Estimation of Dynastic Models- Application: Source of the intergenerational correlation in earnings

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This lecture is based on:
Gayle, Golan and Soytas JME 2022

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Motivation

- The intergenerational correlation of earnings is an important measure of mobility
- Previous work providing causal or structural interpretation
- A growing literature analyzes the possible mechanisms underlying the persistence in earnings.
- What are the roles of labor markets and assortative mating in the observed correlations?
- In addition to parental education and ability, we account for investment of parental time and income when children are young and fertility
- Focus on patterns of fertility, number and spacing of children, specialization in households, and assortative mating

Sources of Correlation

- Parental education, skill ("nature")
- Investment: monetary, parental time when children are young
- What affects investment?
- Understand households decisions of fertility, time allocation and specialization
- Parental education is important to understand these decisions
- The earnings structure is important as well
- Assortative mating and education of parents

Data

- Family-Individual File of the Michigan Panel Study of Income Dynamics (PSID) from 1968 to 1996.
- Two generations, 17-55. Married households
- The PSID measures annual hours of housework for each individual
- Normalized data for time with children: this approach can be found in Hill and Stafford (1974, 1980), Leibowitz (1974), and Datcher-Loury (1988)
- Time with children is computed as the deviation of housework hours from the average housework hours of individuals with no child.
- Account gender and education and year
- Negative values are set to zero
- Discretize to 3 levels of time investment

[CDS and ATUS validation ▷]

summary statistics by education

	Wife				Husband			
Variables	LHS	HS	SC	COL	LHS	HS	SC	COL
Age	31.05	31.08	31.26	32.09	31.13	31.18	31.41	31.94
	(3.99)	(3.91)	(3.90)	(3.99)	(4.04)	(4.05)	(4.00)	(3.94)
No. of children	0.74	0.86	0.82	1.00	0.82	0.84	0.92	0.95
	(0.74)	(0.90)	(0.91)	(0.98)	(0.97)	(0.88)	(0.94)	(0.96)
Labor income ($ US 2006)	8265	16,634	20,443	26,550	32,457	42,688	47,701	64,807
	(9478)	(1514)	(1772)	(2602)	(1952)	(2228)	(2802)	(3795)
Labor market hours	828	1200	1268	1189	1995	2161	2149	2262
	(898)	(886)	(879)	(861)	(796)	(668)	(634)	(610)
Housework hours	1267	1068	946	954	339	375	374	382
	(13.5)	(11.2)	(11.0)	(10.9)	(6.88)	(6.80)	(6.67)	(5.72)
Time w. children	270	280	295	360	78.20	86.40	77.20	92.50
	(421)	(423)	(459)	(499)	(196)	(217)	(224)	(206)
No. observations	204	3758	4524	7586	406	3942	3780	7944
Proportion(%)	1.4	24.8	30.7	43.2	2.9	27.1	25.0	44.9

Data

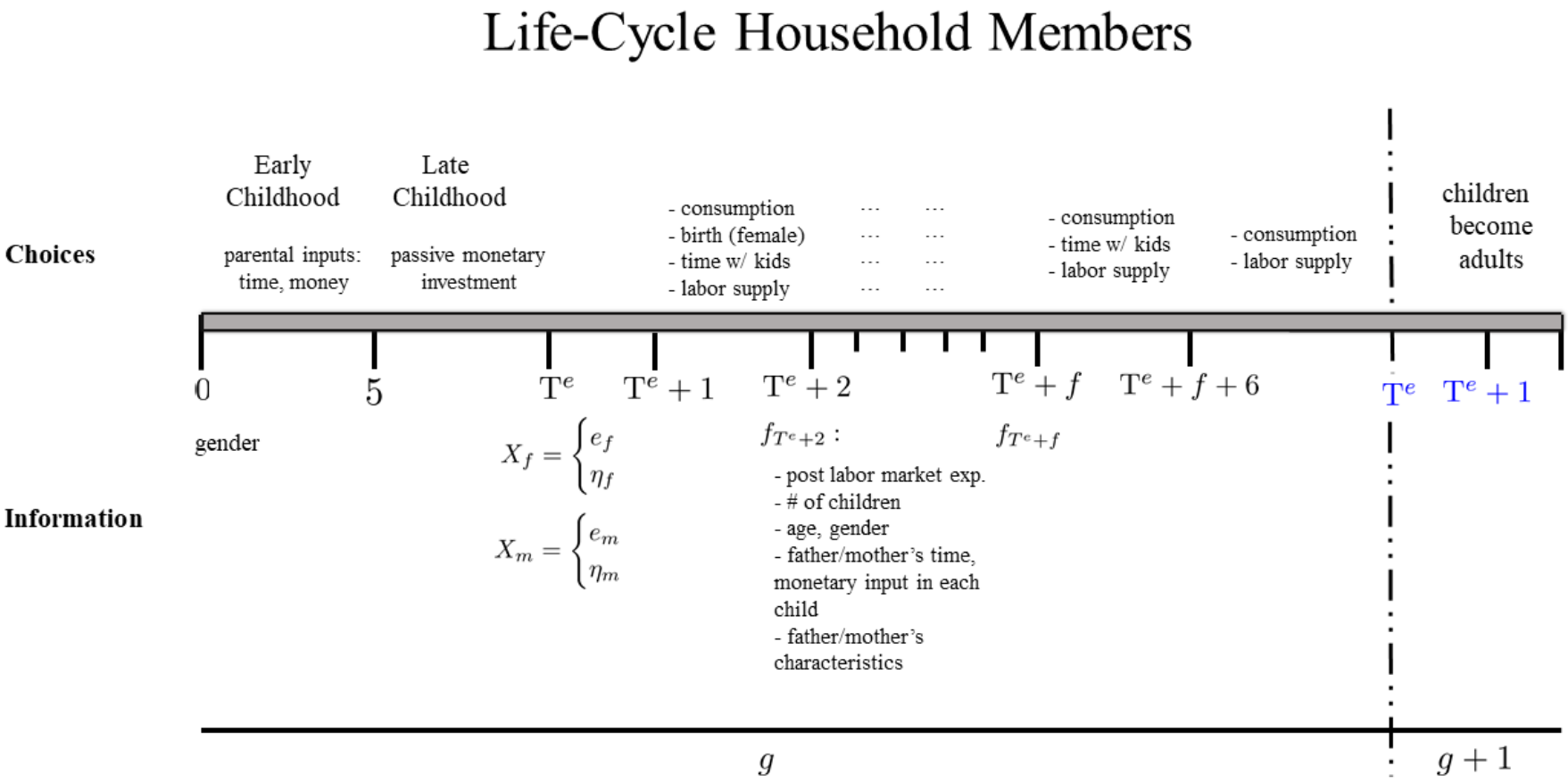
- In the cross section there is negative correlation between wealth and fertility
- Quantity-quality tradeoff, opportunity cost of time
- However, there is also wealth effect which implies positive correlation.
- In our sample of stable married households there is positive correlation
- More educated women nevertheless spend more time with children, despite the higher opportunity cost of time
- This suggest involved tradeoffs in the households and the specialization patterns

