Designing Cash Transfers in the Presence of Children's Human Capital Formation

Joseph Mullins

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Motivation: policies $\rightarrow$ time $+$ money $\rightarrow$ future skills $\rightarrow$ resources in long-run literature

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(4) Solve nonlinear cash assistance problem (Mirrlees, 1971; Diamond, 1980)

- + Two new ingredients change planner's calculus: factor shares of (1) time and (2) money
- - No altruism / OLG (no behav. response, no Pareto improvements)

Three punchlines

(1) Optimal transfers are (conservatively) about 20% more generous than year 2000 benchmark

(2) Optimal transfers feature work disincentives at the bottom of the income distribution

(3) Welfare reform era led to average skill losses ($1,800 in NPV per kid) and welfare losses (3% consumption)

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- Latent Heterogeneity: in preferences, labor market productivity, and child production TFP
- Technology: skill formation, Cobb-Douglas $(\delta_x, \delta_\tau, \delta_\theta)$
- Dynamics: two trade-offs
  1. Welfare now vs later
  2. Private consumption/leisure vs future child skills

Demographics

- Time discrete, indexed by t
- Each mother m endowed with a fixed sequence of births (B_m)
- Problem ends when last child matures ($T_m = \max(B_m) + 18$)
- Children characterized by cognitive and behavioral skills:

$$\theta_{m,f,t} = [\theta_{m,f,t,C}, \theta_{m,f,t,B}]$$

Model

$$\text{Value today} \quad = \quad \text{Payoff today} \quad + \quad \beta \times \text{Value tomorrow}$$

$$\left\{ \begin{array}{c} \text{births} \\ \text{child skills} \\ \text{wages} \\ \text{welfare use} \\ \text{policies} \end{array} \right\} \quad , \quad \left(\begin{array}{c} \text{work} \\ \text{welfare} \\ \text{investment} \\ \text{child skills} \end{array} \right) \quad \mapsto \quad \left\{ \begin{array}{c} \text{births} \\ \text{child skills} \\ \text{wages} \\ \text{welfare use} \\ \text{policies} \end{array} \right\}$$

Preferences

$$
\begin{aligned}
U_{m,t}(c, l, d, \theta, \epsilon) = {} & \alpha_C \log(c) + \alpha_l \log(l) + \alpha_{\theta,k(m)} \sum_f \log(\theta_f) \\
& - \alpha_{S,k(m)} S_d - \alpha_{A,k(m)} A_d - \alpha_{R,1} R_{m,t} A_d \mathbf{1}\{H_d = 0\} \\
& - \alpha_{H,k(m)} \mathbf{1}\{H_d > 0\} + \alpha_{R,2} R_{m,t} A_d \mathbf{1}\{H_d > 0\} \\
& + \epsilon_d
\end{aligned}
$$

- $d \mapsto$ hours ($H_d \in \{0, 30\}$), food stamps ($S_d \in \{0, 1\}$), welfare ($A_d \in \{0, 1\}$)
- $k(m)$ is latent type
- $R_{m,t} \in \{0, 1\}$ indicates a work requirement
- ϵ_d is iid nested logit w/ variances $(1, \sigma_H)$

Resource Constraints

$$c + \sum_f x_f \leq H_d W_{m,t} + \text{transfers}$$

$$l + \sum_f \tau_f + H_d \leq 112$$

$$\text{transfers} \leftarrow (B_m, \underbrace{Z_{A,m,t}, Z_{F,m,t}, Z_{m,T,t}, \Omega_{m,t}}_{Z_{m,t}}, \omega_{m,t}, H_d W_{m,t}, A_d)$$

