Asymmetric Fertility Elasticities

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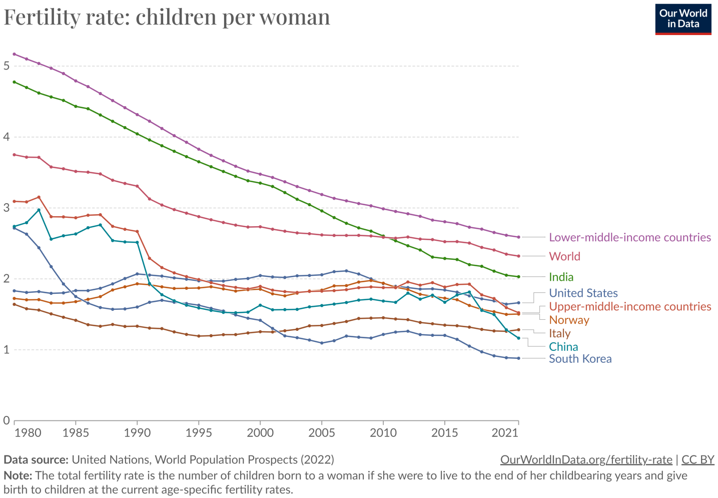
The emergence of below-replacement fertility



- Important for public pension and economic growth (Jones 2022)

Raising fertility is difficult

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SOCIAL POLICY WORLD POLITICS LIFE

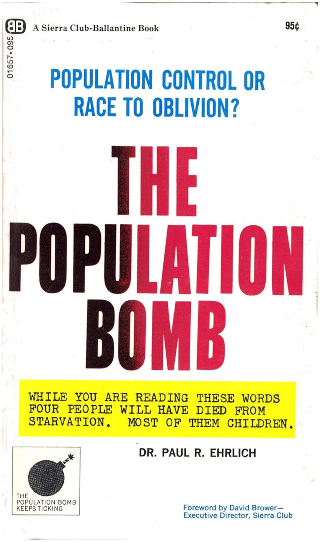
You can't even pay people to have more kids

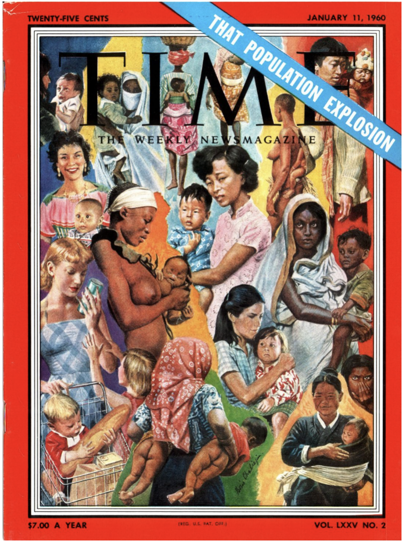
These countries tried everything from cash to patriotic calls to duty to reverse drastically declining birth rates. It didn't work.

By Anna North | Nov 27, 2023, 8:00am EST

- "Pro-natal policies work, but they come with a hefty price tag" (Stone 2020)
- Interestingly, many countries with low fertility problems now were reducing fertility not so long ago (e.g., China, Thailand, Singapore)

The specter of Malthus in the 1960s





The global family planning movement

- Led by global organizations such as the United Nations, the World Bank, and Bill & Melinda Gates Foundation
- Many country-specific policies (e.g., the one-child-policy in China)
- Gradually attaches more benefits to low fertility: economic development, health, gender equity, environment. . .

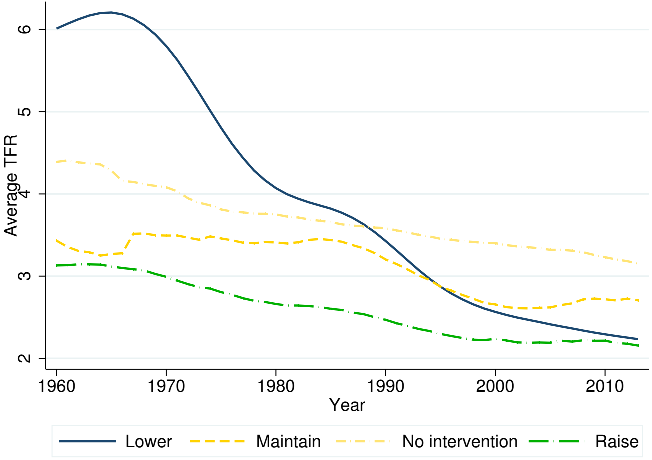
CLIMATE CHANGE | OPINION

Population Decline Will Change the World for the Better

A future with fewer people offers increased opportunity and a healthier environment

