bellman equation is

$$\max\left\{v_t, Y + (t_H^{\star} - t - 1)Y + v_{t_H^{\star}}\right\}$$

We need to show that this equals $(t_H^{\star} - t)Y + v_{t_H^{\star}}$. This is true and only if

$$\begin{aligned} v_t &\leq (t_H^{\star} - t)Y + v_{t_H^{\star}} \\ \Leftrightarrow \sum_{s=t}^{t_H^{\star}-1}(v_s - v_{s+1} - Y) &\leq 0\end{aligned}$$

which is true because $v_s < Y + v_{s+1}$ for all $s < t_H^{\star}$. Hence, the proposed solution in point 2 solves the Bellman equation for all dates t.

Point 3: We first show that there exists a unique period $t_L^\star$ such that (22) holds if and only if $t \geq t_L^\star$. It is sufficient to show that the following is increasing in t:

$$v_t - pv_{t+1} - (1-p)\,\mathcal{V}(t+1,1,Y,0) = v_t - v_{t+1} - (1-p)\left[\mathcal{V}(t+1,1,Y,0) - v_{t+1}\right]$$

The first term, $v_t - v_{t+1}$, is increasing in t by our argument above. The second term is zero whenever $t \geq t_H^\star$. When $t < t_H^\star$, we need to show that the expression in square brackets is decreasing in t. This is the case if and only if

$$\begin{aligned}(t_H^\star - t)\,Y + v_{t_H^\star} - v_t &\geq (t_H^\star - t - 1)\,Y + v_{t_H^\star} - v_{t+1} \\ \Leftrightarrow v_t - v_{t+1} &\leq Y,\end{aligned}$$

which follows from the definition of $t_H^\star$. This argument also implies that $t_L^\star \leq t_H^\star$.

We are now ready to verify that our conjectured solution $\mathcal{V}(t,1,y,0)$ satisfies the Bellman equation. We consider three cases. First, suppose that $t \geq t_H^\star \geq t_L^\star$. Then the right-hand side of the Bellman equation is

$$\max\left\{v_t, p\mathcal{V}(t+1,1,Y,0) + (1-p)\,\mathcal{V}(t+1,1,0,0)\right\} = \max\left\{v_t, v_{t+1}\right\} = v_t,$$

as required. Second, suppose that $t_H^\star > t \geq t_L^\star$, which implies that $v_t \geq p\mathcal{V}(t+1,1,Y,0) + (1-p)\,v_{t+1}$. Then the right-hand side of the Bellman equation is

$$\max\left\{v_t, p\mathcal{V}(t+1,1,Y,0) + (1-p)\,v_{t+1}\right\} = v_t,$$

as required. Finally, suppose that $t < t_L^\star$, which is equivalent to $v_t < p\mathcal{V}(t+1,1,Y,0) + (1-p)\,v_{t+1}$. Then the right-hand side of the Bellman equation is

$$\max\left\{v_t, p\mathcal{V}(t+1,1,Y,0) + (1-p)\,\mathcal{V}(t+1,1,0,0)\right\}.$$

We need to show that this equals the left-hand side, which is given by

$$\mathcal{V}(t,1,0,0) = p\mathcal{V}(t+1,1,Y,0) + (1-p)\,\mathcal{V}(t+1,1,0,0).$$

We are done if we can show that our conjectured solution satisfies

$$\mathcal{V}(t,1,0,0) \geq v_t.$$

We confirm this inequality by induction. It holds with equality at $t = t_L^\star$. Suppose it holds at date

$t+1 \leq t_H^\star$. Then

$$\begin{aligned}\mathcal{V}(t,1,0,0) &= p\mathcal{V}(t+1,1,Y,0) + (1-p)\,\mathcal{V}(t+1,1,0,0) \\ &\geq p\mathcal{V}(t+1,1,Y,0) + (1-p)\,v_{t+1} > v_t,\end{aligned}$$

where the last inequality follows from the definition of $t_L^\star$. This completes the proof. ■

Proof of Proposition 7 **Proof.** If $n^\star = 1$ then $t_L^\star \leq T-1$ for all λ. If $t_L^\star = T-1$ then it must weakly decrease after any change in λ. We therefore focus on $t_L^\star < T-1$. To show that $t_L^\star$ is decreasing in λ, it is sufficient to show that the inequality in (22) is more likely to hold, for a given $t \leq T-2$, after a marginal increase in λ. Hence, we need to show that the following expression is increasing in λ:

$$v_t - (1-p)\,v_{t+1} - p\left[(t_H^\star - (t+1))\,Y + v_{t_H^\star}\right]$$

If $t_H^\star = T$, then this is equal to

$$v_t - (1-p)\,v_{t+1} \tag{24}$$

plus a constant that does not depend on λ. With $n^\star = 1$, we have

$$v_t = \left(1-\lambda^{T-t}\right)V_1$$

so that

$$\frac{\partial v_t}{\partial \lambda} = -(T-t)\,\lambda^{T-t-1}V_1$$

Hence, we obtain that $\frac{\partial[v_t-(1-p)v_{t+1}]}{\partial\lambda} > 0$ if and only if

$$\lambda < (1-p)\,\frac{T-(t+1)}{T-t},$$

which holds for all $t \leq T-2$ if $\lambda < \frac{1-p}{2}$.

