Effects of Fertility on Life Outcomes among Older Adults: A Novel Genetic Instrumental Variable Approach

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Background

- A large literature has been focusing on the effects of fertility on life outcomes
- Challenging to identify causal effects due to endogeneity of fertility behavior
  - Factors determines fertility also influence life outcomes
- Instrumental variables are widely used to make causal identification.
  - Twin IV: exogenous variation due to multiple second births
  - Sex IV: first two children of the same siblings, assuming random variation in gender composition
  - Classical IVs have been used to study Labor market outcomes (Angrist and Evans 1998), children's human developmental outcomes (Angrist, Lavy, and Schlosser 2010), non-cognitive skills (Fletcher and Kim 2019), subjective well-being (Priebe 2020)
  - Limitation: applicable only to parents with at least two children

Method: A Couple-level Genetic Instrumental Variable

First Stage: $F_j = \alpha_0 + \alpha_1 G_{0j}^{NEB} + \alpha_2 G_{1j}^{NEB} + \alpha_3 G_{0j}^{NEB} \times G_{1j}^{NEB} + \boldsymbol{X_{ij}\gamma} + \epsilon_{ij}$

Second Stage: $Y_{ij} = \beta_0 + \beta_1^{IV} \hat{F}_j + \beta_2 G_{0j}^{NEB} + \beta_3 G_{1j}^{NEB} + \boldsymbol{X_i \delta} + \varepsilon_{ij}$

Notes: F_j stands for the couple's realized fertility, G^{NEB} stands for PGS for the number of children ever born (Barban et al. 2016) , and i stands for wife or husband that is embedded in couple j

- Proposed IV: $G_{0j}^{NEB} \times G_{1j}^{NEB}$
  - (Relevance Assumption) Because fertility is a couple-behavior, couples' genetic dispositions for fertility have a multiplicative effect on fertility behavior: α_3 >0
  - (Independence Assumption) conditional on main effects, genetic multiplicative effects are independent form any unobserved confounders ($Cov(\varepsilon_{ij}, G_{0j}^{NEB} \times G_{1j}^{NEB} | G_{0j}^{NEB}, G_{1j}^{NEB}, \boldsymbol{X_{ij}}) = 0$)
  - (Exclusion Restriction): genetic multiplicative effects affect life outcome only through realized fertility ($Cov(Y_{ij}, G_{0j}^{NEB} \times G_{1j}^{NEB} | F_j, G_{0j}^{NEB}, G_{1j}^{NEB}, \boldsymbol{X_{ij}}, \epsilon_{ij}) = 0$)
- Compared to the classical IVs
  - Applicable to all parents regardless of number of children
  - Different local average treatment effect (LATE)
    - Compliers to Sex IV are parents who prefer equal sex ratio
    - Compliers to Fertility IV are those whose fertility behavior can be affected by genetic dispositions.

Data: Health and Retirement Study (HRS)

- HRS
  - A nationally representative longitudinal panel study of older adults in the United States that began in 1992.
  - Contains genetic data (collected since 2006) and couple-level data.
- We construct a dataset of 3,282 unique HRS couples
  - Unique couples report only one spouse in the dataset.
- Outcome variable measures
  - Work history: ever worked or not number of jobs worked, total years worked
  - Economic well-being: income and wealth (multiple wave average, hyperbolic sine transformation)
  - Non-cognitive skills: Big-5 personality traits (multiple wave average)

First Stage Results: Strength of the Proposed IV

	Model 1	Model 2	Model 3
	Outcome: Number of Children Ever Born		
Husband's PGS	0.322***	0.326***	0.316***
	(0.025)	(0.025)	(0.025)
Wife's PGS	0.428***	0.429***	0.434***
	(0.027)	(0.027)	(0.028)
Husband's PGS × Wife's PGS	**0.103*** (0.025)**	**0.104*** (0.025)**	**0.102*** (0.026)**
Husband's Age	-0.011*	-0.011*	-0.011*
	(0.005)	(0.005)	(0.005)
Wife's Age	0.039***	0.039***	0.039***
	(0.005)	(0.005)	(0.005)
Education PGS, Main & Interaction		Controlled	Controlled
Couple's PCs, Main Effects	Controlled	Controlled	Controlled
Couple's PCs, Interaction Effects			Controlled
F-statistics for the interaction term.	16.55	16.86	15.87
R-Squared	0.20	0.20	0.23
N	6,564	6,564	6,564

Note: † p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

- Model 3 is the final first stage model to be used in the subsequent analyses
  - To account for the possibility that the interaction effects are confounded by population structure, Model 3 includes all the 100 interaction terms between couples' PCs.
  - Controlling for EA PGS (Lee et al. 2018) helps to account for pleiotropy that may violate exclusion restriction
- Strong and positive genetic multiplicative effects on fertility