By Stephanie Feldstein on May 4, 2023

Reducing fertility seems to be easier



- Family planning policies played an instrumental role in explaining the rapid fertility convergence (de Silva and Tenreyro 2017)

This paper

- Research questions
  1. Is it more difficult for the government to raise fertility than to reduce it?
  2. If so, what are the policy implications?
  3. What could be the reason behind the asymmetry?
- What we do: new facts + new theory + new policy implications
  1. Empirically: establish asymmetric fertility elasticities using panel regression and cohort exposure methods
  2. Quantitatively: a dynamic model of cost minimization by the government $\Rightarrow$ under asymmetric elasticities, fertility level has large positional values
  3. Theoretically: a behavioral theory of fertility choice under loss aversion

Literature

- Long-run fertility trajectory

  Malthus (1872), Becker (1960), Easterlin (1968), Galor and Weil (2000), Feyrer et al. (2008), Lutz et al. (2007), Ibbitson (2019)

  Contribution: a “slippery slope” perspective of fertility evolution
- Empirical evaluations of fertility policies

  McElroy and Yang (2000), Liu and Raftery (2020), Schultz (2007), Milligan (2005), Laroque and Salanié (2014), Raute (2019)

  Contribution: document systematic asymmetry and its implications
- Structural models of fertility

  Barro and Becker (1989), de la Croix and Doepke (2004), Córdoba and Ripoll (2019), Kim, Tertilt, and Yum (2024)

  Contribution: incorporate loss aversion into fertility choice

Roadmap

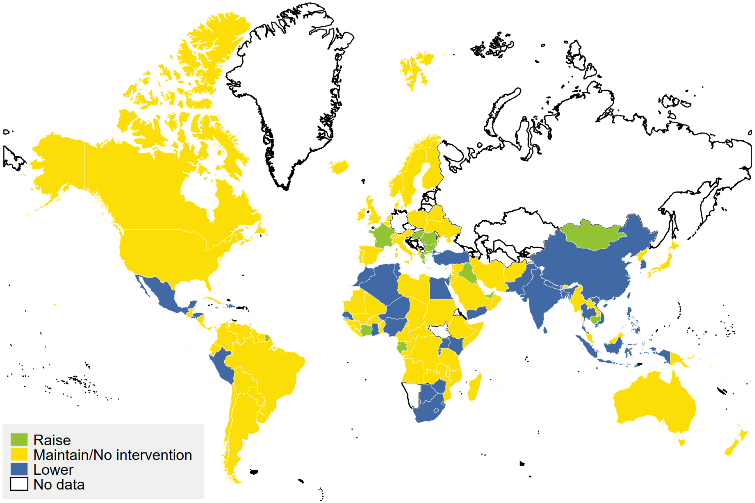
- Empirical results
- Quantitative model for policy implications
- Behavioral theory to provide micro-foundation
- Alternative explanations
- Conclusion

Empirical Analyses

Data

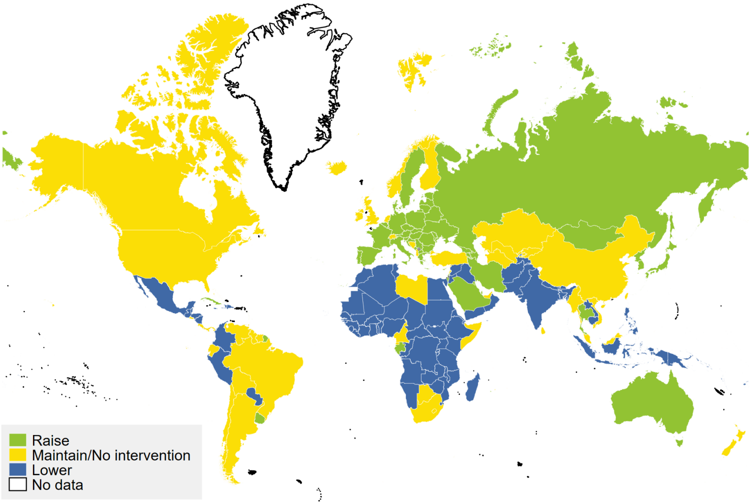
- Fertility data from the United Nations
- Policy stance dummy assigned by the UN Population Division since 1976
- Family planning expenditures from various sources following de Silva and Tenreyro (2017)
- Aggregate control variables from PWT and WDI: GDP per capita, urbanization, infant mortality, female labor force participation
- Individual-level data on fertility, education, and income from the World Value Survey (WVS) Database

