The Fertility Race Between Technology and Social Norms

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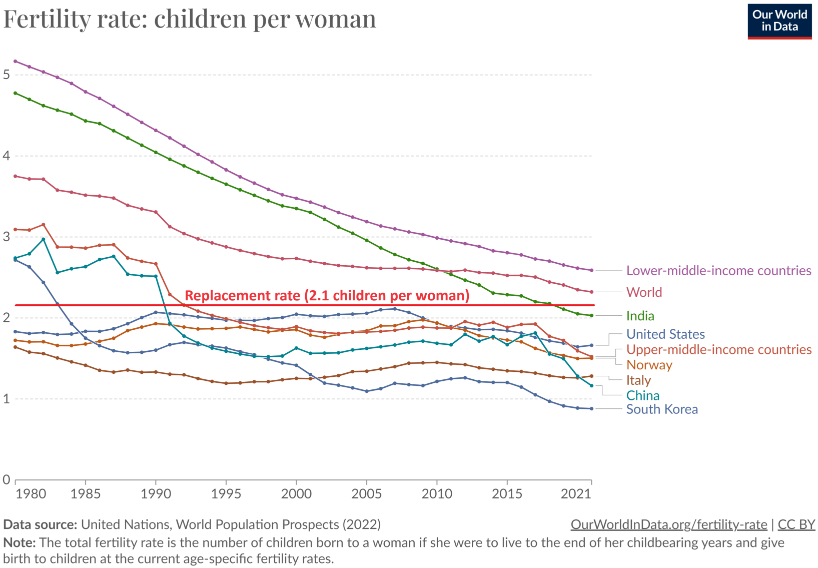
Motivation

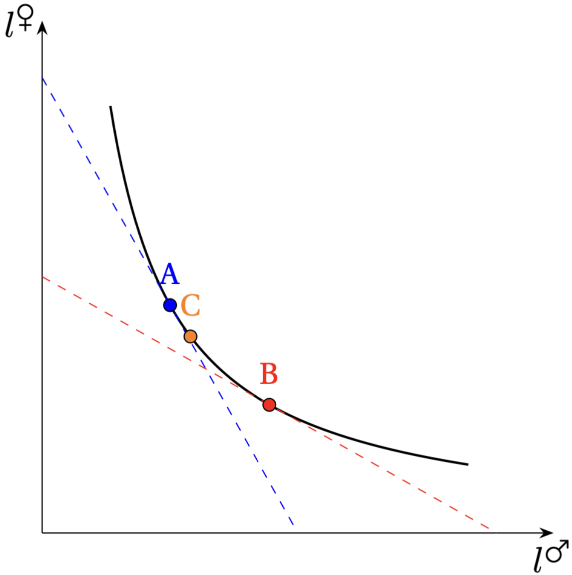


Fertility rate: children per woman
Our World in Data
5
4
3
2
1
0
1980
1985
1990
1995
2000
2005
2010
2015
2021
Replacement rate (2.1 children per woman)
Lower-middle-income countries
World
India
United States
Upper-middle-income countries
Norway
Italy
China
South Korea
Data source: United Nations, World Population Prospects (2022)
OurWorldInData.org/fertility-rate | CC BY
Note: The total fertility rate is the number of children born to a woman if she were to live to the end of her childbearing years and give birth to children at the current age-specific fertility rates.

This paper

- A quantitative model of child bargaining
  - → Childcare allocation under the influence of social norm
  - → Endogenous social norm formation
- A tug-of-war between technological change and social norm
- Document two supporting new facts:
  1. Countries experiencing faster structural change have witnessed more drastic fertility decline
  2. Relationship is stronger in countries with rigid social norms
- Calibrate to the experience of South Korea and conduct counterfactuals

Mechanism: Social Norm as Endogenous Adjustment Cost



Key findings

1. In the presence of gender-biased technological change, countries experience steeper fertility decline if there is
   - → Intense social pressure, or
   - → Reluctance of older cohorts to adapt
2. Slow but eventual fertility recovery as social norm adapt
   - → Within-cohort changes – adaptation
   - → Between-cohort changes – cohort replacement effects
3. Targeted policies, e.g., subsidies to male childcare, could accelerate the transition and result in larger long-run fertility gains

Literature

- Goldin (2024)
- Myong et al. (2021)
- Doepke and Kindermann (2019)
- Fernández and Fogli (2009), Fogli and Veldkemp (2013)