Falsification Test: Validity of the Proposed IV

Table 1. Regression Estimates of the Effect of Fertility on Years of Schooling

	Model 1	Model 2	Model 3
Model Type	Couple's Mean Years of Schooling	Husband's Years of schooling	Wife's Years of schooling
Ordinary Least Square (OLS)	-0.111***	-0.074*	-0.147***
	(0.028)	(0.037)	(0.029)
Two-State Least Square (2SLS)	0.218	0.367	0.125
	(0.314)	(0.437)	(0.324)
Intention to Treatment (ITT)	0.026	0.040	0.015
	(0.031)	(0.042)	(0.032)
Control Variables	Yes	Yes	Yes

Note: † p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001. In ITT model, the coefficients reflect the direct regression of the genetic interaction term on years of schooling.

- Because education is supposed to affect fertility, not the other way around, OLS coefficients of education on fertility would reflect the bias association due to reverse causality.
- As expected, 2SLS results indicate that fertility does not casually affect education. This evidence supports the validity of our genetic IV.

Second Stage Results: Work History Outcomes and Economic Well-being

Table 2. OLS and 2SLS Estimates of the Effects of Fertility on Work History Outcomes by Gender. Control Variables Adjusted

	Model 1	Model 2	Model 3
Subgroup	Ever Worked	Total years of working	Number of Jobs
	OLS		
Male	-0.001	0.120	-0.018
	(0.001)	(0.102)	(0.016)
Female	-0.008***	-1.446***	-0.070***
	(0.002)	(0.151)	(0.014)
	2SLS		
Male	0.004	-0.838	-0.343†
	(0.01)	(1.220)	(0.203)
Female	-0.029	-5.081**	-0.344†
	(0.028)	(1.945)	(0.177)
Control Variables	Yes	Yes	Yes

Note: † p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 3. OLS and 2SLS Estimates of the Effects of Fertility on Economic Well-being Outcomes by Gender.

	Model 1	Model 2	Model 3
Subgroup	Long-term Household Income	Long-term Net Household Wealth	Long-term Labor Income
	OLS		
Male	-0.03***	-0.215***	0.044
	(0.008)	(0.044)	(0.05)
Female	-0.029**	-0.210***	-0.124*
	(0.009)	(0.045)	(0.054)
	2SLS		
Male	-0.054	-0.568	0.217
	(0.1)	(0.522)	(0.594)
Female	-0.009	-0.504	-0.009
	(0.101)	(0.530)	(0.643)
Control Variables	Yes	Yes	Yes

Note: † p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Second Stage Results Cont'd: Personality Traits

Table 4. OLS and 2SLS Estimates of the Effects of Fertility on Personality Outcomes by Gender. Control Variables Adjusted

	Model 1	Model 2	Model 3	Model 4	Model 5
Subgroup	Neuroticism	Extraversion	Openness	Agreeable-ness	Conscientio-usness
	OLS				
Male	-0.004	0.010	-0.011	0.014*	-0.005
	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)
Female	-0.009	-0.003	-0.010	0.013**	-0.007
	(0.008)	(0.007)	(0.007)	(0.005)	(0.005)
	2SLS				
Male	0.035	-0.097	0.056	-0.039	-0.020
	(0.08)	(0.08)	(0.074)	(0.069)	(0.060)
Female	-0.059	-0.174*	-0.022	-0.110†	-0.052
	(0.085)	(0.087)	(0.077)	(0.061)	(0.057)
Control Variables	Yes	Yes	Yes	Yes	Yes

Note: † p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Summary of Findings

- Couples' genetic dispositions have strong and positive interaction effects on their fertility behavior
- Falsification test supports the validity of our proposed IV.
- Fertility causally affects older adults' life outcomes in a gendered pattern
  - With the proposed genetic IV, we found that fertility significantly reduces women's years of working and extraversion.
  - With marginally significant evidence, fertility seems to reduce women's agreeableness and men and women's number of jobs worked as well.
  - Additional analysis (not included in this poster due to limitation of spaces) indicates that fertility improves males', but not females' cognitive abilities.
- Gender differences are likely to result from the gendered division of childcare responsibilities

Limitations and Next Steps

- Limitations
  - Proposed genetic IV is restricted to couple data. This restricts the applicability of the proposed IV
  - Limited power of the fertility PGS (heritability less than 1% in Barban et al. 2016)
- Next steps
  - Apply the proposed genetic IV to UK Biobank dataset to obtain better statistical power.

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