If, on the other hand, $t_H^\star < T$, then the expression of interest is equal to

$$v_t - v_{t+1} + p\left(v_{t+1} - v_{t_H^\star}\right) \tag{25}$$

plus a constant that does not depend on λ. The first term is strictly increasing in λ whenever $\lambda < \frac{1}{2}$. The second term is the sum of increments $v_s - v_{s+1}$ for $s \leq t_H^\star - 1$, all of which are also increasing in λ whenever $\lambda < \frac{1}{2}$. This establishes that $t_L^\star$ is decreasing in λ, as required. Since the terms of interest in (24) and (25) are *strictly* increasing in λ, it also follows that a woman who is indifferent between starting her fertility and waiting for one period at $t = t_L^\star$ (i.e., for whom (22) holds with equality) will now choose $t = t_L^\star + 1$ after a marginal decline in λ. ■

D.4 Extensions

This appendix extends our baseline model in various directions. The associated economic intuitions are discussed in the paper. Our treatment of heterogeneous preferences in terms of a single parameter A in our baseline model is not illuminating in all extensions, in particular in those with general (not quasilinear) preferences and higher birth orders. For a unified treatment, in each extension, we establish a more general version of our main result: A decline in child mortality λ expands the parametric region in which delayed fertility is optimal.

In particular, in each extension, we derive the expected continuation value U_1 of getting pregnant at date 1 and the expected continuation value U_0 of working at date 1. We then derive conditions under which the following implication holds:

$$U_1 \geq U_0 \Rightarrow \frac{\partial \left[U_1 - U_0\right]}{\partial \lambda} > 0. \tag{26}$$

The intepretation of Condition (26) is as follows: If it is satisfied, then any woman who prefers early fertility for a low value of λ will also prefer it for a higher value of λ. Moreover, if a woman is indifferent between delayed and early fertility, then she strictly preferes delayed fertility after a marginal decrease in λ. Hence, establishing (26) is sufficient to argue that a decline in λ encourages a wider set of women to delay.

D.4.1 Income effects

In this section, we make two generalizations to our baseline model. First, the woman's utility takes the general shape $U(n, e, c)$, where $U(.)$ is concave in its three arguments. We assume that the marginal utility of consumption is weakly increasing in both quality and quantity of children:

$$\frac{\partial^2 U}{\partial c \partial n} \geq 0 \text{ and } \frac{\partial^2 U}{\partial c \partial e} \geq 0. \tag{27}$$

Second, to generate meaningful income effects between dates 1 and 2, we now allow the woman's wage before promotion to take a non-zero value $y > 0$.

We define the woman's total income as $m \equiv \sum_{t=1}^{2} y_t (1 - a_t)$. The indirect utility of having n children and earning total income m is

$$V_n(m) = \max_{e,c} \left\{ U(n, e, c) \text{ subject to } c + n(\tau_q + \tau_e e) = m \right\}. \tag{28}$$

We further define the surplus from having n relative to having no children with income m as

$$S_n(m) = V_n(m) - V_0(m).$$

We will make use of the following intermediate results

Lemma 1 *The indirect utility function $V_n(m)$ is concave in m.*

Lemma 2 *The surplus from one child satisfies*

$$S_1(y) \geq S_1(0).$$

We characterize the conditions under which declines in λ encourage delay.

Proposition 8 *If the rate λ of child mortality satisfies*

$$\lambda < \frac{1-p}{2}\frac{S_1(y)}{S_1(0)}, \tag{29}$$

then Condition (26) is satisfied, and a decline in λ encourages a wider set of women to delay.

We can compare Condition (29), under which a decline in λ encourages delay, to the equivalent condition in the baseline model without income effects, which is

$$\lambda \leq \frac{1-p}{2}.$$

It is clear that the Condition (29) is weaker, meaning that switches to delay in response to declines in λ are (weakly) more likely when there are income effects, because $S_1(y) \geq S_1(0)$, as implied by Lemma (2).