Technology/Dynamics

- Wages:

$$\log(W_{m,t}) = \gamma_{0,m} + \gamma_{1,m} Age_{m,t} + \varepsilon_{m,t}$$

$$\varepsilon_{m,t+1} \sim \Pi_W(\cdot|\varepsilon_{m,t})$$

- Cobb-Douglas shares:

$$(\delta_{\tau,j}, \delta_{x,j}, \delta_{\theta,C,j}, \delta_{\theta,B,j})$$

- Welfare use

$$\omega_{m,t+1} = \omega_{m,t} + A_d \mathbf{1}\{\Omega_{m,t} < \infty\}$$

where $\Omega_{m,t}$ is time limit faced by mother m at time t

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(1) Full info on B_m and $\{Z_{m,t}\}_{t=1}^{T_m} \rightarrow$ state reduces to $(m, k(m), \theta, \varepsilon_{m,t}, \omega_{m,t})$

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(3) Recursive coefficients on utility:

$$\tilde{\alpha}_{C,m}(\boldsymbol{a}) = \alpha_C + \alpha_{\theta,k(m)} \sum_{a \in \boldsymbol{a}} \Gamma_{x,a}(\boldsymbol{\delta}), \qquad \tilde{\alpha}_{l,m}(\boldsymbol{a}) = \alpha_C + \alpha_{\theta,k(m)} \sum_{a \in \boldsymbol{a}} \Gamma_{\tau,a}(\boldsymbol{\delta})$$

that build in dynamics of investment problem

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(4) Linear investment rules

Model Solution and Empirical Content

Log preferences:

$\rightarrow$ linear investment rules:

$$\tau_{m,f,t} = \phi_{\tau,m}(a_{m,f,t}, \boldsymbol{a}_{m,t}, \boldsymbol{\delta}) \times \text{non-work hours}$$
$$x_{m,f,t} = \phi_{x,m}(a_{m,f,t}, \boldsymbol{a}_{m,t}, \boldsymbol{\delta}) \times \text{net income}$$

Model Solution and Empirical Content

Log preferences:

$\rightarrow$ linear investment rules:

$$\tau_{m,f,t} = \phi_{\tau,m}(a_{m,f,t}, \boldsymbol{a}_{m,t}, \boldsymbol{\delta})(112 - H_{m,t})$$
$$x_{m,f,t} = \phi_{x,m}(a_{m,f,t}, \boldsymbol{a}_{m,t}, \boldsymbol{\delta})Y_{m,t}$$

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→ indirect utility:

$$u_{m,t}(Y, d) = \tilde{\alpha}_{C,m}(\boldsymbol{a}) \log(Y) + \tilde{\alpha}_{l,m}(\boldsymbol{a}) \log(112 - H_d) - \alpha_{m,d,t}$$

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→ child outcomes:

$$\log(\theta_{m,f,t+1}) = \delta_{x,a} \log(Y_{m,t}) + \delta_{\tau,a} \log(112 - H_{m,t}) + \delta_{\theta} \log(\theta_{m,f,t}) + \mu_{\theta,m,a} + e_m(a, \boldsymbol{a}) + \eta_{m,f,t}$$

Child Outcomes Particularly Important

Child outcomes:

$$\log(\theta_{m,f,t+1}) = \delta_{x,a}\log(Y_{m,t}) + \delta_{\tau,a}\log(112 - H_{m,t}) + \delta_{\theta}\log(\theta_{m,f,t}) \\ + \mu_{\theta,k(m),a} + e_{k(m)}(a, \boldsymbol{a}) + \eta_{m,f,t}$$

- δ_x and δ_τ determine the effect of labor supply response on skill outcomes
- Also consistent with a model with childcare inputs
- That model can have heterogeneous effects of work (in progress)

Identification and Estimation more details

Indirect utility:

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Identification and Estimation

more details

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Three steps:

1. Estimate indirect utility with grouped heterogeneity using panel of work, program participation, and time investment (MLE)

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3. Estimate production parameters using nonlinear GMM
   - Strict version: functions of policy variables only
   - Model version: use all instruments implied by model

Estimates

Behavioral parameters:

- Lots of heterogeneity (model selection, model fit)
- Elasticities decrease with earnings look

