

Gender Roles and Medical Progress

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Introduction

- ▶ What are the determinants of married women's dramatic entry into the workforce in the 20th century?

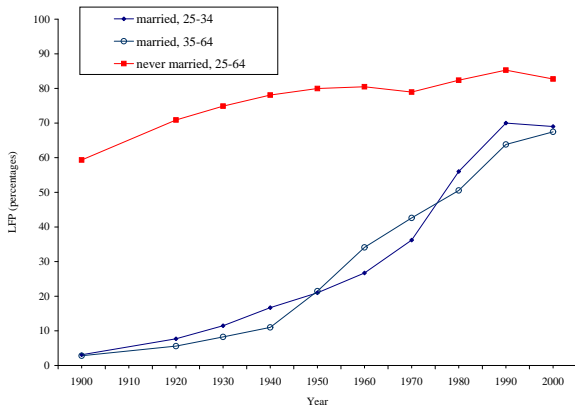


Figure: Female Labor Force Participation by Age and Marital Status

Hypothesis

- ▶ Medical progress
 - ▶ Improvement in maternal health
 - ▶ Diffusion of infant formula
- ▶ Enabled women to reconcile work and motherhood.

Burden of Maternal Role

- ▶ *For median woman in 1920:*
 - Marriage at 21
 - First* birth at age 23
 - Last* birth at 33
 - Completed Fertility: 3.3 children
 - Life expectancy at 10: 55

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 - ▶ Life expectancy at 10: 55
- ▶ *Health burden*
 - ▶ Mortality: One mother died for each 125 living births in 1920
 - ▶ Compounded death risk 3%
 - ▶ Morbidity: One in six mothers suffered different degrees of disablement
 - ▶ Prolonged duration

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 - ▶ Prolonged duration
- ▶ *Care burden*
 - ▶ No reliable alternatives to breast feeding
 - ▶ Requires 14-17 weekly hours per child on average

Medical Progress

- ▶ Dimensions of medical progress
 - ▶ Advances in reproductive medicine
 - ▶ Sharp drop in maternal mortality 1935-1955, decline in the burden of maternal conditions
 - ▶ Women's ability to work increased
 - ▶ Introduction and commercialization of effective breast-milk substitutes
 - ▶ Women's comparative advantage in infant care reduced

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- ▶ Goal: Assess impact on women's economic role
 - ▶ Participation
 - ▶ Gender division of home work
 - ▶ Gender earnings differentials

Main Findings

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- ▶ Infant formula contributes 10% to participation in childbearing years between 1940 and 1960.
- ▶ Diffusion of home appliances unable to account for the rise in married women's participation between 1940 and 1960. Main contribution between 1960 and 1970.
- ▶ *Medical progress is critical for the rise in married women's labor force participation*

Contributions

- ▶ First to consider improved maternal health and diffusion of infant formula as medical factors leading to higher married women's participation
 - ▶ Medical progress driven by scientific discoveries and concerns for public health; *exogenous* to female participation

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 - ▶ Quantification of impact of medical progress on participation by age and over time in comparison to other forces, such as home appliances

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- ▶ Theory:
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 - ▶ Quantification of impact of medical progress on participation by age and over time in comparison to other forces, such as home appliances
- ▶ Empirics:
 - ▶ Novel data on time price of infant formula
 - ▶ Novel historical evidence on maternal morbidity

Outline

- ▶ Evidence on medical progress
- ▶ Building economic measures for
 - ▶ Decline in the burden of maternal conditions
 - ▶ Progress in infant feeding
- ▶ Model
- ▶ Quantitative analysis
- ▶ Ongoing work on maternal health and fertility

Medical Progress

Advances in Reproductive Medicine

- ▶ Developments: Medicalization and hospitalization of childbirth, improved obstetric practices, prenatal care, antibiotics, blood banking
- ▶ Time line: Start in early mid 1800, precipitate 1920s and 1930s

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- ▶ Developments: Medicalization and hospitalization of childbirth, improved obstetric practices, prenatal care, antibiotics, blood banking
- ▶ Time line: Start in early mid 1800, precipitate 1920s and 1930s
- ▶ Implications:
 - ▶ Sharp drop in maternal mortality 1935-1955
 - ▶ Rise in female-male differential in life expectancy
 - ▶ Reduction in incidence and intensity of common maternal conditions