Fertility policy in 1986



Source: United Nations Population Division

Fertility policy in 2013



Source: United Nations Population Division

distribution

Panel regressions

- We estimate the following specification

$$\begin{aligned}\Delta \text{TFR}_{it}/\text{TFR}_{it-1} = \alpha + \beta_1 \text{Policy\_Lower}_{it} + \beta_2 \text{Policy\_Raise}_{it} \\ + \beta_3 \text{Control}_{it} + \sigma_i + \eta_t + \epsilon\end{aligned} \tag{1}$$

- Explanatory variables constructed by

$$\text{Policy\_Lower}_{it} = \frac{1}{N} \sum_{T=t-N}^{t-1} \mathbb{I}(\text{Policy}_{iT} = \text{Lower})$$

$$\text{Policy\_Raise}_{it} = \frac{1}{N} \sum_{T=t-N}^{t-1} \mathbb{I}(\text{Policy}_{iT} = \text{Raise})$$

Results

Table 1: Population Policy and TFR

Dependent Variable	ΔTotal Fertility Rate/Lagged Fertility Rate					
Policy Variables	Last Year		Average in the Last Five Years		Average in the Last Ten Years	
	(1)	(2)	(3)	(4)	(5)	(6)
Lower fertility	-0.0118***	-0.0071***	-0.0129***	-0.0076***	-0.0102***	-0.0042*
	(0.0013)	(0.0055)	(0.0015)	(0.0016)	(0.0020)	(0.0022)
Raise fertility	0.0013	0.0016	0.0034	0.0013	0.0023	0.0002
	(0.0034)	(0.0030)	(0.0039)	(0.0034)	(0.0040)	(0.0039)
Country Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	No	Yes	No	Yes	No	Yes
Observations	10726	9146	10726	9146	9937	8462
R^2	0.133	0.174	0.133	0.173	0.123	0.170

Cohort exposure

- Using individual-level data, we estimate the following specification

$$\begin{aligned}\text{Child}_{icbt} = \alpha + \beta_1 \text{Policy\_Lower}_{icbt} + \beta_2 \text{Policy\_Raise}_{icbt} \\ + \eta \text{Age}_i \times \text{Gender}_i + \gamma_{ct} + \delta_b + \epsilon\end{aligned} \tag{2}$$

- Individual's exposure to policy constructed as

$$\text{Policy\_Lower}_{icb} = \frac{1}{11} \sum_{t \in [b+\text{MAC}_{ct+18}-5,\, b+\text{MAC}_{ct+18}+5]} \mathbb{I}(\text{Policy}_{ct} = \text{Lower})$$

$$\text{Policy\_Raise}_{icb} = \frac{1}{11} \sum_{t \in [b+\text{MAC}_{cb+18}-5,\, b+\text{MAC}_{cb+18}+5]} \mathbb{I}(\text{Policy}_{ct} = \text{Raise})$$

Results

Table 2: Population Policy and the Number of Children

Dependent Variable	Number of Children								
Interpolation of MAC	Country-Specific Year Polynomial			Nearest Neighbor			Socioeconomic Variables		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Target: Lower fertility	-0.776***	-0.762***	-0.624***	-0.844***	-0.655***	-0.875***	-0.831***	-0.821***	-0.631***
	(0.220)	(0.210)	(0.185)	(0.201)	(0.188)	(0.208)	(0.243)	(0.232)	(0.215)
Target: Raise fertility	0.278	0.304*	0.131	0.168	-0.007	0.141	0.259	0.262	0.046
	(0.181)	(0.162)	(0.186)	(0.167)	(0.185)	(0.189)	(0.221)	(0.191)	(0.202)
Baseline Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Income Level-Age-Gender FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Education Level-Age-Gender FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Macroeconomic Controls	No	No	Yes	No	No	Yes	No	No	Yes
Observations	205324	183738	163768	231257	205288	182719	210785	186911	170841
R^2	0.281	0.294	0.301	0.285	0.297	0.303	0.279	0.295	0.298

