# Asymmetric Fertility Elasticities

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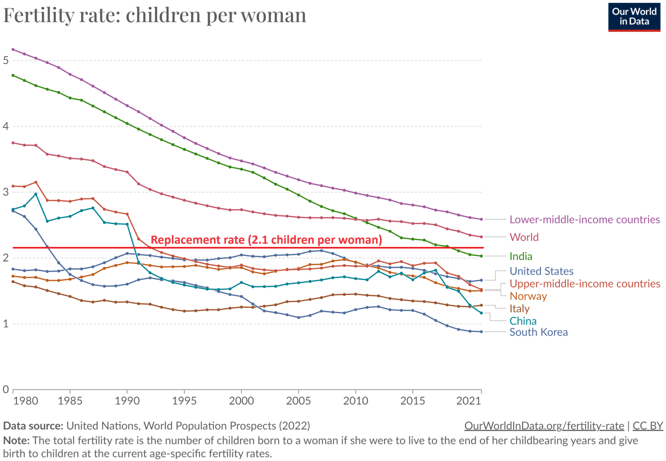
November 24, 2024

# The emergence of below-replacement fertility




- Major implications for the pension system, international relations, firm dynamics, economic growth. . .

# Raising fertility seems to be extremely 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

## Worldwide Efforts to Reverse the Baby Shortage Are Falling Flat

Subsidized minivans, no income taxes: Countries have rolled out a range of benefits to encourage bigger families, with no luck.

34 40 min ago 9 min read

# Reducing fertility seems to be easier

Many countries with low fertility problems now were reducing fertility not so long ago (e.g., China, Thailand, Singapore, Iran, . . .)

background

**Did South Korea's Population Policy Work Too Well?**

*Romancing Singapore*: When yesterday's success becomes today's challenge

**Khamenei on Population Control: 'May God and History Forgive Us'**

# Research question

- Research questions:
    1. Is it systematically more difficult to raise fertility than to reduce it?
    2. If so, what are the micro foundation and the macro implications?
- This paper: new fact + new theory + new policy implications

# This paper

1. Establish a new fact – asymmetric fertility elasticities
   - → Collect historical data on fertility policy stance and funding
   - → Compare fertility responses at the aggregate and the individual levels
   - → Discuss robustness to a variety of checks
2. What explains the asymmetry?
   - → Asymmetry challenges existing fertility theories
   - → Loss aversion to living standard
   - → Discuss alternative explanations (e.g., technological asymmetry)
3. Why does the asymmetry matter?
   - → A "slippery slope" perspective: downward pressure on fertility w/ constant economic fundamentals ⇒ new rationale for global fertility decline
   - → Precautionary motive to set a higher fertility rate target

# Literature

- Empirical evaluations of fertility policies

  McElroy and Yang (2000), Liu and Raftery (2020), Schultz (2007), Milligan (2005), Laroque and Salanié (2014), Raute (2019), González and Trommlerová (2023)

  Contribution: first to systematically compare +ve and -ve policies
- Long-run fertility and population trajectories

  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 and new policy insights
- Structural models of fertility

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

  Contribution: first to incorporate loss aversion into fertility choice

# Outline

- Empirical results using
  - → Aggregate & individual-level data
  - → Policy direction & intensities
- A model of fertility choice under loss aversion
- The "slippery slope" perspective and its implications
- Other potential explanations
- Conclusion

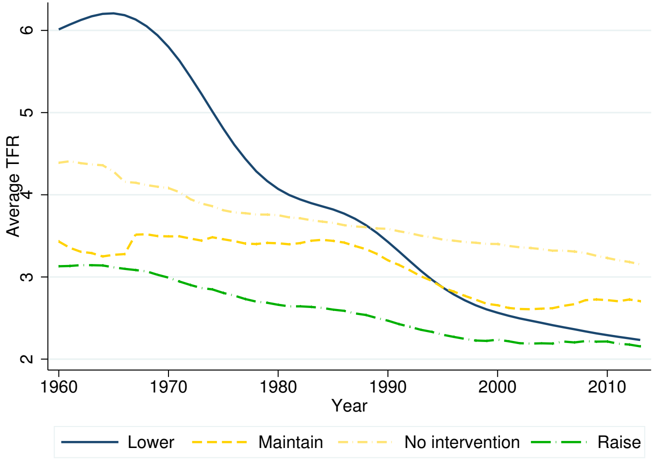
Establish a new fact

# Empirical Findings

# Data

- Fertility level and policy data from the United Nations
  - → Policy stance dummy assigned by the UN Population Division since 1976 - lower, raise, maintain, no intervention map
- Aggregate variables from PWT, WDI, Barro and Lee (2013): GDP per capita, urbanization, infant mortality, female labor force participation, education
- Family planning funding from de Silva and Tenreyro (2017)
- Individual-level data on fertility, education, and income from the World Value Survey (WVS) Database

# Fertility trends by policy stance in 1976




Fertility trends by policy stance in 1976

# Panel regressions

- We estimate the following specification

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

- $\text{Control}_{it}$ includes the level and growth rate of GDP per capita, education, urbanization, infant mortality, and female labor force participation
- Explanatory variables constructed by

