Life-Cycle Fertility, Human Capital, and Family Policies: A Discrete-Continuous Choice Framework

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Motivation

Female labor supply and fertility behavior entail complex dynamics

- Childrearing demands, disproportionately borne by women, impact labor supply
- Labor supply provides monetary resources but it can make having children difficult

These choices can have substantial socio-economic consequences

- Declining fertility rates can affect intergenerational wealth transfers, demand for public infrastructure, privately produced goods
- Higher female labor supply can increase tax revenue and economic growth

Motivation (Continued)

- **Policy interventions:** numerous policies have aimed at supporting both fertility and women's labor supply. (Committee on Women's Rights, 1990; Olivetti and Petrongolo, 2017; Albanesi, Olivetti, and Petrongolo, 2022)

- **Challenges in policy evaluation:**
  - High dynamic interdependence between female labor supply and fertility behavior
  - The complexity of the policy arrangements (ex: interaction between tax schedules and leave policies)

- **Our objective:** to provide an encompassing assessment of the impact of numerous policy alternatives while addressing these challenges

This Paper Does

Policy variation + a structural discrete-continuous choice model

- Extensive quasi-experimental variation over time and across US states in leave and tax-transfer policies
- A structural discrete-continuous choice model
- Assessment of the effects of policies on:
  - women's labor market decisions and outcomes
  - fertility decisions
  - tax revenue and policy costs
- Fully integrate policy variation to obtain the effects of hypothetical national policy implementations
- **Bonus:** prove identification of the utility function (also uses the policy variation)

Preview of Main Results

- **Labor**
  - All leave policies increase labor market outcomes, such as participation and income over the life cycle, despite a higher motherhood penalty
  - FMLA (which has a single eligibility tier) and leave policies with two-tier eligibility are particularly effective at increasing labor market attachment and income
- **Fertility**
  - Leave policies generally reduce completed fertility, particularly two-tier policies that combine protected and paid leave
  - Tax-transfer regimes with high child transfers lead to higher completed fertility, they can offset some of the negative effects of leave policies on fertility
- **Tax revenue and policy costs**
  - All leave policies increase tax revenue over the life cycle net of policy costs; two-tier policies yield the highest gains

Mechanisms

- **Work-leisure tradeoff**
  - Wage-returns to human capital: depreciation and a part-time wage penalty, especially for women with limited labor attachment
  - Participation costs increase with birth, decrease with age and education
  - Marginal utility of leisure displays adjacent complementarity, supporting persistent labor attachment
- **Fertility and child costs**
  - Children aged 1-3 entail the highest nurturing time costs
  - Strong preference for birth spacing of 2-4 years (first two children)
- **Policies**
  - Two-tier leave policies provide benefits for women at two different levels of labor market attachment
  - Tax-transfer policies with high child transfers reduce the need for labor income, which lowers labor supply
  - Costs are temporary but benefits are long-term

Literature Summary

- **Public opinion and cross-country comparisons**
  - Early studies utilized public opinion surveys to gauge hypothetical responses to policies (Goldstein, Lutz, and Testa, 2003)
  - Cross-sectional studies examined policy effects on labor supply and fertility across countries (Billari and Kohler, 2004; Kögel, 2004)
- **Time series and event studies**
  - Time series analyses explored substitution and wealth effects from rising female wages on labor and fertility (Butz and Ward, 1979, 1980; Büttner and Lutz, 1990)
  - Event studies assessed the effects of program adoptions on outcomes like fertility and labor supply (Milligan, 2005; Laroque and Salanié, 2008; Cohen et al., 2013)
- **Causal studies on leave policies**
  - Recent work examines the impact of specific leave policies on labor, fertility, and children's outcomes in the US and abroad (Baum, 2003; Bartel et al., 2014; Flores, Gayle, and Hincapié, 2024; Lalive and Zweimüller, 2009)

Literature: Dynamic Models of Labor and Fertility

- **Dynamic joint determination of labor and fertility**
  - Few studies model dynamic interactions between female labor supply and fertility with panel data (Hotz and Miller, 1988; Francesconi, 2002; Keane and Wolpin, 2010; Adda et al., 2017; Wang, 2022)
  - These studies often incorporate policy simulations to assess hypothetical changes, such as welfare reforms (Keane and Wolpin, 2010) or child allowances (Adda et al., 2017)

Main Contributions

- **Policy evaluation:** evaluate a wide array of leave and tax-transfer policies taking into account dynamic selection in labor supply and fertility
- **Long-term outcomes:** evaluation of long-term outcomes (ex: completed fertility)
- **Eligibility structure:** uncover the impact of the tier structure of leave policies
- **Nurturing time:** integrate the time cost of children in the dynamic labor-fertility trade-off
- **Continuous hours decision:** capture observed variation; crucial to assess the effects of leave policies and marginal tax rates
- **Employer responses:** capture wage responses to the policy environment
- **Identification:** prove identification of the utility function

- **Policy Environment**
- **Individual Data**
- **Model**
- **Identification**
- **Estimation**
- **Estimates**
- **National Implementation of Policies**
- **Conclusion**

Leave Policies in the United States, 1968-2017

Policy data

- State and federal leave policies in the US from 1968 to 2017
- Sources include: Skolnik (1952), Women's Legal Defense Fund (1991), Women's Bureau (1993), Kallman Kane (1998), Waldfogel (1999), and government websites

Policy characteristics

- **Eligibility**: work hours in the prior year required to access benefits
- **Generosity**:
  - *Protection*: weeks of job-protected leave grated
  - *Pay*: weeks of paid leave grated
  - *Replacement rate*: percentage of wages paid during paid leave
- **Tiers**: levels of eligibility (one or two) and corresponding generosity induced by existing laws
- In total, each leave policy is described by 9 variables

Leave Policies in the United States, 1968-2017

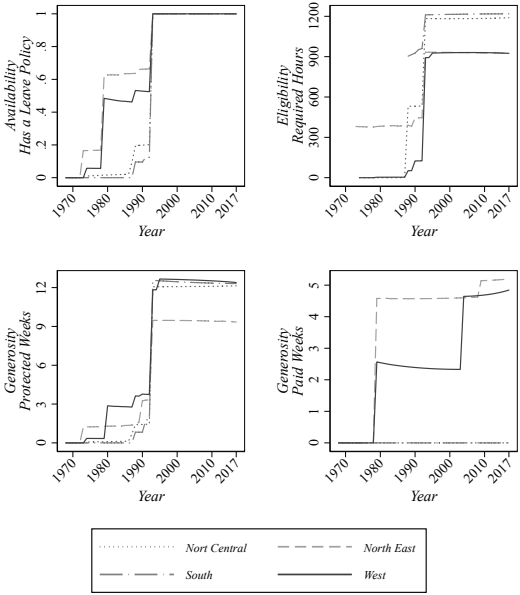
	One-tier Policies				*Two-tier Policies*							
					Tier 1				*Tier 2*			
	Eligibility	*Generosity*			*Eligibility*	*Generosity*			*Eligibility*	*Generosity*		
		Protected	*Paid*	*Rate*		*Protected*	*Paid*	*Rate*		*Protected*	*Paid*	*Rate*
	(hours)	*(weeks)*	*(weeks)*		*(hours)*	*(weeks)*	*(weeks)*		*(hours)*	*(weeks)*	*(weeks)*	
	0	0	6	0.55	0	6	0		360	18	0	
	0	6	0		0	6	0		1000	18	0	
	0	6	6	0.55	0	6	0		1000	22	0	
	0	8	0		0	6	0		1250	12	0	
	1	8	0		0	6	6	0.55	1250	18	6	0.55
	1	10	0		0	6	12	0.55	1250	18	12	0.55 CA 04-17
	160	0	10	0.50	0	6	0		1250	18	0	
	360	12	0		0	8	0		1250	20	0	
RI 79-86	400	10	10	0.55	0	6	0		1820	12	0	WA 90-92
	520	8	0		1	10	0		1250	12	0	
	560	0	6	0.58	160	0	10	0.50	1250	12	10	0.50
	560	6	6	0.58	400	10	10	0.55	1250	22	10	0.55
	643	24	0		400	14	10	0.55	1250	26	10	0.55
NJ 79-89	800	0	10	0.67	400	10	10	0.55	1560	23	10	0.55
	1000	8	0		520	8	0		1250	12	0	
	1000	32	0		560	6	6	0.58	1250	18	6	0.58
	1040	6	0		800	0	10	0.67	1000	16	10	0.67 NJ 90-08
FL >93	1250	12	0		800	0	10	0.67	1000	16	16	0.67
	1250	14	0		1040	6	0		1250	12	0	
	1560	12	0									
	2080	12	0									
Mean	628	9.2	2.6	0.57	267	6.3	4.4	0.57	1197	17.1	4.7	0.57
SD	(590)	(7.7)	(3.9)	(0.05)	(341)	(3.5)	(5)	(0.06)	(280)	(4.3)	(5.5)	(0.06)

Model

Policy Components

- **Tiers**
  - 21 one-tier policies and 19 two-tier policies
  - Second tier of two-tier policies: greater generosity but stricter eligibility
- **Eligibility**
  - Average hours required for eligibility. One-tier: 628 hours, Two-tier: 457 hours (1st tier) and 1,197 hours (2nd tier)
  - 40% of all first tiers require no prior hours
- **Generosity**
  - *Protected:* One-tier: 9.2 weeks, Two-tier: 6.3 weeks (1st tier) and 17.1 weeks (2nd tier)
  - *Paid:* less common, averaging 2.6 weeks (one-tier) and 4.4-4.7 weeks (two-tier)
  - *Replacement rate:* conditional on paid leave, varies between 0.50 and 0.67