Model

Overview

- Dynastic model altruistic households make transfers to children (human capital).
- Adults, males and females match at the first period
- Unitary household
- They choose consumption, birth and time with children every period in which they are fertile
- After fertility period ends they work and consume
- Children become adult and realize their education and skill
- There is no overlap between periods in which adults make fertility and investment decisions, and adulthood of children
- Children become adults; repeats

Timeline - Life Cycle of Household Members



Model

Environment

- Individuals are males, m, or females, f .
- Their types are denoted by a vector x_f, x_m.
- Individuals are children for T^e periods. The first 5 years are early childhood.
- They become adults at age $T^e + 1$ and live for T periods
- At age $T^e + 1$ males and females are matched according to the matching function $G(x_f, x_m)$
- There is no divorce
- No borrowing or saving

Model

Choices

- Females are fertile from age T^e until age T^f . Households choose every period consumption and a vector a :
  1. labor supply vector, h_t : no work, part time, or full time, where $h_t = (h_{ft}, h_{mt})$.
  2. time spent with children of each parent, d_t : low, medium and high
  3. birth, b_t : $(b_t \in (0, 1))$
- State variables z_t include labor market, experience, past time with kids, children gender, age.
- The gender of a child random with equal probability.
  - The age and gender composition of existing children affect choices.
  - Capture the well-known empirical finding that parents have a preference for gender balanced in the sex composition of their children (Angrist and Evans (1998)).

Model

Labor market

- Wages are marginal product
- The log earnings function, $\ln w_{f(m)t}$, depends on

1. $W_{f(m)t}(e, h_{f(m)t})$: Age-education profile, part-time/ full-time work and the interaction with gender

- $H_{f(m)}(h_{f(m)T^e+1}, ..., h_{f(m)t-1})$: Experience, part-time/full-time and gender
- $\eta_{f(m)}$ is individual-specific ability

Model

Intergenerational production function (Education)

1. The offspring's education and ability, $x \equiv (e, \eta)$, are affected by parents' characteristics, early monetary investments, early time investments, and number and timing of siblings.

$$e'_{f(m)} = \Gamma_{f(m)}[x, d^{(0)}, ..., d^{(5)}, w^{(0)}, ..., w^{(5)}, S_{-5})] + \omega_{f(m)}$$

2. Once the education level is determined, ability is determined:

$$\eta'_{f(m)} = \Gamma_{f(m)\eta}(e') + \widetilde{\eta}'_{f(m)}$$

3. Random ability component $\widetilde{\eta}'_{f(m)}$ is independent of $\omega_{f(m)}$

Model

Budget and Preferences

- Budget constraint:

$$c_t + \alpha(z_t)(N_t + b_t)w_t(z_t, h_t) \leq w_t(z_t, h_t)$$

- $\alpha_N(z_t)$ is child care cost share of income; it depends on household education
- The per-period utility $u_{kt}(z_t)$, after substituting the budget constraint is

$$u_{a_t}(z_t) = \theta_{a_t}(z_t) + u_t[w_t(z_t, h_t)(1 - \alpha(z_t)(N_t + b_t)), z_t] + \varepsilon_{a_t}$$

- $\theta_k(z_t)$ preference over work, time with children, and child birth
- Preference shocks: ε_{a_t}
- Discount factor, β, altruistic discount factor: $\lambda N^{-\nu}$

Model

Shocks and their timing

4 shocks and source of uncertainty

1. The matching probability, $G(x_m, x_f)$, is realized at the beginning of adulthood, $T^e + 1$.
2. Preferences shocks, ε_{a_t}, realized at the beginning of each period within a household life-cycle between T^e and $T^e + T^f$ for fertility and between T^e and $T^e + T$ for time allocations.
   - realized before the decisions for each period is made and are i.i.d. across households and time
3. Educational outcome, $\omega'_{f(m)}$: realized at the end of childhood, T^e, and is independent across generation.
4. Innate ability in the labor market, $\widetilde{\eta}_{f(m)}$: realized at the beginning of adulthood, $T^e + 1$, and is persistent over the household life-cycle but independent across parents and children.

Model

Timing of choices

Within each period the model uses a timing for choices made by adults. The timing is:

1. The preferences shocks for the period is chosen by nature and observed by the households.
2. The household makes fertility, time allocation, and consumption decisions.

Model

Valuation Functions

- Altruistic households, utility from consumption, leisure, and the utility of the children
- Expected lifetime utility for a type (f, m) household at $T^e + 1$ has two components: life cycle utility and the discounted utility of children:

$$U^i(f,m) = V^i(f,m) + \beta^{T-T^e-1}\lambda E_{T^e+1}\left[N_{T^f}^{1-v}\overline{U}^{i+1}|f,m\right]$$

  - Where $\overline{U}^{i+1}$ is the average utility of the children

$$\overline{U}^{i+1}(f,m) = \frac{1}{N_{T^f}}\sum_{n=1}^{N_{T^f}}\sum_{f'=1}^{F}\sum_{m'=1}^{M} G(f',m')U_n^{i+1}(f',m')$$

  - Life-cycle: At the optimal choice $I_{a_t}^o$:

$$V^i(f,m) = E_{T^e+1}\left[\sum_{t=T^e+1}^{T}\beta^{t-T^e-1}\sum_{a_t\in A_t} I_{a_t}^o\{u_{a_t}(z_t) + \varepsilon_{a_t}\}\right]$$