Proof of Lemma 1 **Proof.** Fix n, and let (c, e) nnd (c', e') be the solutions to the maximization problem in (28) when income is m and m', respectively. Let $m'' = \mu m + (1-\mu) m'$ for some $\mu \in [0,1]$. Since the budget constraint is linear for a given n, the choice (c'', e''), with $c'' = \mu c + (1-\mu) c'$ and $e'' = \mu e + (1-\mu) e'$, is affordable with income m'. It follows that $V_n(.)$ is concave, because

$$\begin{aligned} V_n(m'') &\geq U(c'', n, e''), \\ &\geq \mu U(c, n, e) + (1-\mu) U(c', n, e') \\ &= \mu V_n(m) + (1-\mu) V_n(m'), \end{aligned}$$

where the second inequality follows from the concavity of $U(.)$. ■

Proof of Lemma 2 **Proof.** We need to show that $V_1(y) - V_0(y) \geq V_1(0) - V_0(0)$, or equivalently:

$$V_1(y) - V_1(0) \geq V_0(y) - V_0(0)$$

It is sufficient to show that

$$\frac{\partial V_1(m)}{\partial m} \geq \frac{\partial V_0(m)}{\partial m}, m \in [0, y] \tag{30}$$

Let c_n be optimal consumption, e_n optimal child quality, and λ_n the Lagrange multiplier on the woman's budget constraint, when the woman has n children at $t = 3$. Let $e_0 = 0$ without loss of

generality. Now (30) redues to

$$\begin{aligned}&\lambda_1 \geq \lambda_0\\ \Leftrightarrow &\frac{\partial U\left(c_1,1,e_1\right)}{\partial c} \geq \frac{\partial U\left(c_0,0,0\right)}{\partial c}\end{aligned}$$

The woman's budget constraint yields $c_1 = c_0 - \tau_q - \tau_e e_0 < c_0$. If $U(.)$ is concave and satisfies (27), we obtain

$$\frac{\partial U\left(c_1,1,e_1\right)}{\partial c} \geq \frac{\partial U\left(c_0,1,e_1\right)}{\partial c} \geq \frac{\partial U\left(c_0,0,0\right)}{\partial c},$$

which completes the proof. ■

Proof of Proposition 8 **Proof.** To establish Condition (26), suppose that $U_0 \geq U_1$. We can write

$$\begin{aligned}U_1 &= V_0\left(0\right) + \left(1+\lambda\right)\left(1-\lambda\right)S_1\left(0\right)\\ U_0 &= p\max\left\{V_0\left(y+Y\right), V_0\left(y\right) + \left(1-\lambda\right)S_1\left(y\right)\right\}\\ &\quad + \left(1-p\right)\max\left\{V_0\left(2y\right), V_0\left(y\right) + \left(1-\lambda\right)S_1\left(y\right)\right\}\end{aligned} \tag{31}$$

Notice that

$$\begin{aligned}0 &\leq U_1 - U_0\\ &\leq V_0\left(0\right) + 2\left(1-\lambda\right)S_1\left(0\right) - V_0\left(2y\right)\\ \Rightarrow V_0\left(2y\right) - V_0\left(0\right) &\leq 2\left(1-\lambda\right)S_1\left(0\right)\end{aligned}$$

Since $V_0\left(.\right)$ is concave we also have $V_0\left(2y\right) - V_0\left(0\right) \geq 2\left[V_0\left(2y\right) - V_0\left(y\right)\right]$. Using Lemma (2), we find that

$$\left(1-\lambda\right)S_1\left(y\right) \geq V_0\left(2y\right) - V_0\left(y\right).$$

Using this inequality to simplify U_0 in (31) and differentiating, we get

$$\frac{\partial\left[U_1 - U_0\right]}{\partial\lambda} = \left(1 - p + p\delta\right)S_1\left(y\right) - 2\lambda S_1\left(0\right),$$

where $\delta = 1\left\{V_0\left(y+Y\right) \leq V_0\left(y\right) + \left(1-\lambda\right)S_1\left(y\right)\right\} \in \{0,1\}$ is an indicator for whether the woman gets pregnant upon promotion. This is positive if

$$\lambda < \frac{1-p+p\delta}{2\lambda}\frac{S_1\left(y\right)}{S_1\left(0\right)}.$$

Since $\delta \geq 0$, the bound in (29) is sufficient for Condition (26), which completes the proof. ■

D.4.2 Higher birth orders

In this section, we consider women for whom it may be optimal to have two children. We replace our assumption that $V_1(A) < V_2(A)$, which guaranteed that at most one child was optimal in the baseline model, with the weaker assumption that the surplus from having children is concave in the quantity of children. Concretely, in the three period model, we assume that:

$$V_1(A) - V_0(A) \geq V_2(A) - V_1(A), \forall A \geq 0. \tag{32}$$

For example, with a Cobb-Douglas utility function $u(n,e) = e^{\alpha} n^{1-\alpha}$, this is always satisfied if $\alpha \leq \frac{1}{2}$, while at most one child is always optimal when $\alpha > \frac{1}{2}$.

