Can legal bans on sex detection technology reduce gender discrimination?

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  - daughters carried to term – when parents have access to SSA – are more likely to be "wanted" $\Longrightarrow$ lower postnatal discrimination
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- Conversely, a ban on SSA might **increase** unwanted girls facing increased discriminated through lower health investments & **strengthen** the fertility stopping rule
- **This paper**: investigates the causal impact of a ban on SSA on gender gap in health outcomes & compares welfare consequences with a policy that tries to shift gender norms

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Context of both policies: India

- Broad category of policy interventions targeting skewed sex ratio:
  (i) **Supply side** interventions such as restriction on access to SSA
  (ii)**Demand side** interventions that try to shift preferences & motivate investments in girl child –such as through sensitization campaigns or financial incentives

- **PNDT Act**, a supply side restriction on sex detection & sex screening techniques, enacted in a staggered manner across Indian states, between 1988 and 2003
- **The Beti Bachao Beti Padhao (BBBP) scheme**, primarily awareness campaign, aimed at gender sensitization emphasising the value of daughters, rolled out in 100 (low CSR) phase 1 districts in 2014-15
- We leverage the geographic & inter-temporal variation in the roll-out of the policies to study their impacts on gender discrimination in health outcomes

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Contribution

- We causally estimate the unintended impacts of the Indian ban –which improved child sex ratio (Nandi and Deolalikar 2013)
  - contribute to the small but growing literature on the impact of supply side restrictions on changing gender bias

- We provide the first estimates of the treatment effects of the mass media & gender sensitisation campaign – the Beti Bachao Beti Padhao (Save Girls, Educate Girls) programme
  - contribute to the literature on the role of mass media awareness& behaviour change campaigns on shifting social norms

- Our setting allows us to identify & contrast the efficacy of a supply-side intervention with a demand side intervention
  - implications for policy design on choice of instruments, in societies with systematic neglect of daughters
  - we harmonise information on exogenous policy shocks to study a range of outcomes – mortality, health investments, nutritional and fertility outcomes that help identify potential channels of our results

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- We find the ban on SSA increased the gender gap in mortality, nutritional outcomes and health investments
- Families that were relatively intensively treated by the ban have higher fertility and lower birth spacing after implementation of the ban
- We find preliminary evidence that the BBBP program reduces neonatal mortality & improve health investments such as breastfeeding

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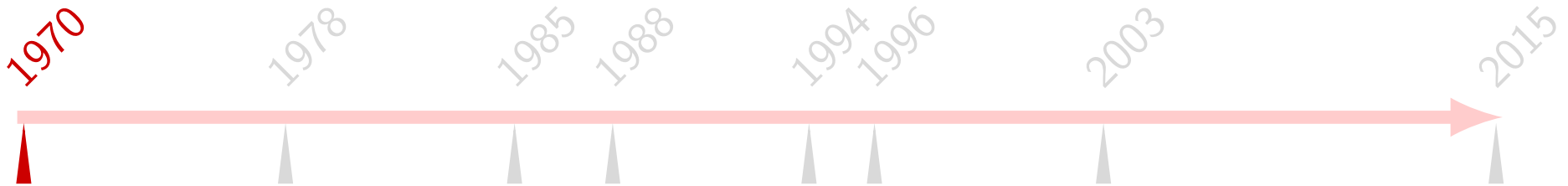

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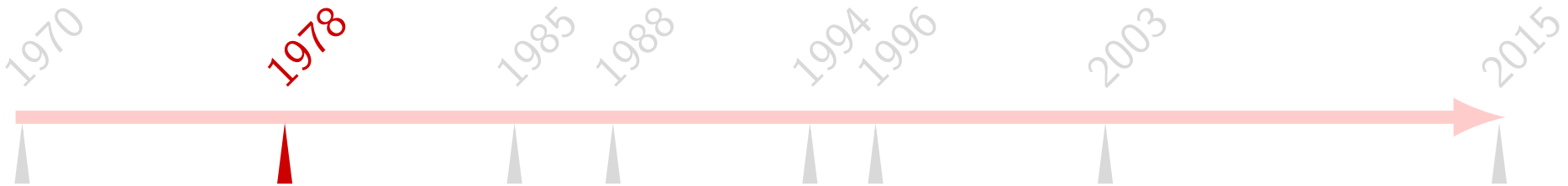

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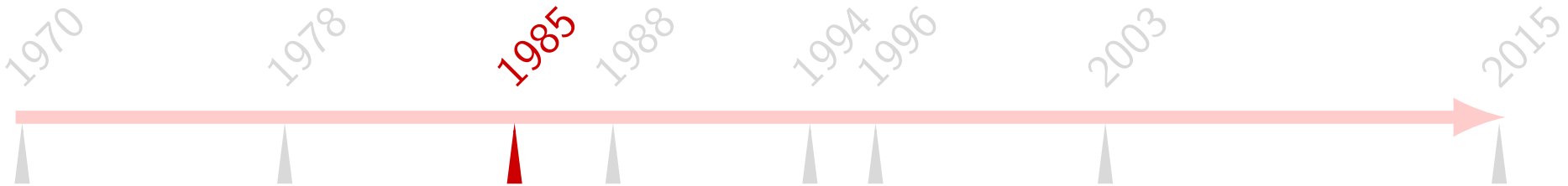