Main contribution: new data facts + endogenous social norm

Roadmap

- Quantitative model
- Cross-country facts
- Calibration
- Results
- Conclusion

Model

Model Setup

- Overlapping generations model with J periods of life
- Fertility decision at period J_f
- Gender $g \in \{♀, ♂\}$ with preference

$$u^g(c^g, n) = c^g + \gamma \cdot \frac{n^{1-\rho} - 1}{1-\rho} \qquad \rho > 0 \tag{1}$$

- Raising each child incurs a time cost ϕ. Parents need to satisfy the childcare provision constraint:

$$n\phi = \left(\beta \cdot (l^{♀})^{\frac{\sigma-1}{\sigma}} + (1-\beta) \cdot (l^{♂})^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}, \qquad \sigma > 1 \tag{2}$$

- Bargaining under limited commitment (Doepke and Kindermann 2019)

Stage 1: Childcare Decision

- For all n, the couple solves:

$$\min_{l^{\female}, l^{\male}} \quad w_t^{\female} l^{\female} + w_t^{\male} l^{\male} + \lambda \cdot w_t^{\male} \cdot \left(\frac{l^{\female}}{l^{\male}} - \eta_t \right)^2, \tag{3}$$

- Exogenous wages $w_t^{\male}$ and $w_t^{\female}$ affected by structural transformation (Ngai and Petrongolo 2017)
- Prevailing social norm η_t
- Parameter λ governs social pressure
- Parents can commit to the solution $l_t^{\female}(n)$ and $l_t^{\male}(n)$

Stage 2: Fertility Decision

- Only mutually agreed-upon fertility is realized, defined as:

$$n_t = \min\{n_t^{♀}, n_t^{♂}\}, \tag{4}$$

- n_t^g is the fertility level that maximizes the ex-post utility

$$n_t^g = \arg\max_n \quad u^g(c_t^g(n), n) \qquad g \in \{♀, ♂\} \tag{5}$$

where $c_t^g(n)$ comes from the bargaining problem in the third stage

Stage 3: Consumption Allocation

- With n children, outside option in the non-cooperative case

$$\overline{u}^g(n) = w_t^g(1 - l_t^g(n)) + \gamma \cdot \frac{n^{1-\rho} - 1}{1 - \rho}, \qquad \rho > 0, \tag{6}$$

- Nash bargaining of consumption

$$\max_{c^{♀}, c^{♂}} \quad \left(u^{♀}(c^{♀}, n) - \overline{u}^{♀}(n)\right)^{1/2} \cdot \left(u^{♂}(c^{♂}, n) - \overline{u}^{♂}(n)\right)^{1/2}, \tag{7}$$

subject to the budget constraint:

$$c^{♀} + c^{♂} = (1 + \alpha) \cdot [w_t^{♀}(1 - l_t^{♀}(n)) + w_t^{♂}(1 - l_t^{♂}(n))], \tag{8}$$

Social Norm

- The prevailing social norm at time t is defined as:

$$\eta_t = \sum_{j=1}^{J-J_f} \phi_{J_f+j,t} \cdot \tilde{\eta}_{J_f+j}, \qquad \sum_{j=1}^{J-J_f} \phi_{J_f+j,t} = 1, \tag{9}$$

- Weights reflect population shares:

$$\phi_{j,t} = \frac{\pi_{j,t}}{\sum_{k=J_f+1}^{J} \pi_{k,t}}, \tag{10}$$

where $\pi_{j,t}$ denotes the population share of the cohort aged j at time t

Older Cohorts' Re-evaluation

- Older cohorts form opinions by solving:

$$\tilde{\eta}_{J_f+j} = \arg\min_{\eta} \; w_t^{\female} \cdot \eta + w_t^{\male} + \psi \cdot \left(\eta - \frac{l_{t-j}^{\female}}{l_{t-j}^{\male}} \right)^2 . \tag{11}$$

- $\frac{l_{t-j}^{\female}}{l_{t-j}^{\male}}$ is the childcare practice adopted by these agents j periods ago
- Parameter ψ governs the "stubbornness"
- Social norm evolution reflects:
  1. Within-cohort effects from re-evaluation
  2. Between-cohort effects from entry and exit