Medical Progress

Advances in Reproductive Medicine

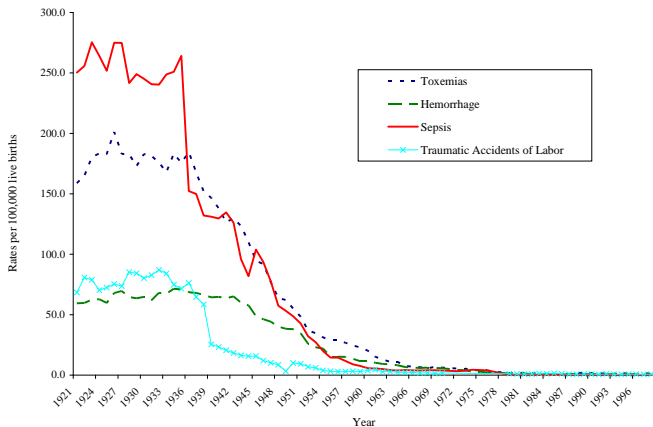


Figure: Trends in causes of maternal deaths

Medical Progress

Advances in Reproductive Medicine

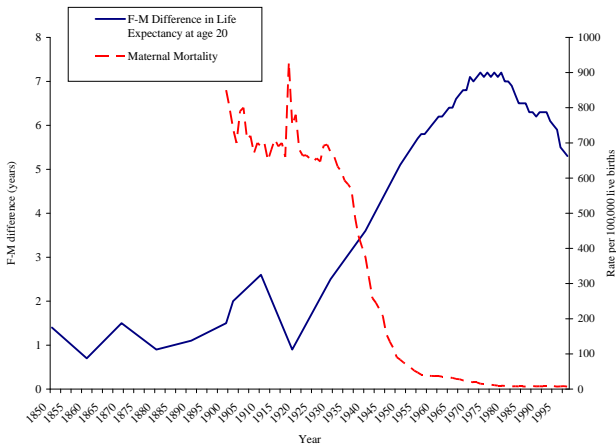


Figure: Trends in Maternal Mortality and the Gender Differential in Life Expectancy at age 20

Medical Progress

Burden of Maternal Conditions

- ▶ Years lost to disability concept from WHO:

$$YLD = I \times D \times DW$$

- ▶ I = incidence, D = duration
- ▶ DW = disability weight (0 for perfect health, 1 for death)

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- ▶ I = incidence, D = duration
- ▶ DW = disability weight (0 for perfect health, 1 for death)
- ▶ Data from hospital based studies in 1920s (Kerr, 1933):
 - ▶ Obstructed labor: 12% incidence (of which 67% perineal lacerations), 55.67 months average duration, some chronic
 - ▶ Toxaemia: 10% incidence, resulting conditions chronic
 - ▶ Haemorrhage: 6% (conditional on survival), chronic anaemia

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- ▶ Disability weights:
 - ▶ Fistula & lacerations 0.43, hypertensive disorders 0.38 (childbearing years)-0.47 (after childbearing), anaemia 0.09, healthy pregnancy 0.22
 - ▶ For comparison: Blindness 0.60, AIDS 0.50, adult malaria 0.17

Medical Progress

Burden of Maternal Conditions

- ▶ Estimated YLD per pregnancy by age in 1920s:

$$YLD^{14-44} = 1.17$$

$$YLD^{44+} = 1.09$$

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- ▶ Adjustment for number of pregnancies:

- ▶ Cohort total fertility rate (TFR)= number of live births per woman
- ▶ Fetal (s) and neonatal death rate at less than one week (n)= incidence of unsuccessful pregnancies ($p = s + n$)
- ▶ Number of pregnancies per woman:

$$P_t = TFR_t * (1 + p_t)$$

$$p_{1920} = 0.077$$

Medical Progress

Burden of Maternal Conditions

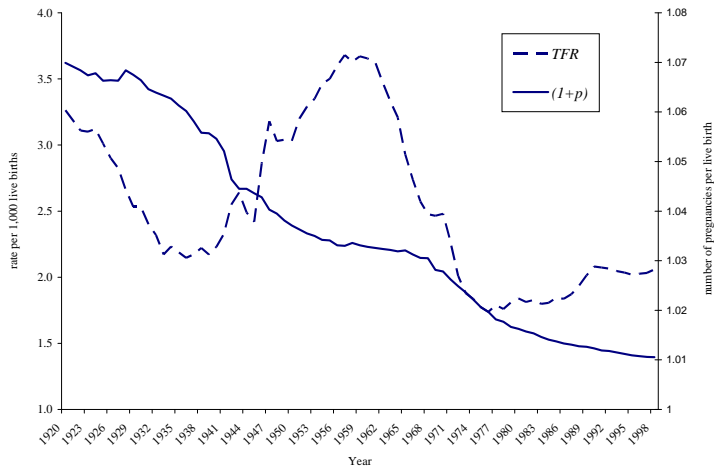


Figure: Completed Fertility and Number of Pregnancies

Burden of Maternal Conditions

Evolution Over Time

- ▶ Assumption: Maternal disability declined at the same rate as maternal mortality.

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- ▶ Assumption: Maternal disability declined at the same rate as maternal mortality.
- ▶ Estimated time series for burden of maternal conditions per pregnancy:

$$\bar{b}_t = YLD^{14-44} \times \tilde{M}_t,$$

$$\underline{b}_t = YLD^{44+} \times \tilde{M}_t,$$

with MM_t = maternal mortality rate and

$$\tilde{M}_t = MM_t / MM_{1920}$$

Medical Progress

Improvement in Maternal Health

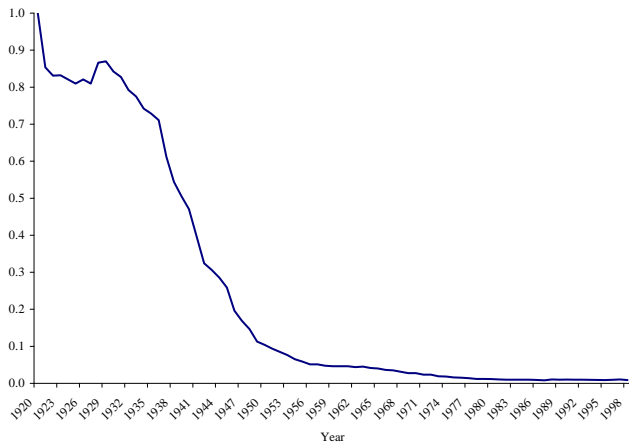


Figure: Evolution of \tilde{M}_t

Medical Progress

Advances in Infant Feeding

- ▶ Spurred by effort to reduce infant mortality from malnutrition and gastrointestinal diseases
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- ▶ Public health and commercial efforts started in mid 1800, medical and pediatric efforts concentrated 1900-1930
- ▶ Outcomes:
 - ▶ Improved quality of water and milk supplies
 - ▶ Development of "humanized infant formula"
 - ▶ Similac ("similar to lactation") is first commercial modern infant formula (1927):

