

Parenthood Timing and Gender Inequality

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Motivation

Parenthood can explain most of the gender inequality in Western labor markets (Kleven et al., 2024)

- ▶ Women's and men's careers follow similar trajectories up to parenthood
- ▶ Substantial gaps emerge at the birth of the first child

Family-friendly policies generally seem to have little effect on gender inequality (Cortés & Pan, 2023)

- ▶ Existing policies are inadequate to address the career impacts of parenthood?
- ▶ Or parenthood not primary cause of gender disparities?

Quantifying the causal effects of parenthood is central to understanding gender inequity and designing policies to address it

Causal Identification Has Proven Challenging

Parenthood (timing) may be selective

- ▶ Human capital, wealth, health, career prospects, the cost of parenthood

Effects of parenthood may depend on parenthood timing

- ▶ Time spent in parenthood, career stage and age at the time of becoming a parent, age of the children

Addressing both simultaneously is an econometric challenge

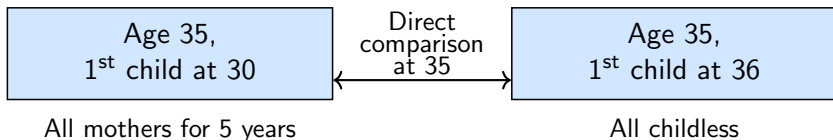
Leading Methods to Quantify the Effects of Parenthood

“Some of the most compelling evidence of the crucial role children (...) has been produced over the past few years” (Bertrand, 2020)

Two methods dominate the debate:

1. Event study (Kleven et al., 2019)
2. IV using in vitro fertilization (Lundborg et al., 2017)

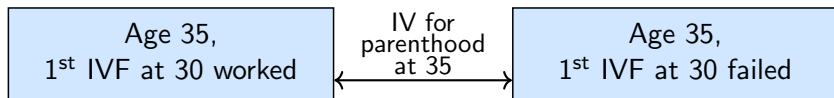
Event study:



- ▶ Clean comparison: specific moment in parenthood vs childlessness
- ▶ Selection is a concern; estimates reflect the effect of parenthood + difference in career trajectories in the absence of children

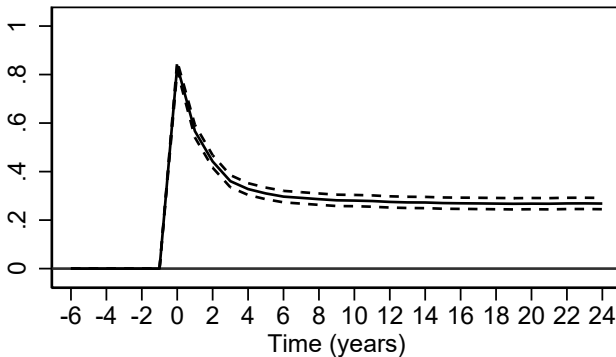
IV-IVF

- ▶ IVF is a type of assisted conception procedure
- ▶ Consider couples undergoing IVF for their first child
- ▶ In last procedure stage an embryo is transferred into uterus
- ▶ Assume conception from this transfer is as-good-as-random
 - ▶ Uncorrelated with past labor market outcomes cond. on age
- ▶ Success of first transfer creates plausibly exogenous variation in parenthood



- ▶ Most women eventually conceive after the first procedure fails...

First Stage: 1st IVF Success and Motherhood

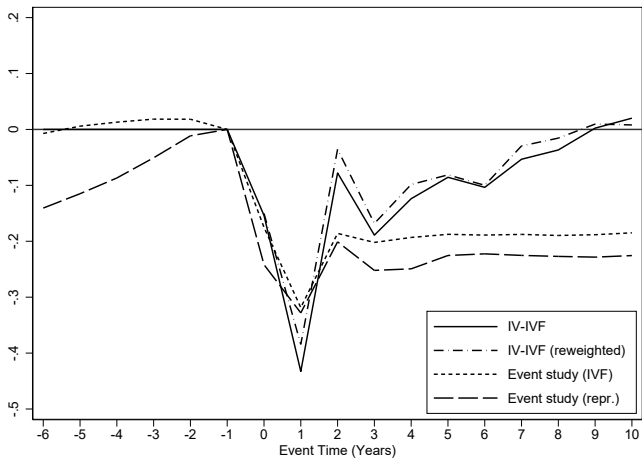


Source: Lundborg et al. (2024)

$$\tau_{RF} = \frac{1}{3}\tau_{Parenthood} + \frac{2}{3}\tau_{Timing}$$

$$\begin{aligned}\tau_{IV} &= \tau_{Parenthood} + 2\tau_{Timing} \\ &= 3\tau_{Parenthood} - 2\tau_{Later\ parenthood}\end{aligned}$$

IV vs ES: Earnings



Source: Lundborg et al. (2024)

Common Challenge in Applied Economics

1. Interested is the effect of program/treatment/intervention
2. Address selection leveraging (quasi-)experimental variation
3. Many (quasi-)experimental “shocks” are temporary
4. Conventional methods cannot separate the effect of treatment from the effect of treatment timing:
 - (A) Focus on reduced form: weighted average of treatment effect and timing effect
 - (B) Assume no timing effect: instrument treatment with assignment

Sometimes economic theory can suggest the direction of bias; not so much in the context of parenthood

This Paper

How much can we say about the causal effect of parenthood?

1. New approach using women's entire assisted conception procedures (ACP) histories
 - ▶ Robust to endogenous timing and dynamic effects
2. Empirical evidence using Dutch data
 - ▶ Focus on couples undergoing intrauterine insemination
3. Assess bias in existing methods
 - ▶ Quantify the extent of selectivity timing and dynamic effects
4. External validity

Literature

Gender inequality in labor market:

- ▶ Bertrand (2011); Blau & Kahn (2017) for overview

Literature on career impacts of children:

- ▶ Intensive margin: Rosenzweig & Wolpin (1980); Bronars & Grogger (1994); Angrist & Evans (1996); Jacobsen et al. (1999); Iacovou (2001); Cruces & Galiani (2007); Maurin & Moschion (2009); Hirvonen (2009); Vere (2011)
- ▶ Address selection: Hotz et al. (2005); Agüero & Marks (2008); Cristia (2008); Miller (2011); Brooks & Zohar (2021); Gallen et al. (2023)
- ▶ Address dynamic effects: Fitzenberger et al. (2013); Angelov et al. (2016); Adda et al. (2017); Chung et al. (2017); Bütikofer et al. (2018); Kleven et al. (2019); Eichmeyer & Kent (2022); Melentyeva & Riedel (2023)
- ▶ Selection and dynamic effects: Bensnes et al. (2023); Gallen et al. (2023)
 - ▶ Leverage women's first IVF, restrict effect heterogeneity across women and time via parametric assumptions, correct LR est. using SR est.

Methodological literature:

- ▶ Sequential experiments in biostatistics: Hernán & Robins (2020)
- ▶ Partial identification of treatment effects: Manski (1989, 1990); Zhang & Rubin (2003); Lee (2009)

Contribution

1. Estimates robust to selective fertility and dynamic effects
 - ▶ I demonstrate that accounting for these factors can reconcile the conflicting ES and IV estimates
2. External relevance
 - ▶ Netherlands vs Scandinavia
 - ▶ Intrauterine insemination vs IVF
3. Methodological approach applicable to various settings
 - ▶ Assignment to job training and educational programs, legal settings with assignment to varying leniency “judges”, clinical trials in extension phase

Model: Outcomes

- ▶ Particular moment since woman's first ACP
- ▶ Outcome when motherhood begins at first ACP:

$$Y(1)$$

- ▶ Childless outcome:

$$Y(0)$$

- ▶ Outcome when motherhood begins after first ACP:

$$Y(2)$$

These scenarios involve women trying to conceive through ACPs

- ▶ I will first focus on quantifying impacts in these scenarios
- ▶ Extrapolation to scenarios where women choose to remain childless afterward (external validity)

Model: Unobservables

Women differ in two unobserved characteristics:

- ▶ “Willingness” to undergo ACPs, $W \in \{1, \dots, \overline{w}\}$
 - ▶ Would try W times total in case all ACPs fail
- ▶ “Reliance” on ACPs, $R \in \{0, 1\}$
 - ▶ No child if all ACPs fail, $R = 1$
 - ▶ “Reliers” \supseteq “compliers” (no child if first ACP fails)

Model: Observables

- ▶ ACP j success indicator, Z_j
 - ▶ $Z_j = 0$ if failed or did not happen
 - ▶ Only ACPs before the first child
- ▶ Number of realized ACPs:

$$A = \min(\{j : Z_j = 1\} \cup \{W\})$$

- ▶ Parenthood indicator:

$$D = Z_A + (1 - Z_A)(1 - R)$$

- ▶ Realized outcome:

$$Y = Y(0)(1 - D) + Y(1)DZ_1 + Y(2)D(1 - Z_1)$$

Treatment Effect

Average treatment effect for reliers:

$$\tau_{ATR} = \mathbb{E}[Y(1) - Y(0)|R = 1]$$

Sequential Unconfoundedness

Assumption (Sequential Unconfoundedness)

$$(Y(1), Y(0), R, W) \perp\!\!\!\perp Z_j | A \geq j.$$

In words: once sperm/embryo at ACP j are implanted, whether this results in a conception is as-good-as-random

- ▶ $Y(1), Y(0), R$ and W can be related
- ▶ Main method relaxes to covariate-conditional version

Outline of the Approach

Objective is to perform a clean comparison:

- ▶ Women who conceive at first ACP vs similar childless women
- ▶ Challenge: selection into parenthood after 1st ACP fails
 1. Conceptions via subsequent ACPs
 2. Conceptions via non-ACP means
- ▶ I address 1. by leveraging women's complete ACP histories
- ▶ Births from 2. may be selective, I use a bounding approach

To present intuition, I consider 1. and 2. in isolation

Simple World: Max 1 ACP, All Reliers

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$$W = 1$$

(willing to try once)

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$$W = 1$$

(willing to try once)


$$Z_1 = 1$$


$$Z_1 = 0$$

Simple World: Max 1 ACP, All Reliers

$$W = 1$$

(willing to try once)


$$Z_1 = 1$$

$$\mathbb{E}[Y(1)]$$


$$Z_1 = 0$$

$$\mathbb{E}[Y(0)]$$

Simple World: Max 2 ACPs, All Reliers

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$$W = 1$$

(willing to try once)


$$Z_1 = 1$$


$$Z_1 = 0$$

Simple World: Max 2 ACPs, All Reliers

$$W = 1$$

(willing to try once)

$$Z_1 = 1$$

$$Z_1 = 0$$

$$W = 2$$

(willing to try twice)

$$Z_1 = 1$$

$$Z_1 = 0, Z_2 = 1$$

$$Z_1 = 0, Z_2 = 0$$

Simple World: Max 2 ACPs, All Reliers

$$W = 1$$

(willing to try once)

$$Z_1 = 1$$

$$W = 2$$

(willing to try twice)

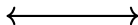
$$Z_1 = 1$$



$$Z_1 = 0$$



$$Z_1 = 0, Z_2 = 1$$

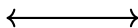
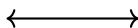
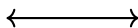
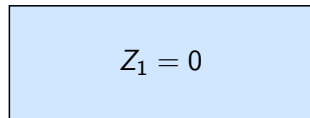
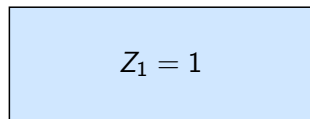


$$Z_1 = 0, Z_2 = 0$$

Simple World: Max 2 ACPs, All Reliers

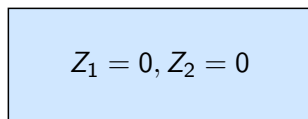
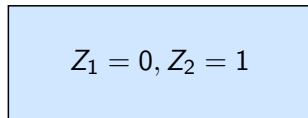
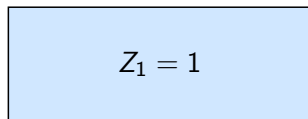
$W = 1$

(willing to try once)

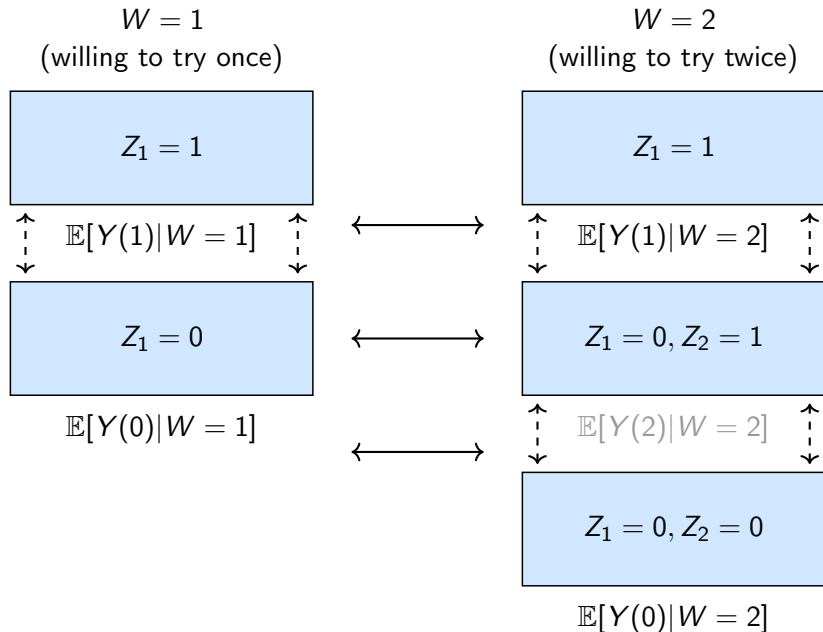


$W = 2$

(willing to try twice)



Simple World: Max 2 ACPs, All Reliers



Simple World (Observed): Max 2 Attempts, All Reliers

$$W = 1$$

(willing to try once)

$$W = 2$$

(willing to try twice)

$$Z_1 = 1$$

$$Z_1 = 0$$

$$Z_1 = 0, Z_2 = 1$$

$$Z_1 = 0, Z_2 = 0$$

Simple World (Observed): Max 2 Attempts, All Reliers

$$W = 1$$

(willing to try once)

$$W = 2$$

(willing to try twice)

$$Z_1 = 1$$

$$\mathbb{E}[Y(1)]$$

$$Z_1 = 0$$

$$\mathbb{E}[Y(0)|W = 1]$$

$$Z_1 = 0, Z_2 = 1$$

$$\mathbb{E}[Y(2)|W = 2]$$

$$Z_1 = 0, Z_2 = 0$$

$$\mathbb{E}[Y(0)|W = 2]$$

Simple World (Observed): Max 2 Attempts, All Reliers

$$W = 1$$

(willing to try once)

$$W = 2$$

(willing to try twice)

$$Z_1 = 1$$

$$\mathbb{E}[Y(1)]$$

$$Z_1 = 0$$

$$\mathbb{E}[Y(0)|W = 1]$$

$$Z_1 = 0, Z_2 = 1$$

$$\mathbb{E}[Y(2)|W = 2]$$

$$Z_1 = 0, Z_2 = 0$$

$$\mathbb{E}[Y(0)|W = 2]$$

Simple World (Observed): Max 2 Attempts, All Reliers

$$W = 1$$

(willing to try once)

$$W = 2$$

(willing to try twice)

$$Z_1 = 1$$

$$\mathbb{E}[Y(1)]$$

$$Z_1 = 0$$

$$\mathbb{E}[Y(0)|W = 1]$$

$$Z_1 = 0, Z_2 = 1$$

$$\mathbb{E}[Y(2)|W = 2]$$

$$Z_1 = 0, Z_2 = 0$$

$$\mathbb{E}[Y(0)|W = 2]$$

$$Pr(W = 1) = \frac{\text{red}}{\text{red} + \text{gray}}$$

Simple World: Max 1 ACP with Non-reliers

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$$W = 1$$

$$R = 1$$

(no child if fail)

$$R = 0$$

(child if fail)