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

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

# Fact 1: Asymmetries in panel regression coefficients

*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 |

compare

# Policy Implementation and Reversal

- Motivated by González and Trommlerová (2023) on Spanish child benefits
- We estimate policy effects conditional the policy stance in the last period

$$\Delta \text{TFR}_{it}/\text{TFR}_{it-1} = \alpha + \sum_{P_1}\sum_{P_2} \beta_{P_1,P_2} \mathbb{1}(\text{Policy}_{it} = P_1) \times \mathbb{1}(\text{Policy}_{i,t-1} = P_2) + \sigma_i + \eta_t + \epsilon \tag{2}$$

$$P_1, P_2 \in \{\text{raise, lower, maintain/no intervention}\}$$

- Compare $\beta_{P_1,P_2}$ with $\beta_{P_2,P_1}$ for $P_1 \neq P_2$

# Fact 2: Asymmetries in policy reversal coefficients

*Table 2:* Asymmetric Response of Policy Implementation and Reversion

| This Period \ Last Period | No Intervention/ Maintain | Lower | Raise |
|---|---|---|---|
| No Intervention/ Maintain | NA | 0.0028 | 0.0006 |
| | | (0.0039) | (0.0048) |
| Lower | **-0.0094*** ** | -0.0123*** | **-0.0105*** ** |
| | (0.0020) | (0.0014) | (0.0030) |
| Raise | **0.0046** | **0.0090*** ** | 0.0035 |
| | (0.0057) | (0.0023) | (0.0035) |

# Cohort exposure design

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

$$\begin{aligned} \text{Child}_{icbt} = \alpha + \beta_1 \text{Policy\_Lower}_{cb} + \beta_2 \text{Policy\_Raise}_{cb} \\ + \eta \text{Age}_i \times \text{Gender}_i + \gamma_{ct} + \delta_b + \epsilon \end{aligned} \tag{3}$$

- Construct individual's exposure to policies in a 10-year fertile window around mean age of childbirth $\text{MAC}_{cb}$:

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

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

# Fact 3: Asymmetries in cohort exposure design

*Table 3:* 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

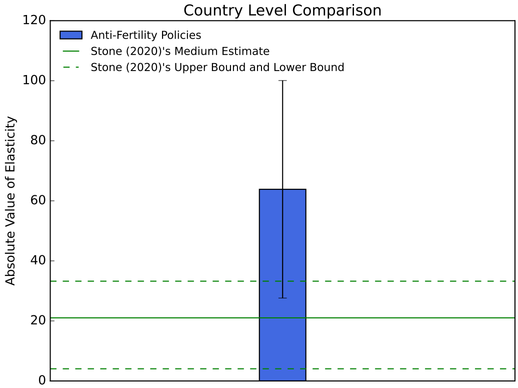
- Using data on family planning funding (de Silva and Tenreyro 2017)

*Table 4:* Elasticity Estimation for Anti-Fertility Policy

| | | |
|---|---|---|
| Dependent Variable | $\Delta$Total Fertility Rate/ Lagged Total Fertility Rate | |
| Construction of Policy Variables | Average in the Last Five Years | |
| | (1) | (2) |
| Family planning 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 |

# Fact 4: Asymmetries in the intensive margin

- Combine with harmonized estimates of pro-fertility policies (Stone (2020))




- The median estimate of pro-fertility elasticities lies outside of the 95% confidence interval of anti-fertility elasticities

# Robustness

- Empirical finding is robust to
  1. Use levels instead of percentage changes in fertility
  2. Policy effects at different horizons
  3. Country-specific trends
  4. Controlling for past fertility to mitigate reverse causality
  5. Split sample by initial fertility and GDP per capita
  6. Evaluate the cumulative contributions of policies to fertility changes for specific countries and compare with existing studies (in progress)

What explains asymmetric fertility elasticities?

# A behavioral model of fertility

# Asymmetry challenges existing models

- Existing models of fertility choice typically look like

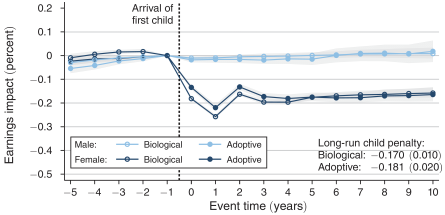
$$\max_{c,n,(e,\ldots)} \quad U(c,n,e,\ldots) \qquad \text{subject to} \qquad c+\chi n+\ldots=I$$

$\Longrightarrow$ smooth aggregate Marshallian demand $n(\chi,\ldots)$

- The smoothness result holds uniformly in this class of models
  - $\rightarrow$ Static and dynamic problems
  - $\rightarrow$ Altruistic and warm glow preferences
  - $\rightarrow$ Continuous and discrete fertility choices
  - $\rightarrow$ Representative and heterogeneous agents
  - $\rightarrow$ With and without quantity-quality trade-off or status competition
- Inconsistent with asymmetric elasticities $\left.\frac{\partial n}{\partial \chi}\right|_{+} > \left.\frac{\partial n}{\partial \chi}\right|_{-}$

# Why loss aversion?

- Having a child often implies sacrificing some other aspects of life
  - → Lifestyle (including leisure): "The sweet, sweet life of America's DINKs"
  - → Career outcomes: the child penalty for women (Klevens et al. 2021)




- Once these "perks" become "rights," the endowment effect kicks in
- Lee Kuan Yew: ". . .There is no turning back the clock, unless we want to stop educating women."

