Child skill production: Accounting for parental and market-based time and goods investments

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Motivation

- Growing evidence suggests that parental investments in children are critical to intergenerational mobility & inequality
- These investments come in many forms:
  - parental time
  - home goods & services (e.g. books, computers, lessons)
  - market-based child care services

2 Outstanding Questions

We explore 2 issues theoretically & empirically:

- How does parental human capital affect different investments in children & child development?
  - through wages: time input prices & family income
  - child skill productivity differences
  - preferences for children's skills
- How do different tax/subsidy policies affect different types of investments & child development?
  - e.g., income taxes, EITC, subsidies for sports & arts programs, child care subsidies
  - substitutability of inputs is critical

Related Literature & Our Focus

- Most of the literature on child development & estimation of skill production functions focuses on the dynamics of investments
  - studies generally reduce investment to a single endogenous input (e.g. Cunha & Heckman 2007, Cunha, Heckman & Schennach 2010, Agostinelli & Wiswall 2020, Caucutt & Lochner 2020)
  - or impose strong assumptions about substitutability between inputs (e.g. Del Boca, Flinn & Wiswall 2014, Griffen 2019, Lee & Seshadri 2019, Mullins 2022, Attanasio et al. 2020)
  - a few recent exceptions free up some assumptions about substitutability (Abbott 2022, Moschini 2023, Molnar 2023, Yum 2022)
- We focus mainly on *intratemporal* allocation decisions about the types of investments families make each period
  - allow substitutability to differ across several types of inputs
  - allow parental skills to impact the relative productivity of inputs

Main Contributions

- Using a dynamic household model of child development, we
  - show when the family decision problem can be separated into *intratemporal* & *intertemporal* decisions
  - characterize effects of input prices & parental education on input choices
- We develop & implement a relative demand estimation strategy for the within-period technology of skill production
  - estimate flexible substitution & relative productivity of different inputs
  - estimate effects of parental education on relative input productivity
  - account for unobserved heterogeneity in parental skills
  - address measurement error in inputs & parental wages
- Exploit relative demand restrictions to simplify estimation of dynamics of skill prod.
  - incorporate panel data on (noisy) skill measures
  - use model to fill in for missing inputs

Key Findings

- Estimate input elasticities of substitution of 0.2–0.5 for
  - parental time vs. home goods/services
  - home inputs (time & goods/services) vs. child care services
- This complementarity implies co-movement of all inputs to price changes
  - wage increases can lead to increases in parental time investments
  - adjustments in other inputs have important implications for the public costs of free child care & investment subsidies
- No evidence that maternal education makes child investment inputs more productive (for children ages 5–12)
  - more educated parents invest more in all inputs, because they have higher incomes & stronger preference for child skills (or higher perceived returns to investment)

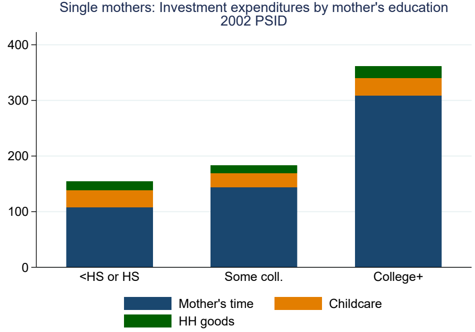
Investments in 2002 PSID-CDS

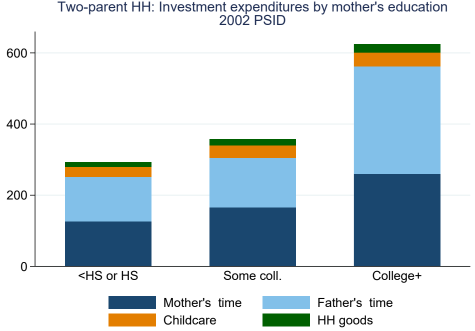
Consider weekly expenditures for families with 1–2 children, both ages 0–12

- Nearly all children were ages 5–12 in 2002 CDS
- "HH goods" investments: school supplies; books & toys; services like tutoring, lessons, community groups & sports
- Parental time: time actively engaging with children in developmental & social activities
  - based on time diaries
  - stricter definition than Del Boca, Flinn, and Wiswall (2014)

Investment Expenditures by Mother's Education

- Expenditures increase with maternal education ▸ Expend. Shares
  - increase in time expenditures partly reflects higher wages ▸ Parental Time
- Expenditures dominated by time investments