Model

Intergenerational Correlation in Income

- Solve for a Stationary Equilibrium (Gayle, Golan, Soytas, 2018)
- Endogenous fertility:
  - Wealth effects imply positive correlation between fertility and education
  - "Quantity-Quality" tradeoff: opportunity cost of time is higher for more educated people
- Household and specialization:
  - women who are married to educated men may temporarily reduce labor supply when children are young and invest time with children- wealth effect
- Assortative mating: educated men are more likely to be married to educated women with high opportunity cost of time
- The degree of specialization depends on the gender pay gaps, and the effect of fathers vs. mothers time in the production function

Estimation Strategy (GGS 2018)

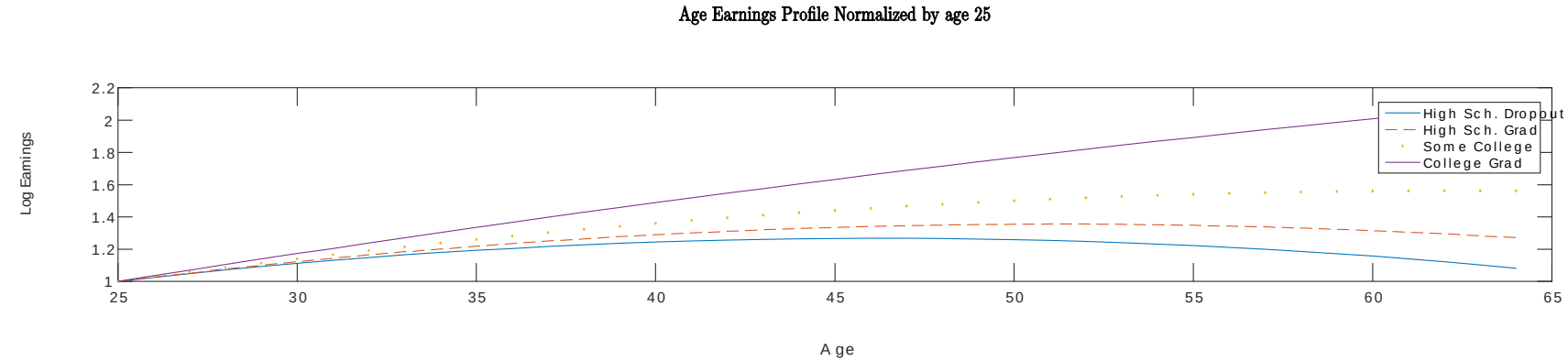
- Assume stationarity across generations and discrete state space
- **Step 1**
  - Estimate *earning equations* and *fixed effects* for both generations; CCP's and *intergenerational transition functions*: education and household type
  - The children's education production function parameters are estimated using a 3SLS $\Rightarrow$obtain *intergenerational transition functions*.
- **Step 2**
  - We derive representation of the ex-ante valuation function $U(x_0)$ in terms of CCP's, transition functions, per-period utility function parameters.
- **Step 3**
  - Using techniques from Hotz, Miller, Sanders, and Smith (1994), we form moment conditions from the CCP's and estimate structural parameters, *discount factors and per-period utility parameters*, using GMM.

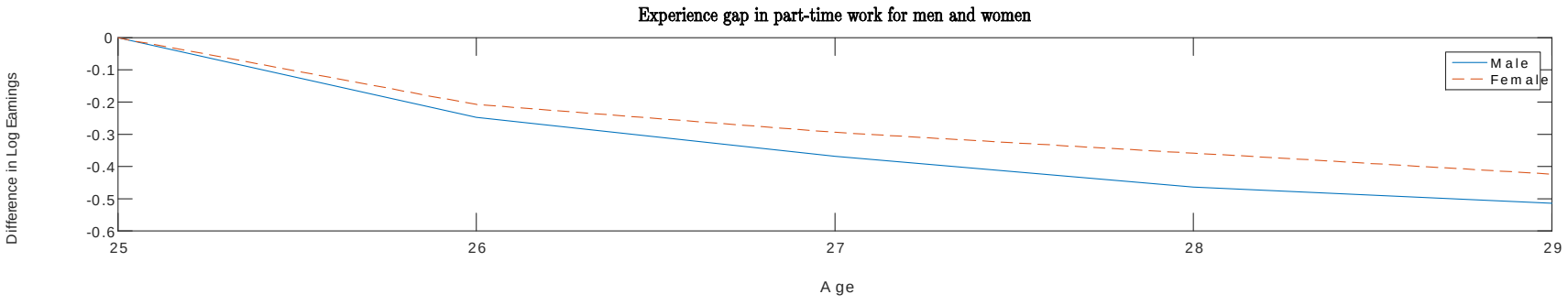
Results

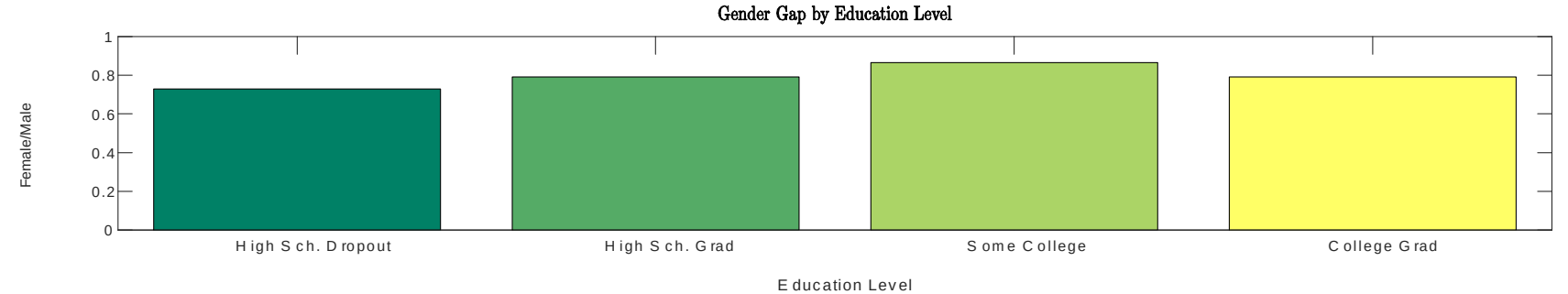
Earnings equation:dependent variable: log of yearly earnings