We characterize the conditions under which declines in λ encourage delay.

Proposition 9 *If the rate λ of child mortality satisfies*

$$\lambda < \frac{1}{1-\Delta(A)}\left[\frac{1-p}{2} - \Delta(A)\right], \forall A \geq 0 \tag{33}$$

where

$$\Delta(A) = \max\left\{\frac{V_2(A) - V_1(A)}{V_1(A) - V_0(A)}, 0\right\}, \tag{34}$$

then Condition (26) is satisfied, and a decline in λ encourages a wider set of women to delay.

The upper bound for λ in Condition (33) is tighter than the equivalent in the baseline model, which is

$$\lambda \leq \frac{1-p}{2}.$$

In particular, the right-hand side of (33) is decreasing in $\Delta(A)$. This quantity, defined in (34), measures the strength of a woman's preference for a second child, relative to her preference for her first child. If a woman does not benefit from having a second child at all, then $\Delta(A) = 0$. Otherwise, $\Delta(A)$ is a number less than one, due to our assumption that surplus is concave.

Proof of Proposition 9 **Proof.** To establish Condition (26), fix a preference parameter A and suppose that $U_0 \geq U_1$, which implies that $V_1(A) \geq 0$. We now have

$$\begin{aligned} U_0 &= (1+\lambda)(1-\lambda) V_1(A) + (1-\lambda)^2 \max\{V_2(A) - V_1(A), 0\} \\ U_1 &= p \max\{Y, (1-\lambda) V_1(A)\} + (1-p)(1-\lambda) V_1(A) \end{aligned}$$

Therefore,

$$\frac{\partial [U_0 - U_1]}{\partial \lambda} = (1 - p + p\delta) V_1(A) - 2\lambda V_1(A) - 2(1-\lambda)\max\{V_2(A) - V_1(A), 0\}$$

where $\delta = 1\{Y \leq (1-\lambda) V_1(A)\} \in \{0,1\}$ is an indicator for whether the woman gets pregnant upon promotion. To establish Condition (26), it is sufficient to show under which condition this

expression is positive when $\delta = 0$. Substituting $\delta = 0$ and rearranging yields the upper bound on λ in Condition (33) and completes the proof. ■

D.4.3 Increasing risk of infertility

We assume that between dates 1 and 2 in our baseline model, the woman becomes infertile with probability ϕ, in which case her probability of childbirth at date 2 drops from $1 - \lambda$ to 0. In this environment, the risk of infertility increases when fertility is delayed.

We characterize the conditions under which declines in λ encourage delay.

Proposition 10 *If the rate λ of child mortality satisfies*

$$\lambda < \frac{1 - p - \frac{\phi}{1-\phi}}{2} \tag{35}$$

then Condition (26) is satisfied, and a decline in λ encourages a wider set of women to delay.

The upper bound for λ in Condition (35) is tighter than the equivalent in the baseline model, which is

$$\lambda \leq \frac{1-p}{2}.$$

In particular, the constraint on λ is more stringent when the likelihood ratio $\frac{\phi}{1-\phi}$ of infertility versus fertility is large.

Proof of Proposition 10 **Proof.** To establish Condition (26), fix a preference parameter A and suppose that $U_1 \geq U_0$, which implies that $V_1(A) \geq 0$. We now have