A General Framework

- Households differ by
  - child's ability: θ
  - child's initial skill: Ψ_1
  - mother's human capital: H_m (include fathers in paper and estimation)
  - non-labor income: Y_t
- Every period, households choose
  - consumption: c_t
  - mother's leisure: $l_{m,t}$
  - investments in children: I_t (composite price given by $\bar{p}_t$)
  - future assets: A_{t+1}
- Interest rate for borrowing/saving: r
  - borrowing limit: $A_{t+1} \geq A_{t,min}$
- Mothers invest in their children for T periods with period $T+1$ household continuation value depending on final child skill level, Ψ_{T+1}:

$$\tilde{V}(H_m, A_{T+1}, Y_{T+1}, \Psi_{T+1})$$

Dynamic Investment Decision Problem

$$V_t(\theta, H_m, A_t, Y_t, \Psi_t) = \max_{c_t, A_{t+1}, l_{m,t}, I_t} u(c_t) + v(l_{m,t}) + \beta E_t[V_{t+1}(\theta, H_m, A_{t+1}, Y_{t+1}, \Psi_{t+1})]$$

subject to

$$\begin{aligned}
c_t + \bar{p}_t I_t + A_{t+1} &= (1+r)A_t + Y_t + w_{m,t} H_{m,t}(1 - l_{m,t}) \\
\Psi_{t+1} &= \mathcal{H}_t\left(I_t, \theta, \Psi_t\right) \\
A_{t+1} &\geq A_{min,t} \\
V_{T+1}(\theta, H_m, A_{T+1}, Y_{T+1}, \Psi_{T+1}) &= \tilde{V}(H_m, A_{T+1}, Y_{T+1}, \Psi_{T+1}) \\
0 \leq l_{m,t} &\leq 1
\end{aligned}$$

Investment Inputs & Prices

- Total investment depends on 3 broad types of investment inputs

$$I_t = f_t\left(\tau_{m,t}, g_t, x_t; H_m\right)$$

  - Home investments: mother's time, $\tau_{m,t}$ and goods, g_t
  - Market-based child care services: x_t
- Input price vector: $\Pi_t \equiv (W_{m,t}, p_t, q_t)$
  - Mother's wages: $W_{m,t} = w_{m,t} H_m$
  - Price of home investment goods: p_t
  - Price of market child care: q_t

Child Skill Production

- Child skills evolve according to:

$$\Psi_{t+1} = \mathcal{H}_t\left(f_t\left(\tau_{m,t}, g_t, x_t; H_m\right), \theta, \Psi_t\right)$$

- Key Assumptions:
  - weak intertemporal separability of inputs through total investment $f_t(\cdot)$
  - $f_t(\cdot)$ is homogenous of degree 1
- Empirically, we assume $f_t(\cdot)$ is a nested CES:

$$f_t = \left[\left(a_{m,t}(H_m)\tau_{m,t}^{\rho} + a_{g,t}(H_m)g_t^{\rho}\right)^{\frac{\gamma}{\rho}} + a_{x,t}x_t^{\gamma}\right]^{\frac{1}{\gamma}}$$

where $\rho < 1, \gamma < 1$

  - accommodates flexible substitution patterns: $\varepsilon_{\tau,g} = \frac{1}{1-\rho}$ & $\varepsilon_{h,x} = \frac{1}{1-\gamma}$
  - mother's human capital can affect (relative) productivity of inputs

Household's Problem

- When mothers work in the market, the household problem can be separated into
  - **Within-period problem:** choose inputs to minimize expenditures given a total investment amount, I_t
    - $\rightarrow$ optimal inputs are proportional to each other & total investment, I_t
    - $\rightarrow$ input ratios depend only on relative input prices & within-period technology $f_t(\cdot)$
    - $\rightarrow$ implies a composite price of total investment: $\bar{p}_t$
  - **Intertemporal problem:** dynamic decision about savings, leisure & total investment, I_t, each period given all $\bar{p}_t$
- Like the 2-stage budgeting approach commonly used in labor supply literature (Gorman 1959, Heckman 1974, Altonji 1986, Blundell & Walker 1986)

Relative Demand

When $f_t(\cdot)$ is nested CES,

$$\frac{\tau_{m,t}}{g_t} = \Phi_{m,t}\left(\frac{W_{m,t}}{p_t}\right) = \left[\frac{a_{g,t}}{a_{m,t}}\frac{W_{m,t}}{p_t}\right]^{\frac{1}{\rho-1}},$$

$$\frac{x_t}{g_t} = \Phi_{x,t}\left(\frac{W_{m,t}}{p_t}, \frac{q_t}{p_t}\right) = \left[\frac{a_{g,t}}{a_{x,t}}\frac{q_t}{p_t}\right]^{\frac{1}{\gamma-1}} \left(a_{m,t}\Phi^{\rho}_{m,t} + a_{g,t}\right)^{\frac{\gamma-\rho}{\rho(\gamma-1)}}$$

- Note: $a_{g,t}$ and $a_{m,t}$ are functions of mother's human capital
- These relationships form the basis for relative demand estimation