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Behavioral parameters:

- Lots of heterogeneity (model selection, model fit)
- Elasticities decrease with earnings look

Production parameters:

- "Strict" and "Model" IV mostly consistent look
  - Use quasi-Bayesian methods to improve precision and impose theoretical content
- Estimates are conservative relative to literature look
- δ_x vs δ_τ: net effect of maternal employment on skills is negative look

There are a lot of assumptions to defend

Use data, prior evidence, or test directly:

- No borrowing/savings/childcare choice (use data)
  - Little savings in data
  - Little formal childcare use. Model identifies employment effects
- Exogenous births/marriage (use prior evidence)
  - Sparse evidence on responsiveness within sample (Gennetian and Knox, 2003)
  - Some evidence of response of selection into sample (Low, Meghir, Pistaferri, and Voena, 2018)
- No returns to experience (test directly)
  - Test and do not reject look
- No effect of skills on investment (test directly)
  - Test and do not reject look
- No substitution for time vs money (test directly)
  - Test and do not reject look

go back

Planner's Problem

The planner chooses (e.g. Diamond (1980)):

$$\boldsymbol{y}(e) = e - \boldsymbol{\tau}(e)$$

to maximize

$$\text{weighted sum of utilities} + \boldsymbol{\lambda}(-\text{costs today} + \text{NPV of inputs})$$

- $\boldsymbol{\lambda}$: marginal value of resources
- e: earnings
- s: household type
- d: work decision

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The planner chooses (e.g. Diamond (1980)):

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to maximize

$$\text{weighted sum of } u_d(\boldsymbol{y}(e), s) + \boldsymbol{\lambda}(-\text{costs today} + \text{NPV of inputs})$$

- $\boldsymbol{\lambda}$: marginal value of resources
- e: earnings
- s: household type
- d: work decision
- $u_d(y, s)$: indirect utility

Planner's Problem

$$\max_{\boldsymbol{y}} \sum_{s,e} \pi(s,e) \Bigg[\mu(s,e) \max_{d\in\{0,1\}} \{u_d(\boldsymbol{y}(d \cdot e), s) + \epsilon_d\}$$
$$+ \boldsymbol{\lambda}(1 - P(s,e)) \left[\tilde{\delta}_x(s) \log(\boldsymbol{y}(0)) + \tilde{\delta}_\tau(s) \log(112) - \boldsymbol{y}(0) \right]$$
$$+ \boldsymbol{\lambda} P(s,e) \left[\tilde{\delta}_x(s) \log(\boldsymbol{y}(e)) + \tilde{\delta}_\tau(s) \log(112 - H) + e - \boldsymbol{y}(e) \right] \Bigg]$$

- π: distribution
- μ: weights
- $P(s,e)$: work probability

A twist on classic public finance

e: earnings	$\boldsymbol{y}(e)$: net income	$\mu(e)$: planner's weight
$\boldsymbol{\lambda}$: MVPF	$P(e)$: work prob.	

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$\boldsymbol{\lambda}$: MVPF $P(e)$: work prob.

Consider marginal increase in $\boldsymbol{y}(e)$:

$$\mu(e)P(e)u_c(\boldsymbol{y}(e)) - \boldsymbol{\lambda} \leftarrow \text{direct effect}$$

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$$+\boldsymbol{\lambda}\frac{\partial P(e)}{\partial \boldsymbol{y}(e)}\left(e - \boldsymbol{y}(e) + \boldsymbol{y}(0)\right) \leftarrow \text{behavioral effect}$$

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$$+\boldsymbol{\lambda} \times \text{Marginal effect of income on skills} \leftarrow \text{direct effect on skills}$$

$$+\boldsymbol{\lambda}\frac{\partial P(e)}{\partial \boldsymbol{y}(e)}\left(e - \boldsymbol{y}(e) + \boldsymbol{y}(0)\right)$$

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$$+\boldsymbol{\lambda}\frac{\partial P(e)}{\partial \boldsymbol{y}(e)} \times \text{Net effect of employment on skills} \leftarrow \text{behavioral effect on skills}$$

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$\boldsymbol{\lambda}$: MVPF $\quad$ $P(e)$: work prob.