Simple World: Max 1 ACP with Non-reliers

$$W = 1$$

$$R = 1$$

(no child if fail)

$$R = 0$$

(child if fail)


$$Z_1 = 1$$

Simple World: Max 1 ACP with Non-reliers

$$W = 1$$

$R = 1$
(no child if fail)

$R = 0$
(child if fail)

$$Z_1 = 1$$

$$Z_1 = 0, D = 0$$

$$Z_1 = 0, D = 1$$

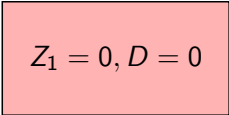
Simple World: Max 1 ACP with Non-reliers

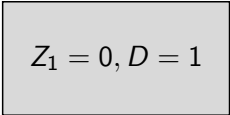
$$W = 1$$

$R = 1$
(no child if fail)

$R = 0$
(child if fail)


$$Z_1 = 1$$


$$Z_1 = 0, D = 0$$


$$Z_1 = 0, D = 1$$

$$Pr(R = 1) =$$



Simple World: Max 1 ACP with Non-reliers

$$W = 1$$

$R = 1$
(no child if fail)

$R = 0$
(child if fail)

$$Z_1 = 1$$

$$F_{Y(1)}$$

$$Z_1 = 0, D = 0$$

$$\mathbb{E}[Y(0)|R = 1]$$

$$Z_1 = 0, D = 1$$

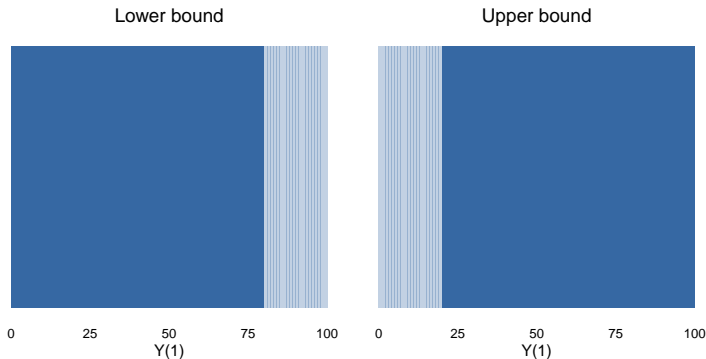
$$\mathbb{E}[Y(2)|R = 0]$$

$$Pr(R = 1) =$$



Intuition: Motherhood Outcome $Y(1)$

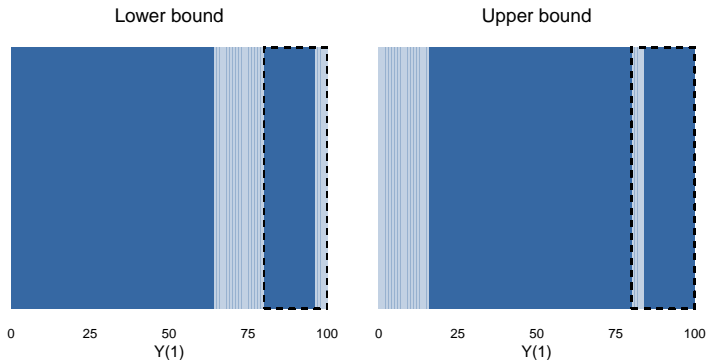
1. Treated group is a rep. sample but their types are unobserved
2. Identify $\Pr(R = 1) = 0.8$ on control group
3. Assume most extreme distributions of types in treated group
4. Bound $\mathbb{E}[Y(1)|R = 1]$



Intuition: Motherhood Outcome $Y(1)$ —Covariates

Pre-ACP covariates can help narrow the bounds:

- ▶ Can identify relier share at each covariate value
- ▶ Baseline bounds assume extreme scenarios where reliers have highest or lowest treated outcomes
- ▶ These distributions of treated outcomes might be inconsistent with conditional relier shares



Bounding τ_{ATR}

Construct the moment:

$$m^L(G, \eta^0) = Y 1_{\{Y < q(r(X_1), X_1)\}} \frac{Z_1}{e_1(X_1)} - Y(1 - D) \prod_{j=1}^A \frac{(1 - Z_j)}{(1 - e_j(X_j))}$$

- ▶ G is the observed data vector
- ▶ η^0 contains the following:
 - ▶ $e_j(X_j) = \Pr(Z_j = 1 | X_j)$
 - ▶ $q(r(X_1), X_1)$ is the $r(X_1)$ -th quantile of Y given X_1 and $Z_1 = 1$
 - ▶ $r(X_1)$ identifies the covariate-conditional relier share

Assumption (Conditional Sequential Unconfoundedness)

$(Y(k), R, W) \perp\!\!\!\perp Z_j \mid X_j$ for all j, k , and $X_j, A \geq j$.

Theorem (Lower Bound)

Under conditional sequential unconfoundedness and regularity, the sharp lower bound on τ_{ATR} is $\mathbb{E}[m^L(G, \eta^0)] / \mathbb{E}[r(X_1)]$.

Relation to Methodological Literature

Conceptions via ACPs: sequential experiments (Hernán & Robins, 2020)

- ▶ Key difference 1: treatment without assignment
- ▶ Key difference 2: selection into randomization (Van den Berg & Vikström, 2022)
- ▶ These methods are not applicable

Non-ACP conceptions: unobserved outcomes in experiments: (Zhang & Rubin, 2003; Lee, 2009)

- ▶ Can be adapted to bound effects of parenthood for compliers
- ▶ Key advantage 1: my bounds cover a more general group
- ▶ Key advantage 2: my bounds are mechanically narrower
- ▶ I use Lee (2009) as a benchmark

Estimating the Bounds

Distribution of $m^L(G, \eta^0)$ is complicated by $q(r(X_1), X_1)$

- ▶ Semenova (2023) addresses a closely related inference challenge
- ▶ Double/debiased machine learning approach
 1. Adjust $m^L(G, \eta^0)$ to make it insensitive to small error in $q(r(X_1), X_1)$
 2. Sample splitting
- ▶ Asymptotic inference as if $q(r(X_1), X_1)$ was known

New moment:

$$\psi^L(G, \xi^0) = m^L(G, \eta^0) + \text{corr}(G, \xi^0)$$

Identifies same parameter:

$$\mathbb{E}[\psi^L(G, \xi^0)] = \mathbb{E}[m^L(G, \eta^0)]$$

Insensitive to estimation error in $q(r(X_1), X_1)$:

$$\partial_{q(\cdot)} \mathbb{E}[\psi^{L+}(G, \xi_r)|X_1]|_{\xi_r=\xi_r^0} = 0 \text{ a.s.}$$

Assisted Conception Procedures

- ▶ IUI (main procedure): sperm injected into uterus
 - ▶ Minimally invasive, primary ACP in most countries
 - ▶ “Free” in NL
- ▶ IVF (secondary procedure): embryo inserted into uterus
 - ▶ Invasive treatment, performed under sedation/anesthesia
 - ▶ Eggs retrieved through the vaginal wall using a specialized needle
 - ▶ In NL, first 3 free; each subsequent costs between 1000 and 4000 EUR

Institutions

- ▶ Dutch family friendly policies similar to OECD average
 - ▶ 16 weeks of fully paid pregnancy+maternity leave
 - ▶ 1 week of paternity leave
 - ▶ Average time in child care similar to OECD average
 - ▶ Net child care cost 10% median household income
- ▶ Dutch employment intensity similar to OECD average
 - ▶ Employment among parents and non-parents relatively high
 - ▶ Part time work much more common
 - ▶ Approximately 15% two-parent families have both partners working part-time

Data

Administrative data from Statistics Netherlands

- ▶ Comprehensive hospital records cover fertility treatments from 2012 to 2017: procedure date and type
 - ▶ Success imputed as having child born within 10 months
- ▶ Tax records cover work hours and income from 2011 to 2023
 - ▶ Include maternity leave and pay
 - ▶ Main bounds account for uncertainty around actual work hours
- ▶ Birth dates, legal family connections, cohabitation
- ▶ Dispensed medication registry