Intertemporal Problem

- Two assumptions:
  1. $\Psi_{t+1} = \theta I_t^{\delta_1} \Psi_t^{\delta_2}$
  2. $\tilde{V}(H_m, A_{T+1}, Y_{T+1}, \Psi_{T+1}) = \tilde{U}(H_m, A_{T+1}, Y_{T+1}) + \alpha(H_m)\ln(\Psi_{T+1})$

  yield a simple FOC for I_t:

$$\underbrace{\bar{p}_t I_t}_{E_t} = \frac{K_t}{u'(c_t)} \qquad \text{where } K_t \equiv \alpha\beta^{T-t+1}\delta_2^{T-t}\delta_1 > 0$$

  $\Rightarrow$ Investment expenditures E_t co-move with c_t

- Characterize input choices for constrained and unconstrained families

Relative Demand: Estimating Within-Period Production, $f_t(\cdot)$

- We use revealed preferences & relative demand to estimate the substitutability & relative productivity of different inputs within periods
- Key requirements:
  - parents work positive hours (wage reflects the price of time)
  - intertemporal separability of inputs through $f_t(\cdot)$
  - $f_t(\cdot)$ is homogeneous of degree 1
  - no preferences for specific inputs
  - implicitly assumes families are knowledgeable about $f_t(\cdot)$; otherwise, identifies beliefs about skill production
- Key advantages (relative to "direct" estimation approach):
  - requires no additional assumptions about dynamics of skill production, $\mathcal{H}_t(\cdot)$
  - unaffected by heterogeneity in input-neutral child ability θ
  - only requires cross-sectional data on inputs & prices, not panel data on skills
  - easy to deal with measurement error in inputs – no need for multiple measures of each input

Relative Demand: Summary of Estimation Results

- Elasticities of substitution ranging from 0.2 to 0.5 imply moderately strong complementarity
- No consistent effects of parental education on relative productivity of inputs
- Estimates are insensitive to how we account for unobserved heterogeneity
  - 2SLS estimates using predicted log wages from 2000 Census
  - including parental log wage FE

Full Production Function: Estimation Overview

We incorporate panel data on cognitive skills (language & math) from PSID-CDS 1997, 2002 & 2007 to estimate the dynamics of skill production given by:

$$\Psi_{i,t+1} = \theta_{i,t} I_{i,t}^{\delta_1} \Psi_{i,t}^{\delta_2}$$

- Use this to derive intertemporal moment conditions on inputs & skills
  - use within-period optimality to simplify this as a function of one observed input (easily address measurement error in inputs)

$$\tau_{i,t} = \Phi_{I,t}(\Pi_{i,t}; a, \rho, \gamma) I_{i,t}$$

  - use model to impute missing inputs (constrained and unconstrained HH)
- Combine with previously discussed relative demand moments
- Estimate via optimally weighted GMM

Full Production Function: Estimates (GMM Using All Moments)

	No Borrowing/Saving	Unconstrained
$\varepsilon_{\tau,g}$	0.20	0.20
	(0.05)	(0.05)
$\varepsilon_{h,x}$	0.49	0.49
	(0.08)	(0.08)
δ_1	0.12	0.08
	(0.04)	(0.04)
δ_2	0.93	0.93
	(0.01)	(0.01)

$$\Psi_{t+1} = \theta I_t^{\delta_1} \Psi_t^{\delta_2}$$

- Moderately strong complementarity, stronger between home inputs
- 10pp increase in investment leads to a roughly 0.01 SD increase in skill
- High self-productivity of skill, δ_2
- Modest effects of mother's education & unobserved skill on productivity of her time

Counterfactual Analysis

We use our GMM estimates for the case of no borrowing/saving to study

1. investment differences by maternal education
2. effects of input price changes
3. cost of free child care

- Calibrate preference parameters (for children's skill & parents' leisure) to match time use patterns separately by maternal education

Investment & Expenditure Gaps by Parental Education

Among **single mothers**, college-educated invest one-third more in their children than do the non-college-educated

- Equalizing technology differences by maternal education only reduces this gap by about 10%
- Investment gaps by mother's education are not driven by productivity differences but by
  - differences in family income
  - differences in preferences (or beliefs about the productivity of investment, δ_1)

Simulating the Effects of Price Changes

Next, we simulate the effects of 30% reductions in input prices when children are ages 5–12

- Contrast with implications from a Cobb-Douglas production function with identical expenditure shares