# A Behavioral Theory of Fertility Choice

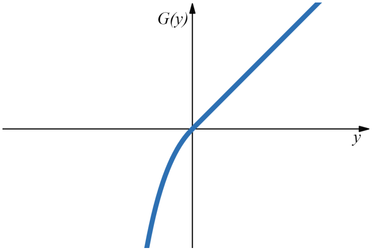
- Conditional on $r$, households solve

$$\max_{c,n} \quad \frac{1}{2}[u(c)+\beta u(n)]+\frac{1}{2}[G(u(c)-u(r))+u(r)]$$

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

- Loss aversion when $\alpha > 0$

$$G(y) = \begin{cases} y & y \geq 0 \\ y - \alpha y^2 & y < 0 \end{cases}$$




- Consistency: $r = c$ in equilibrium with RA
- Results robust to $c$ being a composite good

# Result

- **Proposition 1:** When $\alpha > 0$, the optimal fertility response to an increase in $\chi$ is larger than the optimal response to a decrease in $\chi$

$$\left.\frac{\partial \log n^*}{\partial \log \chi}\right|_{+,\alpha>0} < \left.\frac{\partial \log n^*}{\partial \log \chi}\right|_{-,\alpha>0} < 0 \tag{4}$$

- **Proposition 2:** When $\alpha > 0$, the optimal fertility response to an increase in $r$ is larger than the optimal response to a decrease in $r$

$$\left.\frac{\partial \log n^*}{\partial \log r}\right|_{+,\alpha>0} < \left.\frac{\partial \log n^*}{\partial \log r}\right|_{-,\alpha>0} = 0 \tag{5}$$

FOC asymmetry in $\chi$ asymmetry in $r$

# Result

- **Proposition 3:** When $\alpha > 0$, the optimal fertility response to a decrease in $I$ is larger than the optimal response to a increase in $I$

$$\left.\frac{\partial \log n^*}{\partial \log I}\right|_{-,\alpha>0} < \left.\frac{\partial \log n^*}{\partial \log I}\right|_{+,\alpha>0} < 0 \tag{6}$$

- Explains findings in Chatterjee and Vogl (2019)

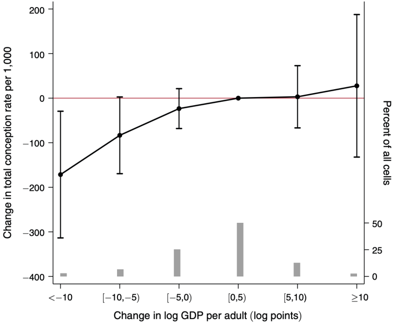



FIGURE 5. NON LINEAR SHORT-RUN ESTIMATES

## Why do asymmetry fertility elasticities matter?

# The “slippery slope” perspective

# Dynamic environment

- In period $t$, fertile households takes $r_t$ as given and choose $\{c_t(r_t), n_t(r_t)\}$
- Adaptive reference updating process

$$r_t = \phi \cdot r_{t-1} + (1-\phi) \cdot c_{t-1} + \epsilon_t \qquad \epsilon_t \sim \mathcal{N}(0, \sigma^2) \tag{7}$$

- $\phi$ is the persistence of past reference:
  - → $\phi = 1$: random walk of $r_t$
  - → $\phi = 0$: immediate updating $r_t = c_{t-1}$ (c.f., the Easterlin hypothesis)
- **The "slippery slope" perspective**: Starting from any consistent reference level $r_0$, the expected fertility $\mathbb{E}(n_t)$ declines with time while the expected consumption $\mathbb{E}(c_t)$ and reference level $\mathbb{E}(r_t)$ rises with time.

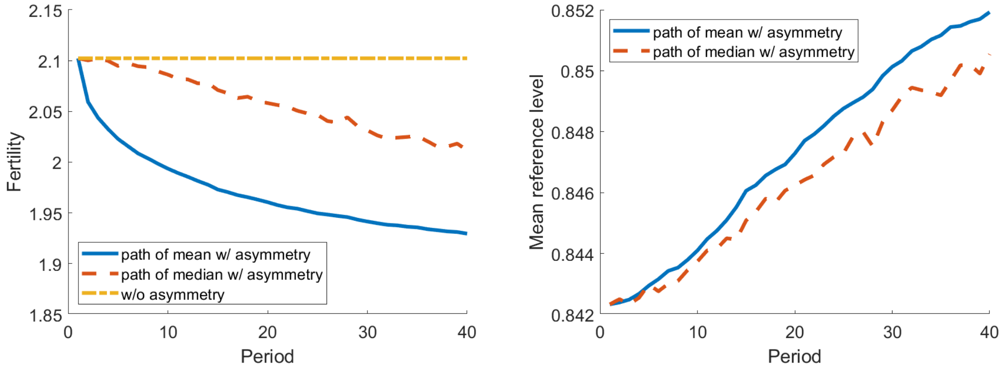
# Calibration

- Proof is simple for
  1. $\phi = 1$: $r_t$ is a random walk $\Longrightarrow \mathbb{E}(x_t) = x_0$ for $x \in \{r, c, n\}$
  2. $\phi = 0$: due to the asymmetric responses to $r$ in Proposition 2

$$\begin{cases} c_t > c_{t-1} & \text{when } \epsilon_t > 0 \\ c_t = c_{t-1} & \text{when } \epsilon_t \leq 0 \end{cases}$$

- Numerical proof for $\phi \in (0, 1)$ based on calibration:
  - $\rightarrow$ $\chi = 0.075$ from Greenwood and Seshadri (2002)
  - $\rightarrow$ $\beta = 34$ to generate $n^* = 2.1$
  - $\rightarrow$ $\gamma = 5.9$ and $\alpha = 98$ to generate pro-fertility elasticity and the degree of asymmetry in the data
  - $\rightarrow$ $\phi = 0.95$ and $\sigma = 0.01$ to illustrate the idea

# The “slippery slope”




- Fertility rate slides without changes in the underlying economic fundamentals ⇒ different mechanism from existing theories
  - → Explanation for the puzzling fall in fertility since 2010 (Kearney et al. 2022)
  - → To maintain fertility, government support needs to rise over time

# Government problem

- Present a simple case to highlight the policy implications
- The policymaker faces social costs from population externalities