Demographic Evolution

- The demographic structure of this economy $\boldsymbol{\pi}_t$ evolves

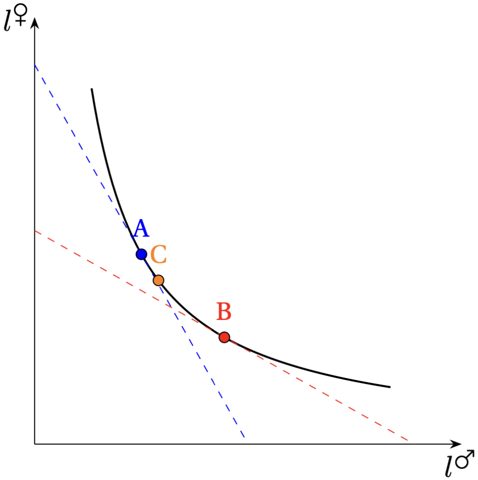
$$\boldsymbol{\pi_{t+1}} = \frac{\mathbf{\Pi_t} \cdot \boldsymbol{\pi_t}}{||\mathbf{\Pi_t} \cdot \boldsymbol{\pi_t}||_{L^2}}, \tag{12}$$

  where $\mathbf{\Pi_t}$ is a $J \times J$ demographic transition matrix

- The element in the first row and J_f-th column of $\mathbf{\Pi_t}$ equals $n_t/2.1$

Model Predictions

- Prediction 1: Economies experiencing faster gender-biased technological changes exhibit more rapid fertility declines.
- Prediction 2: The impact of gender-biased technological changes on fertility is stronger in economies with more stringent social norms.



Cross-Country Facts

Data Source

- Fertility data from the United Nations
- Sectoral employment data from the Groningen Growth and Development Centre (GGDC)
- GDP data from the Penn World Table 10.01
- Cultural tightness data from Uz (2019)
  - → The dispersion of opinions: in a tight culture, people's values, norms, and behavior are similar to each other because deviations are sanctioned
- Gender attitudes data from the International Social Survey Programme (ISSP) Family and Changing Gender Roles modules
- 23 countries spanning all levels of development

Variable Definition

- Speed of fertility change for country i:

$$\text{tfr}_{i,\text{year}} = \alpha_i^{\text{tfr}} + \text{speed\_tfr}_i \times \text{year} + u_i \tag{13}$$

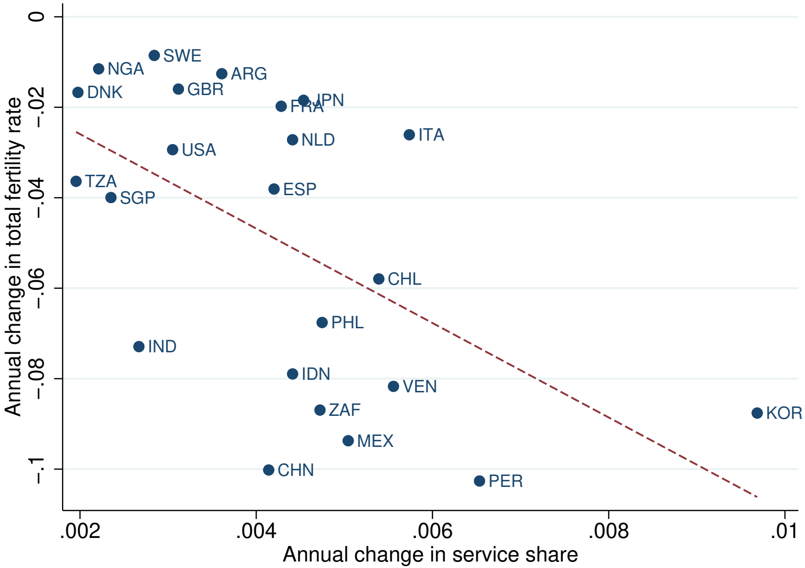
- Speed of structural change for country i:

$$\text{service share}_{i,\text{year}} = \alpha_i^{\text{ser}} + \text{speed\_ser}_i \times \text{year} + v_i \tag{14}$$