30% Reduction in Prices: Constrained Single Mothers

	Nested CES				Cobb-Douglas			
	Wages	Wages (Constant income)	Goods	Child Care	Wages	Wages (Constant income)	Goods	Child Care
A. Change in Investment at Age 5 (%)								
Total Expenditure (E)	-30.00	0.00	0.00	0.00	-30.00	0.00	0.00	0.00
Investment Quantity:								
Mother's Time (τ_m)	-5.70	34.71	1.23	3.82	0.00	42.85	0.00	0.00
Goods (g)	-11.94	25.80	8.60	3.67	-30.00	0.00	42.86	0.00
Child Care (x)	-20.16	14.06	0.68	23.54	-30.00	0.00	0.00	42.86
Total (I)	-9.59	29.15	1.37	7.58	-9.18	29.75	1.60	8.37
B. Effects on Age 13 Achievement								
100 $\times$ Log Achievement at age 13	-8.25	18.68	1.83	5.20	-7.65	19.28	2.07	5.57
Value (% Cons. over Ages 5–12)	-4.99	12.44	1.15	3.28	-4.63	12.87	1.31	3.52

- Due to complementarity, all input quantities move together
- Cobb-Douglas implies stronger own-price & zero cross-price effects
  - stronger own-price effects imply greater public costs of any subsidy

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- Income effects dominate price effects for wage changes, see mother's time investment fall
    - modest reductions in achievement are broadly consistent with effects of EITC on achievement (Dahl & Lochner 2012, Agostinelli & Sorrenti 2018)

Costs of Free Child Care

How much would it cost to eliminate total investment gaps (ages 5–12) by mother's education through free child care to non-college mothers?

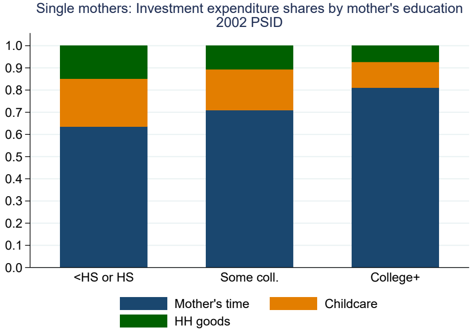
- Would cost $100/week for single non-college mothers
- Families respond to free child care by increasing other inputs
- These reinforcing investment responses help reduce public expenditures but are costly for families

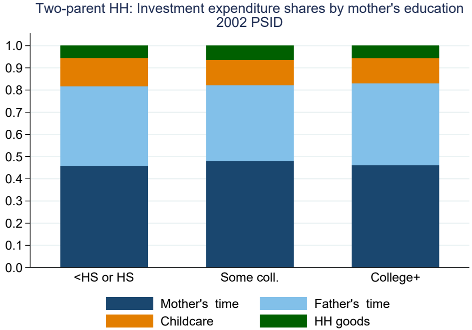
Conclusions

- Families make many different types of investments in their children
- Relative demand estimation is a promising approach to identify input substitutability & relative productivity
  - can also help simplify estimation of skill dynamics & test accuracy of beliefs
- Broad categories of investment inputs are quite complementary
  - implies that inputs co-move in response to taxes/subsidies
  - income effects of wage increases dominate price effects for constrained families, leading to more investment & skill accumulation
- We find no consistent effect of parental education on the productivity of investments for 5–12 year-old American children
  - positive parental education gradient is driven by overall demand – resources & tastes (or perceptions)

Investment Expenditure Shares by Mother's Education

- Expenditure shares are similar across mother's education, especially for two-parent households
  - → More educated mothers spend more on all forms of investment





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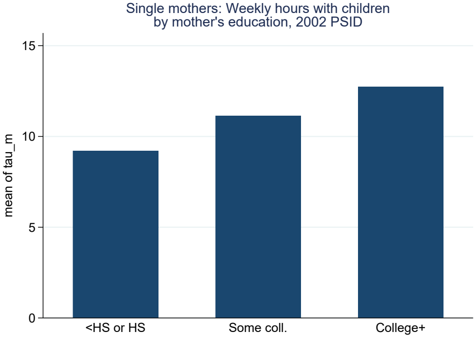
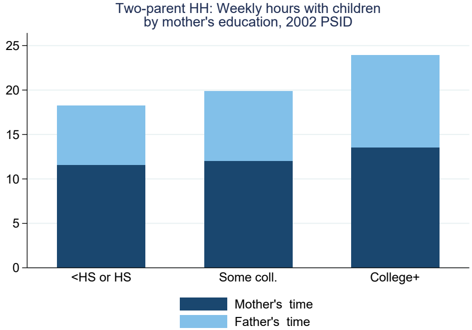
Time Investment by Mother's Education (PSID)