Intensive margin

- Using data on expenditures, we estimate the effects of anti-fertility policies

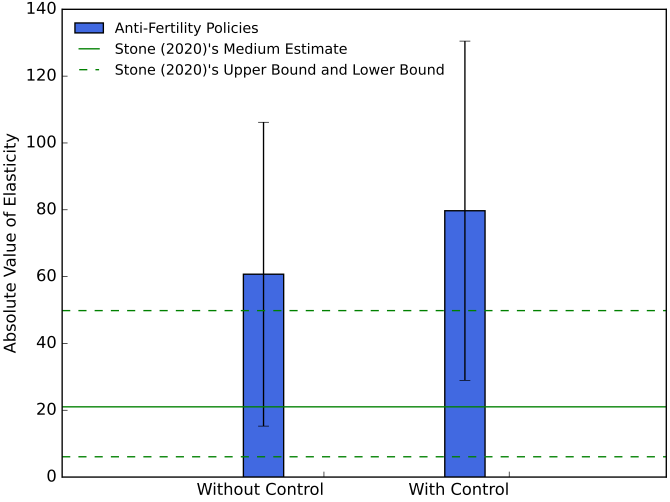
Table 3: Elasticity Estimation for Anti-Fertility Policy

Dependent Variable	ΔTotal Fertility Rate/ Lagged Total Fertility Rate	
Construction of Policy Variables	Average in the Last Five Years	
	(1)	(2)
Anti-fertility policy funding-GDP Ratio	-60.72***	-79.71***
	(22.65)	(25.29)
Country Fixed Effect	Yes	Yes
Year Fixed Effect	Yes	Yes
Control Variables	No	Yes
Observations	2754	2648
R^2	0.220	0.278

- Results consistent with de Silva and Tenreyro (2017)

Results

- Compare with recent meta-study of pro-fertility policies (Stone 2020)



Robustness

- Use levels instead of percentage changes in fertility
- Policy effects at different horizons
- Selection into treatment
- Country-specific trends
- Controlling for past fertility to mitigate reverse causality

Importantly, the object we care about is the ratio between coefficients

Quantitative Model

Model setup (1)

- Government takes reference fertility n_t^r as given, chooses realized fertility n_t to minimize the discounted stream of costs

$$\mathcal{W}(n_t^r) = \max_{n_t} \; - \underbrace{\mathcal{P}(n_t, n_t^r)}_{\text{policy expenditure}} - \underbrace{\mathcal{S}(n_t, \overline{n})}_{\text{social cost}} + \beta \cdot \mathbb{E}_\epsilon \mathcal{W}(n_{t+1}^r)$$

$$\mathcal{P}(n_t, n_t^r) = \begin{cases} \pi^+ \cdot (\log(n_t) - \log(n_t^r)) & \text{if } n_t \geq n_t^r \\ \pi^- \cdot (\log(n_t^r) - \log(n_t)) & \text{if } n_t < n_t^r \end{cases}$$

$$\mathcal{S}(n_t, \overline{n}) = \lambda \cdot (\log(n_t) - \log(\overline{n}))^2$$

- Asymmetric fertility elasticities reflected in $\pi^+ > \pi^- > 0$
- Not considering household welfare due to population ethics and the diversity of policy instruments

Model setup (2)

- Dynamic reference updating an adaptive reference updating process subject to idiosyncratic shocks (Thakral and Tô 2021)

$$\log(n^r_{t+1}) = \phi \cdot \log(n_t) + (1 - \phi) \cdot \log(n^r_t) + \epsilon$$

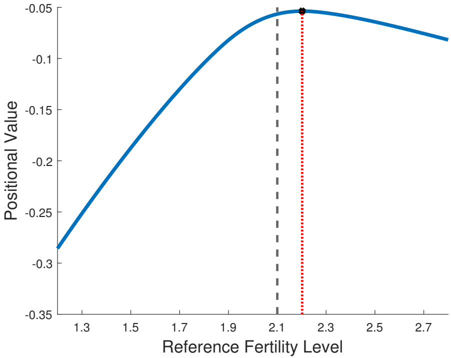
$$\epsilon \sim \mathcal{N}(0, \sigma^2_\epsilon)$$