	<i>Similac</i>	Breast Milk
Protein	0.9%	0.9%
Fat	4.6%	4.4%
Carbs	6.5%	6.6%

Notes: % grams per liter

Advances in Infant Feeding

Measuring Progress

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- ▶ Data:
 - ▶ Newly collected price information for *Similac* and early milk modifiers
 - ▶ Source: Advertisements from Chicago Tribune, Los Angeles Times and Washington Post for 1893-1985
 - ▶ Information: Price, quantity and type in drugstore chains

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- ▶ Time price of infant formula:

$$\text{Time Price} = \frac{\text{Real price 1 liquid oz}}{\text{FTYR Real hourly manufacturing wage}}$$

Advances in Infant Feeding

Measuring Progress

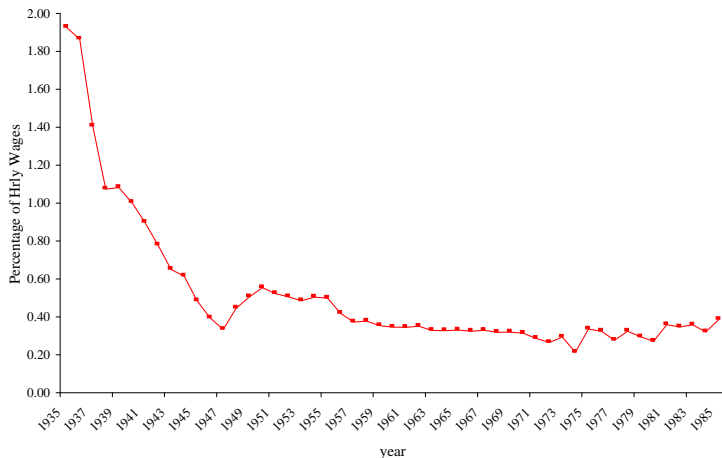


Figure: Time Price of Similac

Advances in Infant Feeding

Changes in Breast Feeding Practices

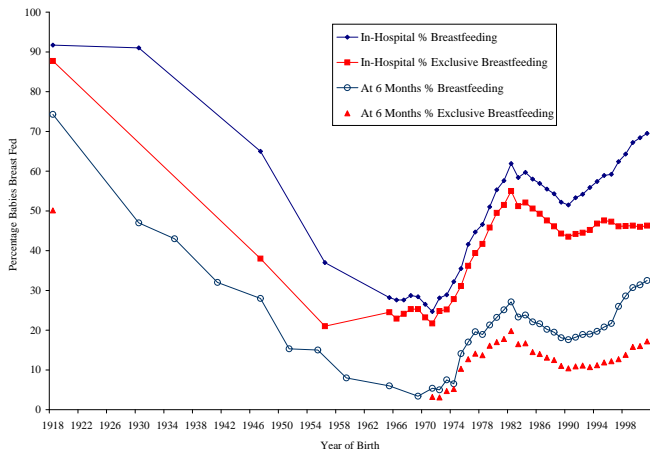


Figure: Trends in incidence, duration and exclusivity of breastfeeding

Model

Demographics and Preferences

- ▶ OG, live for $L > 2$ periods, equally split by gender
 - ▶ Heterogeneous in *intrinsic labor productivity* ζ
 - ▶ Distribution of ζ same across gender
 - ▶ Organized in 2 agent households, wife/husband pair
 - ▶ Perfect assortative matching over ζ

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 - ▶ Perfect assortative matching over ζ
- ▶ Household preferences:

$$\sum_{r=1}^L \beta^{r-1} \left[c_r + \sum_{j=f,m} v(\mu_r^j) \right]$$

- ▶ $\beta \in (0, 1)$ represents the per period discount factor
- ▶ $\mu^j =$ leisure with

$$l = T - p\bar{n} - h$$

$T =$ individual time endowment, $p \in [0, 1] =$ fraction of time spent in the labor force, $\bar{n} =$ fixed number of work hours if employed, $h =$ home hours

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Infant Good Production

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- ▶ Time demand:
 - ▶ b_r = time for pregnancy, childbirth and the burden of maternal conditions

$$b_r = \begin{cases} \bar{b}_r & \text{for } 1 \leq r \leq L_I \\ \underline{b}_r & \text{for } L_I < r \leq L \end{cases}$$

- ▶ f_r = infant feeding

$$f_r = \begin{cases} \phi & \text{for } 1 \leq r \leq L_I \\ 0 & \text{for } L_I < r \leq L \end{cases}$$

- ▶ Childbearing years: $\{1, 2, \dots, L_I\}$, $L_I < L$
- ▶ b_r , f_r adjusted for *exogenous* fertility

Model

Infant Good Production

- ▶ Households choose whether to breast or bottle feed, $\tau_r^l \in [0, 1]$:
 - ▶ $\tau_r^l = 0$ exclusive breast feeding, $\tau_r^l = 1$ exclusive bottle feeding
 - ▶ Wife's time demand at age $r \leq L$:

$$h_r^{fl}(\tau_r^l) = b_r + (1 - \tau_r^l) f_r > 0$$

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- ▶ Expenditure on infant feeding: $q_r^l \tau_r^l$
 - ▶ q_r^l = monetary cost of exclusive bottle feeding
- ▶ Time demand from bottle feeding $\tau_r^l f_r$ part of *general home production*