Variable	Estimate	Variable	Estimate
Age earning profile			
Age Squared	-4.0e-4	Female x Full-time	-0.125
	(1.0e-5)		(0.010)
Age x LHS	0.037	Female x Full-time (t-1)	0.110
	(0.002)		(0.010)
Age x HS	0.041	Female x Full-time (t-2)	0.025
	(0.001)		(0.010)
Age x SC	0.050	Female x Full-time (t-3)	0.010
	(0.001)		(0.010)
Age x COL	0.096	Female x Full-time (t-4)	0.013
	(0.001)		(0.010)
Return to hours worked		Female x Part-time (t-1)	0.150
Full-time	0.938		(0.010)
	(0.010)	Female x Part-time (t-2)	0.060
Full-time (t-1)	0.160		(0.010)
	(0.009)	Female x Part-time (t-3)	0.040
Full-time (t-2)	0.044		(0.010)
	(0.010)	Female x Part-time (t-4)	-0.002
Full-time (t-3)	0.025		(0.010)
	(0.010)		
Full-time (t-4)	0.040		
	(0.010)		
Part-time (t-1)	-0.087		
	(0.010)		
Part-time (t-2)	-0.077		
	(0.010)		
Part-time (t-3)	-0.070		
	(0.010)		
Part-time (t-4)	-0.010		
	(0.010)		

FEATURES OF THE EMPIRICAL EARNINGS EQUATION







3SLS system estimation the education production function

Estimation.

- Problems estimating the causal intergenerational schooling effect of parents' education.
  1. ability "bias" : more "able" mothers may obtain more schooling, if their children are more "able", they will also have more schooling.
  2. The relationship among parental traits, investment, and children's outcomes is normally estimated for mothers-children only. $\Rightarrow$even among mothers with the same abilities: higher education may have children with greater educational and labor market performances because of assortative mating.
- Our estimation strategy internalizes these concerns:
  - The estimated fixed effect included the education production function to mitigate the ability bias.
  - Accounting household: Fathers' education and home time in the education production function.

3SLS system estimation the education production function

Estimation.

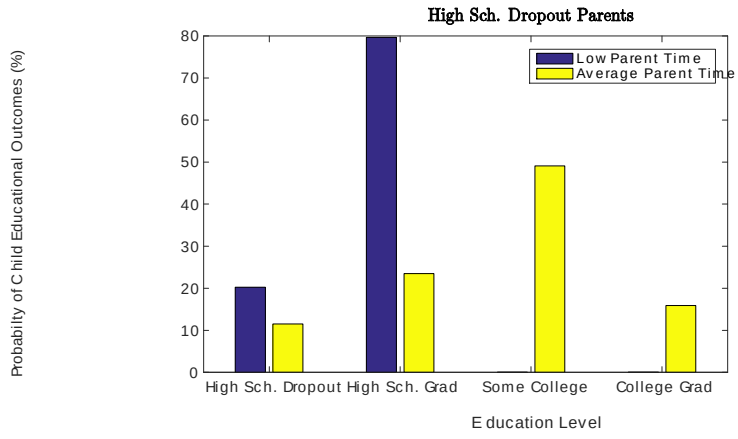
- Endogeneity of which parent and type of household spend parental time.
  1. Output of education production function determined across generations$\rightarrow$the inputs determined over the life-cycle of each generation.$\Rightarrow$ inputs predetermined.
  2. A system of equations with simultaneously: Education production function, labor supply, income, time spent with children, and fertility.
- Need exclusion restrictions motivated by the theoretical model.
  1. Sex composition of siblings (Angrist and Evans (1998)): enters the parental time and fertility equation but not labor supply or education production function directly
  2. The difference in the age-earnings profile by education – provide quasi-experimental variation in income, labor hours, and subsequent fertility.

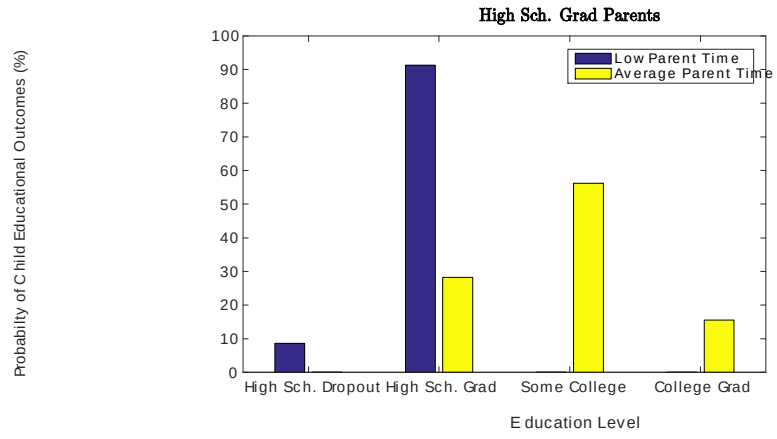
Results

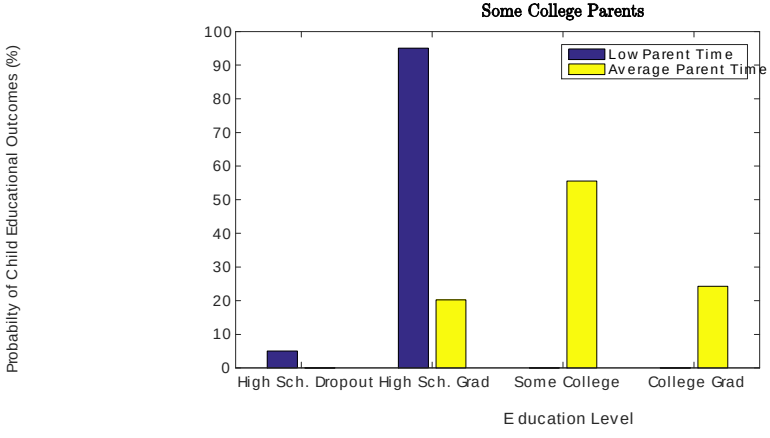
3SLS system estimation the education production function

