The Fertility Race Between Technology and Social Norms

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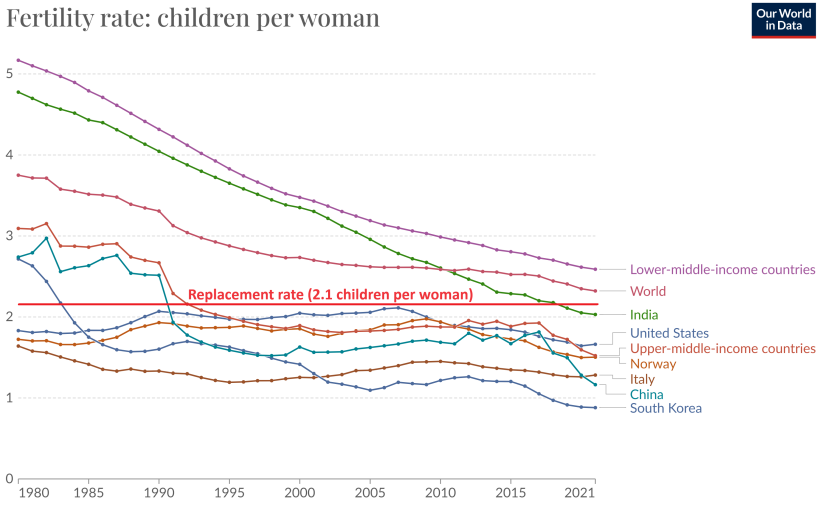
Motivation



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

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

Key findings

1. In the presence of gender-biased technological change, countries experience steeper fertility decline if
   - → Intense social pressure
   - → 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. Government policies could accelerate the transition

Literature

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

Roadmap

- Motivating facts
- Quantitative model
- Calibration
- Results
- Conclusion

Motivating 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
- 23 countries spanning all levels of development

Variable Definition

- Speed of fertility change for country i:

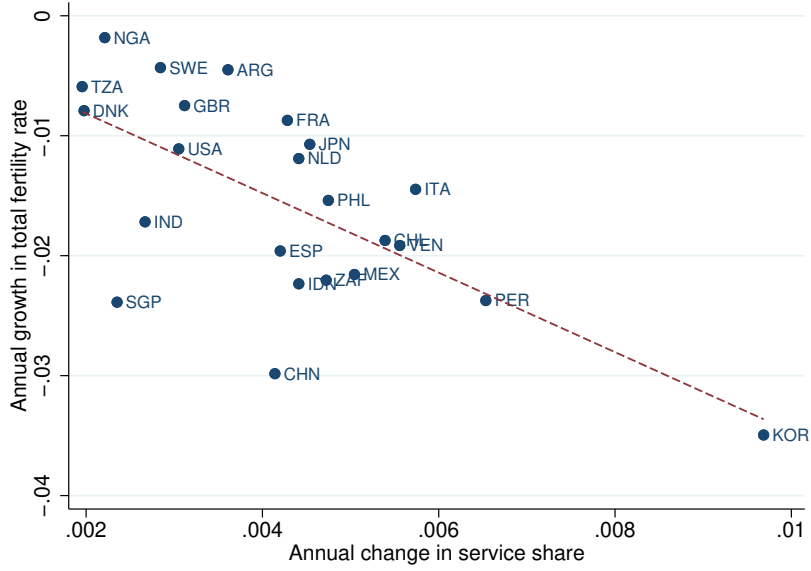
$$\log(\text{tfr})_{i,\text{year}} = \alpha_i^{\text{tfr}} + \text{speed\_tfr}_i \times \text{year} + u_i \tag{1}$$

- Speed of structural change for country i:

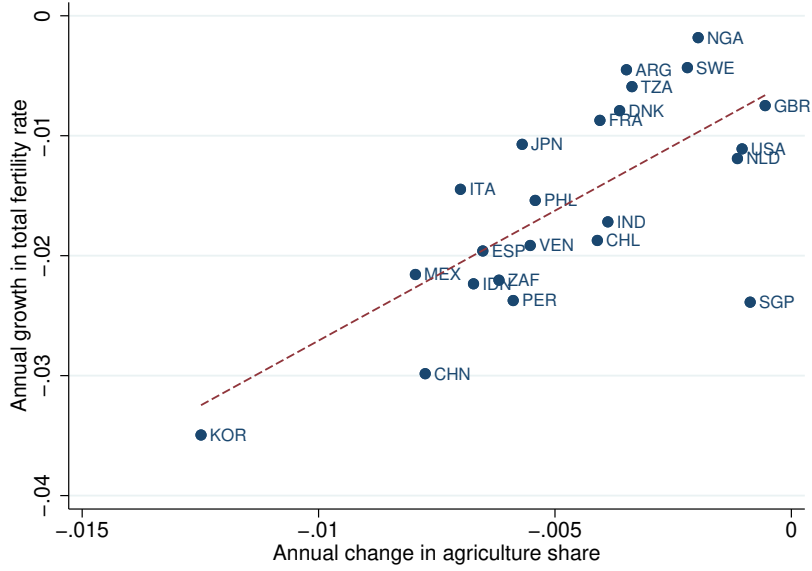
$$\text{service share}_{i,\text{year}} = \alpha_i^{\text{ser}} + \text{speed\_ser}_i \times \text{year} + v_i \tag{2}$$