Main sample: cohabiting couples undergoing ACP for their first child between 2013 and 2016: 15,523

Balance in 1st ACP

Table 1: First ACP Outcomes and Descriptives

	Success (1)	Fail (2)	Difference (1)-(2)	Dif. cond. age & educ. (1)-(2) cond.
Work (W)	0.882 [0.323]	0.863 [0.344]	0.019 (0.009)	0.008 (0.009)
Work (P)	0.884 [0.320]	0.865 [0.342]	0.019 (0.009)	0.013 (0.009)
Hours (W)	1240.315 [604.666]	1207.860 [635.194]	32.455 (16.183)	18.702 (16.560)
Hours (P)	1474.530 [658.231]	1438.590 [695.692]	35.940 (17.713)	18.579 (17.870)
Income 1000s € (W)	28.065 [19.559]	27.418 [20.219]	0.647 (0.516)	0.745 (0.546)
Income 1000s € (P)	37.205 [26.482]	36.952 [29.452]	0.252 (0.746)	0.364 (0.730)
Bachelor deg. (W)	0.480 [0.500]	0.451 [0.498]	0.029 (0.013)	
Bachelor deg. (P)	0.394 [0.489]	0.381 [0.486]	0.013 (0.012)	
Age (W)	31.638 [4.015]	32.388 [4.383]	-0.750 (0.111)	
Age (P)	34.675 [5.513]	35.461 [5.996]	-0.786 (0.152)	
Observations	1,714	13,809		
Joint <i>p</i> -val.			0.000	0.928

Note: Labor market outcomes measured year before first ACP. (W) - woman, (P) - partner. Last column uses inverse probability weights for the first ACP that follow the main specification. Standard deviations in brackets. Standard errors in parentheses.

Balance in Subsequent ACPs

Table 2: Balance in Later ACPs

	Z ₂	Z ₃	Z ₄	Z ₅	Z ₆	Z ₇	Z ₈	Z ₉	Z ₁₀
Work (W)	0.009 (0.010)	-0.004 (0.011)	0.022 (0.011)	0.014 (0.012)	0.039 (0.012)	-0.003 (0.017)	-0.011 (0.018)	0.022 (0.019)	0.030 (0.024)
Work (P)	0.006 (0.010)	0.016 (0.010)	0.012 (0.012)	0.020 (0.012)	-0.004 (0.015)	-0.004 (0.015)	-0.019 (0.019)	0.017 (0.020)	0.030 (0.027)
Hours (W)	32.885 (18.721)	-4.482 (20.032)	52.999 (21.045)	41.332 (22.686)	81.957 (25.131)	11.894 (31.187)	-18.836 (32.937)	72.659 (38.210)	24.819 (48.490)
Hours (P)	21.655 (21.018)	24.730 (21.089)	23.756 (23.574)	38.965 (25.255)	9.666 (30.585)	-6.580 (31.513)	-28.458 (37.976)	30.525 (44.856)	43.722 (52.821)
Income 1000s € (W)	1.481 (0.615)	-0.015 (0.624)	1.685 (0.767)	1.802 (0.830)	2.086 (0.913)	0.150 (1.000)	-0.043 (1.092)	0.866 (1.234)	-0.444 (1.629)
Income 1000s € (P)	-0.749 (0.835)	1.002 (0.912)	2.040 (1.066)	0.800 (1.115)	0.774 (1.424)	0.025 (1.424)	0.259 (1.563)	-0.324 (1.737)	0.149 (2.203)
Observations	12,974	10,774	8,726	6,977	5,411	3,944	2,723	1,850	1,174
Joint <i>p</i> -val.	0.175	0.976	0.234	0.303	0.140	1.000	0.956	0.704	0.917

Note: Each column describes the difference in average characteristics between women for whom the respective ACP succeeds and those for whom it fails, among those who undergo the procedure, using inverse probability weights for each ACP following the main specification. Labor market outcomes and age measured year before first treatment. (W) - woman, (P) - partner. Standard errors in parentheses.

ACP histories

Estimated Success Probabilities

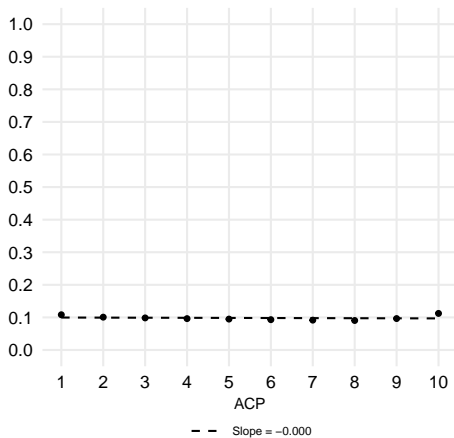


Figure 1: Estimated Success Probabilities

Comparison to Representative Sample

Table 3: Full Sample, Reliers, and Representative Sample

	Success (1)	Fail (2)	Reliers (3)	Rep. (4)	Success vs rep. (1)-(4)	Rel. vs rep. (3)-(4)
Work (W)	0.882 [0.323]	0.863 [0.344]	0.820 [0.333]	0.801 [0.399]	0.080 (0.010)	0.019 (0.005)
Work (P)	0.884 [0.320]	0.865 [0.342]	0.849 [0.344]	0.783 [0.412]	0.101 (0.010)	0.066 (0.005)
Hours (W)	1240.315 [604.666]	1207.860 [635.194]	1117.711 [582.334]	1076.204 [696.245]	164.111 (16.856)	41.508 (8.412)
Hours (P)	1474.530 [658.231]	1438.590 [695.692]	1390.699 [662.920]	1250.948 [793.536]	223.582 (19.211)	139.752 (9.576)
Income 1000s € (W)	28.065 [19.559]	27.418 [20.219]	24.976 [15.359]	21.362 [18.330]	6.703 (0.444)	3.615 (0.222)
Income 1000s € (P)	37.205 [26.482]	36.952 [29.452]	35.299 [24.304]	28.107 [29.076]	9.098 (0.704)	7.193 (0.351)
Bachelor deg. (W)	0.480 [0.500]	0.451 [0.498]	0.398 [0.411]	0.411 [0.492]	0.069 (0.012)	-0.012 (0.006)
Bachelor deg. (P)	0.394 [0.489]	0.381 [0.486]	0.329 [0.397]	0.345 [0.475]	0.049 (0.012)	-0.015 (0.006)
Age (W)	31.638 [4.015]	32.388 [4.383]	33.480 [3.897]	28.713 [4.658]	2.926 (0.113)	4.767 (0.056)
Age (P)	34.675 [5.513]	35.461 [5.996]	36.580 [3.928]	28.713 [4.665]	5.962 (0.113)	7.868 (0.057)
Observations	1,714	13,809	4,882	376,152		

Note: Labor market outcomes measured year before first ACP for main sample and year and 9 months before birth of first child for the representative sample. Representative sample is selected to match the main sample by year of conception. Average relier outcomes are based on sample of women who remain childless 7 years after their first ACP with weights described under implementation. (W) - woman, (P) - partner. Standard deviations in brackets. Standard errors in parentheses.