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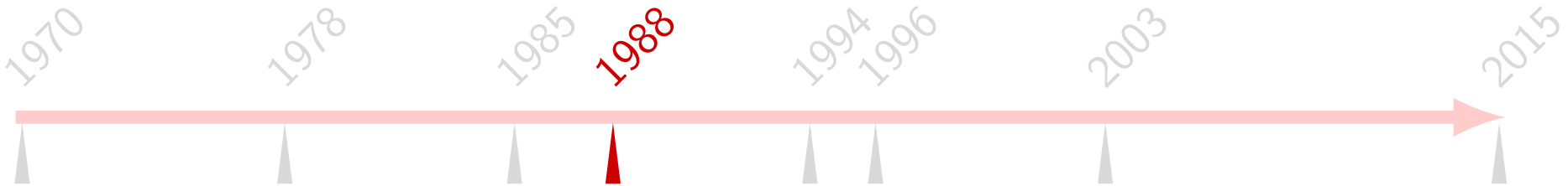

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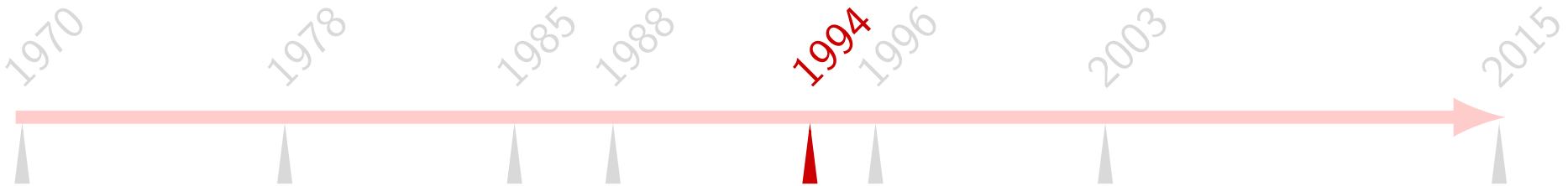

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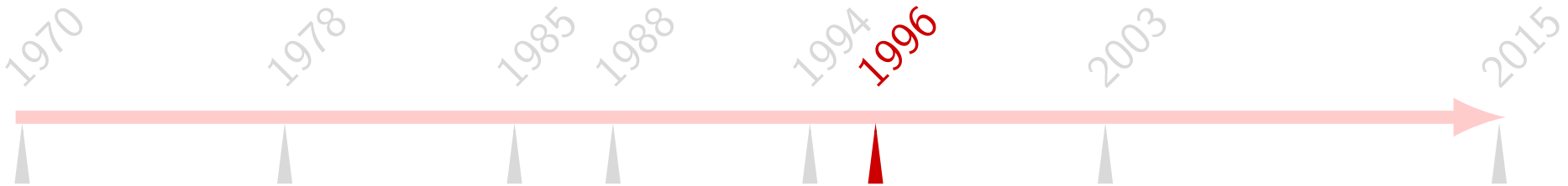

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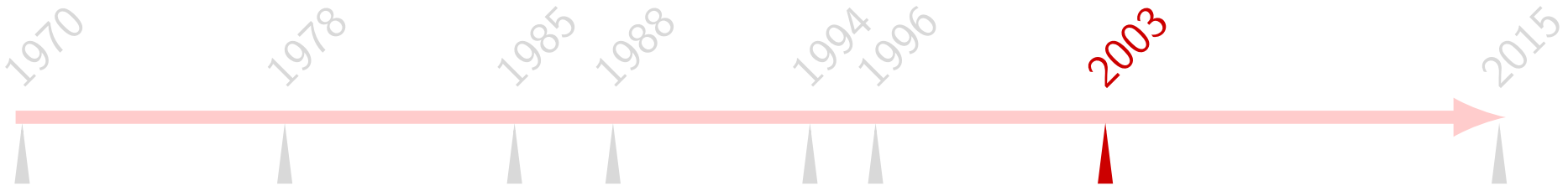

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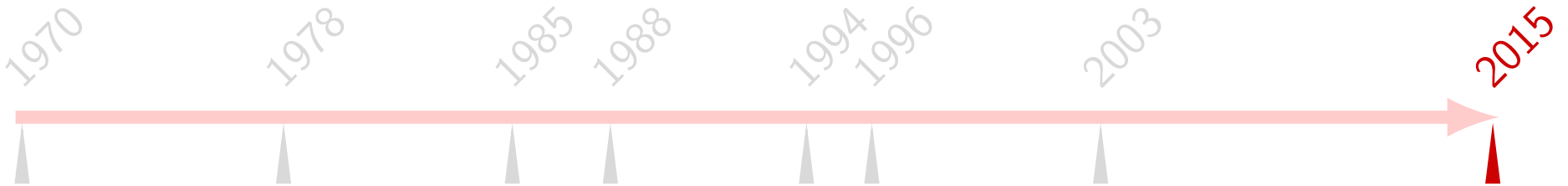