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- ▶ Choice of technology: $\tau^G \in [0, 1]$
 - ▶ $\tau^G = 0$ manual/old, $\tau^G = 1$ mechanized/new
 - ▶ Time demand:

$$H_r \left(\tau^G, \tau^l \right) = g_O \left(1 - \tau_r^G \right) + \tau_r^G g_N + \tau_r^l f_r$$

- ▶ g_N, g_O = time demand under new, old technology, $g_N < g_O$

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- ▶ g_N, g_O = time demand under new, old technology, $g_N < g_O$
- ▶ Expenditures on general home goods: $q_r^G \tau_r^G$
 - ▶ q_r^G = Monetary cost of home appliances

Household Problem

Wages

- ▶ Wages depend on:
 - ▶ Intrinsic labor productivity ζ
 - ▶ Pre-marital labor market investment, $e \in [0, 1]$
 - ▶ Includes any action that raises lifetime earnings, e.g. education, labor market experience
 - ▶ Utility cost: $c(e)$, $c(\cdot)$ increasing and convex
 - ▶ Initial returns: $e^j > 0$

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 - ▶ Initial returns: $e^j > 0$
- ▶ Wage function:

$$w_r^j(\zeta) = \zeta \left(1 + e^j \delta^{\sum_{s=1}^{r-1} (1-p_s^j)} e^j \right) \text{ for } j = f, m, r = 1, 2, \dots, L$$

- ▶ Returns depreciate over time, inversely related to cumulated labor force participation (Goldin, 1989, and Eckstein and Wolpin, 1989)
- ▶ $\delta \in (0, 1)$ = geometric depreciation rate

Household Problem

- ▶ Household budget constraint:

$$\sum_{r=1}^L \frac{\left(c_r - \sum_{j=f,m} w_r^j p_r^j \right)}{(1+R)^r} + \sum_{r=1}^L \frac{\tau_r^G q_r^G}{(1+R)^r} + \sum_{r=1}^{L_I} \tau_r^I q_r^I \leq 0$$

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- ▶ Household choices: $\{ \tau_r^I \}_{r \leq L_I}, \{ e^j, p_r^j, h_r^j, \tau_r^G \}_{r \leq L}^{j=f,m}$
 - ▶ Production technologies, fertility, $\{ q_r^I \}_{r=1}^{L_I}, \{ q_r^G \}_{r=1}^L, R$ and wage function taken as given
 - ▶ Wife's home hours: $h_r^f = h_r^{fl} + h_r^{fG}$
- ▶ Endogenous participation, gender wage differentials by age, distribution of home hours

Equilibrium

- ▶ Technology for production of consumption goods, C , infant formula, K_I , and home appliances, K_G :

$$\theta_t^I K_{I,t} + \theta_t^G K_{G,t} + C_t \leq N_t$$

- ▶ θ_t^I for $I = I, G$ are the marginal rates of transformation into consumption
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- ▶ θ_t^I for $I = I, G$ are the marginal rates of transformation into consumption
- ▶ $N_t =$ aggregate labor supply
- ▶ Average economy-wide wage at date t :

$$\bar{w}_t = \sum_{r=1}^T \sum_{j=f,m} \int_{\xi} w_{r,t}^j(\xi) d\Gamma(\xi)$$

- ▶ Competitive equilibrium time prices:

$$q_t^I / \bar{w}_t = \theta_t^I, \quad I = I, G$$

Household Decisions

Key Properties

- ▶ Choice of effort for $\delta = 1$:

$$\sum_r \beta^{r-1} p_r^f \varepsilon^f \bar{\zeta} - c'(e^f) \leq 0$$

- ▶ Pre-marital investment increases with lifetime participation

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- ▶ Pre-marital investment increases with lifetime participation
- ▶ Choice of participation at $\delta = 1$:

$$\zeta (1 + \varepsilon^f e^f) - \bar{n} v'(I_r^f) \leq 0$$

- ▶ Participation decreasing in b_r and f_r

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- ▶ Allocation of home hours for two earner households at $\delta = 1$:

$$\left(\frac{h_r^{fG}}{h_r^m} \right)^{\zeta-1} = \frac{(1 + \varepsilon^f e^f)}{(1 + \varepsilon^m)}$$

- ▶ $e^f < e^m$ implies $h_r^{fG} > h_r^m$ even with $\varepsilon^f = \varepsilon^m$

Impact of Medical Progress on Household Decisions

Mechanism in the Model

- ▶ Medical progress

- ▶ Improved maternal health \implies Reduction in the burden of maternal conditions, b_r
- ▶ Advances in infant feeding \implies Decline in the time price of infant formula, $\theta_t^I \implies$ Induces bottle feeding

\implies Positive *direct* effect on married women's participation in childbearing years.