Quasi-Experimental Variation in Policies in the USA



Regional Variation in Leave Policies

Availability and eligibility differences

- Significant regional variation in availability, with the Northeast (NE) and West leading in the 1970s-1980s
- Average prior hours for eligibility varied, with the West requiring fewer hours pre-FMLA

Generosity by region

- **Protected**
  - NE and West had substantial pre-FMLA protected leave
  - Lower conditional average protected weeks in the NE after FMLA due to increase in two-tier policies
- **Paid**
  - North Central and South had no paid leave
  - NE and West began offering paid leave from 1979, Temporary Disability Insurance accessed via the Pregnancy Discrimination Act of 1978

Tax-Transfer Policies

- Tax-transfer schedule $T(y)$ (y = gross income) backed out using the flexible function (Feldstein, 1969; Heathcote, Storesletten, and Violante, 2011):

$$T(y) = \left(\underbrace{\pi_0^{tax}}_{\text{lump sum}} + \underbrace{\pi_1^{tax}}_{\text{slope}} y \; \overbrace{\pi_2^{tax}}^{\text{progressivity}} \right)$$

- **Details**
  - π^{tax} depend on marital status (all) and number of dependent children (lump sum and slope)
  - Data from the Panel Study of Income Dynamics (PSID)
  - NBER's TAXISM program (Feenberg and Coutts, 1993)

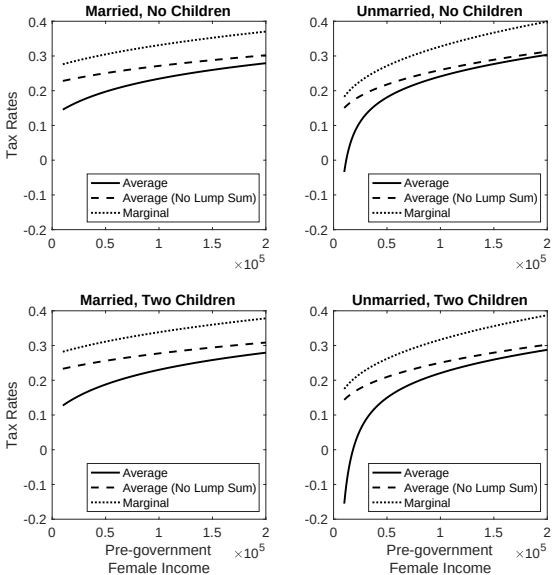
- **Policy variation**
  - Three types of states based on mean income tax: low (e.g. FL, TX), medium (e.g. CT, AZ), high (e.g. DC, CA)
  - Six major reforms at the federal level
    - Economic Recovery Tax Act of 1981 (ERTA), Tax Reform Act of 1986 (TRA), Omnibus Budget Reconciliation Act of 1990 (OBRA-90), Personal Responsibility and Work Opportunity Reconciliation Act of 1996 (PRWORA), Economic Growth and Tax Relief Reconciliation Act of 2001, the Tax Relief Act of 2010
  - Overall 21 tax-transfer regimes (described by 10 parameters each)

Tax-Transfer Regimes in the US, 1968-2017

	Married						*Not Married*					
	Lump sum($)		*Slope (%)*		*Prog.*	*Marg. (%)*	*Lump sum($)*		*Slope (%)*		*Prog.*	*Marg. (%)*
	Base	n_t	*Base*	n_t			*Base*	n_t	*Base*	n_t		
	-9,966	-2,397	15.5	0.455	1.05	31.7	-2,924	-878	9.7	0.392	1.08	28.3
	-3,859	-1,789	0.4	0.005	1.32	22.7	-3,274	-439	7.2	-0.107	1.10	22.5
CA 68-81	-8,563	-1,575	5.5	0.355	1.16	44.2	-3,018	-2,005	0.9	-0.023	1.32	35.5
	-8,244	-1,336	4.4	-0.047	1.15	27.8	-1,775	-826	1.5	0.026	1.23	24.6
	-11,668	-1,330	15.8	-0.018	1.06	33.0	-2,771	-731	8.2	0.216	1.10	28.8
	-2,872	-1,325	0.9	0.011	1.26	24.8	-897	-559	1.7	0.064	1.21	20.8
	-12,138	-1,253	11.4	-0.148	1.08	31.8	-3,450	-251	6.4	-0.323	1.13	25.8
	-4,272	-1,208	3.1	0.028	1.18	29.4	-1,843	-400	10.0	-0.299	1.08	24.3
	-6,002	-1,015	2.8	-0.081	1.17	22.7	-5,326	92	21.4	-1.152	1.03	26.5
	-4,437	-905	2.1	-0.035	1.21	28.4	-1,187	-560	1.8	-0.033	1.23	24.0
	-5,330	-706	4.0	0.060	1.16	29.3	-2,002	586	5.0	-1.267	1.14	13.5
	-4,051	-562	0.3	0.004	1.39	38.5	-1,678	-2,217	0.2	0.013	1.42	36.3
	-5,836	-546	1.5	0.063	1.25	38.5	-678	-381	0.2	-0.001	1.45	30.1
	-3,756	-329	0.5	0.017	1.31	26.0	-688	-201	0.2	-0.004	1.40	21.5
	-2,626	-289	0.8	0.002	1.27	23.2	-516	-223	0.2	-0.004	1.40	20.0
	-7,318	-284	4.9	0.105	1.14	31.1	-1,080	-535	1.1	0.007	1.27	26.1
	-5,691	-277	0.8	0.014	1.31	41.2	-1,125	-191	0.3	-0.005	1.41	31.8
GA 91-96	-4,158	-275	1.6	-0.020	1.23	29.4	-1,443	-527	2.4	-0.009	1.21	26.7
	-7,324	-251	3.1	0.018	1.19	33.4	-1,421	-459	1.2	-0.003	1.27	28.4
	-2,817	-143	0.1	0.000	1.46	32.8	-929	-1,224	0.1	0.000	1.51	29.0
	-5,001	238	0.4	0.003	1.35	33.5	-713	-75	0.2	-0.003	1.44	25.6
Mean	-5,997	-836	3.8	0.038	1.22	31.1	-1,845	-572	3.8	-0.120	1.26	26.2
SD	2,791	656	4.7	0.133	0.11	5.9	1,216	633	5.3	0.390	0.15	5.2

Notes: *Prog.*= progressivity; *Marg.*= marginal tax rate for married women with two kids, income \$50K and husband's income \$62,5K or for not-married woman with two kids and income \$50K

Variation in Average and Marginal Tax Rates: US, 1968-2017



- Means across regimes are comparable to those in Heathcote, Storesletten, and Violante (2017)
- Evidence of a marriage penalty in taxes: marginal tax rates tend to be higher for married women
- Average tax rates tend to decline with the number of children

- Policy Environment
- Individual Data
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Individual Data and Key Variables

- **Data source**
  - 50 years of individual data from the (PSID), 1968–2017
- **PSID files used**
  - Family-Individual File
  - Childbirth and Adoption History File
  - Marriage History File
- **Key variables**
  - Labor: annual hours worked, real hourly earnings
  - Demographic: birth history, household non-labor income, age, education, race, partnership status
  - Partner traits: age, education, labor participation, income
- All monetary values in real dollars indexed to 2015

Measuring Leave Take-up

A measure of leave take-up

- PSID lacks direct data on leave take-up
- Our measure: for women with a birth in t
  - Gap (Δ) in worked hours in t relative to recent worked hours with no birth
  - Contrast Δ against policy availability and individual eligibility

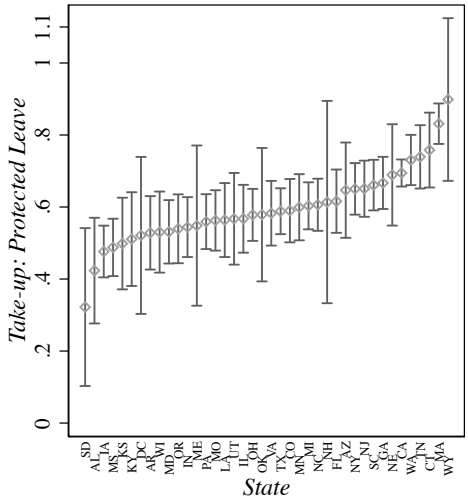
Main assumptions

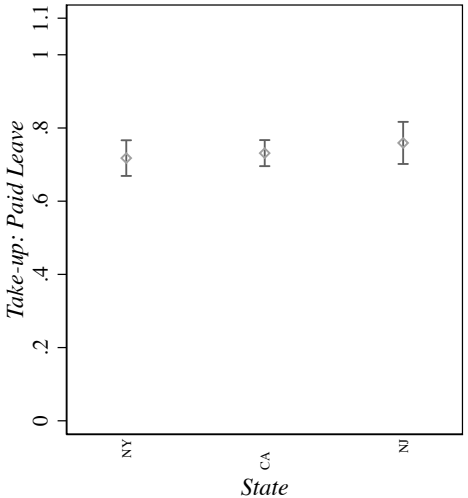
- Does not assume all leave is used (Δ could be less than available leave)
- Conditional on reducing hours, women use benefits
- Gap in hours is not due to a change in jobs/contracts at the exact year of birth