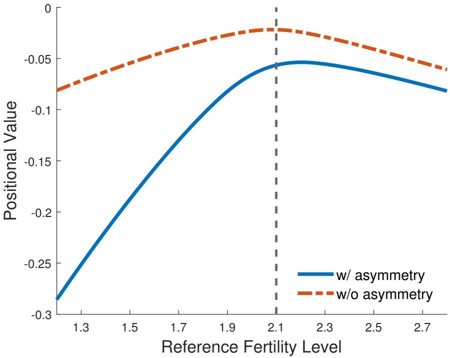
- $\phi \in [0, 1]$ determines how long the government needs to spend to change people's reference point
- A new concept: $\mathcal{W}(n^r_t)$ is the positional value of fertility level that captures the (expected) discount value of policy expenditure and social cost

Calibration

- $\pi^+ = 0.05$ and $\pi^- = 0.014$ (% of GDP) from empirical estimates
- $\beta = 0.96$ for an annual model
- $\overline{n} = 2.1$: a commonly stated policy goal
- $\lambda \in \{0.02, 0.2, 2\}$: TFR=1.64 (USA 2022) results in a social cost of 0.065%, 0.65%, or 6.5% of GDP annually
- $\phi = 0.13$: the expected half-life of the original reference n_t^r is five years
- $\sigma_\epsilon \in \{0.01, 0.05, 0.1\}$

Positional value of fertility Level

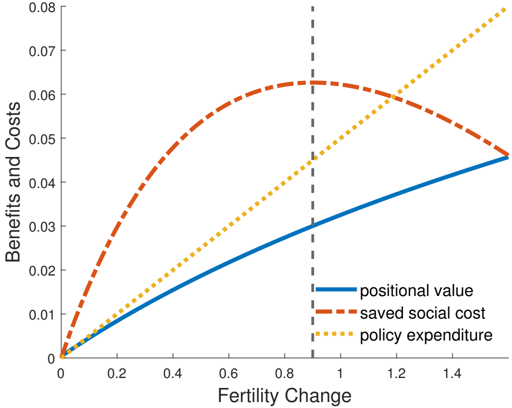




- Key observation: $\pi^{+} > \pi^{-} \implies \text{argmax}_n \mathcal{W}(n) > \overline{n}$
- Countries ignoring asymmetric fertility elasticities might go "too far" when they reduce fertility, landing in the steep part of $\mathcal{W}(n)$

wishful

Benefits and costs of pro-fertility policy when $n_t^r = 1.2$



- Gains in positional value due to changing future reference n_{t+1}^r
- Such gains are large, almost 1/3 to 1/2 of the saved social cost in baseline

Cost-minimizing fertility level

- Following the buffer-stock intuition, we find that the cost-minimizing reference fertility $n^* = \text{argmax}_n \mathcal{W}(n)$:
  - $\rightarrow$ is greater than $\overline{n}$ as long as $\pi^+ > \pi^-$
  - $\rightarrow$ increases with the social cost of fertility deviations from $\overline{n}$
  - $\rightarrow$ increases with the magnitude of reference level shocks
- n^* does not depend much on the speed of reference updating

cost shock speed

A Behavioral Theory of Fertility Choice

A Behavioral of Fertility Choice

- A theory to provide micro-foundation of why $\pi^+ > \pi^-$
- Key ingredient: individuals have loss aversion over consumption
- Households solve

$$\max_{c,n}\,(1-\alpha)(u(c)+v(n))+\alpha G(u(c)-u(x))$$

$$c+\chi n = y \qquad v(n)=\frac{n^{1-\gamma}-1}{1-\gamma} \quad \gamma>1$$

- $\gamma > 1$ is a sufficient condition such that a rise in the cost of children χ raises the marginal cost of consumption c
- c can be interpreted broadly to capture other aspects of living standard
- Loss aversion exists as long as $\alpha > 0$

Loss aversion over consumption

- Individuals have loss aversion à la Santoro et al. (2014)

$$G(y) = \begin{cases} y & y \geq 0 \\ 1 - \exp(-y) & y < 0 \end{cases}$$

which is differentiable at $y = 0$ and $G'(y) < G'(-y)$ for all $y > 0$

- A consistency condition in equilibrium is

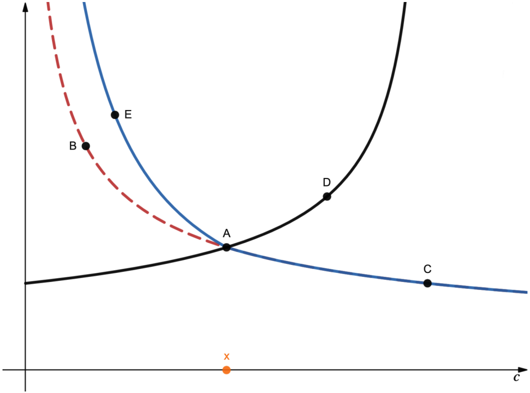
$$x = c$$

so that individual's expectation of the reference coincides with the actual consumption of their peers in this economy with representative agents