Results: Bounds

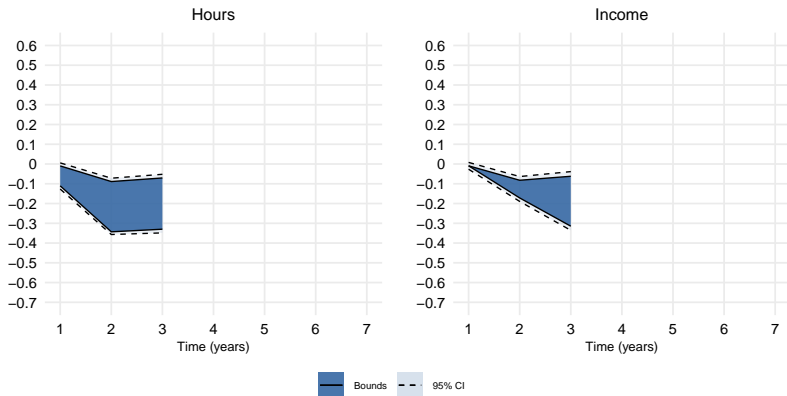


Figure 2: Bounds for women - short run

Baseline Lee bounds

Absolute effects

Results: Bounds

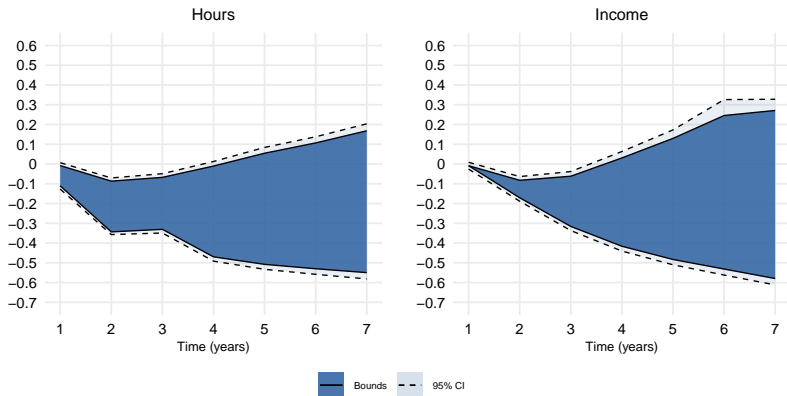


Figure 3: Bounds for women - medium run

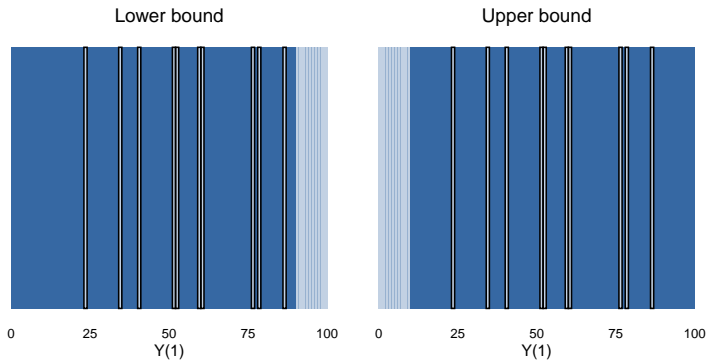
Baseline Lee bounds

Absolute effects

Narrowing the Bounds Further

Use additional information which mother are reliers:

- ▶ Some women have non-ACP children after ACP succeeds
- ▶ May be reasonable to assume they are not reliant on ACPs
- ▶ Consistent with being determined to have at least one child
- ▶ Can exclude such women before selecting reliers



Bounds with Monotonicity

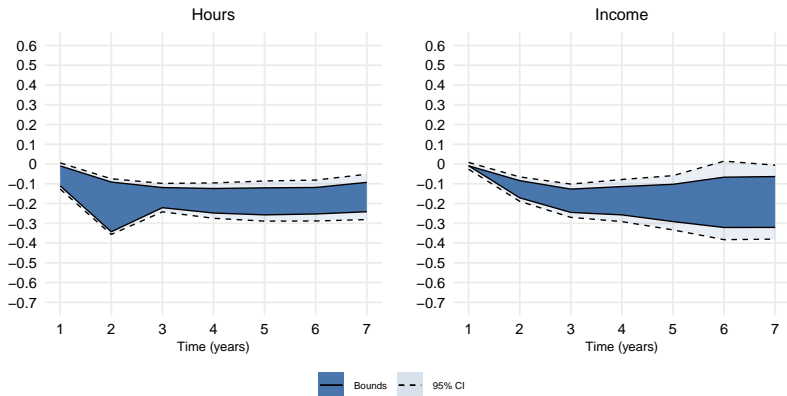


Figure 4: Bounds for women with monotonicity

Absolute

How wide?

Bounds for Men

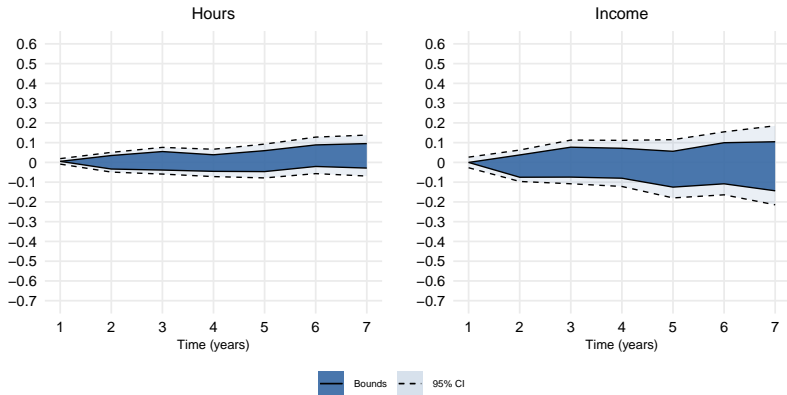


Figure 5: Bounds fo men

Gender Inequality

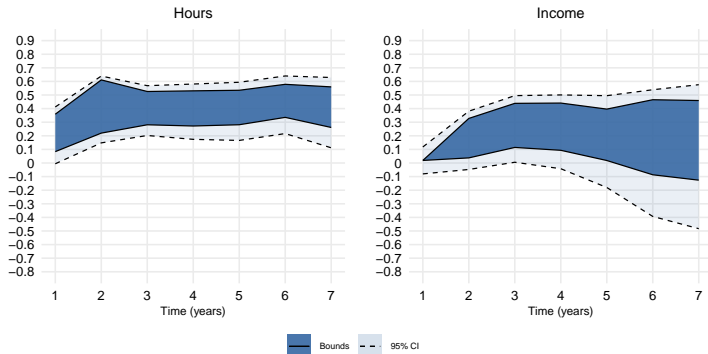


Figure 6: Share of gender inequality caused by parenthood

Next

- ▶ Comparison with Lee (2009) →
- ▶ Bias in IV and ES →
- ▶ Mental health side effects →
- ▶ Conclusion →

Comparison with Lee (2009)

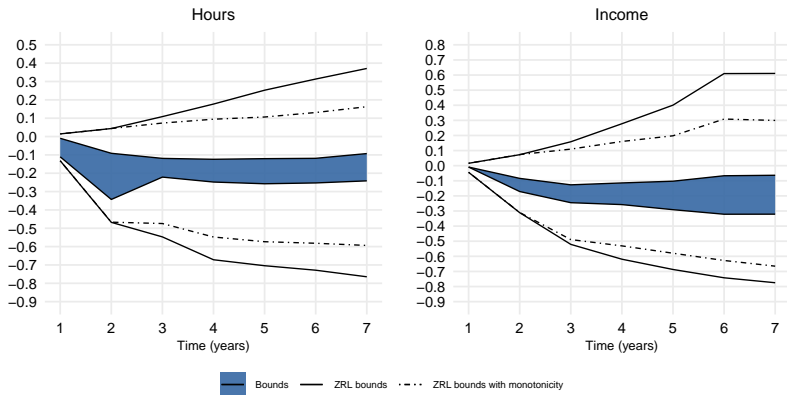


Figure 7: Comparison with Lee (2009) Bounds for Effects on Women

Naive Comparison to Existing Methods

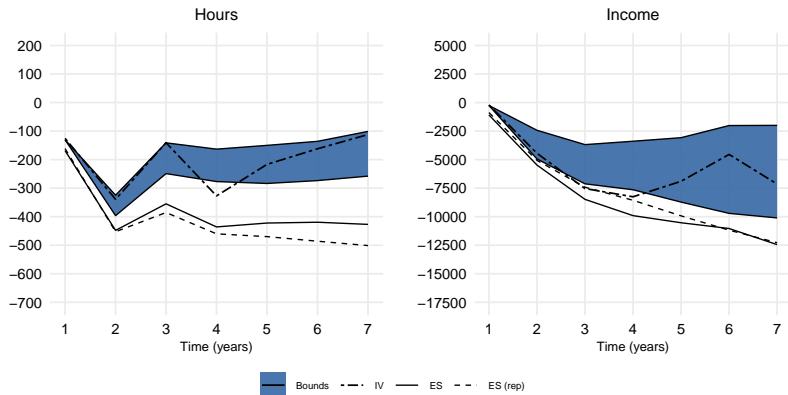


Figure 8: Estimates based on different methods

Quantifying bias in Existing Methods

IV-IVF:

- ▶ Linear combination: effect of parenthood and effect of delaying parenthood
- ▶ I have bounded τ_{ATR}
- ▶ I can point-identify τ_{ATR} assuming statis effects
- ▶ Bounds on the effect of delaying parenthood

Event Study:

- ▶ Imputes childless career trajectories from pre-parenthood outcomes of older mothers
- ▶ I can construct representative group of childless reliers
- ▶ Placebo event study
- ▶ Quantify difference in career trajectories between women with different fertility timing in the absence of children

Effect of Delaying Motherhood

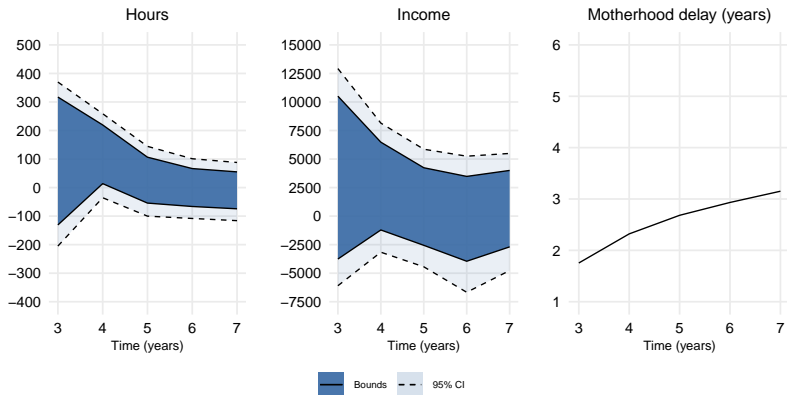


Figure 9: Effect of delaying relative to motherhood at first attempt

$$\tau_{IV} = \tau_{Parenthood} - 2\tau_{Delay}$$

Placebo Event

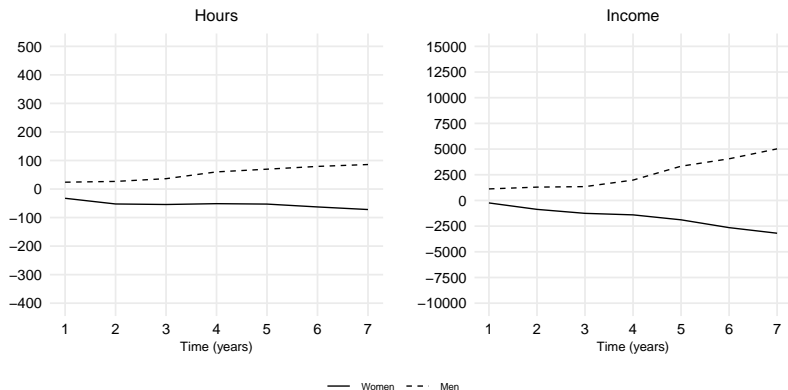


Figure 10: Placebo event study

- Negative selection of early mothers and positive selection of fathers

Gender Inequality: Parenthood and Selection

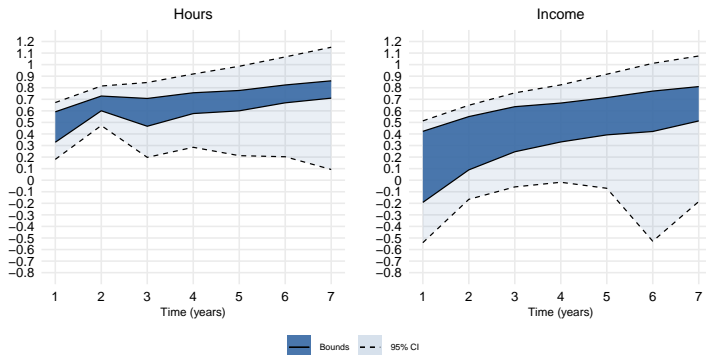


Figure 11: Share of gender inequality explained by section and parenthood

- Consistent with ES estimates attributing almost all gender inequality to parenthood

Mental Health and ACPs

Mental health consequences associated with failure to conceive are a part of the story:

- ▶ Unmet fertility goals may negatively impact mental health, and in turn, labor market outcomes

There are, however, additional concerns:

- ▶ Mental health issues caused specifically by failed conception or ACPs (external)
 - ▶ Focusing on intrauterine insemination helps mitigate this
- ▶ Large impacts unique to ACP families (external)
- ▶ Worsened mental health by threatening monotonicity (internal)

In practice, these impacts may be small (Lundborg et al., 2024)

Monotone Bounds for Non-depressed Childless Women

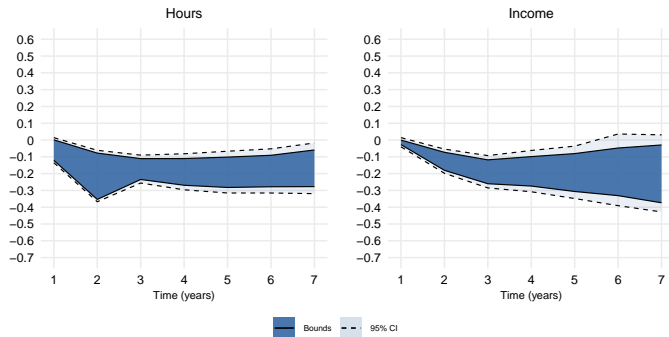


Figure 12: Monotone bounds for women who would not uptake antidepressants if they were to remain childless

Conclusion

Method for evaluating the career cost of parenthood:

- ▶ Robust to selective fertility and dynamic effects
- ▶ Applicable to various settings with sequential treatment assignment and selection

Application to Dutch data:

- ▶ Motherhood reduces work hours and income by 9% to 24%
- ▶ Parenthood causes up to 50% of post-child gender inequality

Relative to conventional methods:

- ▶ IV-IVF might understate the career cost of motherhood
- ▶ ES might overstate the cost of motherhood and benefits of fatherhood
- ▶ Accounting for selection and dynamic effects can reconcile the results

Policy:

- ▶ Large share of gender ineq. may not be due to parenthood per se
- ▶ Family policies may still help by shaping behavior up to parenthood

Extensions

- ▶ Confidence interval comparison Confidence intervals
- ▶ Inequality correcting for age De-aging partners
- ▶ Stable complier group Childless final period
- ▶ Estimator without DML Estimates
- ▶ Monotonicity Discussion Direction Partnered only Partnership and depression Test
- ▶ Testing Bensnes et al. (2023); Gallen et al. (2023) Estimates
- ▶ Heterogeneity Willingness to try
- ▶ Population imputation* ES pop. Mother. imp. Childless imp. Effect imp.

ACP Histories

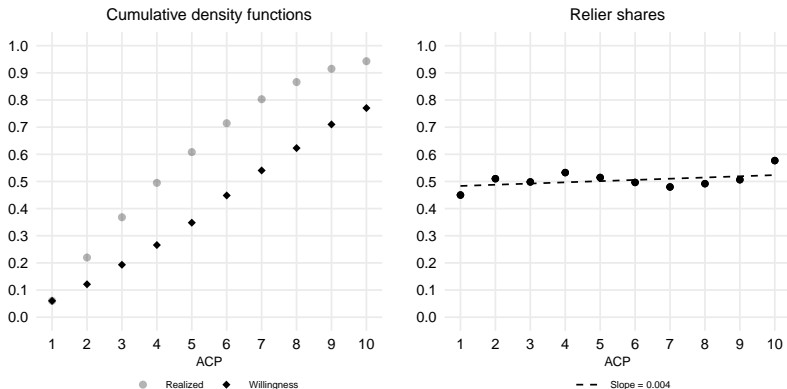


Figure 13: ACP Histories and Reliance

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[ToC](#)

What are the counterfactuals?