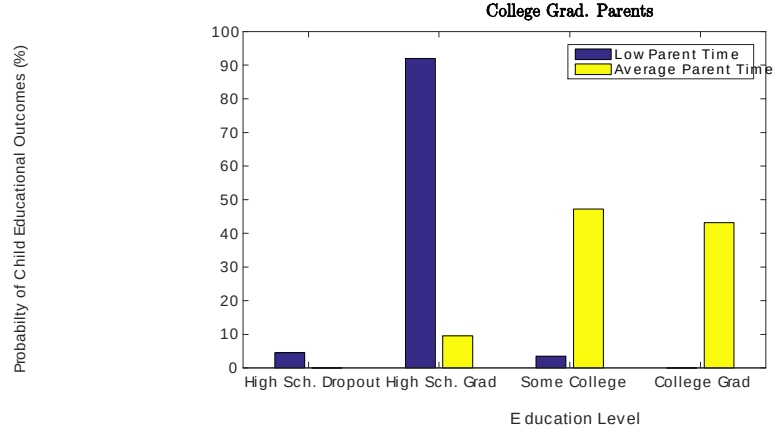
Variable	High School	Some College	College
High School Father	0.063	0.003	-0.002
	(0.032)	(0.052)	(0.0435
Some College Father	0.055	0.132	0.055
	(0.023)	(0.038)	(0.031)
College Father	**-0.044**	**0.008**	**0.120**
	(0.032)	(0.051)	(0.042)
High School Mother	0.089	0.081	-0.019
	(0.040)	(0.065)	(0.052)
Some College Mother	0.007	-0.041	0.017
	(0.030)	(0.049)	(0.039)
College Mother	**0.083**	**0.120**	**0.040**
	(0.036)	(0.057)	(0.047)
Mother's Time	**-0.014**	**0.080**	**0.069**
	(0.021)	(0.034)	(0.027)
Father's Time	**0.031**	**0.100**	**0.026**
	(0.019)	(0.029)	(0.025)
Mother's Labor Income	-0.025	-0.013	0.005
	(0.009)	(0.014)	(0.011)
Father's Labor Income	0.001	0.001	0.002
	(0.003)	(0.004)	(0.003)
Female	-0.002	0.135	0.085
	(0.017)	(0.028)	(0.022)
Number Siblings Under age 3	**-0.014**	**-0.107**	**-0.043**
	(0.017)	(0.027)	(0.022)
Number Siblings between age 3 and 6	-0.029	-0.047	-0.012
	(0.019)	(0.030)	(0.025)
Constant	0.855	-0.231	-0.359
	(0.108)	(0.172)]	(0.140)]
Observations	1335	1335	1335