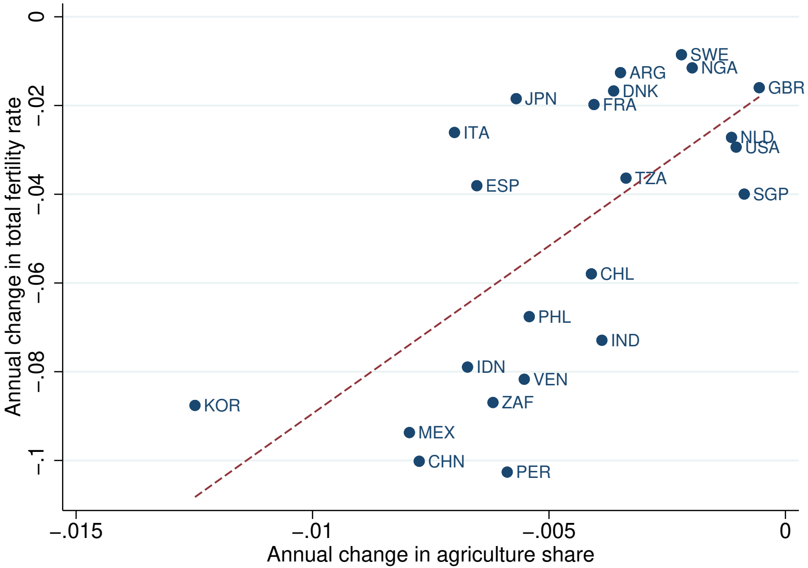
$$\text{agriculture share}_{i,\text{year}} = \alpha_i^{\text{agr}} + \text{speed\_agr}_i \times \text{year} + v_i \tag{15}$$

- Define tight $= 1$ if tightness score in upper half

Service Expansion and Fertility Decline



Agriculture Shrinkage and Fertility Decline



Regression Results: Cross-Section

- Correlation is driven by countries with tight social norms

	Dependent Variable: Fertility Change							
	Service				Agriculture			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
speed_SC	-10.44***	-11.82***	-5.48	-6.89	7.56***	8.39***	5.03**	5.80**
	(3.38)	(3.78)	(4.02)	(4.27)	(1.90)	(2.06)	(2.38)	(2.41)
tight×speed_SC			-5.11*	-5.23*			3.23	3.51*
			(2.56)	(2.56)			(1.95)	(1.93)
speed_gdp		0.30		0.33		0.32		0.38
		(0.35)		(0.33)		(0.31)		(0.30)
Observations	23	23	23	23	23	23	23	23
R-squared	0.31	0.34	0.43	0.46	0.43	0.46	0.50	0.54

Regression Results: Panel

- Same patterns using panel regressions

	Dependent Variable: Fertility Change							
	Service				Agriculture			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Speed_SC	-6.64***	-7.32***	-10.40***	-7.23***	7.66***	8.91***	9.58***	9.61**
	(0.70)	(0.74)	(1.57)	(0.91)	(0.53)	(0.62)	(0.92)	(0.63)
Speed_SC×Norm Change Total			5.35**				-1.94	
			(2.40)				(1.98)	
Speed_SC×Norm Change Recent				0.59				-0.49
				(0.38)				(0.31)
Norm Change Recent				0.59				-19.42***
				(0.38)				(4.09)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FEs	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Trend	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	785	785	785	785	785	785	785	785
R-squared	0.26	0.38	0.39	0.39	0.35	0.45	0.45	0.47

Calibration

Calibration Strategy (1)

- The parameters to be calibrated are:

$$\underbrace{J, J_f}_{\text{demographics}}, \quad \underbrace{\gamma, \rho, \psi, \lambda,}_{\text{preferences}} \quad \underbrace{\beta, \phi, \sigma, \alpha}_{\text{technologies}}.$$

- Some parameters exogenously set:
  - → Each period as 5 years, set $J = 16$ (total lifespan of 80 years) and $J_f = 6$ (childbearing between 25 to 30)
  - → $\alpha = 1.2$ following Doepke and Kindermann (2019)
  - → $\sigma = 3.0$ following Knowles (2013)
  - → $\phi = 0.15$ following de La Croix and Doepke (2003)

Calibration Strategy (2)