$$\text{agriculture share}_{i,\text{year}} = \alpha_i^{\text{agr}} + \text{speed\_agr}_i \times \text{year} + v_i \tag{3}$$

Service Expansion and Fertility Decline



Agriculture Shrinkage and Fertility Decline



Regression Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent variable: speed_tfr							
speed_ser	-3.32	-2.62	-2.32	-1.70				
	(0.80)	(0.84)	(0.98)	(0.97)				
tight × speed_ser			-1.03	-0.98				
			(0.62)	(0.59)				
speed_agr					2.17	1.78	1.58	1.30
					(0.47)	(0.47)	(0.59)	(0.57)
tight × speed_agr							0.74	0.64
							(0.48)	(0.46)
speed_gdp		-0.15		-0.14		-0.15		-0.14
		(0.08)		(0.07)		(0.07)		(0.07)
Observations	23	23	23	23	23	23	23	23

Model

Model Setup

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

$$u^g(c^g, n) = c^g + \gamma \cdot \frac{n^{1-\rho} - 1}{1-\rho} \qquad \rho > 0 \tag{4}$$

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

$$n\phi = \left((l^{♀})^{\frac{\sigma-1}{\sigma}} + (l^{♂})^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}, \qquad \sigma > 1 \tag{5}$$

- Bargaining under limitted committment

Stage 1: Childcare Decision

- For all n, the couple solves:

$$\min_{l^{\female},l^{\male}} \quad w_t^{\female} l^{\female} + w_t^{\male} l^{\male} + \lambda \cdot w_t^{\male} \cdot \left(\frac{l^{\female}}{l^{\male}} - \eta_t \right)^2, \tag{6}$$

- Exogenous wages $w_t^{\male}$ and $w_t^{\female}$
- 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:

$$n_t = \min\{n_t^{\text{♀}}, n_t^{\text{♂}}\}, \tag{7}$$

- n_t^g is the fertility level that maximizes the ex-post utility of gender $g \in \{\text{♀}, \text{♂}\}$ in the third stage.

Stage 3: Consumption Allocation

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

$$\overline{u}^g(n) = w_t^g(1 - l_t^g(n)) + \gamma \cdot \frac{n^{1-\rho} - 1}{1 - \rho}, \qquad \rho > 0, \tag{8}$$

- Nash bargaining of consumption

$$\max_{c^{\female}, c^{\male}} \quad \left(u^{\female}(c^{\female}, n) - \overline{u}^{\female}(n)\right)^{1/2} \cdot \left(u^{\male}(c^{\male}, n) - \overline{u}^{\male}(n)\right)^{1/2}, \tag{9}$$

subject to the budget constraint:

$$c^{\female} + c^{\male} = (1 + \alpha) \cdot [w_t^{\female}(1 - l_t^{\female}(n)) + w_t^{\male}(1 - l_t^{\male}(n))], \tag{10}$$

Social Norm

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

$$\eta_t = \sum_{j=1}^{J-J_f} \phi_{J_f+j,t} \cdot \tilde{\eta}_{J_f+j}, \qquad \sum_{j=1}^{J-J_f} \phi_{J_f+j,t} = 1, \tag{11}$$

- Weights reflect population shares:

$$\phi_{j,t} = \frac{\pi_{j,t}}{\sum_{k=J_f+1}^{J} \pi_{k,t}}, \tag{12}$$

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:

$$\tilde{\eta}_{J_f+j} = \arg\min_{\eta} \; w_t^{\female} \cdot \eta + w_t^{\male} + \psi \cdot \left(\eta - \frac{l_{t-j}^{\female}}{l_{t-j}^{\male}} \right)^2 . \tag{13}$$

- $\frac{l_{t-j}^{\female}}{l_{t-j}^{\male}}$ is the childcare practice adopted by these agents j periods ago
- Parameter ψ governs "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

$$\boldsymbol{\pi_{t+1}} = \frac{\boldsymbol{\Pi_t} \cdot \boldsymbol{\pi_t}}{\|\boldsymbol{\Pi_t} \cdot \boldsymbol{\pi_t}\|_{L^2}}, \tag{14}$$