Protected vs. paid leave

- Protected leave: taken if she returns to work within available protected time
- Paid leave: taken regardless of size of hours reduction at t, since benefits are immediate

Average Leave Take-up by State (1968-2017)





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A Model of Fertility and Female Labor Supply with Leave and Taxation Policies

- Dynamic life-cycle model linking fertility, labor supply, and policy effects
  - Parents have preferences over consumption, participation, leisure time, births, and birth spacing
- Captures decisions across work, leisure, and child-rearing
  - Work hours decision is continuous
  - Leisure hours are bounded by childrearing time
  - Leave take-up depends on reduction on hours and policies available
- Integrates policy environment (leave and tax-transfer regimes) in detail
  - Leave policies: 9 dimensions
  - Tax-transfer policies: 10 dimensions

Preliminaries

- $t \in \{0, 1, \ldots, T\}$: woman's age in years beyond adolescence
- T^F: end of fertile age $(0 < T^F < T)$
- T^R: retirement age $(0 < T^F < T^R < T)$
- $\pi_t \in \{\pi_0, \pi_1, \ldots, \pi_{\rho_r}\}$: policy environment
- z_t: her characteristics (age, race, education, partnership status)
- z_t': partner's (male) characteristics (education)

Choice Set

- $c_t \in \mathbf{R}_+$: consumption
- $h_t \in [0, 1]$: working hours
- $d_t = 1\{h_t > 0\}$
- b_t: whether to have a child at age t $(t \leq T^F)$
- k: index for discrete choices (d_t, b_t)
  - $k = 1$: no work, no birth
  - $k = 2$: work, no birth
  - $k = 3$: no work, birth
  - $k = 4$: work, birth

Human Capital

$$\underline{h}_{t-1} = [h_{t-1}, \ldots, h_{t-\rho_w}]$$

- $\underline{h}_{t-1}$: vector of accumulated human capital (based on past work)
- ρ_w: retention window, full depreciation after

Time Cost of Child Nurturing and Time Constrain

$$\varsigma_t = \sum_{s=0}^{\rho_c} \phi_s b_{t-s} + \phi \sum_{s=\rho_c+1}^{17} b_{t-s}$$

- ς_t: nurturing time required given children's ages
- ϕ_s: time cost of a child of age s
- ρ_c: old (underage) children have the same time cost
- Nurturing time bounds time available for work (h_t) and leisure (l_t)

$$l_t = 1 - h_t - \varsigma_t$$

- Leisure is the residual time after work and nurturing
- Trade-offs: leisure vs labor and nurturing responsibilities

Partnership Dynamics

- Not a choice
- A joint distribution $G(\cdot)$ of partnership status m_t and partner traits z'_t
- Distribution depends of previous choices and policy environment

$$G(m_t, z'_t | m_{t-1}, z_{t-1}, z'_{t-1}, x_{t-1})$$

  - m_t: partnership status (married, cohabiting, single)
  - z'_t: partner's education
  - x_t: state variables of the problem (including current policies and prior choices)

Types of Leave: Protected and Paid

$$h_t^\ell = \{h_{1t}^\ell, h_{2t}^\ell\}$$

- **Protected leave** (h_{1t}^ℓ):
  - operationalized as protection against human capital losses (decreases in wages)
  - generates protected human capital (h_t^*):

$$h_t^* = h_t + h_{1t}^\ell$$

  - targets longer term income (until protected human capital depreciates)

- **Paid leave** (h_{2t}^ℓ):
  - current income replacement during leave at replacement rate $\iota(\pi_t) \in [0, 1]$

Leave Granted

$$\bar{h}_t = b_t \cdot \kappa(\pi_t, h_{t-1}) \cdot h_t^B(\underline{h}_{t-1}) \qquad \in [0,1)^2$$

- $\kappa \in [0,1)^2$:
  - captures eligibility (prior work required) and generosity (how much is grated)
  - depends on policy environment and her prior work
  - details follow directly from table of policies Policies
- h_t^B (base hours):
  - determined by recent work intensity while not having a birth
  - capture the nature of the work contract (ex: full-time, part-time)
  - same as baseline to determine gap in hours upon birth

Leave Granted

$$\bar{h}_t = b_t \cdot \kappa(\pi_t, h_{t-1}) \cdot h_t^B(\underline{h}_{t-1}) \qquad \in [0,1)^2$$

- Example:
  - A women worked with full-time intensity before having a birth ($h_{t-1} = h^F$)
  - She has a birth at t
  - Available policy: one-tier policy requiring $a \in \{0,1\}$ prior hours to grant $p \in \{0,1\}$ weeks of protected leave (p written as a share of weeks per year) and no paid leave
  - Then $\kappa(\pi_t, h_{t-1}) = \mathbf{1}\{h_{t-1} \geq a\} \times p$
  - And leave granted is $\bar{h}_t = \left\{ \begin{array}{c} \mathbf{1}\{h^F \geq a\} \times p \\ 0 \end{array} \right\} \cdot h^F$

Protected Leave Take-Up

$$h_{1t}^{\ell} = (h_t^B - h_t)\mathbf{1}\{0 \leq h_t^B - h_t \leq \bar{h}_{1t}\}$$

- Defines protected leave hours as hours reduced from base hours h_t^B
- Determined by the choice of work hours (not an additional choice)
- Captures potential loss in protection if reduction is too large
- Allows for null, partial, or full use of protected leave

Paid Leave Take-Up

$$h_{2t}^{\ell} = (h_t^B - h_t)\mathbf{1}\{0 \leq h_t^B - h_t \leq \bar{h}_{2t}\} + \bar{h}_{2t}\mathbf{1}\{h_t^B - h_t > \bar{h}_{2t}\}$$

- Defines paid leave hours as hours reduced from base hours h_t^B
- Determined by the choice of hours (not an additional choice)
- Term $\bar{h}_{2t}\mathbf{1}\{h_t^B - h_t > \bar{h}_{2t}\}$: paid leave is not lost even if reduction is larger than leave granted
- Allows for null, partial or full use of paid leave

Tax-Transfer Policies

For a given amount of gross household income W, the tax-transfers amount is:

$$T_k(W, \pi_t, x_t) = \underbrace{\pi^{tax}_{0kt}(x_t)}_{\text{lump-sum}} + \underbrace{\pi^{tax}_{1kt}(x_t)}_{\text{slope}} W \overbrace{\pi^{tax}_{2t}(x_t)}^{\text{progressivity}} \tag{1}$$

- Lump-sum and slope depend on number of children
  - Integrates fixed family allowances (child transfers) for underage children
  - Integrates tax breaks given to parents
- All components of T vary by marital status
  - Captures differences in incentives provided to married and unmarried individuals
- Redistributive features of tax regimes captured by their progressivity
- Given the non-linear, non-additive nature of both leave and tax-transfer policies, their interaction also shapes women's fertility and labor supply decisions

Household Income: Women's Wages

$$w_t = \omega\left(\tau_t\right)\mu \exp\left\{\sum_{r=1}^{\rho_r} \mathbf{1}\{\pi_t = \pi_r\}\left[z_t' B_{r,3} + \sum_{s=1}^{\rho_w}\left(\delta_{r,1s} h^*_{t-s} + \delta_{r,2s} d_{t-s}\right)\right]\right\}$$

- Depends on demographics (z_t) and protected human capital
- $\omega\left(\tau_t\right)$: aggregate trend in labor efficiency for women
  - τ_t: calendar year when the woman is of age t
- μ: fixed individual-specific productivity
- Returns to human capital depend on policy regime

Household Income: Men's Wages and Participation

$$\ln w_t' = \ln \omega' (\tau_t) + \ln \mu(ed', race) + B(ed') \ln(t - 18)$$

- Diminishing returns from potential experience
- Returns are education-specific
- $\omega' (\tau_t)$: aggregate trend in labor efficiency for men
- μ: group-specific productivity, depends on education and race
- **Participation**: full-time (h') or no work, $\Pr[d_t' = 1 | z_t, z_t', d_{t-1}', x_t]$
- **Partner's labor income**:

$$e_t' \equiv w_t' d_t' h'$$

Household Income: Non-Labor Income

$$\ln e_t^{NL} = B^e \ln e_{t-1}^{NL} + B^{NL} X_t + \omega^{NL}(\tau_t) + u_t^e$$

- Autoregressive process to capture persistence
- Separate for single or partnered households
- X_t: subset of the state of the problem
- $\omega^{NL}(\tau_t)$: aggregate trend in non-labor income
- u_t^e: idiosyncratic shock in non-labor income with variance σ_e^2

Household Income: Gross and Net Income

Gross Income

$$W_k(h_t, x_t) = \underbrace{w(x_t)h_t}_{\text{own labor}} + \underbrace{\iota(\pi_t)w(x_t)h_{2t}^{\ell}}_{\text{replacement}} + \underbrace{e'(x_t)}_{\text{partner labor}} + \underbrace{e^{NL}(x_t)}_{\text{non-labor}}$$

Net Income

$$\Upsilon_k(h_t, x_t) = W_k(h_t, x_t) - \underbrace{T_k(W_k(h_t, x_t), \pi_t, x_t)}_{\text{tax-transfer burden}}$$

- Both indexed by discrete choice k
  - Captures participation
  - Number of dependents