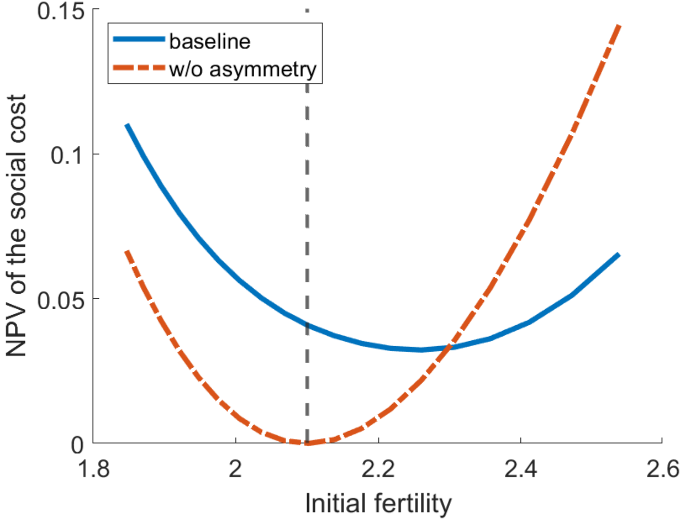
$$\mathcal{S}(n_t|\overline{n}) = \lambda \cdot (\log(n_t) - \log(\overline{n}))^2 \tag{8}$$

- Suppose the policymaker chooses $n_0$ (w/ consistent $r_0$) by permanently changing $\chi$ and solves

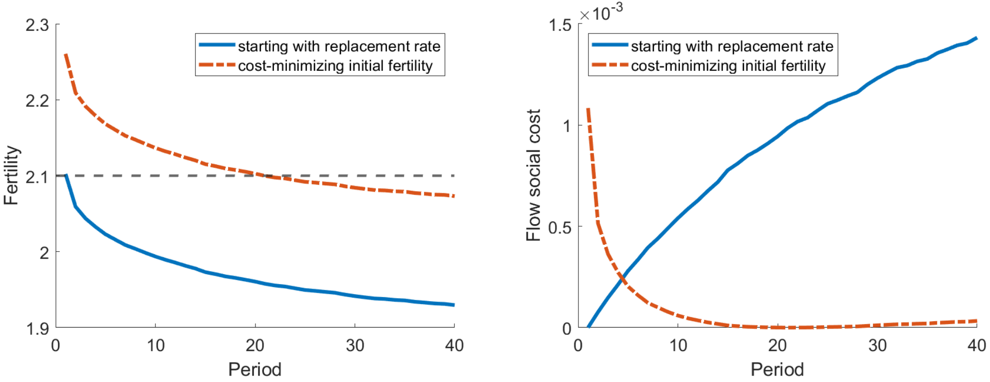
$$\min_{n_0} \quad \mathbb{E}_0 \sum_{t=0}^{\infty} \rho^t \mathcal{S}(n_t|\overline{n}) \tag{9}$$

  where $n_t$ are optimizing choices by households
- Question: What is the level of $n_0$ that minimizes the expected social cost?
- Set $\overline{n} = 2.1, \lambda = 0.2 \Longrightarrow n_{\text{U.S. 2022}} = 1.62$ generates $\mathcal{S} = 0.62\%$ of GDP

# Cost-minimizing initial fertility



# Evolution of fertility and social cost




- When $\rho > 0$, there is an intertemporal tradeoff of social costs

# Policy implications

- **Implication 1:** Unless the discount factor is zero, choosing the replacement rate as the initial level of fertility is never cost-minimizing

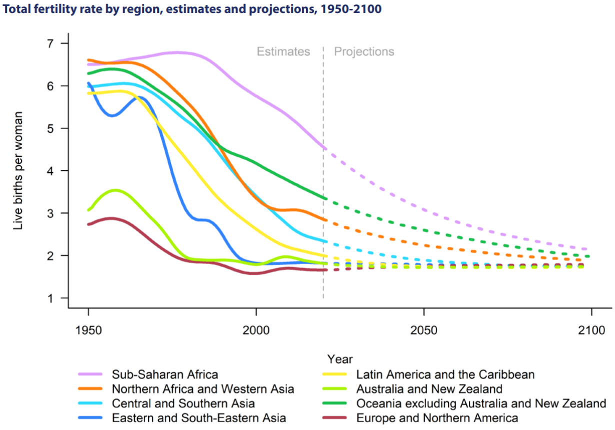
  $\Rightarrow$ One can always find a path that dominates $n_0 = \overline{n}$ in expectation

- **Implication 2:** To maintain $n_0$, policy effort needs to increase in time

- **Implication 3:** The cost-minimizing initial fertility level depends on the degree of asymmetry, the reference updating process, and the social discount factor

  $\Rightarrow$ More intricate than the traditional approach of "getting it close to $\overline{n}$"