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$$\mu(e)P(e)u_c(\boldsymbol{y}(e)) - \boldsymbol{\lambda}$$

$+\boldsymbol{\lambda} \times$ Marginal effect of income on skills $\leftarrow$ factor share of money in skill production

$$+\boldsymbol{\lambda}\frac{\partial P(e)}{\partial \boldsymbol{y}(e)}\left(e - \boldsymbol{y}(0) + \boldsymbol{y}(e)\right)$$

$+\boldsymbol{\lambda}\frac{\partial P(e)}{\partial \boldsymbol{y}(e)} \times$ Net effect of employment on skills $\leftarrow$ factor share of time and money

Key Equation 1: Optimal Size

$$\mathbb{E}[\boldsymbol{y}(e)] = \mathbb{E}\left[\frac{\mu\tilde{\alpha}_C(s)}{\boldsymbol{\lambda}} + \tilde{\delta}_x(s)\right] = \mathbb{E}[\boldsymbol{w}(s)]$$

"Average generosity (as measured by $\boldsymbol{y}$) is equal to average effective weight on households in recipient population"

Key Equation 2: Optimal Shape

Simplified version (fix η, s):

$$\boldsymbol{y}(e) = \underbrace{\boldsymbol{w}}_{\text{first best}} + \underbrace{\frac{\eta}{1+\eta}\left[e + \boldsymbol{y}(0) - \boldsymbol{w} + \mathcal{D}(s,e)\right]}_{\text{wedge}}$$

- $\mathcal{D}(s,e)$: effect of employment on NPV of skills ($\delta_x \uparrow$, $\delta_\tau \downarrow$)
- η: semi-elasticity of employment
- $\mathcal{D}(s,e)$ dictates presence of employment subsidies vs penalties more info

Quantitative Application

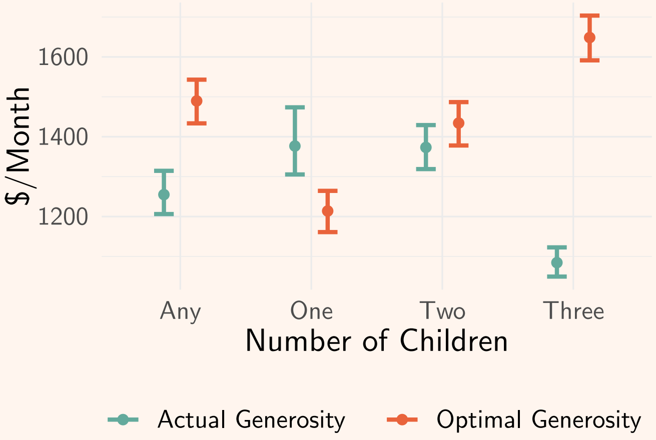
- Choose π using estimated distribution over (s, e) from year 2000

- Choose $\mu/\boldsymbol{\lambda}$ to match transfers to households if no children (using π)

$$\mathbb{E}[\boldsymbol{y}(e)|\text{No Kids}] = \frac{\mu\alpha_C}{\boldsymbol{\lambda}}$$