State Variables

$$x_t \equiv \left(z_t, z_t', d_t', h_{t-\rho_w}, \ldots, h_{t-1}, h^{\ell}_{1t-\rho_w}, \ldots, h^{\ell}_{1t-1}, \underline{a}_t, \ln e_t^{NL}, \pi_t, \underline{\omega}_t\right)'$$

- x_t is the state vector containing individual and household characteristics:
  - z_t, z_t': demographics (e.g., age, education, race, partnership status)
  - d_t': partner's labor force participation
  - $h_{t-\rho_w}, \ldots, h_{t-1}$: recent labor supply hours
  - $h^{\ell}_{1t-\rho_w}, \ldots, h^{\ell}_{1t-1}$: recent protected leave take-up
  - $\underline{a}_t$: ages of children
  - $\ln e_t^{NL}$: non-labor income
  - π_t, ω_t: policy environment and other aggregate factors

Information

- Individuals are surprised by leave and tax-transfer policy innovations
  - DiD assumption, consistent with work in Flores, Gayle, and Hincapié (2024)
  - Key for identification
- Perfect foresight over other aggregate processes
  - Including aggregate wages, aggregate non-labor income
- Expectations over individual variables follow their laws of motion
  - Endogenous: human capital, number of children
  - Stochastic conditional: partnership dynamics (distribution depends on choices and policy environment)

Lifetime Utility Function

$$-E\Bigg\{\sum_{t=0}^{T^R}\sum_{k\in C_t}\beta^t d_{kt}\exp\left(-\alpha c_t - u_k(h_t,x_t) - h_t\xi_t - \epsilon_{kt}\right) + \sum_{t=T^R+1}^{T}\beta^t\exp(-\alpha c_t)\Bigg\}$$

- CARA with absolute risk aversion α
- $u_k(h_t, x_t)$
  - sum of utility from leisure $u_t^{(\ell)}$ and utility from births $u_t^{(b)}$
- ξ_t: idiosyncratic marginal disutility from work (not observed before discrete choice)
- ϵ_{kt}: idiosyncratic preference disturbance for each discrete choice
- T^R: retirement age, after which only consumption affects utility
- C_t: discrete choice set shrinks after fertility age $t > T^F$

Utility Function

- Utility from leisure and work ($\widetilde{x}_t \subset x_t$: age, education, race, partnership status)

$$u_t^{(\ell)} \equiv \underbrace{\widetilde{x}_t' B_0 d_t}_{\text{participation cost}} + \underbrace{\widetilde{x}_t' B_1 l_t}_{\text{leisure utility}} + \underbrace{\sum_{s=0}^{3} \delta_s l_t l_{t-s}}_{\text{leisure persistence}}$$

- Utility from birth

$$u_t^{(b)} \equiv b_t \left(\underbrace{\widetilde{x}_t' \tilde{\gamma}_0 d_t}_{\text{birth utility working}} + \underbrace{\widetilde{x}_t' \gamma_0 (1 - d_t)}_{\text{birth utility not working}} + \underbrace{\sum_{s=1}^{4} \gamma_s b_{t-s} + \gamma_b \sum_{s=5}^{17} b_{t-s}}_{\text{birth spacing utility}} \right)$$

Budget Constraint: Law of Motion for Savings

$$E_t\left[\lambda(\tau_{t+1})s_{t+1} \mid h_t, b_t, x_t\right] + \lambda(\tau_t)c_t \leq \lambda(\tau_t)(s_t + \Upsilon_k(h_t, x_t))$$

- Total resources at t (savings s_t and net income Υ_k) must cover current consumption c_t and next period's savings s_{t+1}
- Follows the approach of Margiotta and Miller (2000)
  - Women can trade contingent claims to smooth consumption over time
  - $\lambda(\tau_t)$: price of consumption units in year τ_t
- Solution to the savings problem is analytical

Optimal Choices: Expected per Period Utility

$$\begin{aligned}\overline{u}_k(x_t) \equiv & E[u_k\left(h_k\left(x_t, \xi^*_{kt}\right), x_t\right)|x_t] + E[h_k\left(x_t, \xi^*_{kt}\right)\xi^*_{kt}|x_t] \\ & + \alpha E[\Upsilon_k(h_k\left(x_t, \xi^*_{kt}\right), x_t)|x_t]\end{aligned}$$

- $\overline{u}_k(x_t)$: conditional expected utility given choice k (expectation over ξ_t)
- $h_k(x_t, \xi^*_{k,t})$: optimal hours worked under choice k with marginal utility shock $\xi^*_{k,t}$

Optimal Choices: Index of Human Capital

$$A_t(x_t) \equiv \sum_{k \in C_t} p_{kt}(x_t) \exp\left(\frac{-\overline{u}_k(x_t)}{B_t}\right) E\left[\exp\left(\frac{-\varepsilon^*_{kt}}{B_t}\right) \middle| x_t\right]$$
$$\times \left[\int\left(\int A_{t+1}(x_{t+1}) g_{kh}(x_{t+1}|x_t) dx_{t+1}\right) q_k(h|x_t) dh\right]^{1-\frac{1}{B_t}}$$

- $A_t(x_t)$: index of household capital at time t, representing expected future utility value
- $p_{kt}(x_t)$: conditional choice probability of alternative k
- B_t: Bond price at calendar year $\tau(t)$ (induced by aggregate prices $\lambda(\tau_t)$)
- $g_{kh}(x_{t+1}|x_t)$: density of future states based on current choices
- $q_k(h|x_t)$: density of hours (induced by ξ_t)
- $A_{T^R+1}(x_{T^R+1}) \equiv 1$ (no value of human capital upon retirement)

Optimal Discrete Choices: Participation, Birth

$$\sum_{k \in C_t} d_{kt} \left[\overline{u}_k(x_t) - (B_t - 1) \ln \left[\int \left(\int A_{t+1}(x_{t+1}) g_{kh}(x_{t+1}|x_t) dx_{t+1} \right) q_k(h|x_t) dh \right] + \epsilon_{kt} \right]$$

- At each age before retirement ($t \leq T^R$)
- Woman maximizes a weighted sum of current utility and future value
  - Expected current utility: net income, non-pecuniary benefits from current work and birth choices, and idiosyncratic preference shocks
  - Expected future value: affected by the accumulation of human capital and changes to family composition
- Given function A_t, it is a standard discrete choice problem
- Derivation follows prior work (Altuğ and Miller, 1998; Gayle, Golan, and Miller, 2015; Hincapié, 2020; Khorunzhina and Miller, 2022)

Optimal Continuous Choices: Hours (w/ Birth, w/o Birth)

$$-\xi_t = \alpha w(x_t)\left(1+\iota(\pi)\frac{\partial h^{\ell}_{2t}}{\partial h}\right)\left[1-\pi^{tax}_{kt1}(x_t)\pi^{tax}_{kt2}(x_t)W_k(h_{kt},x_t)^{\pi^{tax}_{kt2}(x_t)-1}\right]+\frac{\partial u_k(h_{kt},x_t)}{\partial h}$$
$$-\frac{(B_t-1)}{\int A_{t+1}(x_{t+1})g_{kh}(x_{t+1}|x_t)dx_{t+1}}\times\int\left[\frac{\partial A_{t+1}(x_{t+1})}{\partial h}+\frac{A_{t+1}(x_{t+1})}{g_{kh}(x_{t+1}|x_t)}\frac{\partial g_{kh}(x_{t+1}|x_t)}{\partial h}\right]g_{kh}(x_{t+1}|x_t)dx_{t+1}$$

- First order condition balances utility and income effects to determine optimal hours:
  - marginal disutility of work (ξ_t), known when deciding hours
  - marginal effect on current net income (labor, replacement, tax-transfer burden)
  - marginal non-pecuniary benefits from current leisure (including interactions with past leisure)
  - marginal effect on household continuation value (future wages via changes in protected human capital, future leave availability via satisfaction of eligibility requirements, future utility of leisure, future household structure)

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Identification: Overview

- **Proposition 1:** representation of the household capital value index and the ex-ante conditional value function in terms of a path of choices (Arcidiacono and Miller, 2019)
  - Path used: no work and no birth ($k = 1$) from $t + 1$ on
- **Corollary 1.1:** semi-parametric identification of expected per-period utility $\overline{u}_k(x_t)$
  - Standard result in the discrete choice literature, except here we have to account for the preference shock ξ from the continuous choice
  - Hence, only the expected utility is identified (up to standard normalization)
- **Proposition 2:** marginal utility $\frac{\partial u_k\left(h^*, \widetilde{x}_t\right)}{\partial h}$ and absolute risk-aversion α are identified
  - For any observed value of optimal hours h^* and $\widetilde{x}_t \subset x_t$
  - Requires exclusion restriction and at least one demand-side instrument $\widetilde{\nu}_t$ (e.g. policy variation)
- **Corollary 2.1:** utility function $u_k(\widetilde{h}, \widetilde{x}_t)$ is identified
  - Yields from Corollary 1.1 and Proposition 2
  - Notice $u_k(\widetilde{h}, \widetilde{x})$ is not a central object of analysis
  - Relevant objects: $\underbrace{\text{expected flow utility } \overline{u}_k\left(x_t\right)}_{\text{discrete choices}}$, $\underbrace{\text{marginal utility } \partial u_k(h, \widetilde{x}_t)/\partial h}_{\text{continuous choices}}$