Broadly:

- ▶ Do not want/plan children
- ▶ **Want/plan children**

Motherhood outcome:

- ▶ Get immediately
- ▶ Get naturally after few attempts
- ▶ **Get with medical assistance**

Childless outcome:

- ▶ Do not try
- ▶ Try and fail naturally
- ▶ **Try and fail with medical assistance (+ naturally?)**

Extrapolation requires carefully addressing mental health consequences of failure (and medical procedures)

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Confidence Intervals

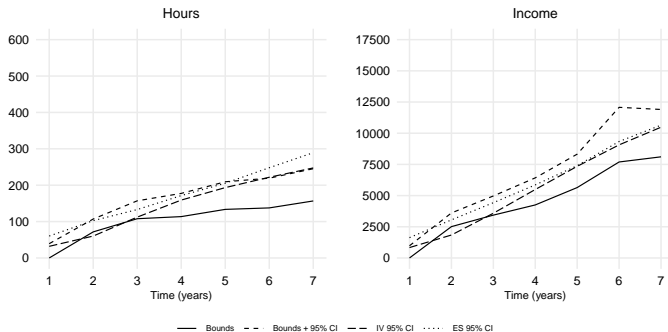


Figure 14: 95% CI for different methods

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Monotonicity

Is monotonicity realistic?

- ▶ Yes, if families are determined to have at least one child.
 - ▶ Decreasing marginal returns to children.
 - ▶ Stronger sufficient assumption: success cannot increase total (natural) births.
- ▶ No, if first treatment success increases the likelihood of attempting to conceive naturally.
 - ▶ Couples may realize they are fertile and try more.
 - ▶ First child may “save the relationship” resulting in more attempts to conceive.

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Monotone Bounds: Women who Remain Childless

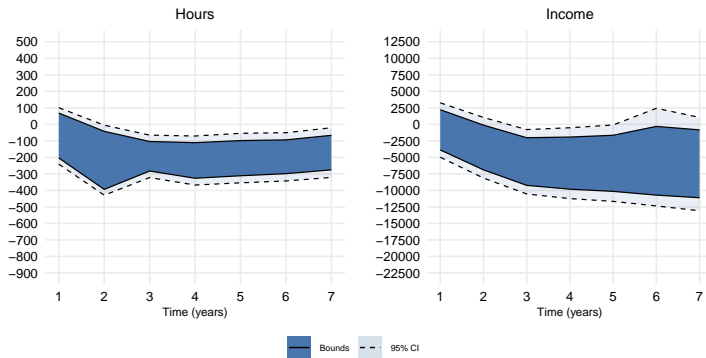
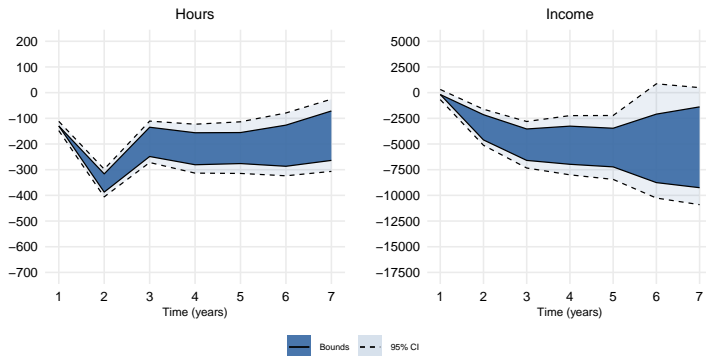


Figure 15: Monotone bounds using final status

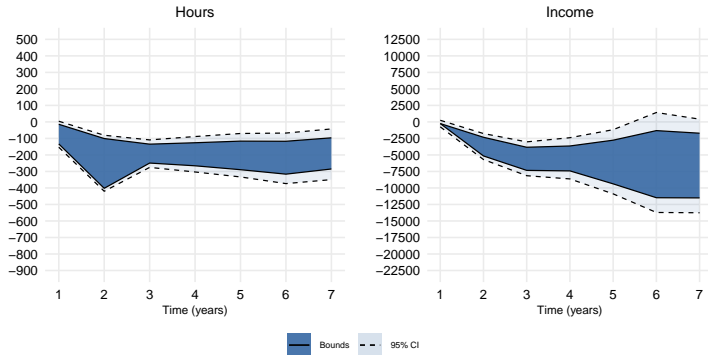
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Simple estimator



- ▶ $\mathbb{E}[Y(1)|R = 1] = \mathbb{E}[g(X_1) + \varepsilon|R = 1]$
- ▶ $\mathbb{E}[g(X_1)|R = 1]$ identified on chillness reliers using baseline method
- ▶ Only need to bound $\mathbb{E}[\varepsilon|R = 1]$

Relaxing Monotonicity Direction



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Relaxing Monotonicity to Partnered Women

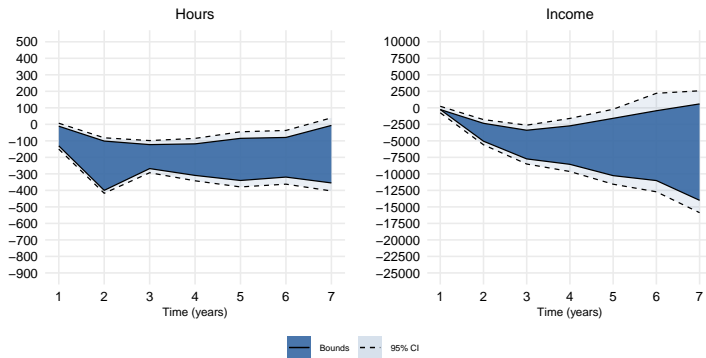


Figure 16: Monotone bounds using women who stay partnered

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Relaxing Monotonicity for Depression and Partnership

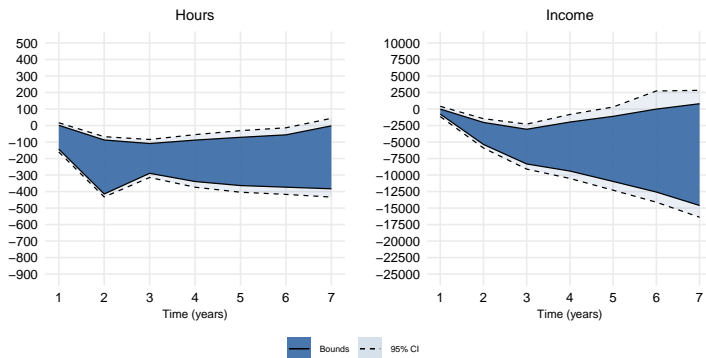
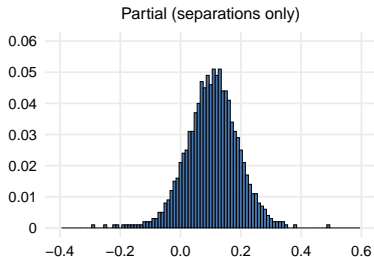
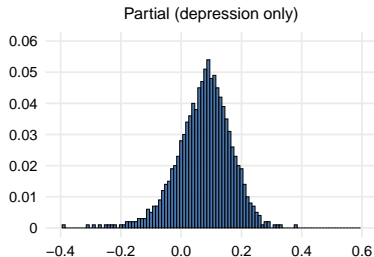
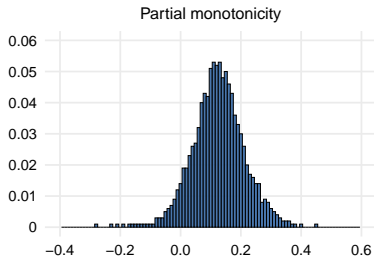
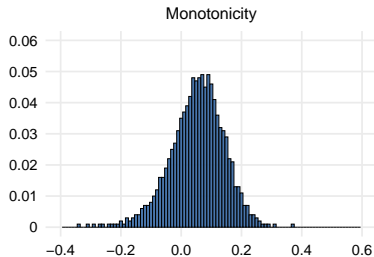


Figure 17: Monotone bounds using women who stay partnered and do not uptake antidepressants