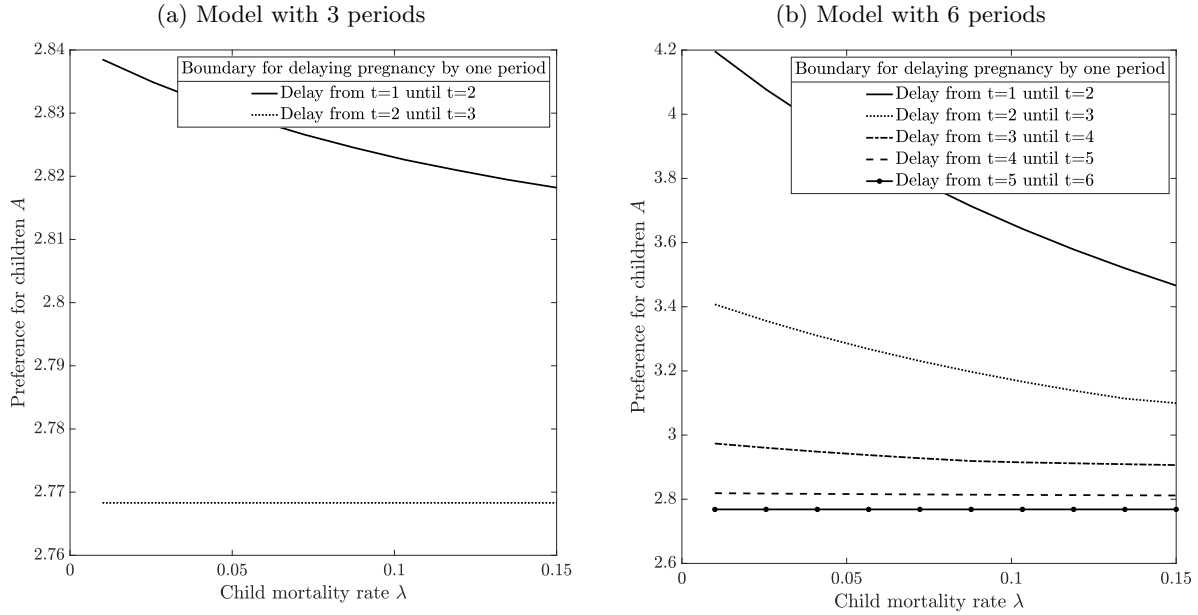
$$\begin{aligned} U_1 &= [1 - \lambda + \lambda(1-\phi)(1-\lambda)] V_1(A) \\ U_0 &= p[\phi Y + (1-\phi)\max\{Y, (1-\lambda)V_1(A)\}] \\ &\quad + (1-p)(1-\phi)(1-\lambda)V_1(A) \end{aligned}$$

Therefore,

$$\frac{\partial [U_1 - U_0]}{\partial \lambda} = V_1(A)[\delta p(1-\phi) + (1-p)(1-\phi) - \phi - (1-\phi)2\lambda]$$

where $\delta = 1\{Y \leq (1-\lambda)V_1(A)\} \in \{0,1\}$ is an indicator for whether the woman gets pregnant upon promotion. To establish Condition (26), it is sufficient to show under which condition this expression is positive when $\delta = 0$. Substituting $\delta = 0$ and rearranging yields the upper bound on λ in Condition (35) and completes the proof. ■

Figure A.10: Numerical example: The effect of a reduction in child mortality on fertility delay with risk of infertility



The figure plots the critical values of the preference parameter A, which measures the strength of the preference for children, as a function of the rate λ of child mortality. If A is above the top line in panel (a), it is optimal to get pregnant early at $t = 1$. If A is between the top and the bottom line, it is optimal to delay fertility $t = 2$. If A is below the bottom line, then no fertility (or, equivalently, delay until $t = 3$) is optimal. The region of delay becomes wider as λ declines. Similarly, panel (b) shows the optimal regions of pregnancy timing for a model with 6 periods. The parameter values are: $\tau_q = \tau_e = 2$, $u(n, e) = Ae^{\alpha}n^{1-\alpha}$, $\alpha = 0.9$, $Y = 1$, $p = 0.1$. We assume in this figure that the probability of a live birth at period t is $(1 - \lambda)(1 - 0.04 * t)$, which declines linearly over time for any given λ.

D.4.4 Marriage decisions

We assume that, at the beginning of each period $t = 1, 2$, the woman can search for a potential marriage partner. Her search succeeds with probability σ. If she finds a potential partner at $t = 1$, she can marry or reject him. Marriage implies that the woman leaves the labor market, potential wages drop to zero. Rejection implies that she cannot get pregnant, so that her probability of childbirth upon choosing $a_1 = 1$ drops to zero. If she does not find a partner at $t = 1$, she also cannot get pregnant. If the woman is unmarried at $t = 2$, she can conduct another (independent) search for a partner, which also succeeds with probability σ.

A woman who has not found a partner at date 1 will celarly find it optimal to work and chose $a_1 = 0$. Only a woman who has found a partner makes the crucial decision in our model, namely, whether to attempt early fertility or delay.

Consider a woman who has found a partner at date 1. If she marries him, it is optimal to get pregnant immediately and choose $a_1 = 1$. We let U_1 be the continuation payoff from this strategy. If she does not marry him, it is optimal to work and choose $a_1 = 0$. We let U_0 be the associated continuation payoff.

We characterize the conditions under which declines in λ encourage delay in both marriage and

fertility. This is the case if, in terms of the continuation payoffs U_0 and U_1 that we have defined, Condition (26) holds.