# Rethink the global campaign towards $\overline{n} = 2.1$




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

- This paper: There is precautionary motives to set $n_0 > \overline{n}$

# Alternative Explanations

# Alternatives

| | Loss Aversion | Propagation | Tech. asym. | Constraints |
|---|---|---|---|---|
| **Empirical findings** | | | | |
| Asym. responses to policies | Yes | No | Yes | Yes |
| Asym. responses to policy reversal | Yes | No | No | No |
| Asym. responses to income shocks | Yes | No | No | Yes |
| **Implications** | | | | |
| "Slippery slope" perspective | Yes | No | No | Yes |
| Precautionary high fertility | Yes | Yes | Yes | Yes |

more

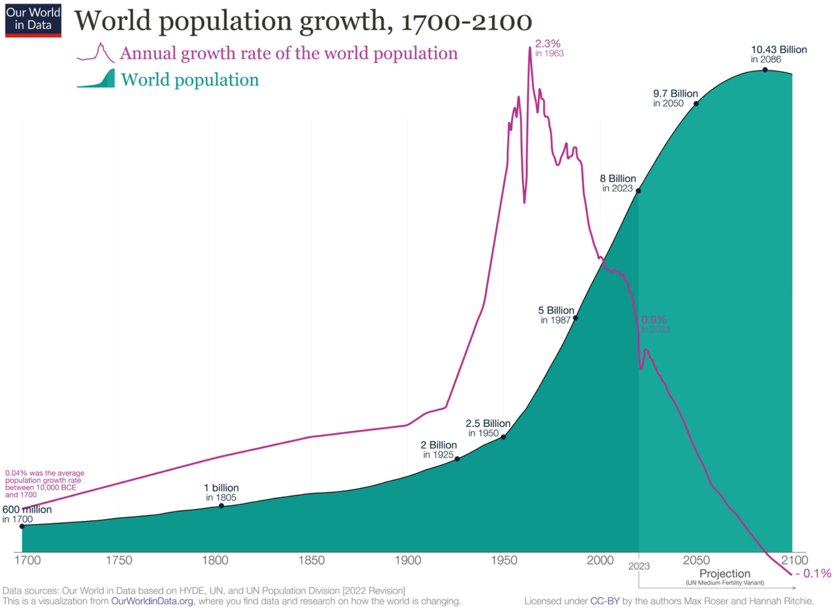
# Conclusion

1. Document a new fact: asymmetric fertility elasticities
2. Provide a micro-foundation using loss aversion
3. The "slippery slope" perspective offers new implications

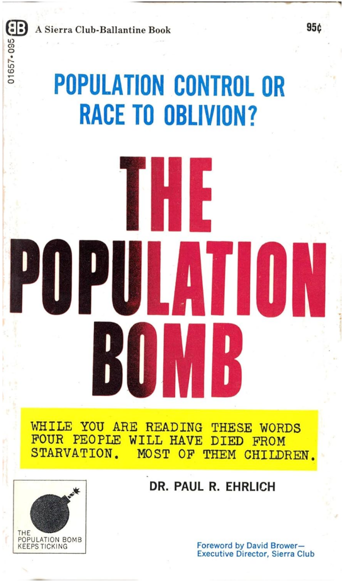
"Demographics determine the destiny of a people." —Lee Kuan Yew

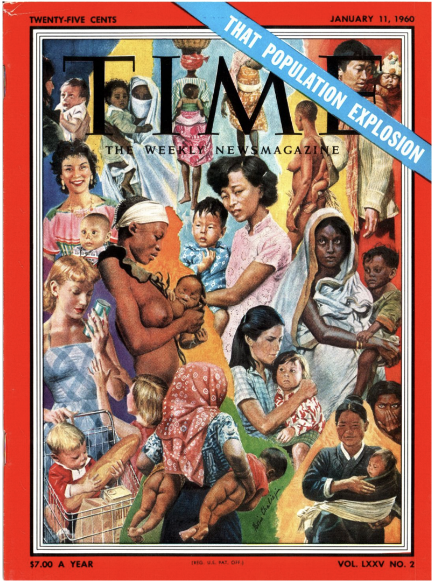
# Appendix

# The specter of Malthus in the 1960s



# The population bomb



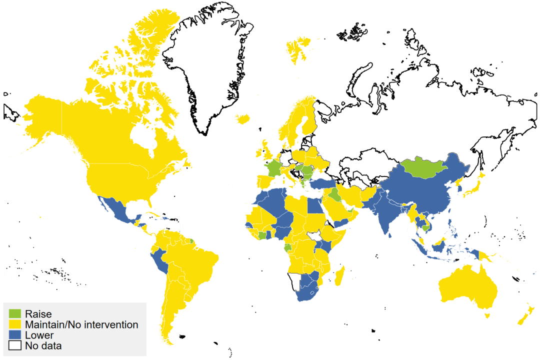



# The global family planning movement

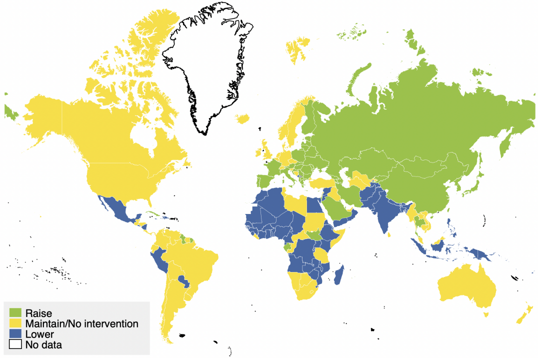
- Led by global organizations such as the United Nations, the World Bank, USAID, and Bill & Melinda Gates Foundation
- $4.2 billion spent across low- & lower-middle-income countries in 2021
- Many country-specific policies (e.g., the one-child-policy in China)
- Gradually attaches more benefits to low fertility: economic development, health, gender equity, environment. . .
- Evidence that fertility policies played an important role in the rapid fertility decline (de Silva and Tenreyro 2020)