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Testing Monotonicity



Heterogeneity by Willingness to Undergo Procedures

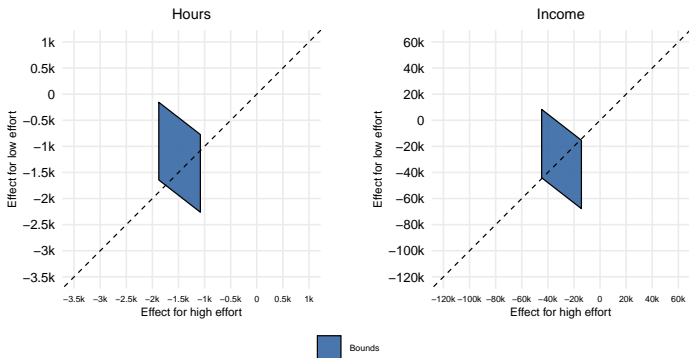


Figure 18: Cumulative outcomes 6 years after, G above or below 6

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Monotone Bounds: Excluding Depression

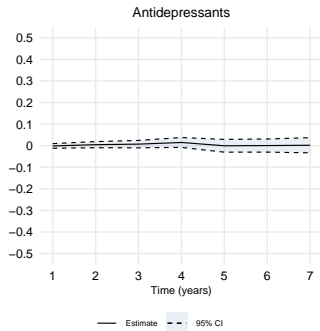


Figure 19: Effect on antidepressant take-up

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Monotone Bounds: Correcting for Partner's age

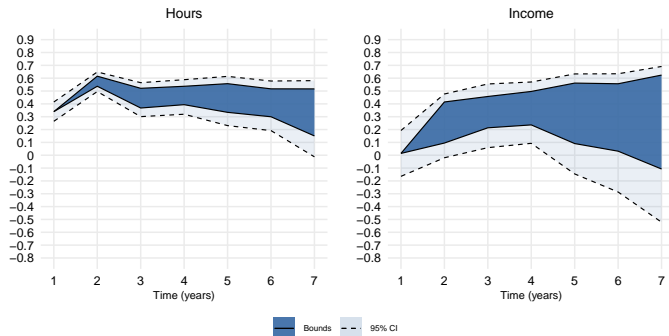


Figure 20: Monotone bounds using male income at same age as female

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Monotone Bounds: Women who Remain Childless

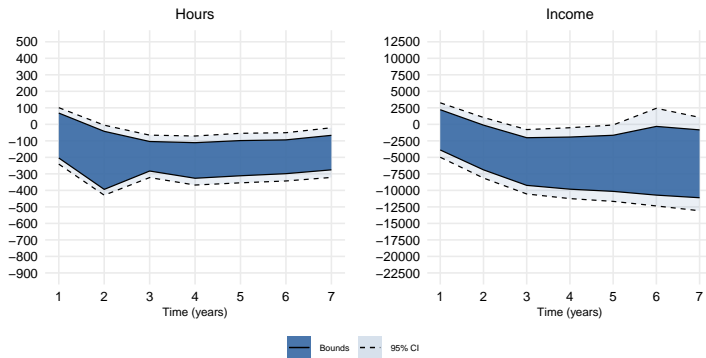


Figure 21: Monotone bounds using final status

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Testing the Plug-in Approach

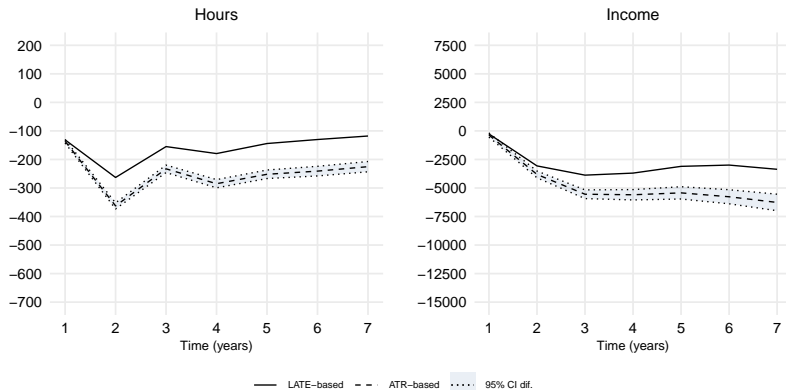


Figure 22: Plug-in estimators exploiting different number of treatments

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Event Study: Population vs IUI Sample

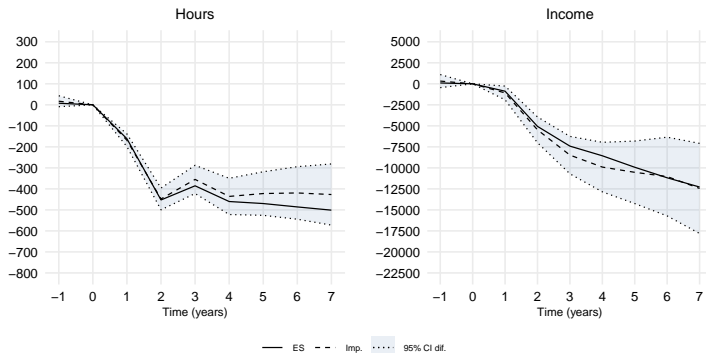


Figure 23: ES for population and women with first IUI success

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Imputing Population Motherhood Outcomes Using IUI Sample

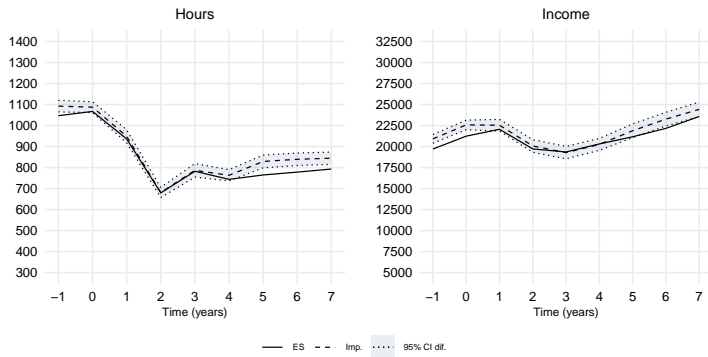


Figure 24: Population Outcomes vs IUI-imputation (age & education)

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Imputing Population Childless Outcomes Using IUI Sample

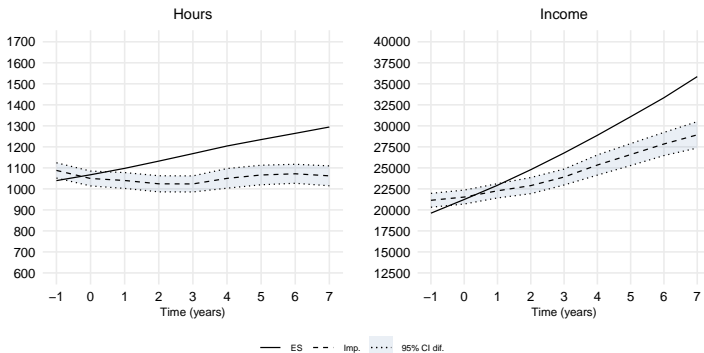


Figure 25: Population Outcomes vs IUI-imputation (age & education)

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Event Study vs IUI-imputation for Population

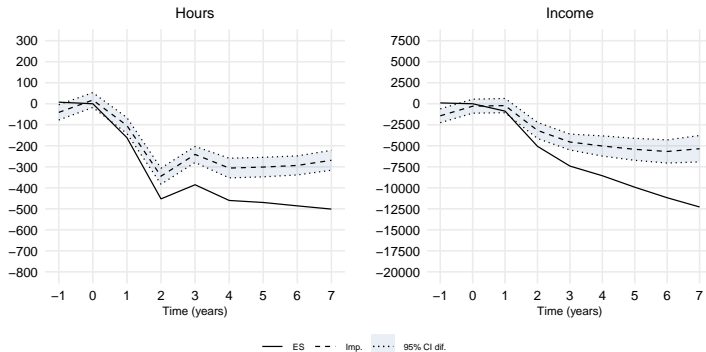


Figure 26: Event study vs IUI-imputation for population (age & education)

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