Identification: Proposition 1

Let $x_{t+1}^{(kh)}$ (or simply $x_{t+1}^{(k)}$ if $k \in \{1,3\}$) denote the evolution of the state into $t+1$ given discrete choice k and hours choice h_{kt}. The index of household capital A_t can be written as:

$$A_t\left(x_t\right) = \prod_{s=0}^{T-t}\left[p_{1t+s}(x_{t+s}^{(1)})\Gamma\left(\frac{B_{t+s}+1}{B_{t+s}}\right)^{B_{t+s}}\exp\left\{-\overline{u}_1(x_{t+s}^{(1)})\right\}\right]^{\chi_t(s)}$$

where the cumulative discount factor $\chi_t(s)$ is defined as:

$$\chi_t(s) \equiv \frac{1}{B_{t+s}}\left[\prod_{r=0}^{s-1}\left(1-\frac{1}{B_{t+r}}\right)\right]^{\mathbf{1}\{s>0\}}$$

and the ex-ante conditional value function (of the perfect-foresight version of the problem, WLOG) for choice k is given by:

$$\begin{aligned}V_k\left(x_t\right) =& \overline{u}_k(x_t) - (B_t-1)\sum_{s=0}^{T-t-1}\chi_{t+1}(s)\ln\Gamma\left(\frac{B_{t+1+s}+1}{B_{t+1+s}}\right)^{B_{t+1+s}} \\ &- (B_t-1)\ln\int\left(\prod_{s=0}^{T-t-1}\left[p_{1t+1+s}(x_{t+1+s}^{(kh,1)})\exp\left\{-\overline{u}_1(x_{t+1+s}^{(kh,1)})\right\}\right]^{\chi_{t+1}(s)}\right)q_k(h|x_t)dh\end{aligned}$$

Identification: Corollary 1.1

For $k \in \{2,3,4\}$ the log-odds ratio relative to alternative 1 can be written as:

$$\begin{aligned}\ln\left(\frac{p_{kt}(x_t)}{p_{1t}(x_t)}\right) =& \overline{u}_k(x_t) - \overline{u}_1(x_t) \\ &- (B_t - 1)\ln\int\left(\prod_{s=0}^{T-t-1}\left[p_{1t+1+s}(x_{t+1+s}^{(kh,1)})\exp\left\{-\overline{u}_1(x_{t+1+s}^{(kh,1)})\right\}\right]^{\chi_{t+1}(s)}\right) q_k(h|x_t)dh \\ &+ (B_t - 1)\sum_{s=0}^{T-t-1}\chi_{t+1}(s)\left[\ln p_{1t+1+s}(x_{t+1+s}^{(1,1)}) - \overline{u}_1(x_{t+1+s}^{(1,1)})\right]\end{aligned}$$

Identification: Proposition 2

Assuming there exists at least one demand side shifter $\widetilde{\nu}_t$ with at least two points in its support $\widetilde{\nu}_1, \widetilde{\nu}_2$:

$$\frac{\partial u_k\left(h^*, x_t\right)}{\partial h_t} + \alpha E\left[w(x_t)\left(1+\iota(\pi)\frac{\partial h_{2t}^{\ell}}{\partial h_t}\right)\left[1-\pi_{1k}^{tax}(x_t)\pi_{2k}^{tax}(x_t)W_k(h^*,x_t)^{\pi_{2k}^{tax}(x_t)-1}\right]\middle|\widetilde{\nu}_j, \widetilde{x}_t, h_t\right] =$$

$$(B_t-1)\sum_{s=0}^{T-t-1}\chi_{t+1}(s)E\left[\frac{1}{p_{1t+1+s}(x_{t+1+s}^{(kh,1)})}\frac{\partial p_{1t+1+s}(x_{t+1+s}^{(kh,1)})}{\partial h} - \frac{\partial \overline{u}_1(x_{t+1+s}^{(kh,1)})}{\partial h}\middle|\widetilde{\nu}_j, \widetilde{x}_t, h_t\right] \quad \text{for } j=1,2.$$

Therefore for every value h^* of hours worked observed in the data and every $\widetilde{x}_t$, then $\frac{\partial u_k\left(h^*, \widetilde{x}_t\right)}{\partial h}$ and α are identified

Identification: Corollary 2.1

For $k \in \{2,3,4\}$ and any $\widetilde{h}$, current utility $u_k(\widetilde{h}, \widetilde{x})$ can be expressed as:

$$\begin{aligned} u_k(\widetilde{h}, \widetilde{x}_t) &= \int \left\{ u_k(h^*, \widetilde{x}) + \int_{h^*}^{\widetilde{h}} \frac{\partial u_k(h, \widetilde{x}_t)}{\partial h} dh \right\} q_k(h^* | \widetilde{x}_t) dh^* \\ &= E\left[u_k\left(h^*, \widetilde{x}_t\right) \middle| \widetilde{x}_t \right] + \int \left[\int_{h^*}^{\widetilde{h}} \frac{\partial u_k\left(h, \widetilde{x}_t\right)}{\partial h} dh \right] q_k(h^* | \widetilde{x}_t) dh^* \end{aligned}$$

and

$$E\left[u_k\left(h^*, \widetilde{x}_t\right) \middle| \widetilde{x}_t \right] = \int \left\{ \overline{u}_k\left(x_t\right) - E\left[h_k\left(x_t, \xi_{kt}^*\right) \xi_{kt}^* | x_t \right] - \alpha E[\Upsilon_k(h_k\left(x_t, \xi_{kt}^*\right), x_t) | x_t] \right\} dF\left(z_t \middle| \widetilde{x}_t\right)$$

Therefore $u_k(h_t, \widetilde{x}_t)$ is identified since $\overline{u}_k(x_t)$, $\frac{\partial u_k(h, \widetilde{x}_t)}{\partial h}$, and α are identified, and Υ_k is known. Hence, from FOC ξ_t^* is also identified.

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Estimation: Overview

- Follows identification strategy and proceeds in three stages leveraging quasi-experimental variation in policy across states and over time
  - **Stage I**: wage and income equations, partnership dynamics, conditional choice probabilities
  - **Stage II**: marginal utility of leisure, absolute risk aversion; uses the Euler equation for optimal hours; method: SMM
  - **Stage III**: remaining parameters from labor and birth discrete choices; uses the log odds ratio in terms of ex-ante conditional value functions; method: quasi-MLE

Estimation: Stage I

- Women's wages
  - Exclusion restriction: only leave policy affects the wage equation
  - Tax-transfer policies affect the household's budget constraint through their impact on net income
  - Reported wage $\widetilde{w}_t$ measures marginal product with error $\widetilde{\epsilon}_t$

$$\widetilde{w}_t \equiv w_t \exp(\widetilde{\epsilon}_t)$$

  - First-differences estimator with consistency adjustments for aggregate wages and individual fixed productivity

- Estimation of other first-stage processes (partnership dynamics, non-labor income, spouse income, conditional choice probabilities) is standard
  - They all depend on the state x_t, including the policy environment

- Time cost of nurturing
  - Regress reported home hours on a collection of indicators $\{b_t, \ldots, b_{t-3}\}$
  - Controlling for race, partnership status, and years of education

Estimation: Stage II

$$\xi_{kt} = -\alpha w(x_t)\left(1+\iota(\pi)\frac{\partial h^{\ell}_{2t}}{\partial h}\right)\left(1-\pi^{tax}_{2k}(x_t)\pi^{tax}_{1k}(x_t)W_k(h_{kt},x_t)^{\pi^{tax}_{2k}(x_t)-1}\right)+\left(\tilde{x}_t'B_1+2\delta_0 l_{kt}+\sum_{s=1}^{3}\delta_s l_{t-s}\right)$$
$$+\left(\frac{(B_t-1)}{\int A_{t+1}(x_{t+1};\theta_1)g_{kh}(x_{t+1}|x_t)dx_{t+1}}\times\right.$$
$$\left.\int\left[\frac{\partial A_{t+1}(x_{t+1};\theta_1)}{\partial h}+\frac{A_{t+1}(x_{t+1};\theta_1)}{g_{kh}(x_{t+1}|x_t)}\frac{\partial g_{kh}(x_{t+1}|x_t)}{\partial h}\right]g_{kh}(x_{t+1}|x_t)dx_{t+1}\right), \qquad \text{for } k=2,4$$

- Euler equation depends on a subset of the structural parameters $\theta_1 = \{B_1, \delta_0, ..., \delta_3, \alpha\}$ capturing risk aversion and the marginal utility of leisure
- It also depends on the idiosyncratic marginal utility of work, whose distribution is characterized by θ_ξ
- Estimation of θ_1 and θ_ξ takes as given the first-stage estimates and proceeds using SMM
- Uses observations of women who worked
- For each candidate vector $\{\theta_1, \theta_\xi\}$:
  1. Solve for the $A_{t+1}(x_{t+1})$ index recursively
  2. Use Euler equation to obtain simulated optimal hours
  3. Compare moments of the conditional distributions of simulated and observed hours (e.g. conditional on policy variables following identification argument)

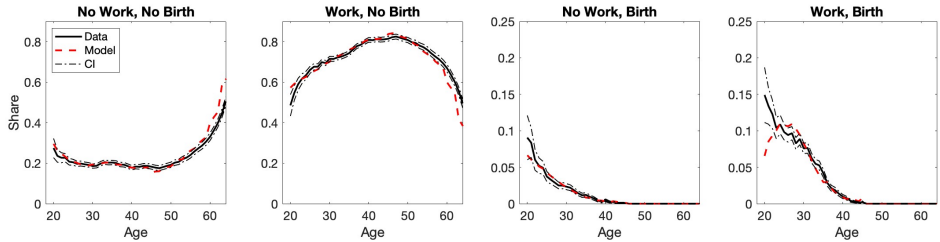
Estimation: Stage III

$$\ln L(\theta_2, \cdot) = \sum_i \sum_t \sum_{k \in C_t} d_{kit} \ln p_{kit}(x_{it}|\theta_2, \cdot)$$