PARENTAL TIME EFFECT ON THE EDUCATION OF CHILDREN

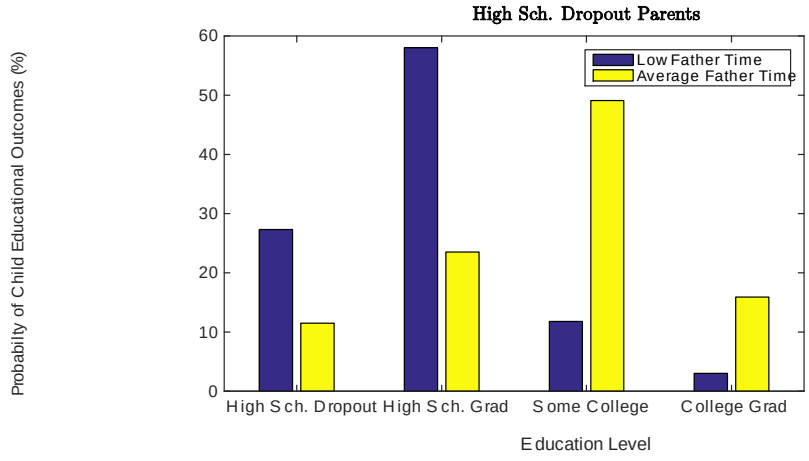


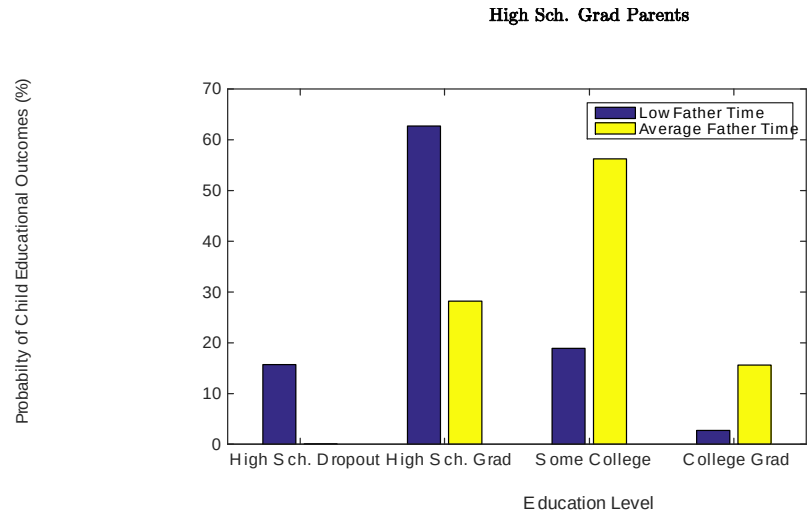


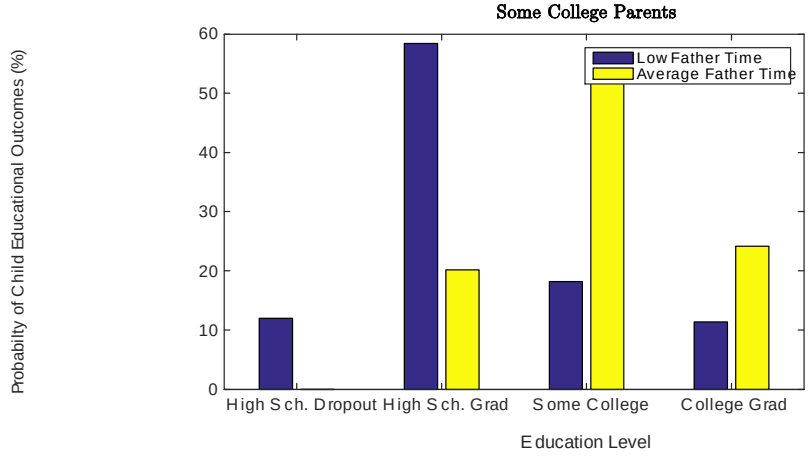


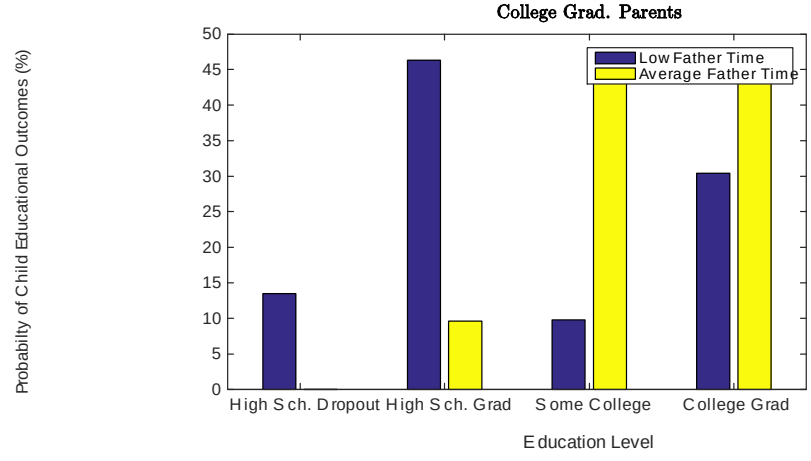


FATHERS TIME EFFECT ON THE EDUCATION OF CHILDREN









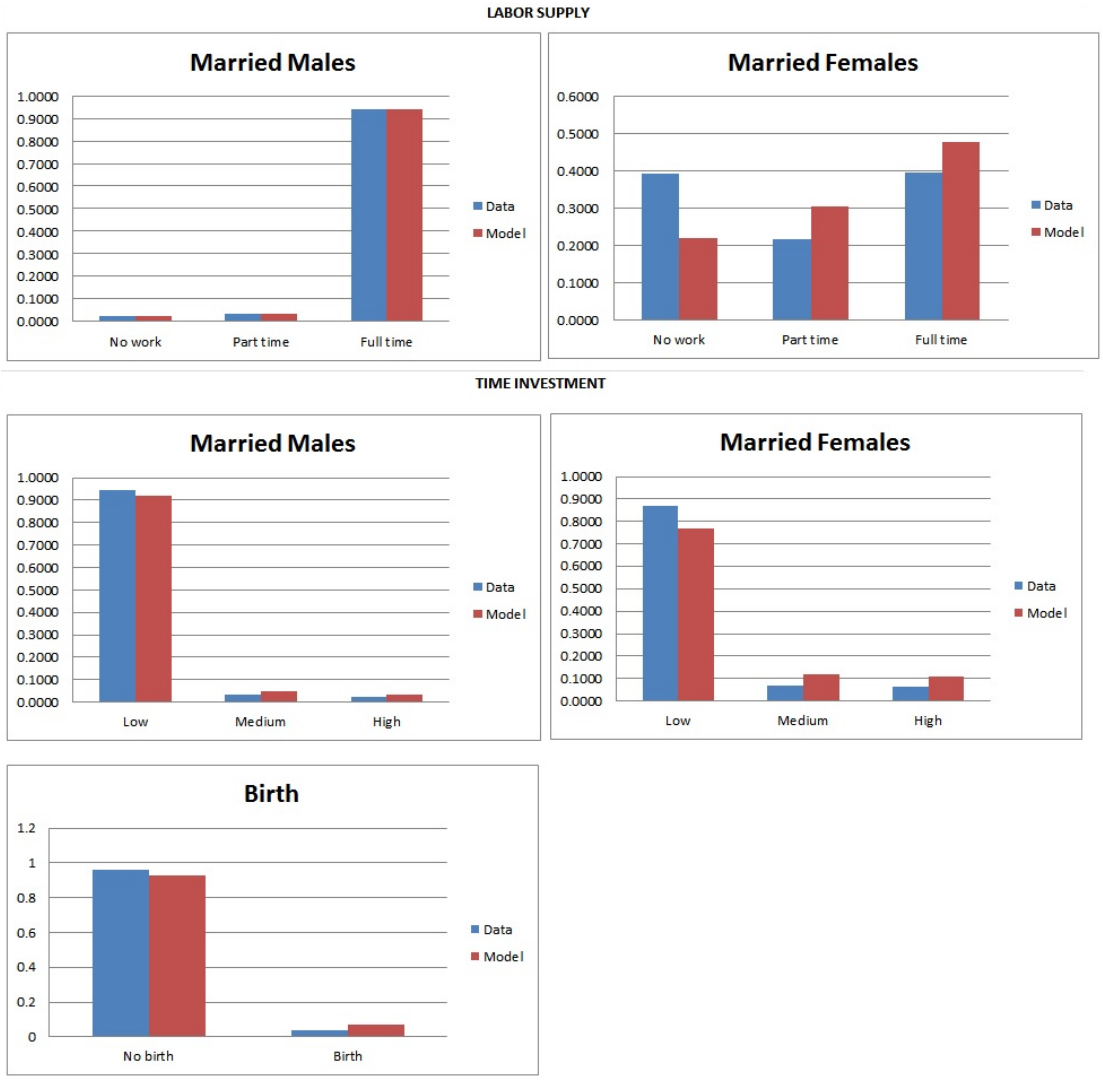
Results

Preferences

- $\lambda = 0.795$; suppose there is one child. The value of a child's utility is 79.5% relative to the parent's utility
- $\upsilon = 0.1$ implies that the value of the second child relative to the first is 0.68 relative to that of the first child, for the third it is 0.6
- There is net costs of children for all households
- Costs as a share decline in education of both spouses

Results

Model Fit



Results

Intergenerational correlation of log labor earnings

INTERGENERATIONAL CORRELATION OF LOG LABOR EARNINGS

	Family Earnings	
	Data	Model
Panel A: Fathers-sons		
Average earnings from age 30 to 40‡	0.337	0.251
	(0.086)	(0.056)
Panel B: Mothers-daughters		
Average earnings from age 30 to 40‡	0.286	0.222
	(0.077)	(0.050)
Panel C: All		
Average earnings from age 30 to 40‡	0.31	0.236
	(0.070)	(0.053)

Results

Counterfactual

- CF0-Baseline:
  1. Eliminate the dispersion of parental education input in the PF, with the education being assigned to high school for all parents.
  2. The spouse matching function is set to be uniform with equal probabilities for each person to marry a spouse with each one of the four education categories.
  3. The earnings equation is set so compensation does not vary with age and experience (it is set for age 32 and average experience of high school graduate).
  4. The returns to full-time work is set to be twice as large as the returns to part-time work, understating the returns to full-time work.
  5. The direct monetary cost of raising children that is a function of education are set to the values of high school graduates and the only variation in direct monetary cost of raising children is due to gender.