back

# Fertility policy in 1986 and 2021



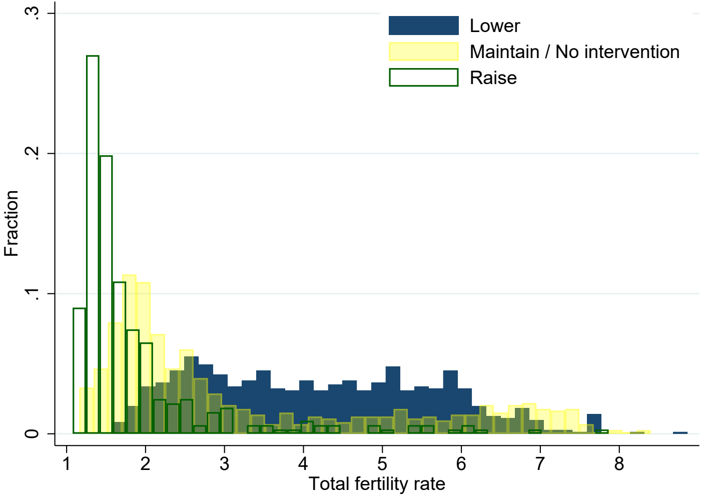

Source: United Nations Population Division




Source: United Nations Population Division

back distribution

# Fertility policy distribution

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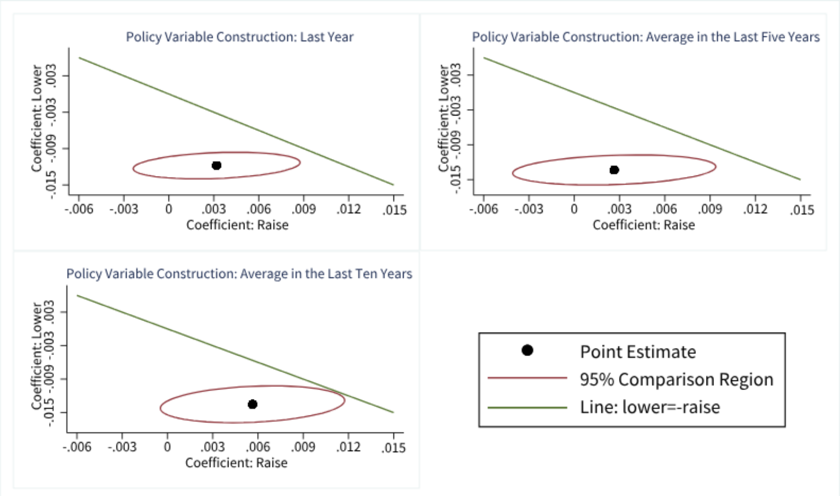
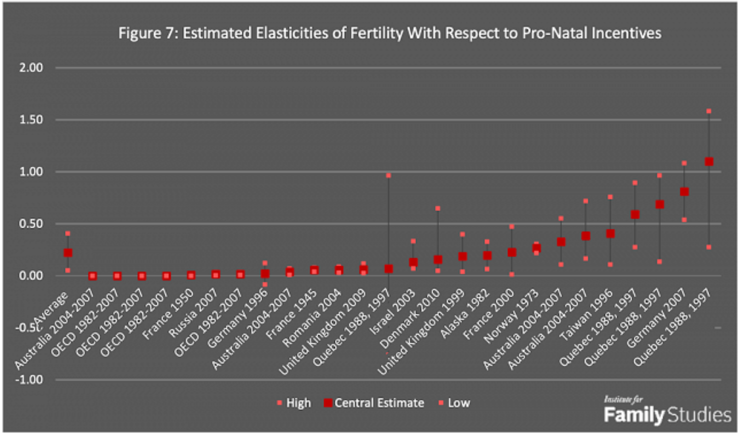
# The sum of coefficients is significantly negative




- Wald test-based comparison regions for simultaneous inference for two parameters (Eckert and Vach 2020)

back

# Responses to pro-fertility policies




- "An increase in the present value of child benefits equal to 10% of a household's income can be expected to produce between 0.5% and 4.1% higher birth rates." (Stone 2020)

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# Technological Reversibility

1. 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) & “Do it for Denmark”
2. Family policies: childlessness tax (Soviet) & maternity capital (Russia)
3. Access to tech.: planned parenthood (global) & Decree 770 (Romania)
4. Reproductive coercion: forced sterilization (Bangladesh) & monthly gynecological exam w/ plant-level birth target (Romania)

Fertility policies have different combinations of cost-effectiveness and repugnancy. But each of them is technologically feasible in either direction

back

# Control for past fertility

*Table 5:* Population Policy and TFR: Control Average TFR in the Last Five Years

| Dependent Variable | $\Delta$Total Fertility Rate/Lagged Fertility Rate | | | |
|---|---|---|---|---|
| Construction of Policy Variables | Last Year | | Average in the Last Five Years | |
| | (1) | (2) | (3) | (4) |
| Lower fertility | -0.0121*** | -0.0065*** | -0.0134*** | -0.0070*** |
| | (0.0014) | (0.0015) | (0.0016) | (0.0017) |
| Raise fertility | 0.0031 | 0.0013 | 0.0033 | 0.0009 |
| | (0.0037) | (0.0033) | (0.0043) | (0.0038) |
| Country Fixed Effect | Yes | Yes | Yes | Yes |
| Year Fixed Effect | Yes | Yes | Yes | Yes |
| Control Variables | No | Yes | No | Yes |
| Average TFR in the Last Five Years | Yes | Yes | Yes | Yes |
| Observations | 9881 | 8446 | 9881 | 8446 |
| $R^2$ | 0.134 | 0.182 | 0.133 | 0.182 |

back

# Country-specific trends

*Table 6:* Population Policy and TFR: Control Country-Specific Linear Trend

| Dependent Variable | ΔTotal Fertility Rate/Lagged Fertility Rate | | | |
|---|---|---|---|---|
| Construction of Policy Variables | Last Year | | Average in the Last Five Years | |
| | (1) | (2) | (3) | (4) |
| Lower fertility | -0.0040** | -0.0050** | -0.0038 | -0.0054** |
| | (0.0018) | (0.0019) | (0.0026) | (0.0026) |
| Raise fertility | -0.0006 | -0.0001 | -0.0004 | 0.0009 |
| | (0.0039) | (0.0037) | (0.0047) | (0.0045) |
| Country Fixed Effect | Yes | Yes | Yes | Yes |
| Year Fixed Effect | Yes | Yes | Yes | Yes |
| Country-Specific Linear Trend | Yes | Yes | Yes | Yes |
| Control Variables | No | Yes | No | Yes |
| Observations | 10726 | 9146 | 10726 | 9146 |
| $R^2$ | 0.204 | 0.220 | 0.203 | 0.220 |