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 - ▶ Women's participation at all ages rises
 - ▶ Women's contribution to general home production declines

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- ▶ Higher expected participation during childbearing \implies Women's pre-marital investment in market skills and relative wages rise \implies
 - ▶ Women's participation at all ages rises
 - ▶ Women's contribution to general home production declines
- ▶ *Positive complementarities between medical progress and women's participation*

Quantitative Analysis

Calibration

- ▶ Functional forms:

$$v(l) = \psi_0 \frac{l^{1-\psi}}{1-\psi} \text{ with } \psi_0, \psi \geq 0$$

$$c(e) = \gamma_0 \frac{e^{1-\gamma}}{1-\gamma} \text{ with } \gamma_0 > 0 \text{ and } \gamma < 0$$

- ▶ ξ distributed log-normal with mean $\bar{\xi}$ and st. dev. σ_ξ

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- ▶ ξ distributed log-normal with mean $\bar{\xi}$ and st. dev. σ_ξ
- ▶ Each period is 5 years
 - ▶ Childbearing years: 23-33
 - ▶ Post-childbearing: 34-63
 - ▶ $L_I = 2, L = 8$

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 - ▶ Post-childbearing: 34-63
 - ▶ $L_I = 2, L = 8$
- ▶ Strategy: Match key model outcomes to 1920 empirical counterparts

Quantitative Analysis

Parameters

- ▶ Model parameters: $\beta, \psi_0, \psi, \bar{n}, \gamma_0, \gamma, \varepsilon^f, \varepsilon^m, \delta, b, f, \zeta, g_0, g_N, \bar{\zeta}, \sigma_\zeta$
- ▶ Exogenous prices: $\theta_t^I, \theta_t^G, R = 1/\beta = 5\%$

Calibrated Parameters			
Estimated		Matched to data targets	
θ_{1920}^I	0.06	θ_{1920}^G	0.6
ζ	0.77	ψ_0	$3.8000e - 05$
$\{\varepsilon^f, \varepsilon^m\}$	$\{0.61, 0.86\}$	γ_0	$2.6700e - 04$
γ	-0.5	$\bar{\zeta}$	0.6
ψ	17.25	σ_ζ	0.7
\underline{b}, \bar{b}	$\{0.057, 0.038\}$	δ	0.9
f	0.0134	$\{g_0, g_N\}$	$\{0.5, 0.25\}$

Quantitative Analysis

Calibration

Match with data targets in 1920		
Statistic	Value in 1920	Model
Adoption of home appliances	7%	7%
Average bottle feeding rate	12%	12%
Married women's LFP, age 23-33	9%	9%
Married women's LFP, age 34-63	13%	13%
Female/male earnings ratio	13%	14%
Home hours of married women	52	51
Home hours of men	3	13

Transition

Exogenous sources of change over time

- ▶ Medical progress and fertility

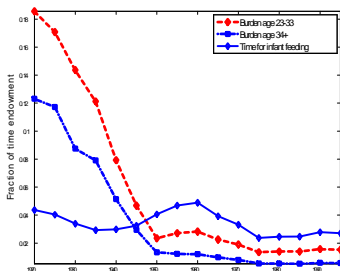


Figure: Maternal conditions and time demand for infant feeding adjusted by number of pregnancy and births and life expectancy

- ▶ Reduction in the time price of infant formula
- ▶ Reduction in the time price for home appliances (Greenwood, Seshadri, Yorugoklu, 2005)

Transition

Full Model

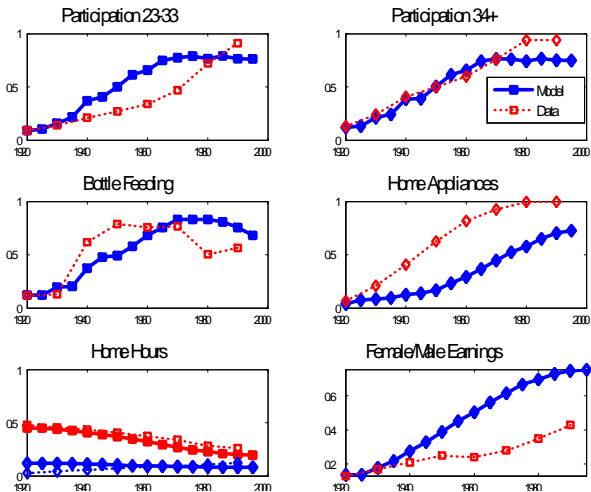


Figure: Predicted model transition compared to the data.

Transition

Counterfactuals

Summary of Experiments	
Sources of Progress	Components
Full model	Medical Progress+ Progress in home appliances
Medical Progress	Improvement in maternal health+ Advances in infant feeding
Improvement in maternal health	Decline in burden of maternal conditions+
	Rising life expectancy+
	Reduction in number of pregnancies per birth
Advances in infant feeding	Decline in the time price of infant formula
Progress in home appliances	Decline in the time price of home appliances

Transition

Fertility Only

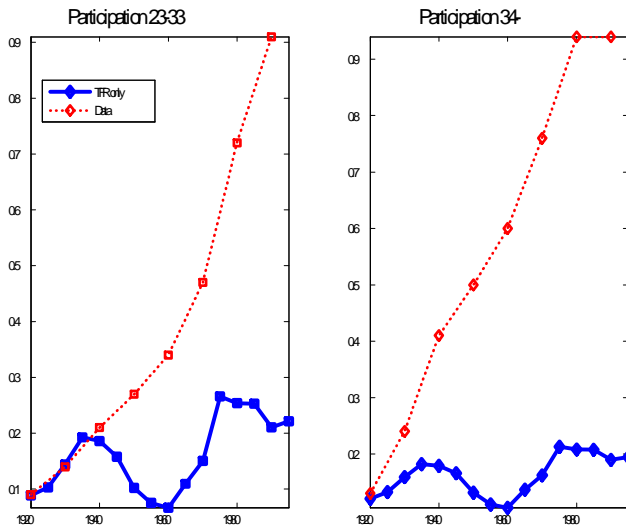


Figure: Isolating the impact of fertility.