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

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

Calibration

Calibration Strategy (1)

- The parameters to be calibrated are:

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

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

Calibration Strategy (2)

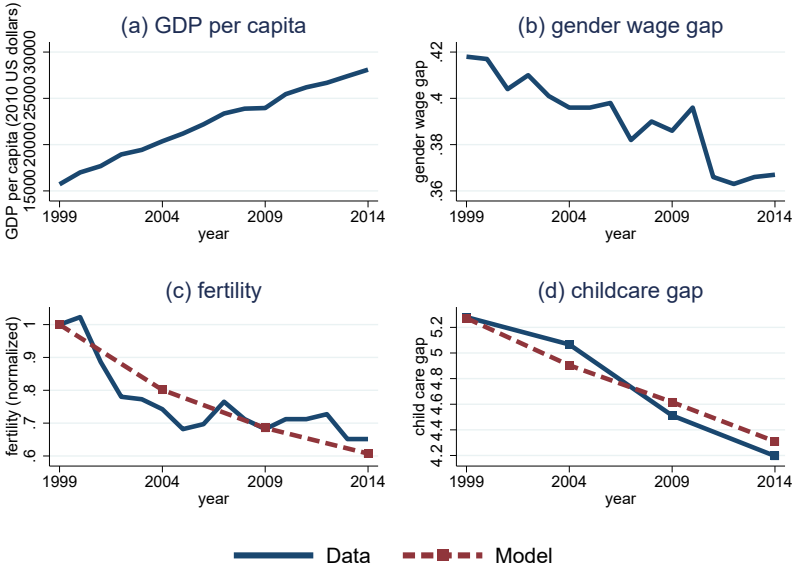
- The fertility weight, γ, is inferred from the initial fertility level
- The fertility curvature, ρ, governs the trade-off between consumption and fertility, identified by the fertility response to rising opportunity costs
- The childcare substitutability, σ, is determined by the initial gender gap 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)

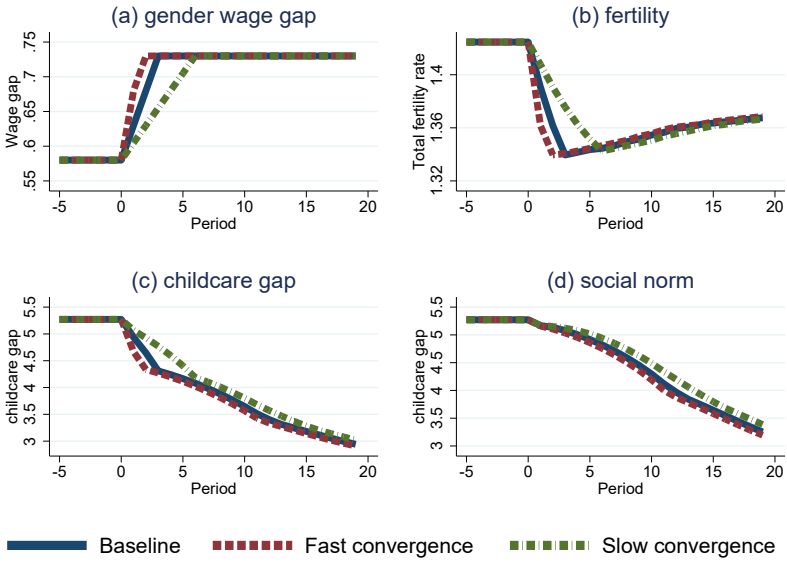
	Parameter	Value	Data moment	Source	Model fit
γ	Fertility weight	0.24	$n_{1999} = 1.42$	United Nations	1.42
σ	Childcare substitutability	3.05	$\eta_{1999} = 5.25$	Park (2021)	5.25
ρ	Fertility curvature	2.4	$n_{1999} \sim n_{2014}$	United Nations	See Figure 1
ψ	Stubbornness	3.0	Within-cohort effects	KGSS	80%
λ	Social pressure	0.0006	$\eta_{1999} \sim \eta_{2014}$	Park (2021)	See Figure 1
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)