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# Split samples

| Panel A: Subsample with High TFR in 1960 | | | | |
|---|---|---|---|---|
| Dependent Variable | ΔTotal Fertility Rate/Lagged Fertility Rate | | | |
| Construction of Policy Variables | Last Year | | Average in the Last Five Years | |
| | (1) | (2) | (3) | (4) |
| Lower fertility | -0.0076*** | -0.0056*** | -0.0080*** | -0.0057*** |
| | (0.0014) | (0.0014) | (0.0018) | (0.0018) |
| Raise fertility | 0.0003 | 0.0005 | 0.0009 | 0.0007 |
| | (0.0034) | (0.0055) | (0.0062) | (0.0056) |
| Observations | 5936 | 5247 | 5936 | 5247 |
| $R^2$ | 0.339 | 0.390 | 0.337 | 0.388 |
| Panel B: Subsample with Low TFR in 1960 | | | | |
| Dependent Variable | ΔTotal Fertility Rate/Lagged Fertility Rate | | | |
| Construction of Policy Variables | Last Year | | Average in the Last Five Years | |
| | (1) | (2) | (3) | (4) |
| Lower fertility | -0.0150** | -0.0117** | -0.0151*** | -0.0117** |
| | (0.0028) | (0.0049) | (0.0023) | (0.0047) |
| Raise fertility | 0.0016 | 0.0030 | 0.0024 | 0.0038 |
| | (0.0038) | (0.0037) | (0.0044) | (0.0043) |
| Country Fixed Effect | Yes | Yes | Yes | Yes |
| Year Fixed Effect | Yes | Yes | Yes | Yes |
| Control Variables | No | Yes | No | Yes |
| Observations | 4789 | 3899 | 4789 | 3899 |
| $R^2$ | 0.128 | 0.147 | 0.128 | 0.147 |

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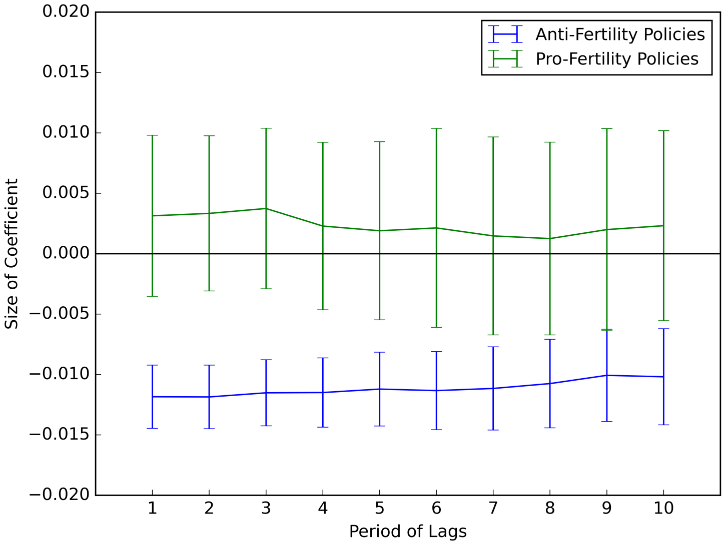
# Different horizons

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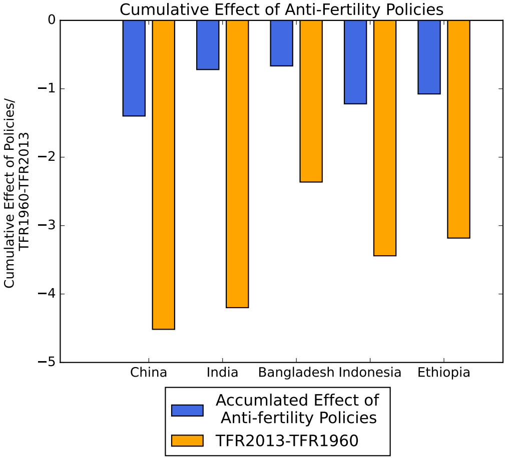
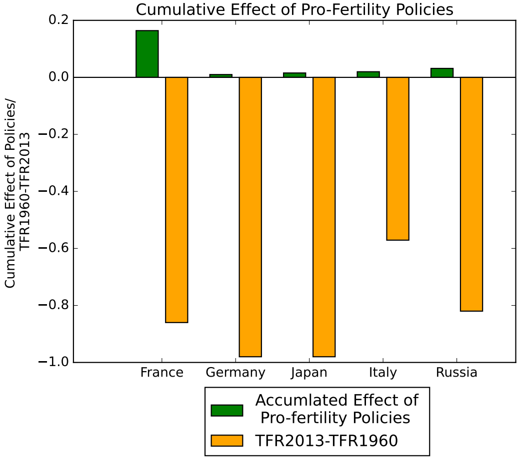
# Cumulative effects