Transition

Medical Progress + Fertility

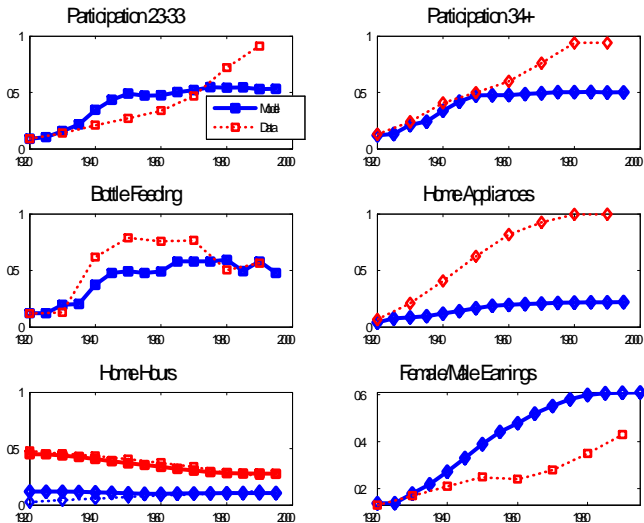


Figure: Transition with medical progress only.

Medical Progress

Maternal Health + Fertility

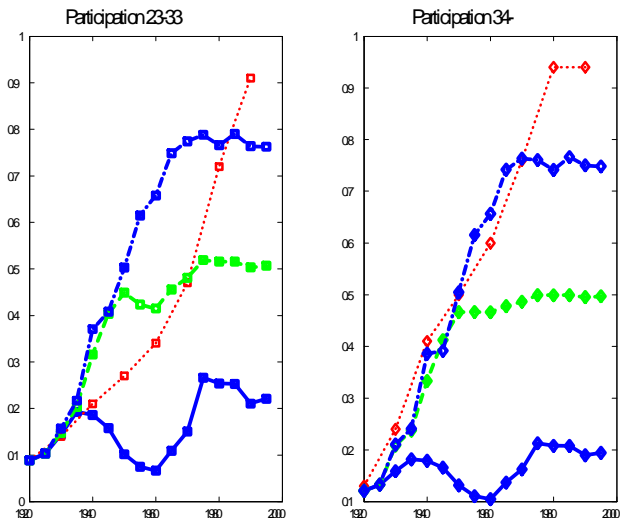


Figure: Isolating the impact of maternal health.

Medical Progress

Marginal Impact of Infant Formula

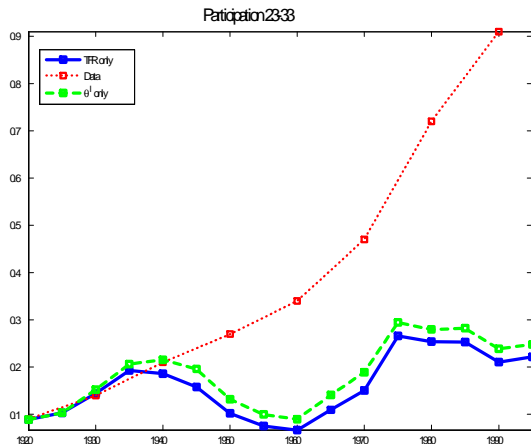


Figure: Effect of infant formula in isolation.

Transition

Marginal Impact of Infant Formula with Improved Maternal Health

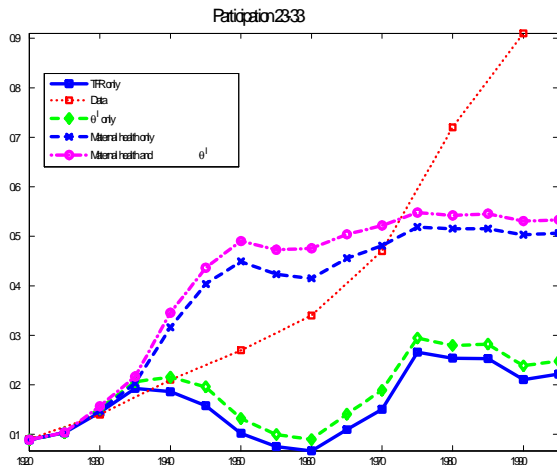


Figure: Joint effect of maternal health and infant formula.