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Institutional context of the ban

- Ultrasound technology had significant advantages: cheap, highly accessible, non-invasive, portable machines– allowing availability in rural areas
  - Bhalotra and Cochrane (2010) estimate the spread of ultrasound technology led to selective abortion of up to 480,000 girls per year between 1995-2005, 6 percent of potential female births
- Govt of India enacted Pre-natal Diagnostic Techniques (Regulation and Prevention of misuse) Act (PNDT Act) in 1994, operational in 1996, put a ban on using the sonogram to determine the sex of the fetus
  - Imprisonment up to three years and with fine of fifty thousand rupees for the first offence and higher penalty for any subsequent offence & confiscation of medical license & equipment

Efficacy of the PNDT Act on preventing sex selection

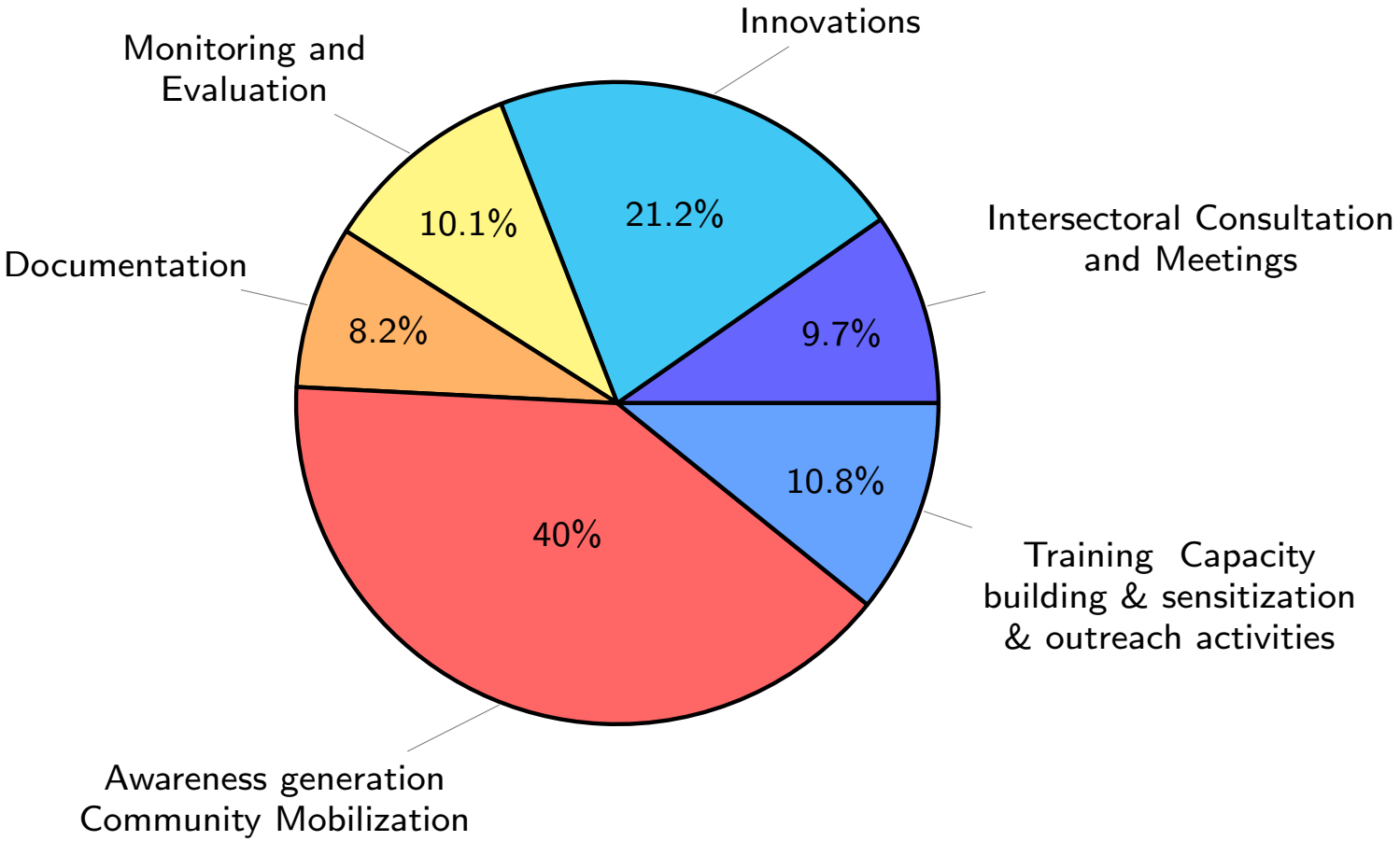
- Nandi and Deolalikar (2013) find that the ban raised the child sex ratio (females per 1000 males) by 14–26 points
  - increase of at least an additional 106,000 surviving girls aged 0 to 6 years in the newly-treated rural areas
  - raised the odds of a female birth by 0.7 to 1 percent, Nandi (2015)