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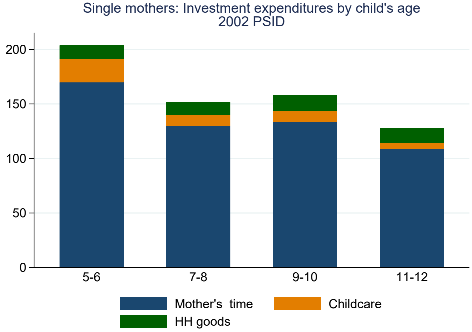
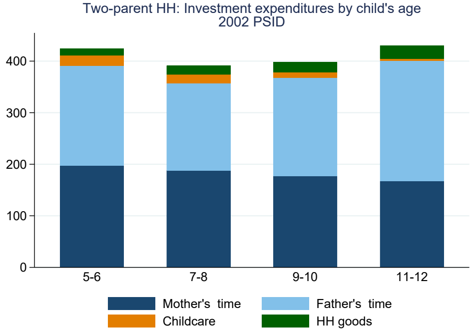
Investment Expenditures by Child's Age (PSID)





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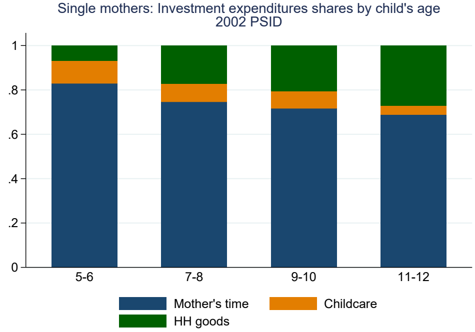
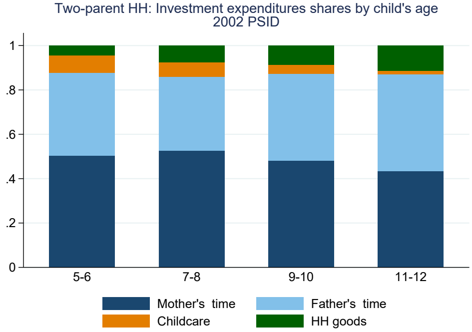
Investment Expenditure Shares by Child's Age (PSID)





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Linking Empirical & Theoretical Specifications

- Let parental human capital be $H_{j,i,t} = exp(Z_{i,t}\Gamma_j + \tilde{\eta}_{j,i})$, so

$$\ln(W_{j,t}) = \ln(w_{j,t}) + Z_t\Gamma_j + \tilde{\eta}_j$$

- Assuming that $\varphi_j(H_j) = H_j^{\bar{\varphi}_j}$ implies that $a_j(Z, \eta_j) = \exp(Z\phi_j + \eta_j)$ where $\phi_j = \Gamma_j\bar{\varphi}_j\rho$ and $\eta_j = \tilde{\eta}_j\bar{\varphi}_j\rho$
- For $\rho < 0$ $(0 < \varepsilon_{\tau,g} < 1)$, the marginal effects of characteristics that improve parental wages ($\Gamma_j > 0$) will imply $\phi_j < 0$ when parental skills raise the marginal value of parental time inputs (i.e., $\varphi_j'(H) > 0$)
- Because parental HC is factor augmenting, an increase in parental HC raises the total effective time input, which may cause parents to spend relatively less time investing

No Measurement Error in Wages, Time or Goods Inputs

If $\xi_{W_m \tau_m / g,i,t} = 0$, then estimating equation simplifies to:

$$\ln(R_{Y_c,i,t}) = Z'_{i,t}\tilde{\phi}_g + \left[\frac{\gamma - \rho}{\rho(\gamma - 1)}\right] \ln\left(1 + R_{m,i,t}\right) + \left(\frac{\gamma}{\gamma - 1}\right) \ln \tilde{P}_{c,i,t} + \xi_{Y_c/g,i,t}$$

- Can estimate using OLS

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Measurement Error in Inputs

If $\xi_{W_m,i,t} = 0$, then estimating equation simplifies to:

$$\ln(R_{Y_c,i,t}) = Z'_{i,t}\tilde{\phi}_g + \left[\frac{\gamma-\rho}{\rho(\gamma-1)}\right]\ln\left(1+e^{\ln(\tilde{\Phi}_{m,i,t})}\right) + \left(\frac{\gamma}{\gamma-1}\right)\ln\tilde{P}_{c,i,t} + \xi_{Y_c/g,i,t}$$

where $\tilde{\Phi}_{m,i,t} \equiv \frac{W_{m,i,t}\tau_{m,i,t}}{p_{i,t}g_{i,t}}$

- Substitute predicted values $\ln\widehat{(R_{m,i,t})}$ (from relative demand estimation for mother's time vs. HH goods) in for $\ln(\tilde{\Phi}_{m,i,t})$ above and estimate via OLS