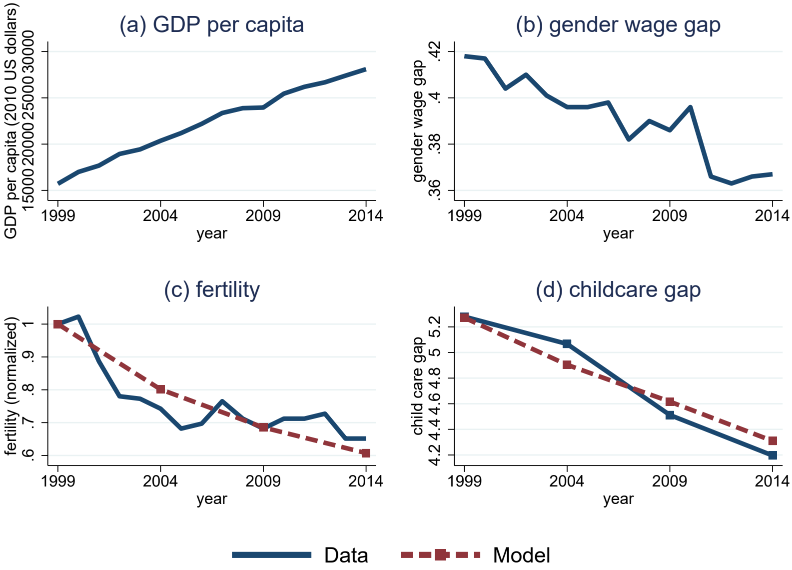
- The fertility weight, γ, is inferred from the initial fertility level
- The fertility curvature, ρ, governs the trade-off between consumption and fertility, identified by the fertility response to rising opportunity costs
- The relative childcare productivity, β, is determined by the initial gender gap in childcare time.
- The weight of individual's own experience in the formation of opinions, i.e., “stubbornness”, ψ, is calibrated to match the share of between-cohort component in driving social norm changes
- The social pressure parameter, λ, is calibrated to the persistence of gender gaps in childcare over time

Data Source

Calibrate to match South Korea from 1999 to 2014

- Gendered wage path from the World Bank
- Fertility path from the United Nations
- Childcare time by gender from the Korea Time Use Survey
- Opinion change from the Korean General Social Survey

Calibration Results (1)



Calibration Results (2)

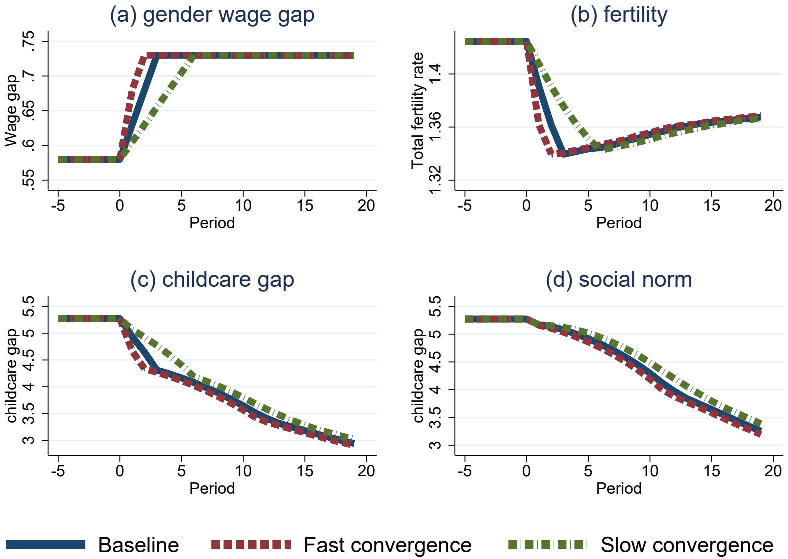
	Parameter	Value	Data moment	Source	Model fit
γ	Fertility weight	0.24	$n_{1999} = 1.42$	United Nations	1.42
σ	Childcare substitutability	3.0		Knowles (2013)	
β	Childcare productivity	0.57	$\eta_{1999} = 5.25$	Park (2021)	5.25
ρ	Fertility curvature	2.4	$n_{1999} \sim n_{2014}$	United Nations	See Figure 3
ψ	Stubbornness	3.0	Within-cohort effects	KGSS	80%
λ	Social pressure	0.0006	$\eta_{1999} \sim \eta_{2014}$	Park (2021)	See Figure 3
α	Economies of scale	1.2		Doepke and Kindermann (2019)	
ϕ	Time costs per child	0.15		de La Croix and Doepke (2003)	
J	Total number of periods	16	80 years	World Health Organization	
J_f	The fertile period	6	25 to 30 yo	Statista	

Calibration Results (3)