The Beti Bachao Beti Padhao (BBBP) Scheme

- The Beti Bachao Beti Padhao (BBBP) Scheme was launched primarily to ensure survival, protection & education of the girl child
  - first launched in 100 districts(low CSR) in 2014-15 (Phase 1),expanded to 61 additional districts in 2015-16 (Phase 2)
- Mass communication strategy involved spreading awareness through radio jingles, television messages, SMS, handouts in regional languages, celebrating the birth of girl child in community, mobilize people through film shows, rallies, quiz shows, involved school principals, teachers, ICDS staff,village Sarpanch and members of the Panchayat, ANM's, Aanganwadi and ASHA workers
  - A recent NCAER survey(2020) from 14 states finds nearly 88 per cent of respondents were aware of the BBBP scheme's campaign
- Ensuring proper implementation of PNDT was part of BBBP scheme
  - Provides a unique setting to comment on the relative efficacy of legal bans when combined with demand side interventions

BBBP budgetary allocations

Budgetary allocation in percentage per district for the years 2014-16.



Data

- **Mortality & fertility** analyses use retrospective birth histories between 1975 and 2016 for women aged 15-49 years from the latest National Family Health Survey (NFHS 4)
  - 1.3 million observations for all births drawn from data over 600,000 rural and urban households from all 640 Indian districts
  - Fertility data includes complete birth histories of 699686 women
- **Child health outcomes**: use pooled child health data from all four rounds of the NFHS, conducted in 1992-93, 1998-99, 2005-06 and 2015-16
  - 393,167 observations on child health
  - includes information on objective biomarkers of health & health investments

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Outcome variables

- **Mortality Outcomes**: (i) neonatal mortality (ii)infant mortality (iii) under-five mortality
- **Health outcomes**:
  - Biomarkers: Health Outcomes (i) Height for age (ii) Weight for age (iii) BMI
  - Health investments (i) Breastfeeding duration (ii) ANC visit (iii) Tetanus shot
- **Fertility outcomes**: probability of birth, proportion of girls born, birth spacing (gap between two successive births)

Empirical strategy

- Exploit exogenous variation from the staggered rollout (spatial & intertemporal) to compare outcomes of girls & boys within the same mother
  - Main estimating framework controls for mother FE, birth year FE, statespecific time trends
  - Control for a number of confounding factors including mother specific preferences
- Quasirandom variation in sex of firstborn to explore relative difference in outcomes for firstborn girl families
  - the respective policy shock and the sex of firstborns, both act as treatments

Mortality and Health outcomes

$$\begin{aligned} Y_{\text{imst}} &= \beta_0 + \beta_1 \text{Treat}_{\text{imst}} + \beta_2 Female_{\text{imst}} + \\ &+ \boxed{\beta_3} (\text{Treat} \times Female)_{\text{imst}} + \delta_{st} + \tau_t + \phi_m + \epsilon_{\text{imst}} \end{aligned} \tag{1}$$

- Y_{imst} is one of mortality indicator, nutritional outcome or health investments for child i born to mother m in state s in year t.
- $Treat_{imst} = 1$ if child i born to mother m is born in state s in the year t where the respective policy has been implemented & 0 otherwise
- δ_{st} state-specific time trends
- τ_t birth year fixed effect
- ϕ_m mother fixed effect
- Standard errors are clustered at the state level for PNDT & at the district level for BBBP

Leveraging quasi-random variation by firstborn family type

If families with firstborn girls are more intensively treated by the policies, welfare implications should be greater in such families

$$\begin{aligned} Y_{\text{imst}} &= \beta_0 + \beta_1 \text{Treat}_{\text{imst}} + \beta_2 FirstbornFemale_{\text{imst}} \\ &+ \boxed{\beta_3} (\text{Treat} \times FirstbornFemale)_{\text{imst}} + \delta_{st} + \tau_t + \phi_m + \epsilon_{\text{imst}} \end{aligned} \quad (2)$$

- Y_{imst} is indicator for mortality or health outcome for child i born to mother m in state s, born in year t
- $Treat_{imst} = 1$ if child i of mother m is born in state s in year t post policy & 0 otherwise
- $FirstbornFemale_{im} = 1$ if mother m of child i has a firstborn girl child & 0 otherwise
- δ_{st} state specific time trend
- τ_t birth year fixed effect
- ϕ_m mother fixed effect

Impact of PNDT on Mortality

	Birth orders 2 and above			All birth orders		
	(1) NNM	(2) IMR	(3) U5MR	(4) NNM	(5) IMR	(6) U5MR
Treat	0.000621	0.000896	-0.00216	-0.00417*	-0.00336*	-0.00423*
	(0.00250)	(0.00188)	(0.00244)	(0.00228)	(0.00191)	(0.00211)
Female	-0.0154***	-0.00895***	-0.00318	-0.0152***	-0.0125***	-0.00846***
	(0.00159)	(0.00255)	(0.00398)	(0.00145)	(0.00155)	(0.00279)
Treat X Female	0.0104***	0.00885***	0.00748*	0.00733***	0.00829***	0.00686**
	(0.00212)	(0.00320)	(0.00382)	(0.00186)	(0.00213)	(0.00274)
Bootstrapped p value	0.000500	0.0186	0.0740	0.00630	0.00210	0.0197
Observations	367006	367006	367006	648798	648798	648798
Mean of Dep. Variable	0.0455	0.0683	0.0803	0.0437	0.0628	0.0723
SD	0.208	0.252	0.272	0.205	0.243	0.259