Optimal choice

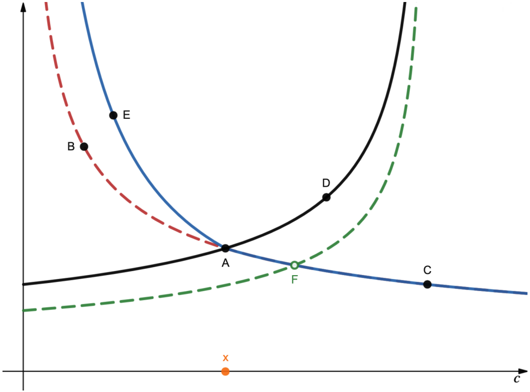
- The first-order condition of optimal consumption satisfies

$$(1-\alpha)u'(c) + \alpha u'(c)G'(u(c) - u(x)) = \frac{1}{\chi}v'\left(\frac{y-c}{\chi}\right)$$



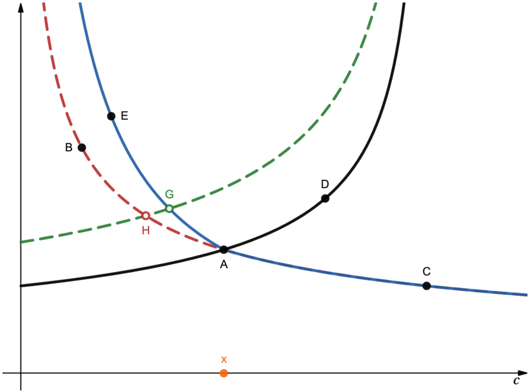
Falling price of fertility χ

- When χ falls, optimal choices coincide with and without loss aversion



Rising price of fertility χ

- When χ rises, optimal consumption falls *less* with loss aversion $\Longrightarrow$ fertility needs to reduce by *more* due to the budget constraint



Alternative explanations

- Propagation mechanisms (e.g., peer pressure) make elasticities larger but do not induce asymmetry
- Fertility policies are technologically feasible in either direction
  - → Propaganda: "It's better to make a family disappear than to make a second new birth appear" (China) & "have one for mum, one for dad and one for the country" (Australia)
  - → Family planning access: planned parenthood & Decree 770 of Romania
  - → Transfers: childlessness tax (Soviet) & maternity capital (Russia)
  - → Reproductive coercion: forced abortion & ?
- The choice of methods is affected by the preference of constituents

Conclusion

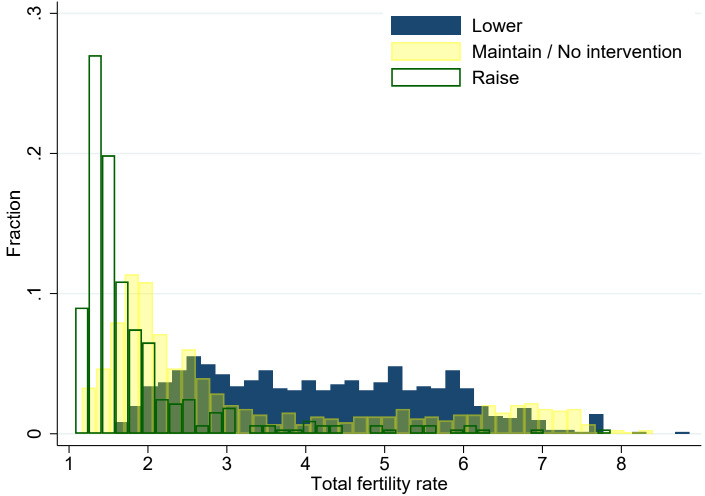
1. Document asymmetric fertility elasticities in the data
2. Build a dynamic cost-minimization model to study the positional value of fertility levels $\Rightarrow$ a "slippery slope" perspective
3. Provide a micro-foundation using a behavioral theory of fertility choice under loss aversion

"Demographics determine the destiny of a people." —Lee Kuan Yew

More research is needed!