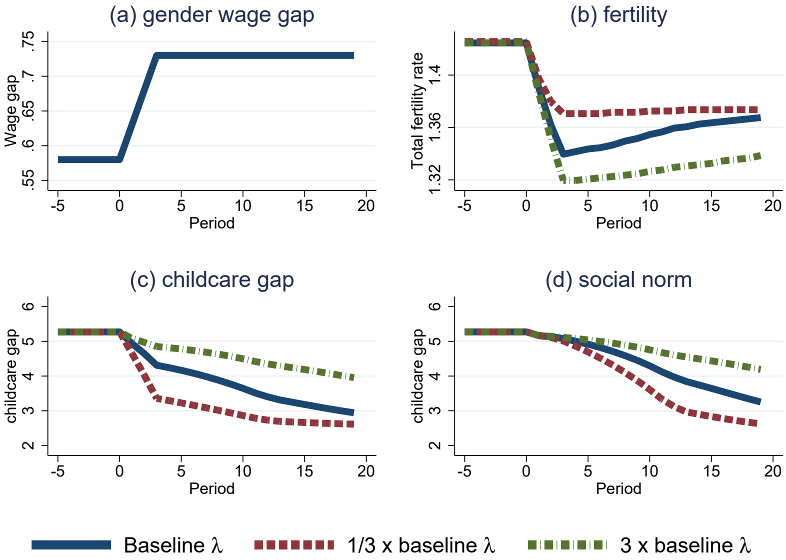
	Old tech. & old norm	New tech. & new norm	New tech. & old norm
$w^{♀}/w^{♂}$	0.58	0.74	0.74
η	5.25	2.53	5.25
$l^{♀}/l^{♂}$	5.25	2.53	4.66
n	1.43	1.37	1.32

Counterfactual

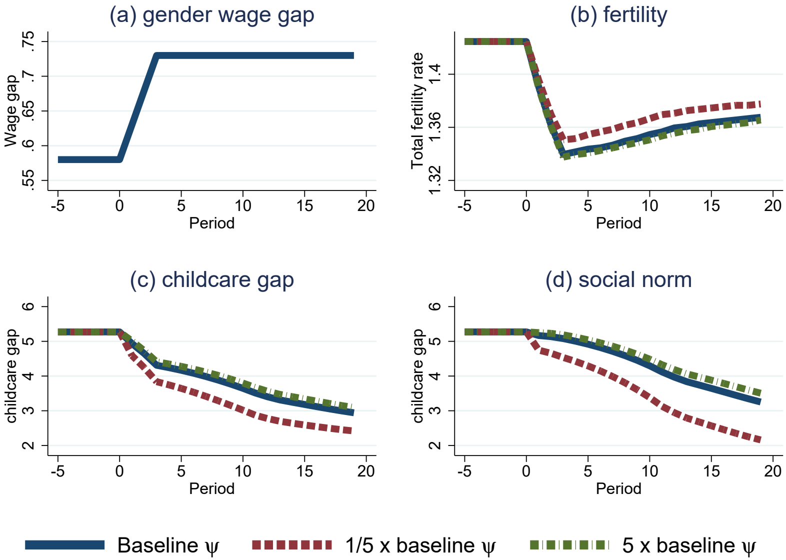
Counterfactual 1: The Speed of Technological Change



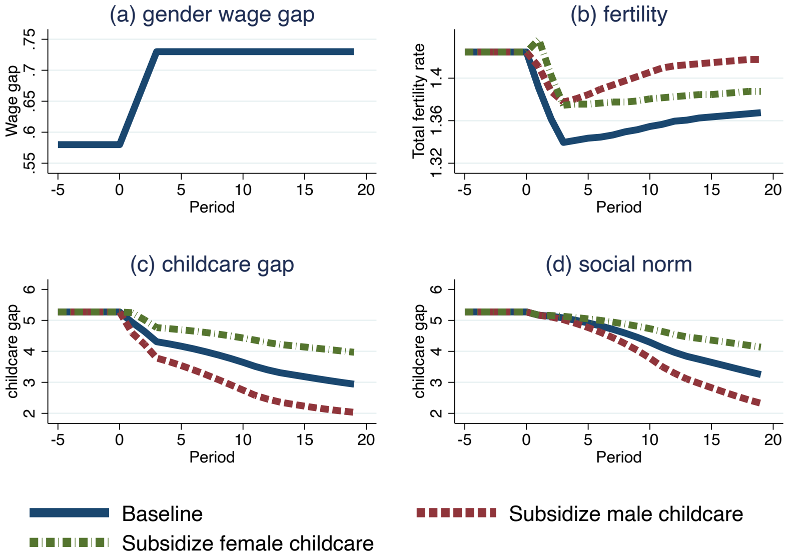
Counterfactual 2: The Role of Social Pressure