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

All estimations include mother fixed effects, birthyear fixed effects, and state-specific time trends. The sample includes children born between 1985 and 2005. The first 3 columns include children born at a birth order of two or higher, while the last three columns include children born at all birth orders. Standard errors are clustered at the state level. The wild cluster bootstrap p values for the interaction terms are included in "bootstrapped p value"

Mortality estimates for PNDT by firstborn female family

	1985-2016			1985-2005		
	(1) NNM	(2) IMR	(3) U5MR	(4) NNM	(5) IMR	(6) U5MR
Treat	-0.000547	-0.00396	-0.00846***	0.00102	-0.00234	-0.00550*
	(0.00305)	(0.00262)	(0.00238)	(0.00321)	(0.00316)	(0.00286)
Treat X Firstborn Female	0.00867**	0.0144***	0.0145***	0.00880***	0.0148***	0.0140***
	(0.00338)	(0.00357)	(0.00373)	(0.00319)	(0.00332)	(0.00369)
Bootstrapped p value	0.0451	0.00150	0.00710	0.0360	0.000600	0.00670
Observations	675306	653584	556263	367006	367006	367006
Mean of Dep. Variable	0.0433	0.0646	0.0825	0.0455	0.0683	0.0803
SD	0.204	0.246	0.275	0.208	0.252	0.272

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

All estimations include mother fixed effects, birthyear fixed effects, and state-specific time trends. The sample includes children born at a birth order of 2 or higher. The first 3 columns include children born during 1985-2016, while the last three columns include children born during 1985-2005. Standard errors are clustered at the state level. The wild cluster bootstrap p values for the interaction terms are included in "bootstrapped p value".

Mortality estimates for BBBP

	Birth orders 2 and above			All birth orders		
	(1) IMR	(2) U5MR	(3) NNM	(4) IMR	(5) U5MR	(6) NNM
Female	-0.00787***	-0.000419	-0.0126***	-0.0131***	-0.00888***	-0.0148***
	(0.00193)	(0.00319)	(0.00149)	(0.00135)	(0.00218)	(0.00107)
Female X Treat	0.0273	0.0118	-0.0399	0.00636	-0.000171	-0.0318*
	(0.0425)	(0.0377)	(0.0256)	(0.0270)	(0.0240)	(0.0185)
Observations	222734	124308	244567	405111	213497	449230
Mean of Dep. Variable	0.0663	0.110	0.0448	0.0563	0.0982	0.0390
SD	0.249	0.313	0.207	0.231	0.298	0.194

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: All estimations include mother fixed effects, birthyear fixed effects, and district-specific time trends. The sample includes children born between 2005 and 2016. The first 3 columns include children born at a birth order of two or higher, while the last three columns include children born at all birth orders. Standard errors are clustered at the district level.

Impact of PNDT on health outcomes

	Birth orders 2 and above			All birth orders		
	(1) HFA	(2) WFA	(3) BMI	(4) HFA	(5) WFA	(6) BMI
Treat	2.646***	1.431***	-0.132	2.703***	1.494***	-0.318
	(0.604)	(0.189)	(0.701)	(0.521)	(0.285)	(0.566)
Female	0.129	0.0736	0.0391	0.128*	0.0732	0.0338
	(0.0975)	(0.0615)	(0.0388)	(0.0657)	(0.0493)	(0.0349)
Treat X Female	-0.161*	-0.156**	-0.0993	-0.120**	-0.110**	-0.0714
	(0.0786)	(0.0562)	(0.0689)	(0.0569)	(0.0452)	(0.0445)
Bootstrapped p value	0.0261	0.0325	0.253	0.0403	0.0332	0.150
Observations	14244	14244	14244	23779	23779	23779
Mean of Dep. Variable	-2.257	-1.970	-0.727	-2.149	-1.883	-0.713
SD	1.705	1.231	1.357	1.667	1.224	1.349

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: All estimations include mother fixed effects, birthyear fixed effects, and state-specific time trends. The sample includes children born between 1988 and 2005. The first 3 columns include children born at a birth order of two or higher, while the last three columns include children born at all birth orders. Standard errors are clustered at the state level. The wild cluster bootstrap p values for the interaction terms are included in "bootstrapped p value".

Health estimates for BBBP

	Birth orders 2 and above			All birth orders		
	(1) HFA	(2) WFA	(3) BMI	(4) HFA	(5) WFA	(6) BMI
Female	0.561***	0.346**	0.0864	0.316***	0.158	0.0142
	(0.157)	(0.157)	(0.150)	(0.115)	(0.101)	(0.110)
Female X Treat	0.0842	0.0465	0.0690	-0.0976	-0.241	-0.267
	(0.536)	(0.407)	(0.455)	(0.394)	(0.271)	(0.319)
Observations	2220	2220	2220	4697	4697	4697
Mean of Dep. Variable	-1.558	-1.748	-1.127	-1.348	-1.548	-1.024
SD	1.840	1.355	1.503	1.780	1.293	1.475

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: All estimations include mother fixed effects, birthyear fixed effects, and state-specific time trends. Sample includes children born from 2005-2016, and children below the age of 1 at the time of the survey. The first 3 columns include children born at a birth order of two or higher, while the last three columns include children born at all birth orders. Standard errors are clustered at the district level.