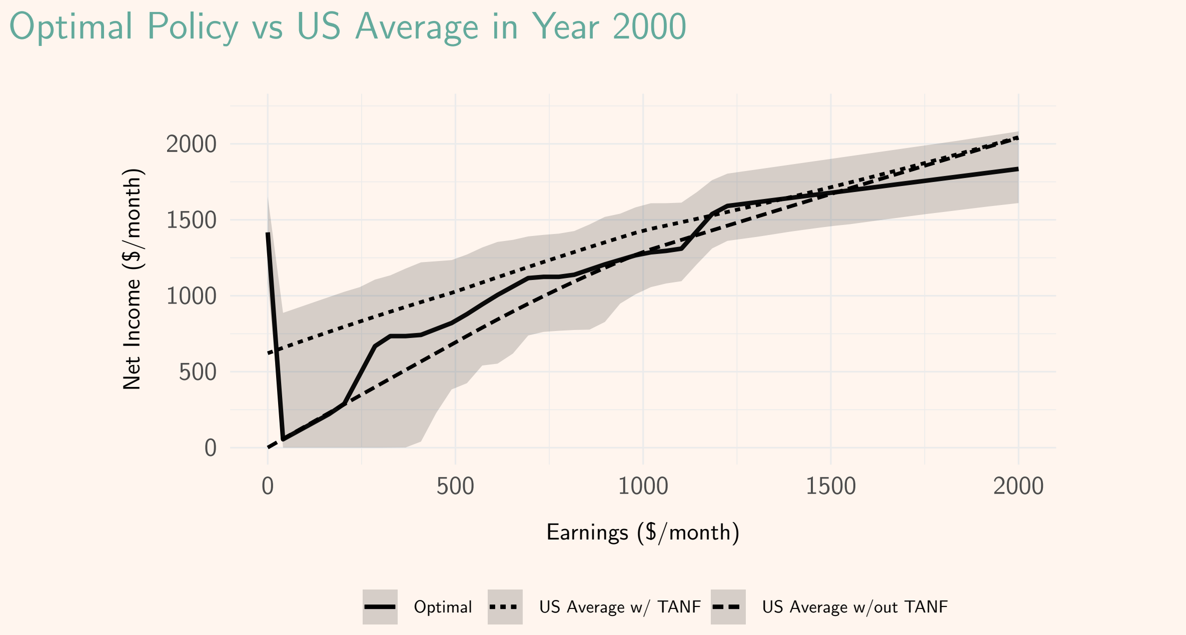
- Two exercises:
  1. Compare actual size to optimal size using equation (1)
  2. Solve full non-linear problem