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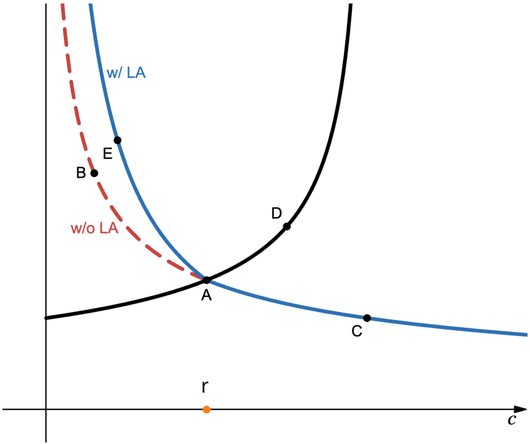
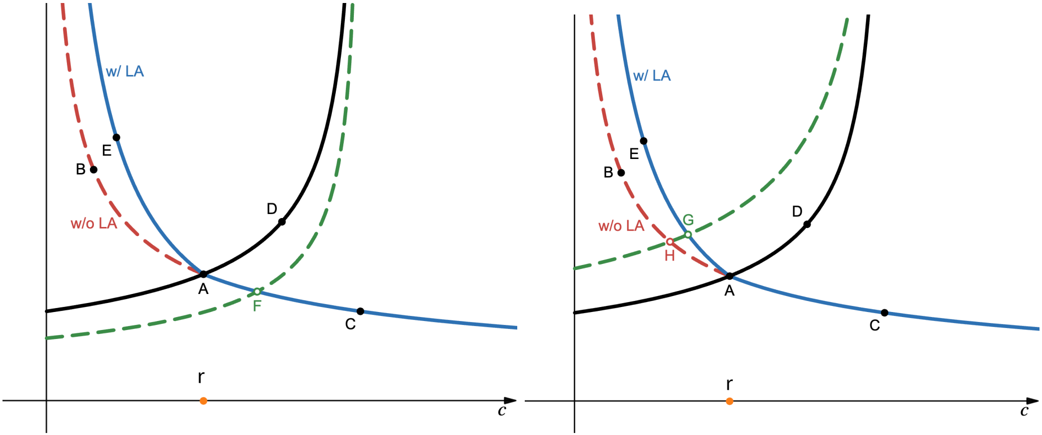
# First-order condition

- The first-order condition of optimal consumption satisfies

$$u'(c) \cdot (1 + G'(u(c) - u(r)) = \frac{\beta}{\chi} \cdot u'\left(\frac{I-c}{\chi}\right)$$



# Asymmetry in $\chi$




- Comparative static when $\chi$ falls (left) or rises (right)

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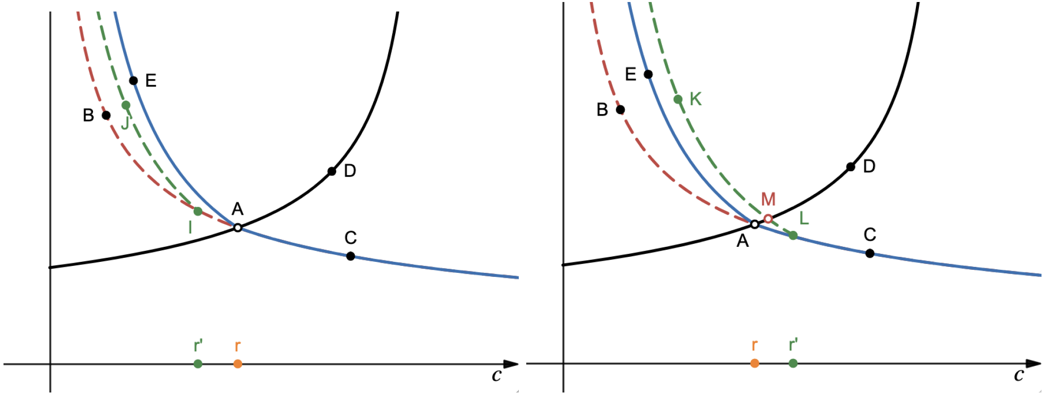
# Asymmetry in $r$




- Comparative static when $r$ falls (left) or rises (right)

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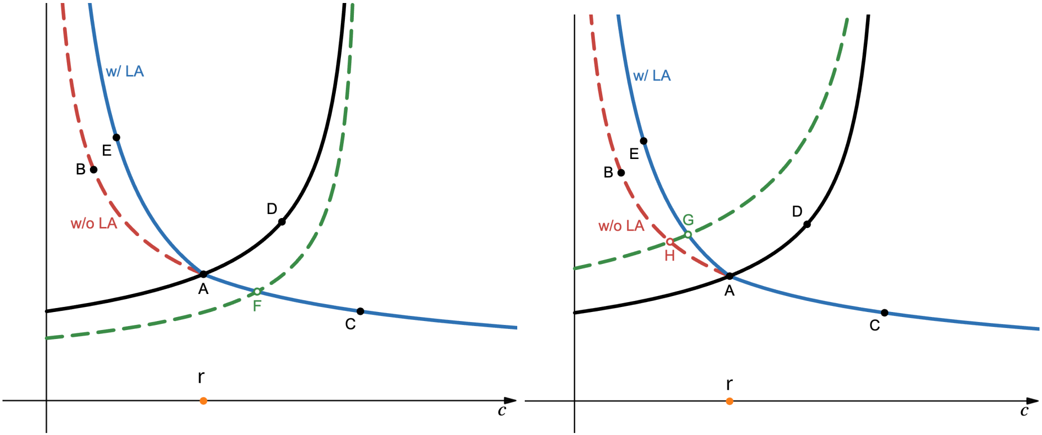
# Asymmetry in $I$




- Comparative static when $I$ rises (left) or falls (right)

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