Transition

Home Appliances + Fertility

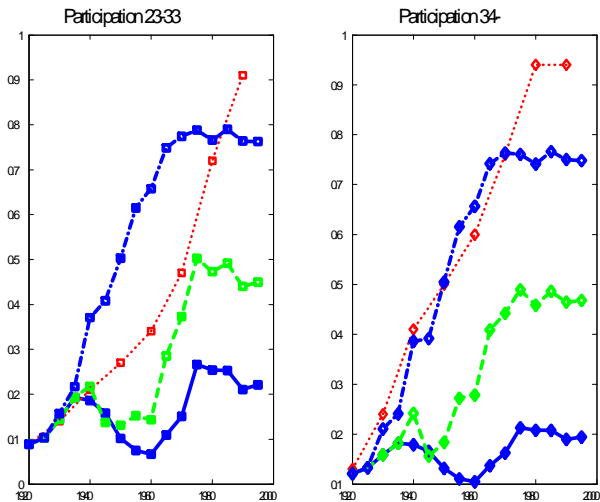


Figure: Isolating the impact of home appliances

Transition

Maternal Health vs Home Appliances

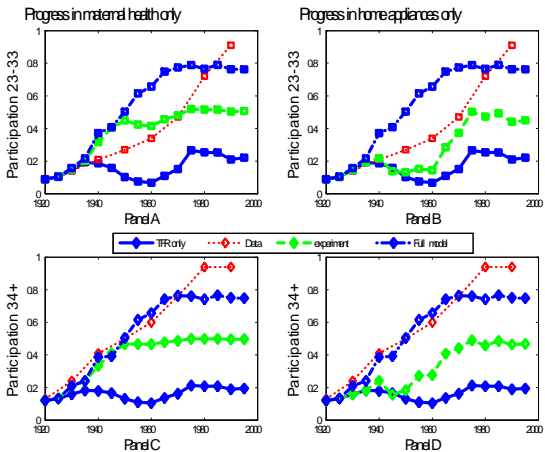


Figure: Maternal health vs progress in home appliances.

Transition

Forces Outside the Model

- ▶ Model overpredicts participation at age 23-33 relative to data between 1940-1960
 - ▶ Forces that depress participation in those years
 - ▶ "Marriage bars" (Goldin, 1990)
 - ▶ Cultural aversion to women in the workforce (Fernández, 2007, Fogli and Veldkamp, 2007)

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 - ▶ Diffusion of oral contraception (Goldin and Katz, 2002)
 - ▶ Favorable shifts in the labor market (Galor and Weil, 1996, Blau and Kahn, 1999, Olivetti, 2007)
- ▶ Experiment to quantify forces:
 - ▶ Set ε^f to match participation at age 23-33 in the data

Forces Outside the Model

Quantification

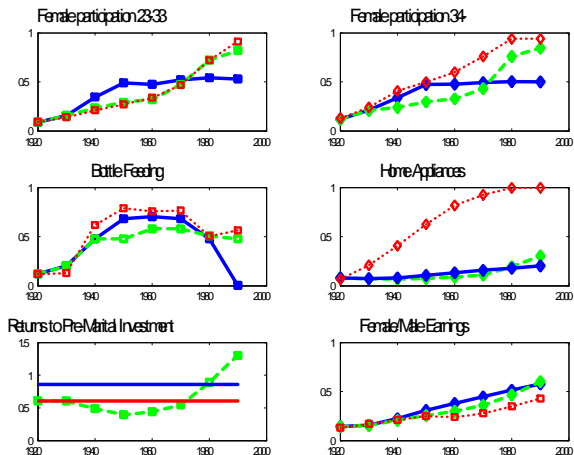


Figure: Matching participation 23-33 with medical progress only.

Forces Outside the Model

Quantification

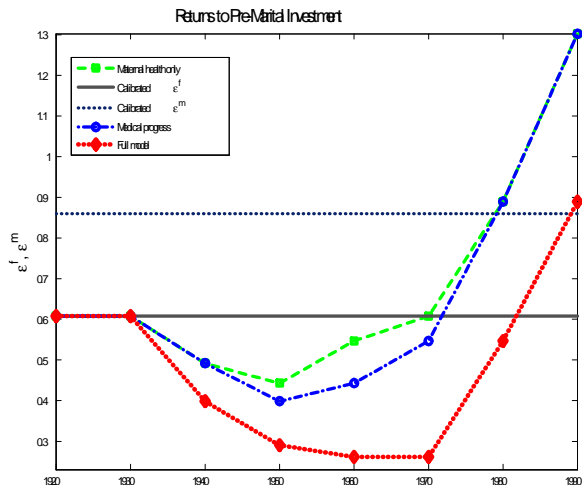


Figure: Effect of outside forces on returns to pre-marital investment in market skills.

Transition

Summing Up

- ▶ Medical progress
 - ▶ Alone it can fully account for rise in married women's participation at age 23-33 up to 1970 and over predicts participation in the data
 - ▶ Infant formula adds 10% points to participation at age 23-33 during the fertility peak
 - ▶ Increased life expectancy adds 5% to participation at age 34+ for 1935-1945

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- ▶ Marriage bars, cultural factors depressing married women's participation 1935-1955 have quantitatively significant effects

Conclusion

- ▶ Improved maternal health and diffusion of infant formula play critical role in married women's participation historic rise
- ▶ Relevance:
 - ▶ Efforts leading to medical progress pre-date rise in participation, resulted from benchmark scientific discoveries
 - ▶ Enables rise in married women's participation during Baby Boom

Conclusion

- ▶ Improved maternal health and diffusion of infant formula play critical role in married women's participation historic rise
- ▶ Relevance:
 - ▶ Efforts leading to medical progress pre-date rise in participation, resulted from benchmark scientific discoveries
 - ▶ Enables rise in married women's participation during Baby Boom
- ▶ Broader implications:
 - ▶ Economy-wide income rises by 42% between 1920 and 1990 in the model, as a result of medical progress via women's rising investment in market skills and participation
 - ▶ For developing countries, improved maternal health helps to break link between low per capita income and high fertility

Maternal Health and Fertility

- ▶ Key assumption in this paper: Fertility exogenous
 - ▶ Improved maternal health and infant formula can explain rise in participation *despite* rising fertility
- ▶ Ongoing work considers *fertility choice*: Improved maternal health reduces cost of children, unambiguously rises demand for children

Maternal Health and Fertility

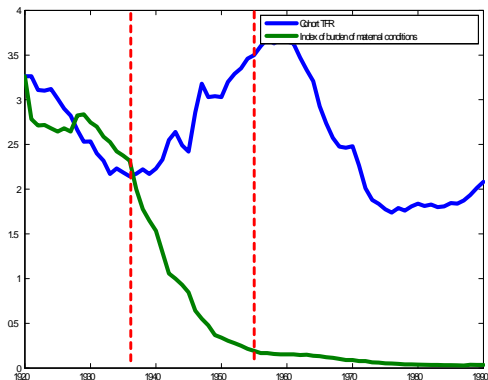


Figure: Cohort TFR and "maternal health shock."