Impact of PNDT and BBBP on health investments: duration of breastfeeding

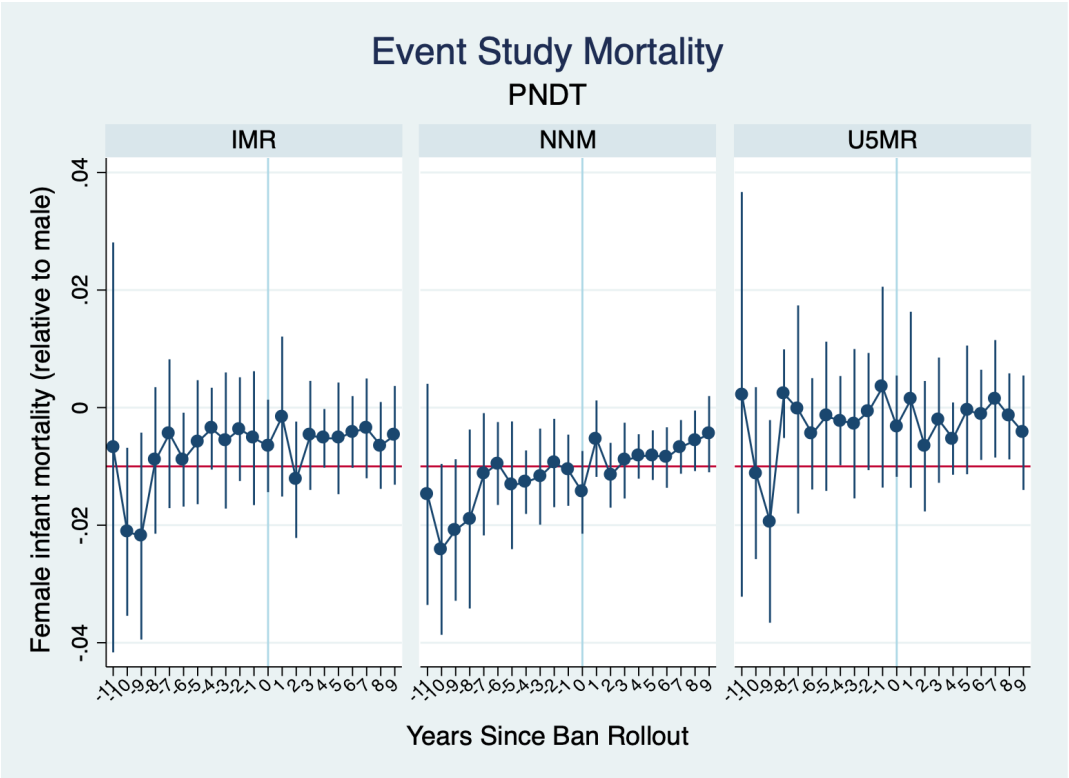
	Birth orders 2 and above		All birth orders	
	(1)	(2)	(3)	(4)
	Breastfed	Breastfed	Breastfed	Breastfed
Treat PNDT	-13.22***		-13.78***	
	(2.272)		(1.960)	
Female	-0.000838	0.754	-0.0100	0.338
	(0.105)	(0.530)	(0.109)	(0.308)
Treat PNDT X Female	-0.552**		-0.253	
	(0.235)		(0.188)	
Treat BBBP		-5.670***		-1.640
		(1.818)		(1.128)
Treat BBBP X Female		3.822**		1.550
		(1.699)		(1.273)
Bootstrapped p value	0.00900		0.192	
Observations	26974	254	44022	580
Mean of Dep. Variable	12.81	1.376	12.64	1.557
SD	9.121	2.527	9.061	2.582