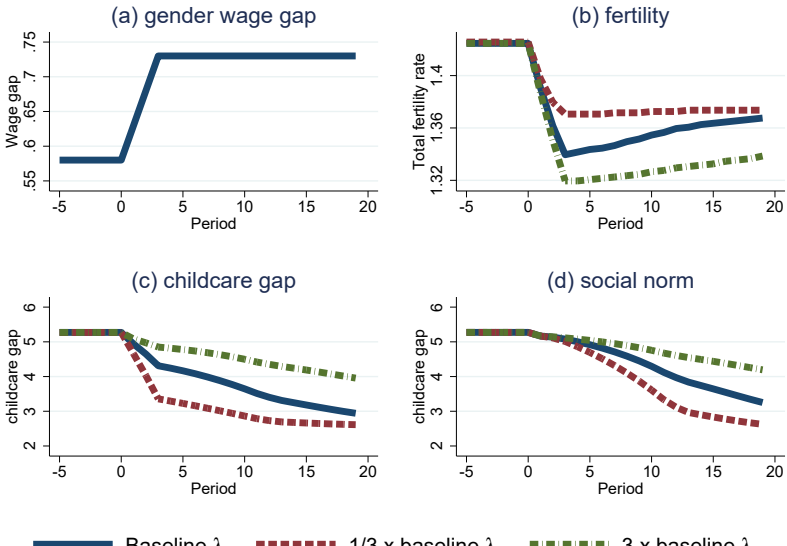
	Old tech. & old norm	New tech. & new norm	New tech. & old norm
$w^{♀}/w^{♂}$	0.58	0.74	0.74
η	5.25	2.53	5.25
$l^{♀}/l^{♂}$	5.25	2.53	4.66
n	1.43	1.37	1.32

Counterfactual

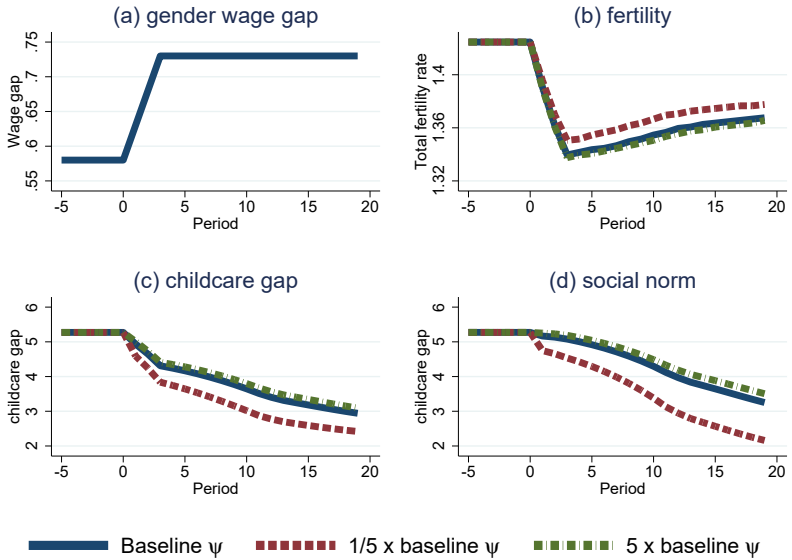
Counterfactual 1: The Speed of Technological Change



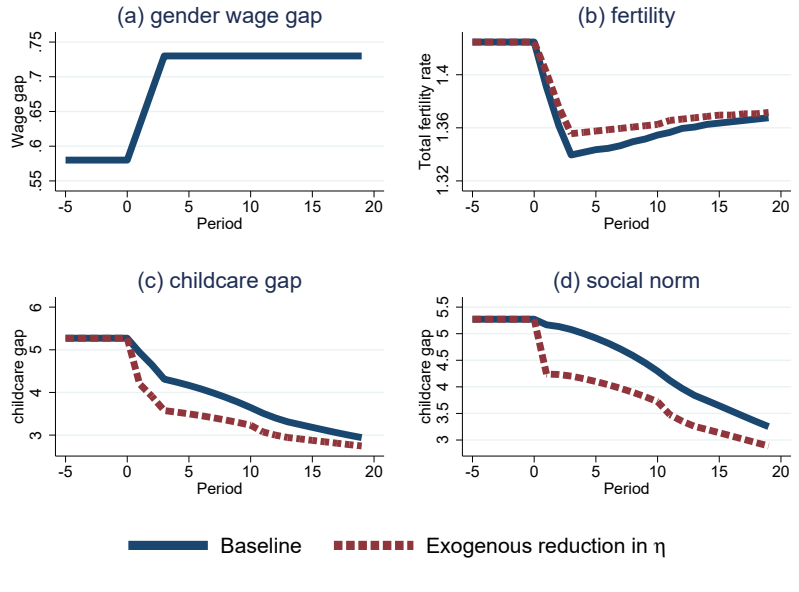
Counterfactual 2: The Role of Social Pressure



Counterfactual 3: The Role of Older Cohorts' Reevaluation



Counterfactual 4: Policy Evaluation



Conclusion

- A quantitative model to study the fertility impacts of gender-biased technological change with endogenous social norm
- Intense social pressure and reluctance to adapt result in steep fertility decline and entrenched traditional norms
- Slow but eventual fertility recovery
- Policies could accelerate the transition