Maternal Health and Fertility

On Going Work

- ▶ Explore link between maternal health and fertility choice
 - ▶ Existing literature only considers infant and child health (Doepke, 2005)

Maternal Health and Fertility

On Going Work

- ▶ Explore link between maternal health and fertility choice
 - ▶ Existing literature only considers infant and child health (Doepke, 2005)
- ▶ Approach
 - ▶ Empirical analysis: Exploit cross-state variation in *maternal health shock*
 - ▶ Fertility rises by more in those states and for those cohorts that are more exposed to maternal health shock
 - ▶ Decline in infant and child mortality have small impact
 - ▶ Theory: Include maternal, infant and child mortality in stochastic dynamic model of fertility choice

Maternal Health and Fertility

On Going Work

- ▶ Hypothesis:
 - ▶ Medical progress drives both secular decline in fertility (reduction in infant/child mortality) and Baby Boom (decline in maternal mortality)

Advances in Infant Feeding

Measuring Progress

- ▶ Cost of bottle feeding:

Estimated cost of bottle feeding in 1936

	Boys		Girls	
	min	max	min	max
Monthly cost				
<1 month	21.7	28.9	20.3	27.1
1-3 months	27.1	32.5	27.1	32.5
3-7 months	32.5	40.6	30.7	38.4
7-12 months	29.8	39.7	28.4	37.9
Annual Cost				
	354.8	455.0	339.5	435.2

- ▶ Cost of bottle feeding as percentage of average yearly wage income of white, male full time year round workers
 - ▶ 1936: 6-10%
 - ▶ 1960: 1.5%

Time price of home appliances

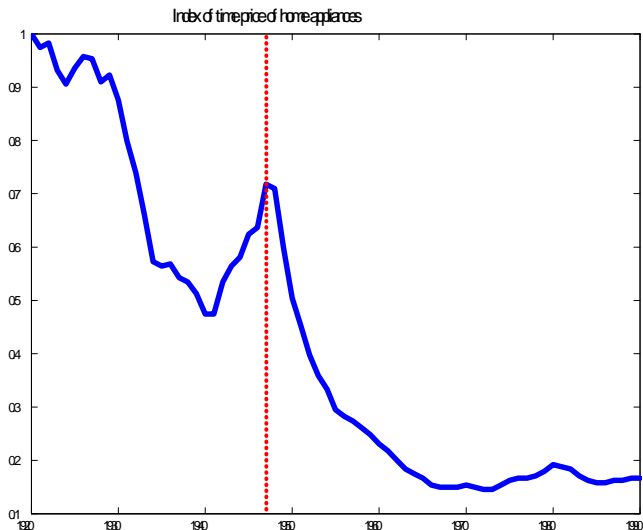


Figure: Time price of home appliances. (Source: Gordon, 1990, and NIPA.)

Transition

Infant Formula

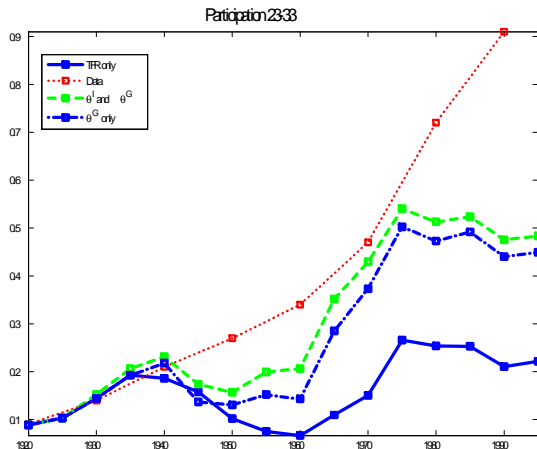


Figure: Home appliances and infant formula.

Maternal Health

Life Expectancy

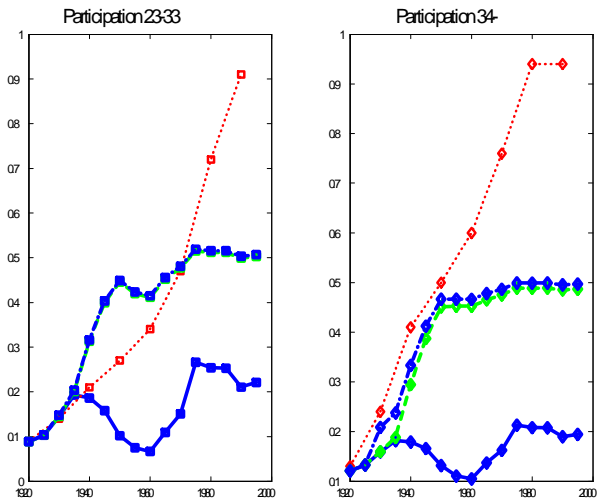


Figure: Isolating the impact of life expectancy