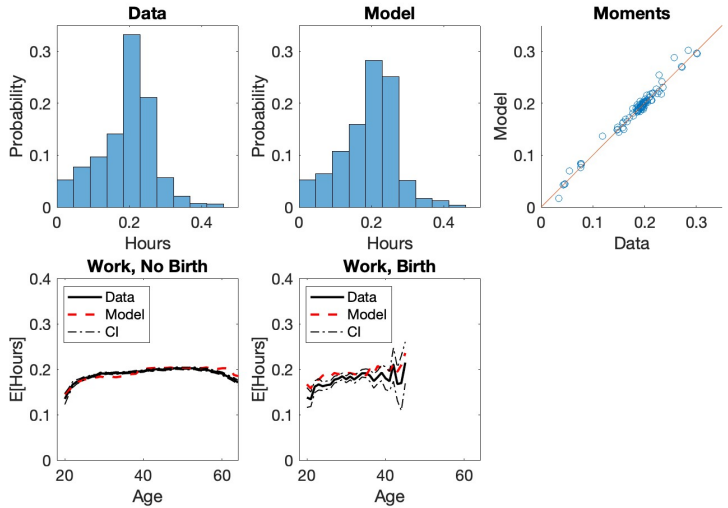
$$p_{kit}(x_{it}|\theta_2, \cdot) = \frac{\exp\left(V_{kit}\left(x_{it}|\theta_2, \cdot\right) - V_{1it}\left(x_{it}|\theta_2, \cdot\right)\right)}{\sum_{j \in C_t} \exp\left(V_{jit}\left(x_{it}|\theta_2, \cdot\right) - V_{1it}\left(x_{it}|\theta_2, \cdot\right)\right)}$$

- Remaining parameters to be estimated, $\theta_2 = (B_0, \gamma_0, \tilde{\gamma}_0, \gamma_1, ..., \gamma_6)$, capture the utility cost of labor market participation and the lifetime expected utility from birth
- V_{kit}: conditional value functions
- Estimation based on the four discrete choices, uses all observations
- Must integrate over possible hours for all observations (not just working women)
- Takes as given the first- and second-stage estimates

Model Fit: Discrete Choices (Participation, Birth)



Model Fit: Continuous Choices (Hours)



Notes: hours scaled as a fraction of annual hours by dividing by (24×365). The moments panel corresponds to the estimation moments in the second stage, all in terms of scaled hours.

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Estimates: Work-Leisure Tradeoffs

- **Wage-returns to human capital**
  - High depreciation: returns to lag human capital decline rapidly
  - Part-time penalty: working part-time can decrease wages
- **Partnership dynamics**
  - Strong attachment to the labor market: decreases likelihood of staying single, increases likelihood of becoming single if partnered (affecting their tax burden)
- **Utility**
  - Participation cost: declines with age and education, and is higher for black and partnered women
  - Marginal utility of leisure: increases with education, displays adjacent complementarity ($t-1$ and t) which generates persistency in attachment

Estimates: Fertility Tradeoffs

- **Time cost of children**
  - For children 1 to 3 years old it is between 249 and 381 annual hours
  - Hence, mothers with two children in this age range pay a time cost $\sim$ 28% full-time hours
- **Partnership dynamics**
  - Recent births: increase likelihood of staying single, decrease likelihood of separating (affecting their tax burden)
- **Lifetime expected utility from birth**
  - Higher for women with more completed education, black women, and partnered women
  - Lower for working women
  - Spacing: higher utility from births between two and four years apart

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National Implementation: Setup

- **Objective:** to assess the impact of the national implementation of locally observed leave and tax-transfer policies on:
  - leave take-up, partnership, fertility, women's labor market outcomes and the motherhood penalty, tax revenue, and policy costs

- **Methodology**
  - Forward simulation of choices and outcomes under each of the policies until age 64
  - Leverages the quasi-experimental policy variation already embedded in the dynamic model, backward-solving the model is not necessary

- **Initial condition**
  - Balanced sample of 1,970 unique women around entry into the workforce
  - Each one replicated 30 times, creating a simulation sample of 59,100 women

National Implementation: Policy Grid

- **Grid:** subset of all observed policies, 7 leave policies $\times$ 4 tax-transfer policies $=$ 28 policies in the grid
- **Leave policies in the grid**
  - LP1: no leave; control group (e.g TX $<$93)
  - LP2: FMLA, one-tier with only protected leave (e.g FL $>$93)
  - LP3: one-tier policy with only paid leave (e.g NJ 79-89)
  - LP4: one-tier policy with both paid and protected leave (e.g RI 79-86)
  - LP5: two-tier version of FMLA with only protected leave in both tiers (e.g WA 90-92)
  - LP6: two-tier policy; first tier: only paid leave; second tier: paid and protected (e.g NJ 90-08)
  - LP7: two-tier policy; paid and protected in both tiers (e.g CA 04-17)
- **Tax-transfer policies in the grid** (based on tax parameters for the married)
  - TP1: low child transfers and lower marginal tax rate (e.g GA 91-96)
  - TP2: low child transfers and medium marginal tax rate (e.g NM 87-90)
  - TP3: high child transfers and high marginal tax rate (e.g CA 68-81)
  - TP4: high child transfers and medium marginal tax rate (e.g WI 02-10)

National Implementation: Policy Grid

Leave Policies in the Simulation Grid

Policy ID	Tier 1				Tier 2				Place-Time
	Eligibility	Generosity			Eligibility	Generosity			
	(hours)	Protected (weeks)	Paid (weeks)	Rate	(hours)	Protected (weeks)	Paid (weeks)	Rate	
LP1	0	0	0	0					TX < 93
LP2	1250	12	0	0					FL > 93
LP3	800	0	10	0.67					NJ 79-89
LP4	400	10	10	0.55					RI 79-86
LP5	0	6	0	0	1820	12	0	0	WA 90-92
LP6	800	0	10	0.67	1000	16	10	0.67	NJ 90-08
LP7	0	6	12	0.55	1250	18	12	0.55	CA 04-17

Tax Policies in the Simulation Grid

Policy ID	Married						Not Married						Place-Time
	Lump sum ($) π_0^{tax}		Slope (%) π_1^{tax}		Progr. π_2^{tax}	Marginal Rate (%)	Lump sum ($) π_0^{tax}		Slope (%) π_1^{tax}		Progr. π_2^{tax}	Marginal Rate (%)	
	Base	n_t	Base	n_t			Base	n_t	Base	n_t			
TP1	-4,158	-275	1.61	-0.020	1.230	29.4	-1,443	-527	2.40	-0.009	1.206	26.7	GA 91-96
TP2	-7,318	-284	4.92	0.105	1.143	31.1	-1,080	-535	1.07	0.007	1.272	26.1	NM 87-90
TP3	-8,563	-1,575	5.52	0.355	1.156	44.2	-3,018	-2,005	0.90	-0.023	1.319	35.5	CA 68-81
TP4	-11,668	-1,330	15.8	-0.018	1.059	33.0	-2,771	-731	8.15	0.216	1.103	28.8	WI 02-10

National Implementation: Leave Take-up

Policy Effects: Take-up

Protected Leave					Paid Leave				
	Tax-Transfer Policy					Tax-Transfer Policy			
Leave Policy	TP1	TP2	TP3	TP4	Leave Policy	TP1	TP2	TP3	TP4
LP1					LP1				
LP2	0.300	0.281	0.211	0.212	LP2				
LP3					LP3	0.562	0.575	0.640	0.641
LP4	0.147	0.146	0.120	0.120	LP4	0.655	0.661	0.688	0.686
LP5	0.398	0.383	0.296	0.298	LP5				
LP6	0.447	0.427	0.343	0.344	LP6	0.684	0.682	0.698	0.696
LP7	0.417	0.397	0.308	0.308	LP7	0.662	0.658	0.662	0.657

Notes: Leave take-up is measured as the total amount of leave granted across all women and all ages, divided by the total amount of leave used. *Leave Policies*: **LP1**: no-leave; **LP2**: FMLA; **LP3**: one-tier policy with only paid leave; **LP4**: a one-tier policy with both paid and protected leave; **LP5**: two-tier version of FMLA with only protected leave in both tiers; **LP6**: two-tier policy with only paid leave in the first tier and both types in the second tier; **LP7**: two-tier policy with paid and protected leave in both tiers. *Tax-Transfer Policies*: **TP1**: low child transfers, lower marginal tax rate; **TP2**: low child transfers, medium marginal tax rate; **TP3**: High child transfers, high marginal tax rate; **TP4**: High child transfers, medium marginal tax rate.