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

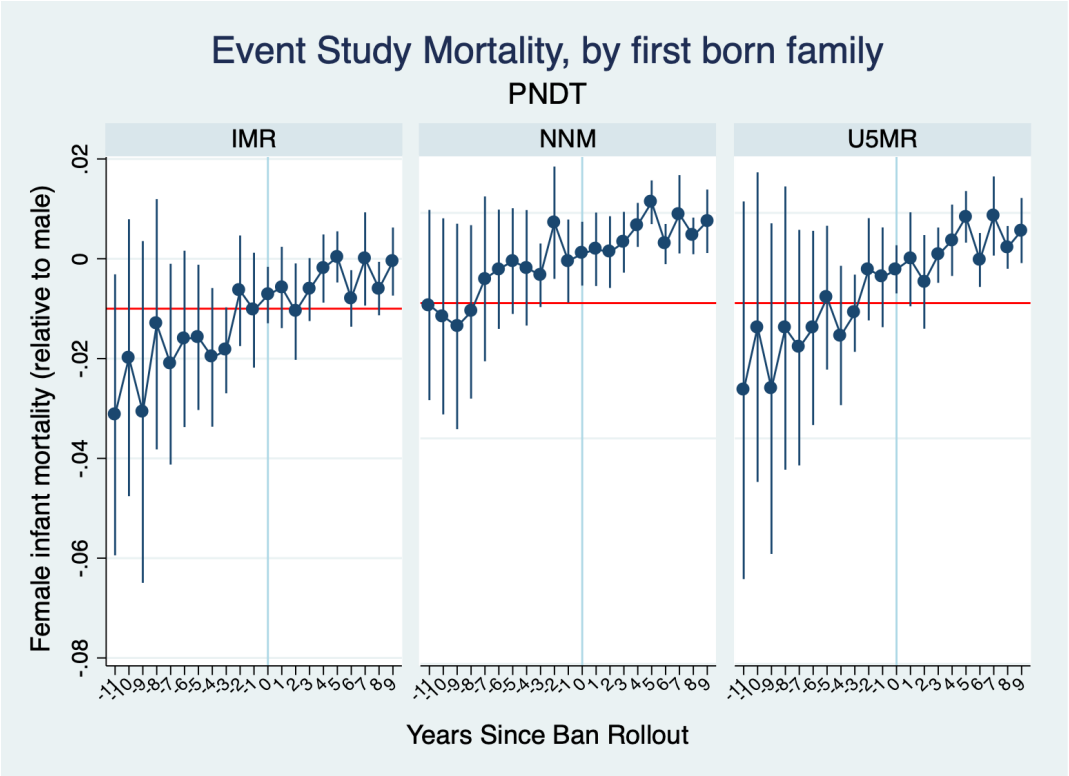
Note: "Breastfed" refers to duration of breastfeeding in months. All estimations include mother fixed effects, birthyear fixed effects, and state-specific time trends. The sample includes children born between 1988 and 2005 for PNDT and 2005 and above for BBBP.

Analysis of pre-intervention trends: Mortality outcome



The estimates plotted are from the regression of child mortality on the interaction between Treat and Female, for 10 years before and after the ban. Birth orders are restricted to 2 and above. We control for state-specific time trends, child birth year, birth order and mother fixed effects. Standard errors are clustered at the state level. The plot displays 95 percent confidence intervals.

Analysis of pre-intervention trend: Event Study Graph for Mortality by Firstborn family



The estimates plotted are from the regression of child mortality on the interaction between $Treat$ and $FirstbornFemale$, for 10 years before and after the ban. Birth orders are restricted to 2 and above. Additional controls include state-specific time trends, child birth year, birth order and mother fixed effects. Standard errors are clustered at the state level. The plot displays 95 percent confidence intervals.

Mechanism: Fertility

We test two potential channels through which a ban on SSA could affect the gender gap in child health

- An increase in number of unwanted female births $\Longrightarrow$ neglect of girls
  - We examine if the ban increases the proportion of female births
- Selective continuation of fertility for Firstborn female families to attain the desired sex composition of children $\Longrightarrow$ girls end up with larger families & greater sibling competition for resources
  - We test if fertility increases relatively more in firstborn female families

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Mechanism: Testing selective fertility channel:Comparing various policy shocks

	(1)	(2)	(3)
Treat Early Diffusion	0.100***		
	(0.00328)		
Firstborn Female	0.00736***	-0.0120***	0.00317***
	(0.000737)	(0.00120)	(0.000103)
Treat Early Diffusion X Firstborn Female	-0.0180***		
	(0.00193)		
Treat PNDT		-0.00507**	
		(0.00188)	
Treat PNDT X Firstborn Female		0.0246***	
		(0.00210)	
Treat BBBP			0.000258
			(0.000452)
Treat BBBP X Firstborn Female			0.000944
			(0.000710)
Observations	21150435	21150435	21150435
Mean of Dep. Variable	0.0599	0.0599	0.0599
SD	0.237	0.237	0.237

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: The dependent variable takes the value 1 if the woman gave birth in that year, and 0 otherwise. $TreatPNDT$ takes the value 1 if the PNDT Act is implemented in the state where the mother is located. $TreatEarlyDiffusion$ takes the value 1 if the woman gives birth between 1985 and 1994, and 0 if woman gives birth in or after 1995. $TreatBBBP$ takes the value 1 if the child belongs to one of the 100 districts in which the BBBP scheme was introduced and if the child is born after June 2015. Estimates include birth year fixed effects and state-specific time trends. Standard errors are clustered at the state level. The sample includes all children born between 1985-2016.

Mechanism: Proportion of girls born to a mother

	(1) All birth orders	(2) Birth order 2 plus
Treat PNDT	0.0204***	0.0306***
	(0.00481)	(0.00629)
Observations	648798	367006
Mean of Dep. Variable	0.474	0.487
SD	0.499	0.500

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

	(1) All birth orders	(2) Birth order 2 plus
Treat BBBP	-0.0261	-0.0379
	(0.0164)	(0.0256)
Observations	394932	212355
Mean of Dep. Variable	0.494	0.508
SD	0.500	0.500

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: Treat PNDT is whether the PNDT Act is implemented in the state. Treat BBBP takes the value 1 if the child belongs to one of the 100 districts in which the BBBP scheme was introduced and if the child is born after June 2015. All specifications includes mother fixed effects, year fixed effects and state-specific time trends. For the PNDT regression, the sample includes children born between 1985 and 2005, and the regression for BBBP includes children born between 2005 and 2016.