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Measurement Error in Inputs & Wages

$$E\left[\ln(R_{Y_c,i})\middle|Z_i, R_{m,i}, \tilde{P}_{c,i}, g_i^o\right] = \quad Z_i'\tilde{\phi}_g + \left[\frac{\gamma-\rho}{\rho(\gamma-1)}\right] E\left[\ln\left(1 + R_{m,i}e^{-\xi_{W_m\tau_m/g,i}}\right)\middle|R_{m,i}\right]$$
$$+ \left(\frac{\gamma}{\gamma-1}\right)\ln\tilde{P}_{c,i} - E[\xi_{g,i}|g_i^o]$$

- Distributional assumptions on measurement errors enable a GMM approach (requires integrating over expectation term in red)

Taking a second order Taylor approximation for term in red and assuming normality in $(g_i, \xi_{g,i})$ yields:

$$E\left[\ln(R_{Y_c,i})\middle|Z_i, R_{m,i}, \tilde{P}_{c,i}, g_i^o\right]$$
$$\approx Z_i'\tilde{\phi}_g + \left(\frac{\gamma-\rho}{\rho(\gamma-1)}\right)\ln\left(1 + R_{m,i}\right) + \sigma^2_{W_m\tau_m/g}\left(\frac{\gamma-\rho}{\rho(\gamma-1)}\right)\left(\frac{R_{m,i}}{2(1+R_{m,i})^2}\right)$$
$$+ \left(\frac{\gamma}{\gamma-1}\right)\ln(\tilde{P}_{c,i}) - \sigma^2_{\xi_g}\left(\frac{\ln(g_i^o) - E[\ln(g_i^o)]}{Var(\ln(g_i^o))}\right)$$

- Can estimate via GMM or OLS

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Estimation: Full Production Function

We use the following:

- Intratemporal optimality implies $\tau_{m,i,t} = \Phi_{m,X}(\Pi_{i,t})X_{i,t}$, where $\Phi_{m,X}(\cdot)$ depends on within-period technology $f_t(\cdot)$
- Optimal dynamics of investment allow us to solve for X_{t+s} as a function of
  - X_t & $\bar{p}_{t+s}/\bar{p}_t$ in the unconstrained case
  - $W_{m,t+s} + W_{f,t+s} + y_{t+s}$ & $\bar{p}_{t+s}$ in the constrained case

to obtain the following skill dynamics based on observed data:

$$\tilde{\Psi}_{i,t+5} = \delta_1 \sum_{t=s}^{4} \delta_2^{4-s} \left[\ln \left(\frac{\bar{p}_{i,t}\tau_{m,i,t}}{\bar{p}_{i,t+s}\Phi_{m,X}(\Pi_{i,t})} \right) + \kappa \ln \left(\frac{W_{m,i,t+s} + W_{f,i,t+s} + y_{i,t+s}}{W_{m,i,t} + W_{f,i,t} + y_{i,t}} \right) \right]$$
$$+ Z_{i,t}\hat{\phi}_\theta + \delta_2^5 \tilde{\Psi}_{i,t} + \tilde{\xi}_{\theta,i,t+5}$$

- $\kappa = 0$ reflects unconstrained case; $\kappa = 1$ reflects no borrowing/saving case
- assumes log utility over consumption & leisure in no borrowing/saving case
- age is only time-varying factor affecting $\theta_{i,t}$

Estimating Log Wage Fixed Effects, $\eta_{j,i}$

Estimating log wage fixed effects, $\eta_{j,i}$, for mothers & fathers, we

- use gender-specific regressions of log wages on experience, experience-squared, year & state indicators
- drop all years with children ages ≤ 12 in HH
- require at least 5 observations over 1968–2007
  - median of 10 obs. per person

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PSID-CDS Data

- CDS followed children ages 0–12 in 1997, re-surveying them in 2002 & 2007
  - we focus on children ages 0–12 in any given year
- Cognitive measures: *Letter-Word (LW)* & *Applied Problems (AP)* scores from Woodcock-Johnson tests at ages 3+
- Time investment: time parents spend actively engaging in social & developmental activities with child
  - 1 random weekday & 1 random weekend day
- Child care expenditures based on following:
  - child-specific weekly expenditures from current arrangement
  - total weekly HH expenditures on child care divided by number of children ages 0–12
- HH goods/services inputs (2002 & 2007): spending on school supplies; toys; sporting activities; tutoring; lessons (dance, music, other hobbies); and community group activities

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Price Data

- Price of child care services, P_{ct}
  - *Child Care Aware of America* provides average annual prices for full-time family-based care centers for 4-year-old children by state & year
  - using data from 2006–2018, we regress state-year costs on state FE, linear time trend, and average state-year hourly wages for child care workers from CPS ($R^2 = 0.86$), then predict state-year values back to 1997
- HH goods/services input prices, p_t
  - *Regional Price Parities by State (RPP)* from BEA measures differences in prices by state & year for 2008–2017
    - use goods & services (excluding rent/shelter) components
    - combine *RPP* with regional *CPI* (separately for goods & services excluding rent) to project back from 2008 values
  - weighted average of prices for goods (70%) and services (30%) — based on rough breakdown of HH goods & services investment spending in CEX & PSID-CDS