National Implementation: Leave Take-up

- **Paid vs. protected leave take-up**
  - Paid take-up is consistently higher than protected take-up across all regimes
- **Two-tier policy advantage**
  - Two-tier policies (LP5–LP7) significantly boost take-up by attracting women at different levels of prior labor attachment
  - This makes two-tier policies effective in increasing access to leave benefits
- **Interactions with tax-transfer policy**
  - Tax-transfer regimes with higher child transfers (TP3, TP4) generally induce lower protected take-up and slightly higher paid take-up
  - Driven by a higher share of eligible mothers decreasing working hours beyond available protection, thereby decreasing average protected leave take-up
  - At the same time, since they do not lose their paid leave, average paid leave take-up increases

National Implementation: Partnership

Marriage Rate

Leave Policy	Tax-Transfer Policy TP1	TP2	TP3	TP4
LP1	0.635	0.641	0.717	0.589
LP2	0.641	0.646	0.722	0.595
LP3	0.627	0.631	0.705	0.581
LP4	0.631	0.634	0.707	0.583
LP5	0.665	0.670	0.739	0.616
LP6	0.649	0.651	0.722	0.599
LP7	0.664	0.664	0.723	0.606

Cohabitation Rate

Leave Policy	Tax-Transfer Policy TP1	TP2	TP3	TP4
LP1	0.032	0.022	0.012	0.063
LP2	0.024	0.018	0.011	0.053
LP3	0.034	0.024	0.013	0.066
LP4	0.029	0.021	0.012	0.061
LP5	0.021	0.015	0.010	0.047
LP6	0.024	0.018	0.011	0.054
LP7	0.023	0.017	0.011	0.053

Ever Separated if Partnered

Leave Policy	Tax-Transfer Policy TP1	TP2	TP3	TP4
LP1	0.655	0.608	0.498	0.695
LP2	0.650	0.604	0.495	0.687
LP3	0.635	0.595	0.497	0.692
LP4	0.634	0.594	0.498	0.692
LP5	0.614	0.569	0.468	0.656
LP6	0.610	0.573	0.481	0.671
LP7	0.568	0.535	0.462	0.648

Equal Education Partnership

Leave Policy	Tax-Transfer Policy TP1	TP2	TP3	TP4
LP1	0.551	0.552	0.542	0.553
LP2	0.548	0.549	0.540	0.553
LP3	0.546	0.550	0.539	0.550
LP4	0.541	0.544	0.535	0.549
LP5	0.550	0.549	0.539	0.552
LP6	0.541	0.541	0.531	0.548
LP7	0.532	0.534	0.528	0.542

Notes: *Leave Policies*: **LP1**: no-leave; **LP2**: FMLA; **LP3**: one-tier policy with only paid leave; **LP4**: a one-tier policy with both paid and protected leave; **LP5**: two-tier version of FMLA with only protected leave in both tiers; **LP6**: two-tier policy with only paid leave in the first tier and both types in the second tier; **LP7**: two-tier policy with paid and protected leave in both tiers. *Tax-Transfer Policies*: **TP1**: low child transfers, lower marginal tax rate; **TP2**: low child transfers, medium marginal tax rate; **TP3**: High child transfers, high marginal tax rate; **TP4**: High child transfers, medium marginal tax rate.

National Implementation: Partnership

- **Marriage vs. cohabitation**
  - Two-tier policies generate the largest gains in marriage rates (up to 3.0 pp) and the largest decline in cohabitation rates (up to 1.6 pp)
  - FMLA also increases the marriage rate by up to 0.6 pp and it decreases the cohabitation rate by up to 0.9 pp
  - The policy with the highest lump sums, child transfers and marginal tax rates (TP3) generates the highest rates of marriage and the lowest rates of cohabitation
- **Separation**
  - Given any given tax-transfer regime, leave policies generally decrease the likelihood of separation
  - TP3 also reduces separation
- **Assortative mating**
  - Much less sensitive to variation in policy
  - All leave policies decrease assortative mating (though only marginally)

National Implementation: Fertility

Completed Fertility				
	Tax-Transfer Policy			
Leave Policy	TP1	TP2	TP3	TP4
LP1	2.45	2.48	2.64	2.54
LP2	2.33	2.37	2.60	2.50
LP3	2.26	2.31	2.53	2.45
LP4	2.23	2.26	2.48	2.39
LP5	2.24	2.26	2.45	2.36
LP6	2.04	2.08	2.36	2.28
LP7	2.07	2.11	2.38	2.30

Share of New Mothers				
	Tax-Transfer Policy			
Leave Policy	TP1	TP2	TP3	TP4
LP1	0.858	0.862	0.896	0.874
LP2	0.809	0.815	0.877	0.851
LP3	0.810	0.819	0.872	0.854
LP4	0.799	0.807	0.862	0.842
LP5	0.787	0.787	0.832	0.805
LP6	0.730	0.735	0.811	0.785
LP7	0.734	0.742	0.820	0.796

Notes: *Leave Policies*: **LP1**: no-leave; **LP2**: FMLA; **LP3**: one-tier policy with only paid leave; **LP4**: a one-tier policy with both paid and protected leave; **LP5**: two-tier version of FMLA with only protected leave in both tiers; **LP6**: two-tier policy with only paid leave in the first tier and both types in the second tier; **LP7**: two-tier policy with paid and protected leave in both tiers. *Tax-Transfer Policies*: **TP1**: low child transfers, lower marginal tax rate; **TP2**: low child transfers, medium marginal tax rate; **TP3**: High child transfers, high marginal tax rate; **TP4**: High child transfers, medium marginal tax rate.

National Implementation: Completed Fertility

- **Leave policies**
  - All leave policies reduce completed fertility compared to no leave
  - Two-tier policies with both paid and protected leave have the strongest negative effect, reducing completed fertility by up to 40 children per 100 women
  - Consistent with previous DID findings (FGH, 2024) that protected leave reduces medium-term fertility in the US
- **Tax-Transfer policies**
  - Tax-transfer policies with high child transfers (TP3, TP4) increase completed fertility by up to 32 children per 100 women
- **Policy interaction**
  - Tax-transfer regimes with high child transfers mitigate the negative effects of leave policies on completed fertility

National Implementation: Birth Timing and Spacing

- **Age of first birth:**
  - Leave policies generally delay the first birth, especially two-tier policies with both paid and protected leave (LP6, LP7), which delay first births by up to 8 months
  - High child transfer tax-transfer regimes (TP3, TP4) accelerate first births by up to 5 months
- **Birth spacing:**
  - Overall effect of policies on birth spacing is limited, suggesting birth spacing is mostly driven by mothers' preferences

National Implementation: Motherhood Penalty (First Birth)

Labor income ($)

Leave Policy	Tax-Transfer Policy TP1	TP2	TP3	TP4
LP1	-4,061	-4,107	-3,446	-3,454
LP2	-8,005	-7,426	-5,221	-5,276
LP3	-4,715	-4,548	-3,746	-3,652
LP4	-5,350	-5,069	-4,352	-4,197
LP5	-11,858	-11,910	-10,229	-9,833
LP6	-8,900	-8,601	-7,552	-7,341
LP7	-9,700	-9,086	-7,475	-7,314

Participation

Leave Policy	Tax-Transfer Policy TP1	TP2	TP3	TP4
LP1	-0.083	-0.098	-0.119	-0.116
LP2	-0.061	-0.073	-0.116	-0.112
LP3	-0.065	-0.077	-0.101	-0.102
LP4	-0.066	-0.077	-0.104	-0.096
LP5	-0.008	-0.020	-0.085	-0.081
LP6	-0.023	-0.028	-0.063	-0.060
LP7	-0.026	-0.033	-0.097	-0.091

Hours

Leave Policy	Tax-Transfer Policy TP1	TP2	TP3	TP4
LP1	-191	-193	-181	-181
LP2	-317	-310	-259	-258
LP3	-204	-203	-188	-184
LP4	-236	-234	-213	-207
LP5	-348	-359	-358	-352
LP6	-335	-331	-314	-307
LP7	-360	-351	-315	-311

Wages

Leave Policy	Tax-Transfer Policy TP1	TP2	TP3	TP4
LP1	-0.526	-0.583	-0.532	-0.535
LP2	-0.916	-0.873	-0.647	-0.650
LP3	-0.816	-0.796	-0.716	-0.700
LP4	-0.810	-0.801	-0.837	-0.767
LP5	-1.016	-1.146	-1.280	-1.169
LP6	-0.798	-0.854	-1.058	-1.009
LP7	-1.036	-1.010	-1.125	-1.083

Notes: The motherhood penalty of first birth is estimated using an event study specification, accounting for three periods before birth and ten periods after. Penalty computed only for women who were not mothers at the start. *Leave Policies*: **LP1**: no-leave; **LP2**: FMLA; **LP3**: one-tier policy with only paid leave; **LP4**: a one-tier policy with both paid and protected leave; **LP5**: two-tier version of FMLA with only protected leave in both tiers; **LP6**: two-tier policy with only paid leave in the first tier and both types in the second tier; **LP7**: two-tier policy with paid and protected leave in both tiers. *Tax-Transfer Policies*: **TP1**: low child transfers, lower marginal tax rate; **TP2**: low child transfers, medium marginal tax rate; **TP3**: High child transfers, high marginal tax rate; **TP4**: High child transfers, medium marginal tax rate.