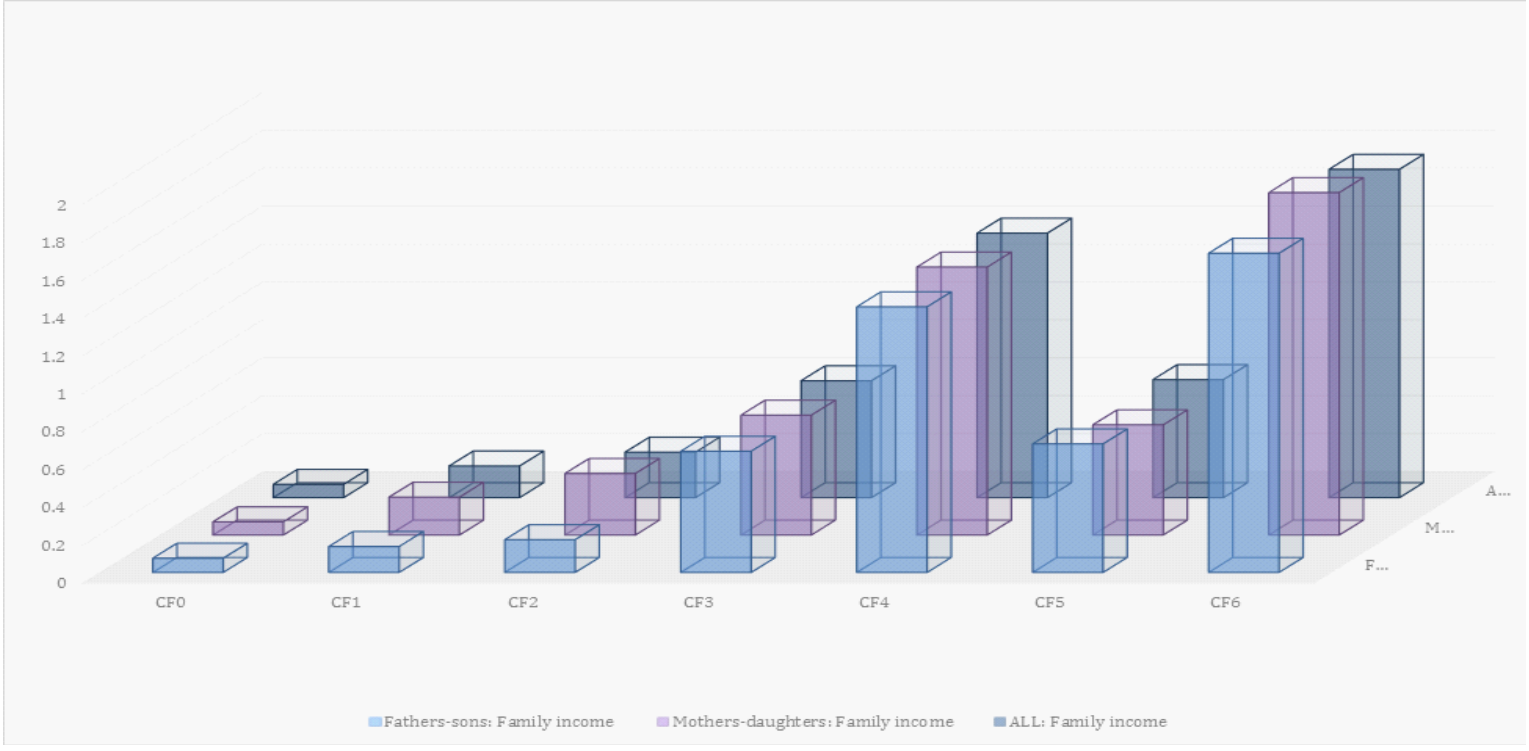
Results

Counterfactual

- AM-Assortative mating: adds back the assortative mating function in the data.
- AEP-Age-earnings profile: adds back the age-earnings relationship into the earnings equations (in addition to the assortative mating added in CF1).
- RTE-Labor market experience: adds to CF2 the experience effect in the earnings equation.
- FTPT-Part- versus full time: adds the true returns to full time versus part time to the earnings equation; thus in counterfactual 4, the matching function and the earnings equations are similar to the one in the original simulation.
- UC-Education effect of direct cost: adds back the direct monetary cost estimates which vary by education group.
- NA-Adds back education to the production function to FTPT

Results

Decomposition of the source of IGC



Note: CF0-Baseline. CF1-Assortative mating effect. CF2-Age-earnings profileeffect. CF3-Labor market experience effect. CF4-Part- versus full time effect. CF5-Education effect of direct costof children. CF6 -Direct effect of Parents' Education.

Probability of Parents in the bottom 20, Children in the bottom 20

Parents-Child Transitions, Family Income

	Actual	**Sim**	**CF 0**	**CF 1**	**CF 2**	**CF 3**	**CF 4**	**CF 5**	**CF 6**
FI at age 35	0.35	0.27	0.21	0.21	0.21	0.23	0.22	0.25	0.29
Average FI1	0.35	0.34	0.21	0.24	0.21	0.28	0.31	0.28	0.36
Lifetime FI2	-	0.33	0.22	0.22	0.24	0.28	0.32	0.28	0.35

[1] average labor income from age 30 to 40, * Model with high discounts

[2] lifetime discounted labor income from age 25 to 55

Probability of Parents in the top 20, Children in the top 20

Parents-Child Transitions, Family Income

	Actual	**Sim**	**CF 0**	**CF 1**	**CF 2**	**CF 3**	**CF 4**	**CF 5**	**CF 6**
FI at age 35	0.22	0.29	0.21	0.22	0.23	0.23	0.35	0.24	0.38
Average FI1	0.23	0.33	0.21	0.21	0.22	0.25	0.38	0.25	0.45
Lifetime FI2	-	0.32	0.22	0.21	0.22	0.23	0.30	0.24	0.35