Proposition 11 *If the rate λ of child mortality satisfies*

$$\lambda < \frac{1 - p - \frac{1-\sigma}{\sigma}}{2} \tag{36}$$

then Condition (26) is satisfied, and a decline in λ encourages a wider set of women to delay both marriage and fertility.

We conclude that the constraint on λ is more stringent when the likelihood ratio $\frac{1-\sigma}{\sigma}$ associated with not finding a partner is large.

Proof of Proposition 11 **Proof.** To establish Condition (26), fix a preference parameter A and suppose that $U_1 \geq U_0$, which implies that $V_1(A) \geq 0$. We now have

$$\begin{aligned} U_1 &= (1+\lambda)(1-\lambda) V_1(A) \\ U_0 &= y + p\left[(1-\sigma) Y + \sigma \max\left\{Y, (1-\lambda) V_1(A)\right\}\right] \\ &\quad + (1-p)\sigma(1-\lambda) V_1(A) \end{aligned}$$

The expression for U_0 follows from the fact that a woman who does not marry at $t = 1$ has another chance to marry and have children at date 2 with probability σ, which is the likelihood that a new potential partner is found. Clearly, these continuation values are identical to those in the previous subsection in the proof of Proposition 10, except that the probability ϕ of infertility is replaced by the probability $1 - \sigma$ of not finding a partner at date 2. The result follows immediately. ■

D.4.5 Career choices

We assume that a woman commits to a choice of careers at date 1. If she chooses a "risky" career, then the process governing her potential wages y_t is the same as in our baseline model. If she chooses a "safe" career, then she earns $y_1 = 0$ at date 1, as in the baseline model, but receives a guaranteed wage potential $y_t = \bar{y}$ at date 2 if she does not get pregnant. We assume that

$$\bar{y} = pY + w < Y$$

Hence, the safe career pays the average wage of the risky career, plus a premium w. The safe career has a flatter trajectory than the risky one, and offers no chance of promotion to a wage as high as Y. We focus on the interesting case with a positive premium $w > 0$. Indeed, for $w = 0$, the risky career is a dominant strategy because the option to leave the labor market implies that the woman's utility is a convex function of future wages. To facilitate the exposition, we further

assume an upper bound on the premium w:

$$0 < w < \frac{(1-p)p}{p+\lambda} Y. \tag{37}$$

We characterize the conditions under which declines in λ encourage delay in both marriage and fertility.

Proposition 12 *If the rate λ of child mortality satisfies*

$$\lambda < \frac{1-p}{2} \tag{38}$$

then Condition 12 is satisfied, and a decline in λ encourages a wider set of women to delay both marriage and fertility.

We conclude that, under the same upper bound on λ as in the baseline model, declines in λ encourage delay in the model with career choices. An interesting auxiliary result characterizes optimal career choices:

Proposition 13 *The woman's optimal policy is as follows:*

1. ***No Fertility:*** *If $A < A^{\star}(\lambda)$, where $\underline{A}$ is defined by $V_1(A^{\star}(\lambda)) = \frac{w}{(1-p)(1-\lambda)}$, the woman chooses a safe career, and works at $t = 1$ and at $t = 2$ with probability 1.*

2. ***Delayed Fertility:*** *If $A^{\star}(\lambda) \leq A < \bar{A}(\lambda)$, where $\bar{A}(\lambda)$ is defined by $V_1\left(\bar{A}(\lambda)\right) = \frac{pY}{(p+\lambda)(1-\lambda)}$, then the woman chooses a risky career, works at $t = 1$, and gets pregnant at $t = 2$ if and only if she is not promoted.*

3. ***Early Fertility:*** *If $\bar{A}(\lambda) \leq A$, then the woman gets pregnant at $t = 1$, and gets pregnant again at $t = 2$ if and only if she does not have a surviving child yet. Her choice of career is indeterminate.*

Proof of Proposition 12 **Proof.** To establish Condition (26), fix a preference parameter A. In this environment, the continuation value of choosing to get pregnant at date 1, in which the woman's choice of career is irrelevant, is

$$U_1 = (1+\lambda)(1-\lambda) V_1(A).$$

The continuation value of not getting pregnant at date 1 is evaluated under the optimal choice of career, and equals

$$U_0 = \max\{U_0^s, U_0^r\},$$

where U_0^s and U_0^r are the continuation values of working at date 1 and choosing the safe and risky

career, respectively, which are formally defined by

$$U_0^s = \max\{pY + w, (1-\lambda) V_1(A)\}$$
$$U_0^r = p \max\{Y, (1-\lambda) V_1(A)\} + (1-p) \max\{0, (1-\lambda) V_1(A)\}.$$