National Implementation: Motherhood Penalty

- **Effect of leave policies on the motherhood penalty**
  - All leave policies, especially policies with protected leave, increase the motherhood penalty in labor income, worked hours, and wages
  - Relative to no-leave (LP1) the penalty in
    - labor income ↑ between $198 (LP3) and $7,803 (LP5)
    - worked hours ↑ between 3 hours (LP3) and 177 hours (LP5)
    - wages ↑ between $0.11 (LP2) and $0.74 (LP5)
    - participation ↓ between 0.3 pp (LP3) and 7.8 pp (LP5)
  - Two-tier policies (LP5-LP7) with low child transfers (TP1, TP2) ↓ participation penalty the most; they give access to mothers with lower labor attachment, fostering post-birth participation

- **Comparison with previous studies**
  - Findings are consistent (even in magnitude to a reasonable degree) with those in FGH (2024), despite not targeting causal effects or even the motherhood penalty itself
  - Extends the causal assessment to FMLA (LP2), FMLA does increase the motherhood penalty but less than two-tier policies

National Implementation: Motherhood Penalty

- **Impact of tax-transfer policies**
  - Tax-transfer policies have a smaller effect on the motherhood penalty compared to leave policies
  - High child transfer policies (TP3, TP4) reduce the motherhood penalty in labor income and hours but increase it in participation
    - Mothers receiving higher transfers are more likely to leave the labor market
    - However, conditional on participation, they avoid the part-time penalty in wages by working more hours
- **Interaction between tax-transfer and leave policies**
  - One-tier leave policies (LP2-LP4) with high child transfers: larger decrease in the penalty in hours and lower increase in the penalty in participation, which can offset human capital loss
  - Two-tier leave policies (LP5-LP7) with high child transfers: close the penalty in hours only modestly, leading to a larger penalty in wages due to insufficient offsetting of the human capital impact from lower participation

National Implementation: Labor Market Outcomes

Participation Rate

Leave Policy	Tax-Transfer Policy TP1	TP2	TP3	TP4
LP1	0.826	0.790	0.682	0.709
LP2	0.860	0.823	0.707	0.738
LP3	0.842	0.806	0.697	0.722
LP4	0.855	0.820	0.717	0.745
LP5	0.900	0.872	0.781	0.811
LP6	0.900	0.870	0.771	0.800
LP7	0.884	0.852	0.750	0.778

Mean Hours

Leave Policy	Tax-Transfer Policy TP1	TP2	TP3	TP4
LP1	1,929	1,745	1,380	1,487
LP2	2,147	1,948	1,503	1,624
LP3	1,936	1,759	1,399	1,491
LP4	1,971	1,792	1,427	1,535
LP5	2,546	2,356	1,855	1,960
LP6	2,304	2,125	1,706	1,808
LP7	2,265	2,081	1,646	1,751

Mean Wage ($)

Leave Policy	Tax-Transfer Policy TP1	TP2	TP3	TP4
LP1	17.5	16.7	15.2	15.6
LP2	18.7	17.7	15.7	16.3
LP3	18.2	17.3	15.6	16.1
LP4	18.4	17.4	15.7	16.3
LP5	21.1	20.1	17.5	18.0
LP6	20.3	19.2	17.1	17.6
LP7	20.1	19.1	16.8	17.4

Present Value Labor Income (Million $)

Leave Policy	Tax-Transfer Policy TP1	TP2	TP3	TP4
LP1	0.476	0.406	0.253	0.279
LP2	0.622	0.531	0.314	0.348
LP3	0.500	0.428	0.270	0.294
LP4	0.523	0.449	0.287	0.317
LP5	0.967	0.858	0.540	0.580
LP6	0.779	0.687	0.449	0.485
LP7	0.739	0.646	0.407	0.442

Notes: *Share of Years Working* is the total years worked divided by total years in the labor market (from entry to age 64 in simulation). *Present Value* of income is calculated at entry with a 5% interest rate. *Net Income* refers to after-tax household income, excluding single men households. *Leave Policies*: **LP1**: no-leave; **LP2**: FMLA; **LP3**: one-tier policy with only paid leave; **LP4**: a one-tier policy with both paid and protected leave; **LP5**: two-tier version of FMLA with only protected leave in both tiers; **LP6**: two-tier policy with only paid leave in the first tier and both types in the second tier; **LP7**: two-tier policy with paid and protected leave in both tiers. *Tax-Transfer Policies*: **TP1**: low child transfers, lower marginal tax rate; **TP2**: low child transfers, medium marginal tax rate; **TP3**: High child transfers, high marginal tax rate; **TP4**: High child transfers, medium marginal tax rate.

National Implementation: Labor Market Outcomes

- **Effects of leave policies on labor market outcomes of all women**
  - All leave policies boost participation, hours, wages, and income over the life cycle
  - Among one-tier polices FMLA (LP2) is the most effective, increasing
    - participation rate by up to 10.2 pp
    - mean hours by up to 618 annual hours
    - average wage by up to $3.6
  - Two-tier policies (ex: LP5) create even higher gains
- **Protected leave and human capital**
  - Higher take-up of protected leave in two-tier policies helps maintain human capital, increasing future wages and participation
  - A policy without job protection (LP3) yields smallest impacts on labor market outcomes

National Implementation: Labor Market Outcomes

- **Effects of tax-transfer policies on labor market outcomes of all women**
  - All tax-transfer policies reduce labor market outcomes relative to the baseline with low child transfers and lower marginal tax rates (TP1)
  - Regime with the highest child transfers and marginal tax rates (TP3) reduces labor market outcomes the most
    - Lower marginal utility of consumption
    - Increased substitution of labor income with transfer income over time
    - Effect sustained by the utility complementarity of adjacent leisure

National Implementation: Policy Cost and Tax Revenue

Present Value Protected Income
($ Per Household)

Leave Policy	Tax-Transfer Policy TP1	TP2	TP3	TP4
LP1				
LP2	988	785	300	296
LP3				
LP4	261	238	114	111
LP5	3,087	2,617	1,176	1,145
LP6	2,296	1,976	1,019	994
LP7	2,101	1,778	830	803

Present Value Replacement Income
($ Per Household)

Leave Policy	Tax-Transfer Policy TP1	TP2	TP3	TP4
LP1				
LP2				
LP3	1,396	1,297	986	950
LP4	1,434	1,340	1,005	967
LP5				
LP6	2,837	2,631	1,982	1,909
LP7	2,727	2,524	1,925	1,854

Present Value Tax Revenue
(Million $ Per Household)

Leave Policy	Tax-Transfer Policy TP1	TP2	TP3	TP4
LP1	0.297	0.250	0.280	0.167
LP2	0.336	0.285	0.304	0.187
LP3	0.305	0.258	0.287	0.175
LP4	0.308	0.261	0.292	0.179
LP5	0.441	0.383	0.397	0.260
LP6	0.382	0.330	0.356	0.231
LP7	0.372	0.319	0.339	0.218

Excess Revenue Relative to No-Leave
($ Per Household)

Leave Policy	Tax-Transfer Policy TP1	TP2	TP3	TP4
LP1				
LP2	38,675	34,485	24,008	19,854
LP3	8,239	7,293	7,052	7,152
LP4	10,842	10,609	12,259	12,084
LP5	143,594	132,944	116,446	92,758
LP6	84,665	79,264	75,635	63,306
LP7	75,172	68,871	59,216	50,728

Notes: *Protected Income* is the labor income generated by protected human capital gained through leave. Present value of income is calculated at entry with a 5% interest rate. *Net Income* refers to after-tax household income, excluding single men households. *Leave Policies*: **LP1**: no-leave; **LP2**: FMLA; **LP3**: one-tier policy with only paid leave; **LP4**: a one-tier policy with both paid and protected leave; **LP5**: two-tier version of FMLA with only protected leave in both tiers; **LP6**: two-tier policy with only paid leave in the first tier and both types in the second tier; **LP7**: two-tier policy with paid and protected leave in both tiers. *Tax-Transfer Policies*: **TP1**: low child transfers, lower marginal tax rate; **TP2**: low child transfers, medium marginal tax rate; **TP3**: High child transfers, high marginal tax rate; **TP4**: High child transfers, medium marginal tax rate.

National Implementation: Policy Cost and Tax Revenue

- **Leave policies**
  - All leave policies in the grid increase the government's net revenue relative to no leave
  - By a minimum of $7,052 per household in present value
  - Two-tier policies show the highest gains in tax revenue net of policy cost by retaining more women in the workforce
- **Impact of high child transfers**
  - Tax-transfer regimes with high child transfers reduce the overall tax revenue gains from leave policies
  - This is due to reduced labor market participation as higher transfers allow income substitution, which affects taxable income
- **What explains the net gains from leave policies?**
  - Financial costs of leave policies are fairly temporary, labor market gains are long-term
    - Cost of protected human capital declines quickly with depreciation
    - Cost of paid leave is only faced at the time of birth

- Policy Environment
- Individual Data
- Model
- Identification
- Estimation
- Estimates
- National Implementation of Policies
- Conclusion

Conclusion

- **What we do**
  - Combine extensive quasi-experimental variation on US leave and tax-transfer policies (1968-2017)
  - with a dynamic discrete-continuous choice model of fertility and work (extensive and intensive)
  - Counterfactually implement a grid of 28 policies at the national level
  - Prove identification of the utility function
- **Key findings**
  - Labor market vs. fertility: policies that boost women's labor participation (ex: two-tier leave) tend to decrease fertility, while those that increase fertility (ex: high child transfers) often reduce labor market outcomes
  - Balancing policy goals: a combination of two-tier leave with high child transfers offers a balanced approach, enhancing labor market outcomes while only moderately affecting fertility
  - Budget impact: regardless of the tax-transfer arrangement, all leave policies increase government revenue relative to no-leave scenarios
- Our findings highlight potential policy solutions that support women's labor outcomes and the government's budget, while managing the trade-off with fertility outcomes