[1] average labor income from age 30 to 40, * Model with high discounts

[2] lifetime discounted labor income from age 25 to 55

Results

CF3 Impact Labor Market Experience

- Experience (CF3), account for around 61% of the observed persistence.
- Female labor supply, full time work increases the most for households in which both spouses have at least high school education
- Fertility declined ; the largest decline is for households in which both spouses have some college or college degree
- Mothers' time per child increased at a higher rate in high education households: the average mother time with children declined in households in which mothers have less than high school
- Fathers' time with children increase in high education households declines in households in which both parents have high school education or less
- It is the decrease in fertility of well educated households together with "Quantity-Quality tradeoff" that causes the increase in persistence

Results

CF4 Part-Time versus Full-time Work

- Adding the disproportionately larger returns to full time work increase the correlation to above the one observed in the data
- Full-time work of females rises especially educated females
- Full-time work for males slightly declined
- Fertility of educated women with more educated husbands declines the most
- Again the correlation increases because of the disproportional increase in time per child of educated mothers
- Fathers time with children decreases but not as much as the increase in maternal time per child

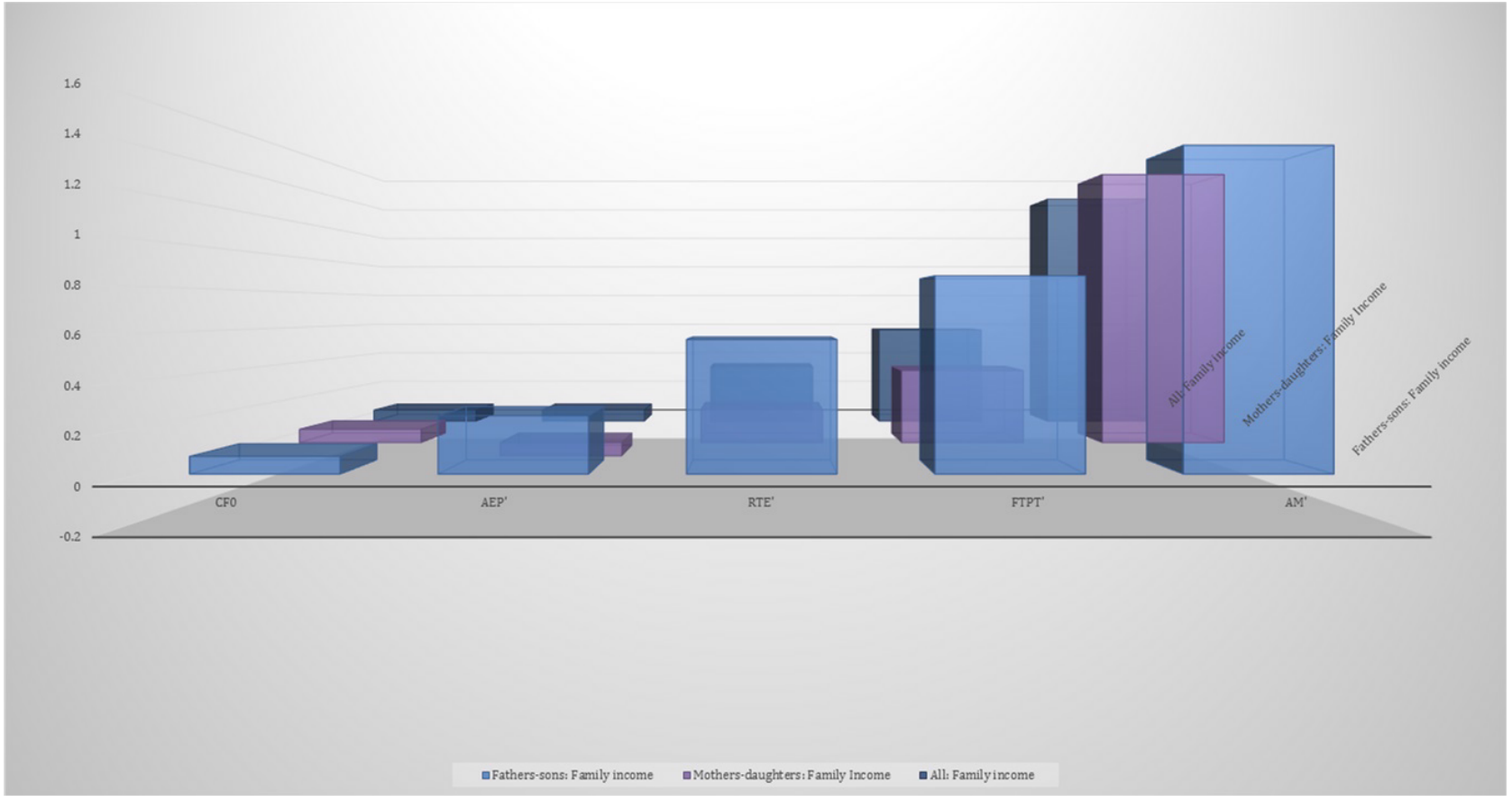
Results

CF5 Cost of Children

- CF5 reduces the correlation relative to around 0.166, accounting for between 59% and 69% of the intergenerational persistence
- In the spirit of Barro and Becker (1989) neutrality results
- We see fertility increases from 0.088 in CF4 to 0.171 in CF5.
- This is due to increase in fertility of college educated females, especially in households with educated males
- Maternal time per child in households with at least some college females and at least HS males declines
- Maternal time per child in households with at most high school education of both parents increases
- While male time with kids increases, more so in educated females household it does not offset the impact of decline in maternal time

Results

Decomposition of the source of IGC



Summary of Results

- Counterfactual simulations are used to demonstrate the relative importance of the factors affecting mobility.
- Parental time with children, especially maternal time gaps creates persistence in earnings
- Earnings structure can generate large part of the observed persistence without the effect of parental education in the human capital production function
- Assortative mating cannot alone generate much persistence but it interacts with the earnings structure to reduce mobility
- "Quality-Quantity" tradeoff is quantitatively important
  - Educated women have high opportunity cost of time, so fertility declines
  - Wealth effect increases demand for children in more educated households as well as quality