Mechanism: Birth spacing

	(1) Birth spacing (in months)
First Born Female	1.665***
	(0.0659)
Treat	0.0919
	(0.0549)
Firstborn Female X Treat PNDT	-0.270**
	(0.111)
Observations	5266795
Mean of Dep. Variable	39.97
SD	25.30
Firstborn Female	1.503***
	(0.0447)
Treat BBBP	0.503
	(1.410)
Firstborn Female X Treat BBBP	-1.652
	(1.894)
Observations	5266795
Mean of Dep. Variable	39.97
SD	25.30

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: Treat PNDT is whether the PNDT Act is implemented in the state.Treat BBBP takes the value 1 if the child belongs to one of the 100 districts in which the BBBP scheme was introduced and if the child is born after June 2015. All estimations include fixed effects firstborn girl x state and year of first birth x state. Sample includes the full set of births that take place between 1975 and 2016, and mothers with exactly two births. The dependent variable is defined as the number of months between a woman's first and second birth. Standard errors are clustered at the state

Conclusion

- We find that the ban on sex determination worsens outcomes for surviving girls relative to boys
- Families with firstborn girls have higher fertility, lower birth spacing and higher mortality in the post-ban period with worse child health outcomes
  - We compare our results to ABT(2020) and show that the access to and restriction of ultrasound technologies and abortions leads to symmetrically equal but opposite effects
- Our preliminary results on BBBP suggest the potential usefulness of demand-side elements to tackle gender bias
  - BBBP policy exposure reduced neonatal mortality(all births) & improved breastfeeding duration for female children for higher order births
- Our results imply supply side restrictions on SSA need to be thought through very carefully as it can lead to other forms of discrimination that undermine the purpose of the policy

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Thank you!

Appendix

Table: Mom FE: Mortality, B3P, 2005 and above, state and birth year FE

	Birth orders 2 and above			All birth orders		
	(1) IMR	(2) U5MR	(3) NNM	(4) IMR	(5) U5MR	(6) NNM
Female	-0.0143***	-0.0295	-0.0171***	-0.0216***	-0.0204	-0.0201***
	(0.00370)	(0.0209)	(0.00287)	(0.00264)	(0.0171)	(0.00205)
Treat	0.329**	0.0942	0.0225	0.339**	0.104	0.0319**
	(0.146)	(0.102)	(0.0232)	(0.140)	(0.0630)	(0.0144)
Treat X Female	-0.186	-0.0848	-0.0565**	-0.0588	-0.118	-0.0337*
	(0.205)	(0.139)	(0.0280)	(0.134)	(0.105)	(0.0180)
Observations	66600	4236	88223	129783	6814	173835
Mean of Dep. Variable	0.0839	0.613	0.0516	0.0714	0.614	0.0448
SD	0.277	0.487	0.221	0.257	0.487	0.207

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: Neonatal Mortality (NNM) takes the value 1 if a child died before completing 1 month. Infant Mortality (IMR) takes the value 1 if the child died before completing 1 year. Under-5 mortality (U5MR) takes the value 1 if a child died before completing 5 years. $Treat$ takes the value 1 if the child belongs to one of the 100 districts in which the BBBP scheme was introduced and if the child is born after June 2015. $Female$, defined at the child level, takes value 1 if child's gender is female. All estimations include mother fixed effects, birthyear fixed effects, and state-specific time trends. The treatment group includes children born after June 2015 and the control group includes children born between 2010 and 2014. The first 3 columns include children born at a birth order of two or higher, while the last three columns include children born at all birth orders. Standard errors are clustered at the district level.

Table: MOM FE: Breastfeeding, B3P, 2005 and above, state and birth year fixed effects

	(1) Birth orders 2 and above	(2) All birth orders
Female	-0.394	-0.00276
	(0.271)	(0.230)
Treat	-2.189	-1.734
	(2.057)	(1.327)
Treat X Female	4.871**	2.266
	(2.336)	(1.691)
Observations	8368	16930
Mean of Dep. Variable	5.193	5.064
SD	8.612	8.384

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: "Breastfed" refers to duration of breastfeeding in months. $Treat$ takes the value 1 if the child belongs to one of the 100 districts in which the BBBP scheme was introduced and if the child is born after June 2015. $Female$ takes the value 1 if the child's gender is female. All estimations include mother fixed effects, birthyear fixed effects, and state-specific time trends. The treatment group includes children born after June 2015 and the control group includes children born between 2010 and 2014. The first 3 columns include children born at a birth order of two or higher, while the last three columns include children born at all birth orders. Standard errors are clustered at the state level. The wild cluster bootstrap p values for the interaction terms are included in "bootstrapped p value".

District level budgetary provisions- 2014-15 (for 6 months)