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Summary statistics for full sample: 2002 and 2007

	N	mean	sd	min	max
$\ln(\tilde{W}_m)$	1110	2.44	0.66	-3.07	3.99
$\ln(\tilde{W}_f)$	835	2.93	0.60	1.25	4.90
$\ln(\tilde{P}_{c,i})$	1512	1.10	0.32	0.27	1.89
Child's age	1512	9.53	2.10	5.00	12.00
Mother HS grad	1510	0.33	0.47	0.00	1.00
Mother some coll.	1510	0.32	0.47	0.00	1.00
Mother coll+	1510	0.27	0.44	0.00	1.00
Mother's age	1512	37.56	6.43	21.00	55.00
Father HS grad	951	0.36	0.48	0.00	1.00
Father some coll.	951	0.22	0.42	0.00	1.00
Father coll+	951	0.33	0.47	0.00	1.00
Father's age	937	40.50	7.04	20.00	65.00
Mother white	1499	0.58	0.49	0.00	1.00
Num children age 0-5	1512	0.19	0.42	0.00	2.00
Num of children	1512	2.02	0.73	1.00	6.00
Year=2007	1512	0.22	0.41	0.00	1.00

OLS & 2SLS estimates for mother time/goods relative demand

	OLS	OLS	OLS	OLS	2SLS (pred wage)	2SLS (state, year)
$\ln(\tilde{W}_{m,t})$	0.645*	0.646*	0.609*	0.758*	0.553*	0.749*
	(0.071)	(0.071)	(0.078)	(0.092)	(0.196)	(0.216)
Married	-0.075	-0.074	-0.121	0.022	-0.071	-0.069
	(0.095)	(0.095)	(0.104)	(0.108)	(0.096)	(0.095)
Child's age	-0.141*	-0.141*	-0.147*	-0.147*	-0.140*	-0.139*
	(0.022)	(0.022)	(0.025)	(0.024)	(0.022)	(0.022)
Mother HS grad	0.099					
	(0.350)					
Mother some coll.	0.106	0.011	-0.043		0.026	-0.018
	(0.351)	(0.102)	(0.117)		(0.113)	(0.117)
Mother coll+	-0.061	-0.157	-0.245		-0.119	-0.218
	(0.357)	(0.112)	(0.131)		(0.155)	(0.164)
Mother's age	-0.008	-0.008	-0.002		-0.007	-0.009
	(0.008)	(0.008)	(0.008)		(0.008)	(0.008)
Mother white	-0.244*	-0.243*	-0.095	-0.328*	-0.233*	-0.249*
	(0.090)	(0.089)	(0.107)	(0.102)	(0.091)	(0.090)
Num. of children ages 0-5	0.156	0.158	0.081	0.163	0.168	0.155
	(0.126)	(0.125)	(0.144)	(0.169)	(0.126)	(0.125)
Num. of children	0.089	0.089	0.090	0.027	0.082	0.097
	(0.062)	(0.062)	(0.068)	(0.066)	(0.063)	(0.063)
Mother's cognitive score			-0.005			
			(0.003)			
Mother's log wage FE				-0.346*		
				(0.114)		
Constant	2.126*	2.213*	2.602*	1.745*	2.398*	1.999*
	(0.469)	(0.355)	(0.449)	(0.366)	(0.520)	(0.553)
R-squared	0.190	0.190	0.167	0.193		
Sample size	727	727	603	562	720	727

OLS estimates for parental time vs. goods relative demand, by parent type

	(1) All Mothers	(2) Single Mothers	(3) Married Mothers	(4) Married Fathers
$\ln(\tilde{W}_{j,t})$	0.646*	0.711*	0.628*	0.678*
	(0.071)	(0.155)	(0.079)	(0.090)
Married	-0.074			
	(0.095)			
Child's age	-0.141*	-0.162*	-0.132*	-0.107*
	(0.022)	(0.043)	(0.026)	(0.027)
Parent some coll.	0.011	0.198	-0.124	-0.130
	(0.102)	(0.173)	(0.128)	(0.131)
Parent coll+	-0.157	0.009	-0.269*	0.071
	(0.112)	(0.222)	(0.132)	(0.127)
Parent's age	-0.008	-0.014	-0.005	-0.010
	(0.008)	(0.014)	(0.009)	(0.008)
Mother white	-0.243*	-0.413*	-0.170	-0.053
	(0.089)	(0.167)	(0.107)	(0.123)
Num. of children age 0-5	0.158	-0.139	0.291*	0.148
	(0.125)	(0.239)	(0.147)	(0.134)
Num. of children	0.089	0.081	0.107	0.168*
	(0.062)	(0.109)	(0.076)	(0.080)
Constant	2.213*	2.471*	1.982*	1.282*
	(0.355)	(0.691)	(0.429)	(0.434)
R-squared	0.190	0.197	0.194	0.154
Sample size	727	236	491	582