Appendix

Fertility policy distribution



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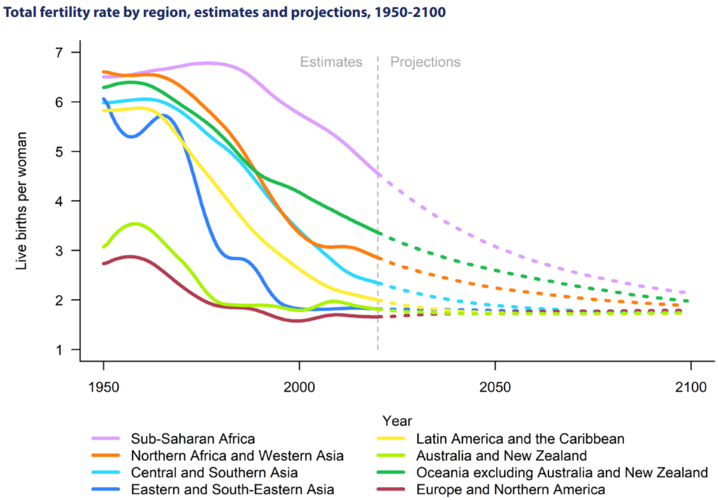
Wishful long-run fertility predictions



Source: United Nations Department of Economic and Social Affairs, Population Division (2019a). *World Population Prospects 2019.*

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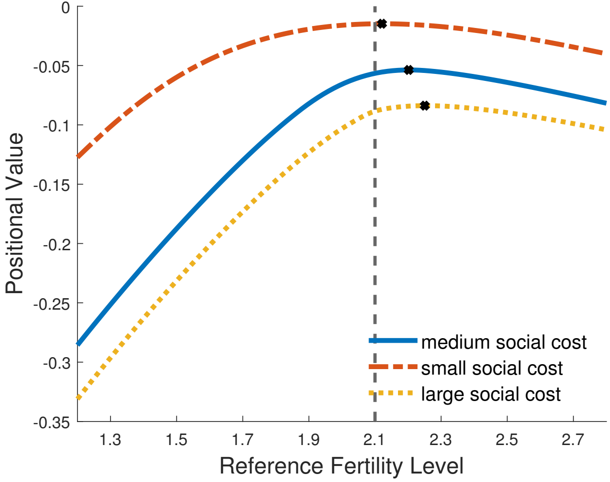
The role of social cost λ



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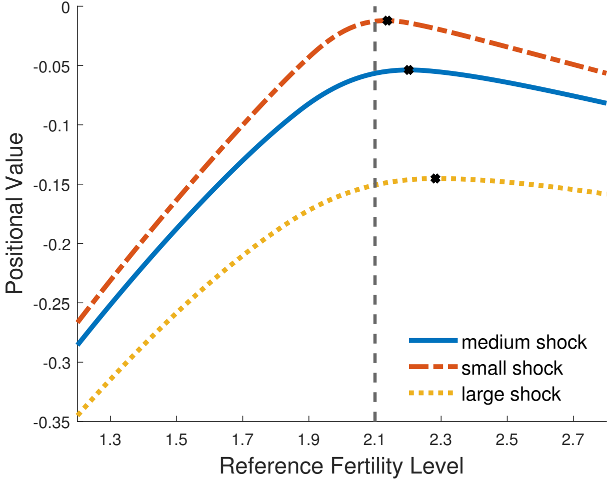
The role of reference shock σ_ϵ



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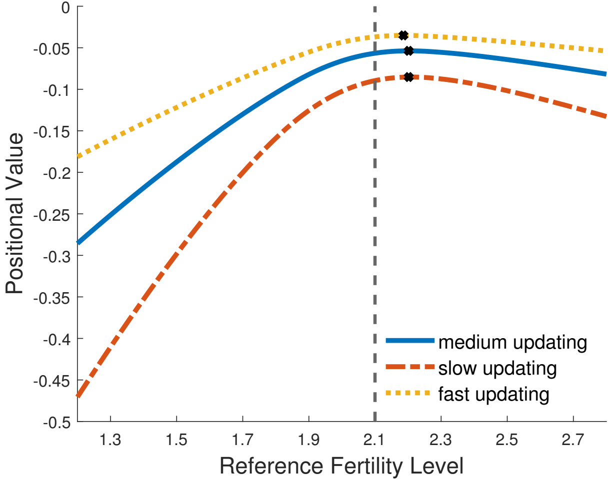
The role of reference updating speed ϕ



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