Counterfactual 3: The Role of Older Cohorts' Reevaluation



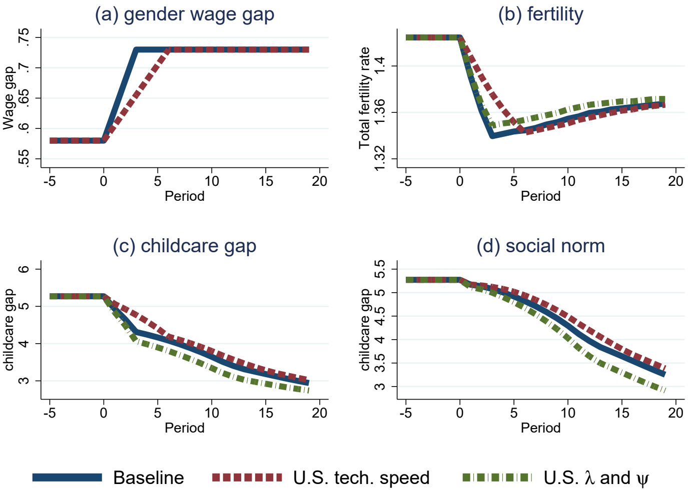
Counterfactual 4: Gender-Specific Childcare Subsidy



Counterfactual 5: U.S. Parameters

details

- U.S. has slower structural change, less social pressure, and less stubbornness

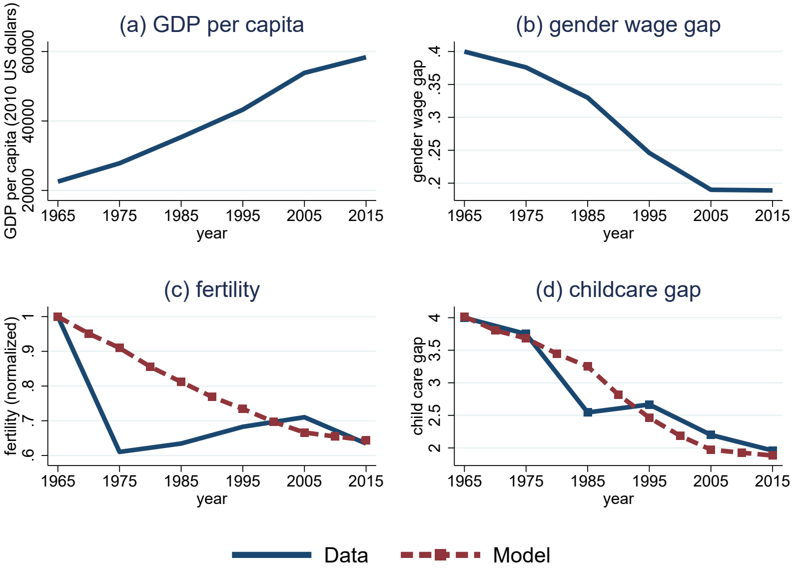


Conclusion

- A quantitative model to study the fertility impacts of gender-biased technological change with endogenous social norm
- Slow but eventual fertility recovery
- Intense social pressure and reluctance to adapt result in steep fertility decline and entrenched traditional norms
- Targeted policies, e.g., subsidies to male childcare, could accelerate the transition and result in larger long-run fertility gains

Calibration Results - U.S. (1)

back



Calibration Results - U.S. (2)

back

	Parameter	Value	Data moment	Source	Model fit
γ	Fertility weight	1.27	$n_{1965} = 2.90$	United Nations	2.90
σ	Childcare substitutability	3.0		Knowles (2013)	
β	Childcare productivity	0.55	$\eta_{1965} = 4.0$	Egerton et al. (2005)	4.0
ρ	Fertility curvature	2.4	$n_{1965} \sim n_{2015}$	United Nations	See Figure 9
ψ	Stubbornness	2.0	Within-cohort effects	GSS	30%
λ	Social pressure	0.0005	$\eta_{1965} \sim \eta_{2015}$	Egerton et al. (2005)	See Figure 9
α	Economies of scale	1.2		Doepke and Kindermann (2019)	
ϕ	Time costs per child	0.15		de La Croix and Doepke (2003)	
J	Total number of periods	16	80 years	World Health Organization	
J_f	The fertile period	6	25 to 30 yo	Statista	