Suppose that $U_1 \geq U_0$, which implies $V_1(A) \geq 0$. We must have $U_1 \geq U_0^r$, which yields

$$\begin{aligned} 0 &\leq U_1 - U_0^r \\ &\leq (1+\lambda)(1-\lambda) V_1(A) - pY - (1-p)(1-\lambda) V_1(A) \\ \Rightarrow V_1(A) &\geq \frac{pY}{(p+\lambda)(1-\lambda)}. \end{aligned} \tag{39}$$

We argue that we must have $U_0^r \geq U_0^s$ by considering three cases. First, suppose that $(1-\lambda) V_1(A) > Y$. Then, $U_0^r - U_0^s = 0$. Second, suppose that $(1-\lambda) V_1(A) \in [pY + w, Y]$. Then, $U_0^r - U_0^s = p(Y - (1-\lambda) V_1(A)) \geq 0$. Third, suppose that $(1-\lambda) V_1(A) < pY + w$. Then $U_0^r - U_0^s = (1-\lambda) V_1(A) - w \geq 0$, where the inequality follows from (39) and (37).

Hence, we have

$$U_1 - U_0 = U_1 - U_0^r,$$

and differentiating yields

$$\frac{\partial [U_1 - U_0]}{\partial \lambda} = [1 - p + p\delta - 2\lambda] V_1(A)$$

where $\delta = 1\{Y \leq (1-\lambda) V_1(A)\} \in \{0, 1\}$ is an indicator for whether the woman gets pregnant upon promotion. To establish Condition (26), it is sufficient to show under which condition this expression is positive when $\delta = 0$. Substituting $\delta = 0$ and rearranging yields the upper bound on λ in Condition (38) and completes the proof. ■

Proof of Proposition 13 **Proof.** In the proof of Proposition 38, we establish that $U_1 \geq U_0$ implies $U_0 = U_0^r$. Hence, the point with $U_0 = U_1$, at which the woman is indifferent between early and delayed fertility, is the same as in the baseline model. Hence, the woman gets pregnant at date 0, in which case her career choice is indeterminate, if and only if $A \geq \bar{A}(\lambda)$, where $\bar{A}(\lambda)$ is defined as in Proposition 1 in the paper. Moreover, for $A \leq \underline{A}$, where $\underline{A}$ is defined as in Proposition 1, it is optimal never to get pregnant, in which case the woman strictly prefers the safe career because it offers higher average earnings whenever $w > 0$.

For $\underline{A} < A < \bar{A}(\lambda)$, we have

$$U_0^r - U_0^s = pY + (1-p)(1-\lambda) V_1(A) - \max\{pY + w, (1-\lambda) V_1(A)\}$$

At $A = \underline{A}$, we have

$$U_0^r - U_0^s = -w < 0.$$

At $A = \bar{A}(\lambda)$, we have $U_0^r = U_1$, and

$$U_0^r - U_0^s = (1+\lambda)(1-\lambda) V_1\left(\bar{A}(\lambda)\right) - \max\left\{pY + w, (1-\lambda) V_1\left(\bar{A}(\lambda)\right)\right\}$$

We argue that at this point, we must have $U_0^r - U_0^s > 0$. This follows by considering two cases. First, if $pY + w \leq (1-\lambda) V_1\left(\bar{A}(\lambda)\right)$, then $U_0^r - U_0^s = \lambda(1-\lambda) V_1\left(\bar{A}(\lambda)\right) > 0$. Second, if $pY + w > (1-\lambda) V_1\left(\bar{A}(\lambda)\right)$, then

$$\begin{aligned} U_0^r - U_0^s &= (1+\lambda)(1-\lambda) V_1\left(\bar{A}(\lambda)\right) - pY - w \\ &= \frac{(1-p)pY}{p+\lambda} - w > 0 \end{aligned}$$

where the last line substitutes the definition of $\bar{A}(\lambda)$, and the inequality follows from our assumption in (37).

Notice that, over the interval $A \in \left[\underline{A}, \bar{A}(\lambda)\right]$, $U_0^r - U_0^s$ is a piecewise linear function of $V_1(A)$ with at most one kink, which starts strictly negative and ends strictly positive. Moreover, the function has a single crossing with zero where $A = A^\star(\lambda)$, which must be on the increasing part of the function and is obtained by solving

$$(1-p)(1-\lambda) V_1(A^\star(\lambda)) = w.$$

At this crossing point, we must have $pY + w > (1-\lambda) V_1(A^\star(\lambda))$; otherwise the function is locally decreasing, contradicting the single crossing property. Hence, we conclude women with $A < A^\star(\lambda)$ optimally choose the safe career and never get pregnant. To complete the proof, it is simple to check using our assumption in (37) guarantees that $A^\star(\lambda) < \bar{A}(\lambda)$. ■

D.4.6 Women's Health

In this appendix, we consider the potential implications of shocks to women's health in our model. In our baseline model, we denote the woman's health by h and assume that a positive health shock $dh > 0$ can have two potential implications.