Calibration Targets

Table: Weekly Hours of Time Investment and Work

	Mother's Education	
	Non-College	College
A. Single Mothers		
Mother's Time Investment	10.04	12.42
Mother's Hours Worked	42.26	38.22
B. Two-Parent Households		
Mother's Time Investment	9.56	12.13
Mother's Hours Worked	38.43	38.58
Father's Hours Worked	43.85	44.03

Back

Calibrated Preference Parameters (No Borrowing/Saving)

	Mother's Education	
	Non-College	College
A. Single Mothers		
α	3.93	4.90
ψ_m	1.27	1.46
B. Two-Parent Households		
α	2.26	3.11
ψ_m	0.50	0.54
ψ_f	0.66	0.57

Back

Gaps by Parental Education

	Baseline	Equalizing: Preferences	Preferences and Wages	All but Technology	Wages	Technology	Wages and Technology
A. Single Mothers							
Total Investment							
Expenditure (E)	50.56	34.09	3.32	0.00	15.98	50.56	15.98
Price ($\bar{p}$)	14.23	14.23	-6.08	-1.67	-6.08	19.02	-4.01
Quantity (X)	32.31	17.86	9.17	2.11	22.54	28.42	20.35
Mother's Time Investment (τ_m)	23.75	10.24	5.57	0.12	18.51	22.79	18.21
B. Two-Parent Households							
Total Investment							
Expenditure (E)	102.68	49.28	-2.01	0.00	33.04	102.68	33.04
Price ($\bar{p}$)	46.88	46.88	2.32	0.71	2.32	48.77	1.58
Quantity (X)	37.82	1.52	-3.75	-0.56	30.67	36.33	31.01
Mother's Time Investment (τ_m)	26.97	-6.49	-6.98	-4.58	26.29	31.47	31.99

Back

Effects of Small vs. Large Price Changes

Table: Elasticity of Total Investment Quantity with Respect to Input Prices

Price Change	Nested CES				Cobb-Douglas				% Difference between Co Douglas and Nested CE		
	Wages	Wages (Constant income)	Goods	Child Care	Wages	Wages (Constant income)	Goods	Child Care	Wages	Wages (Constant income)	Goods
A. Single Mothers											
10% Change	0.28	-0.80	-0.04	-0.23	0.28	-0.80	-0.05	-0.24	0.37	-0.14	6.20
30% Change	0.32	-0.97	-0.05	-0.25	0.31	-0.99	-0.05	-0.28	-4.35	2.04	16.56
50% Change	0.38	-1.24	-0.05	-0.29	0.34	-1.32	-0.06	-0.34	-9.78	5.95	31.80
B. Two-Parent Households											
10% Change	0.16	-0.93	-0.03	-0.13	0.16	-0.94	-0.03	-0.13	-2.65	0.51	4.39
30% Change	0.19	-1.16	-0.03	-0.14	0.17	-1.18	-0.03	-0.15	-8.07	1.88	14.80
50% Change	0.23	-1.54	-0.03	-0.15	0.20	-1.60	-0.04	-0.18	-14.57	4.39	29.96

Back

30% Reduction in Prices: Two-Parent Households

	Nested CES				Cobb-Douglas			
	Wages	Wages (Constant income)	Goods	Child Care	Wages	Wages (Constant income)	Goods	Child Care
A. Change in Investment at Age 5 (%)								
Total Expenditure (E)	-30.00	0.00	0.00	0.00	-30.00	0.00	0.00	0.00
Investment Quantity:								
Mother's Time (τ_m)	-3.33	38.10	0.75	2.10	0.00	42.86	0.00	0.00
Father's Time (τ_f)	-3.22	38.26	0.73	2.01	0.00	42.86	0.00	0.00
Goods (g)	-9.74	28.94	8.07	1.96	-30.00	0.00	42.86	0.00
Child Care (Y_c)	-18.52	16.40	0.44	21.63	-30.00	0.00	0.00	42.85
Total (X)	-5.68	34.75	0.88	4.14	-5.22	35.40	1.01	4.46
B. Effects on Age 13 Achievement								
100 $\times$ Log Achievement at age 13	-4.71	22.22	1.12	2.78	-4.29	22.64	1.29	3.01
Value (% Cons. over Ages 5–12)	-1.78	9.03	0.43	1.07	-1.63	9.23	0.50	1.16

- Achievement effects for two-parent HH are smaller but qualitatively similar

back