First, it has the potential to make the woman more productive on the labor market, which we model by letting the probability $p(h)$ of being promoted depend on health, with $p'(h) > 0$.

Second, better health can increase the utility value of having a child, either directly or via its (negative) effect on the prices of child quality and quantity. To capture the latter effects concisely, we write $V_1(A; h)$ for the reduced-form value of having children when the woman's health is h, with $\frac{\partial V_1}{\partial h} > 0$. We further write $\bar{A}(h)$ for the value of the preference parameter A that makes a woman with health h indifferent between early fertility and delay, defined by

$$(p(h) + \lambda)(1-\lambda) V_1\left(\bar{A}(h); h\right) = p(h) Y. \tag{40}$$

We focus on conditions under which $\frac{d\bar{A}(h)}{dh} > 0$, which implies that women become more likely to

delay fertility after experiencing a positive shock to their own health.

We derive the following condition:

Proposition 14 *The effect* $\frac{d\bar{A}(h)}{dh}$ *of a shock to women's health on the incentives to delay has the same sign as*

$$Y\frac{\lambda}{\left(p\left(h\right)+\lambda\right)^{2}\left(1-\lambda\right)}p'\left(h\right)-\frac{\partial V_{1}\left(\bar{A}\left(h\right);h\right)}{\partial h}. \tag{41}$$

This proposition demonstrates that there are two competing effects. The first term in (41) pushes towards $\frac{d\bar{A}(h)}{dh}>0$, thus increasing women's incentives to delay their fertility. This effect is driven by the effect of health on their career prospects. The second term, by contrast, pushes towards $\frac{d\bar{A}(h)}{dh}<0$, meaning that fewer women delay their fertility, because good health increases the marginal benefit of more attempts at having a child.

Equation (41) also makes clear that the latter effect, which encourages early fertility, tends to dominate whenever the baseline rate λ of child mortality is low. Indeed, for small enough λ, the first term in Equation (41) converges to zero, and we have $\frac{d\bar{A}(h)}{dh}<0$.

In order to understand this result intuitively, consider a woman who faces low child mortality with $\lambda\simeq 0$ and who is at the margin between early and delayed fertility, so that the indifference condition in Equation (40) holds with equality. This condition now yields $V_1\simeq Y$. The marginal woman is approximately indifferent between receiving a high wage Y and receiving the utility benefit V_1 of having a child. It follows that changes in the probability $p\left(h\right)$ of promotion have only a second-order effect on the behavior of the marginal woman. In this case, the effect of a health shock is determined mostly by its direct effect on the value of children, i.e., the second term in Equation (41). Therefore, a shock to women's health encourages early fertility. We note that this result is in contrast to our baseline specification, in which we study shocks to child health, and which continues to explain our empirical results when the baseline rate of child mortality is low.

Proof of Proposition 14 **Proof.** Applying the implicit function theorem to Equation (40), we obtain

$$\begin{aligned}\frac{\partial V_{1}\left(\bar{A}\left(h\right);h\right)}{\partial A}\frac{d\bar{A}\left(h\right)}{dh} &= \frac{Y-\left(1-\lambda\right)V_{1}\left(\bar{A}\left(h\right);h\right)}{\left(p\left(h\right)+\lambda\right)\left(1-\lambda\right)}p'\left(h\right)-\frac{\partial V_{1}\left(\bar{A}\left(h\right);h\right)}{\partial h}\\ &= \frac{Y\left[1-\frac{p(h)}{p(h)+\lambda}\right]}{\left(p\left(h\right)+\lambda\right)\left(1-\lambda\right)}p'\left(h\right)-\frac{\partial V_{1}\left(\bar{A}\left(h\right);h\right)}{\partial h}\\ &= Y\frac{\lambda}{\left(p\left(h\right)+\lambda\right)^{2}\left(1-\lambda\right)}p'\left(h\right)-\frac{\partial V_{1}\left(\bar{A}\left(h\right);h\right)}{\partial h},\end{aligned}$$

where the second line follows by substituting (40). The first term converges to zero as $\lambda\to 0$. Therefore, for λ small enough, $\frac{d\bar{A}(h)}{dh}$ has the same sign as $-\frac{\partial V_{1}\left(\bar{A}(h);h\right)}{\partial h}<0$. ■