Actual vs Optimal Generosity of Cash Transfers

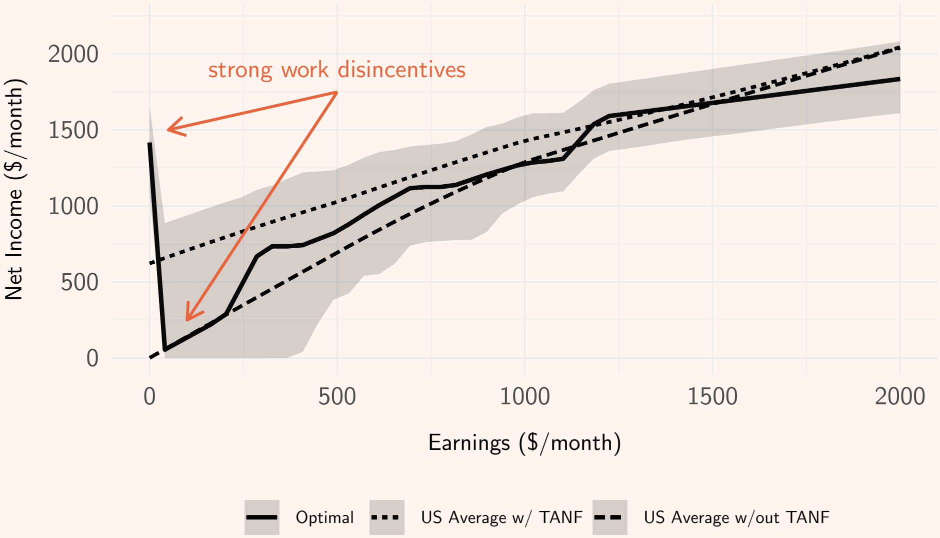


95% credibility intervals shown

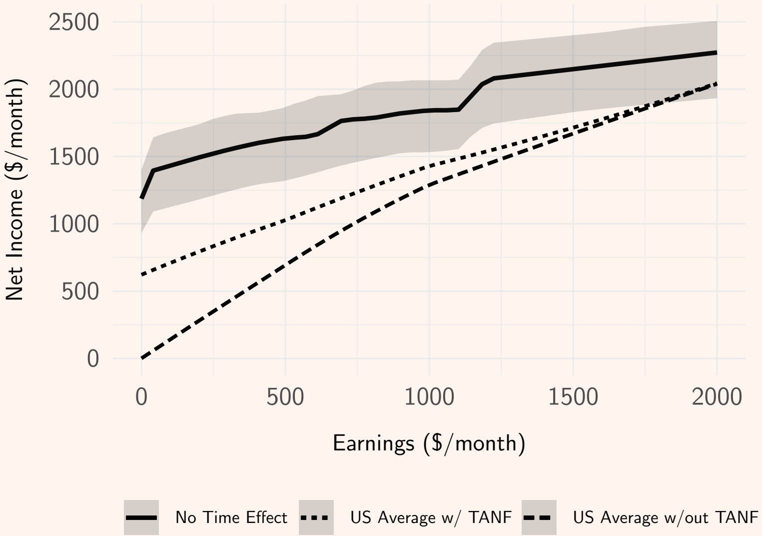
- Overall: 25% difference in overall size
- Big misses for larger households
- Regardless of whether investments public or private


Optimal Policy vs US Average in Year 2000
Net Income ($/month)
2000
1500
1000
500
0
0
500
1000
1500
2000
Earnings ($/month)
Optimal
US Average w/ TANF
US Average w/out TANF

Optimal Policy vs US Average in Year 2000

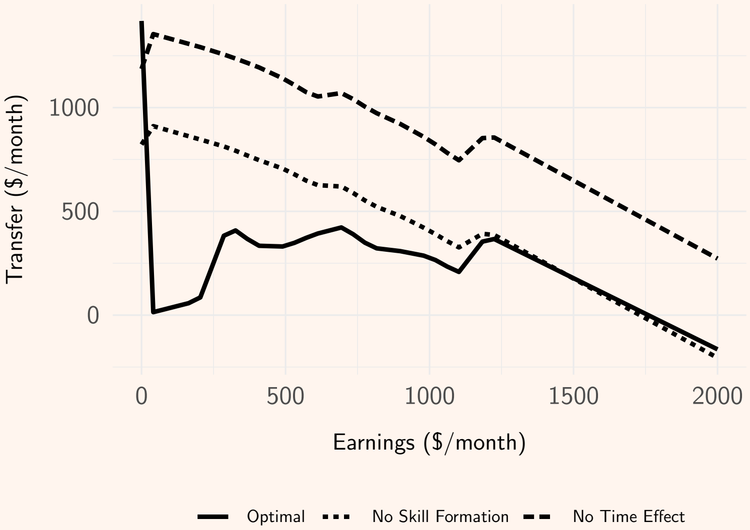


Optimal Policy: No Time Effect ($\delta_\tau = 0$)



- Set $\delta_\tau = 0$.
- Work subsidies at bottom
- δ_τ has huge effect on optimal shape

Comparison of Transfers



- δ_τ affects shape, work incentives
- δ_x affects generosity, size of work credit

Conclusion

- Lesson: accounting for skill formation makes a big difference when evaluating cash transfers and work incentives
- It's particularly important to get the "employment effect" on skills right. Validating in revision.
  - Also not policy invariant!
- Two big next steps:
  1. Household formation: marriage and cohabitation
  2. Childcare policy

Welfare Reform

Welfare Reform Counterfactual

Exercise: “freeze” policy environment just before PROWRA (1996)

- Think: no time limits, work requirements, EITC expansions

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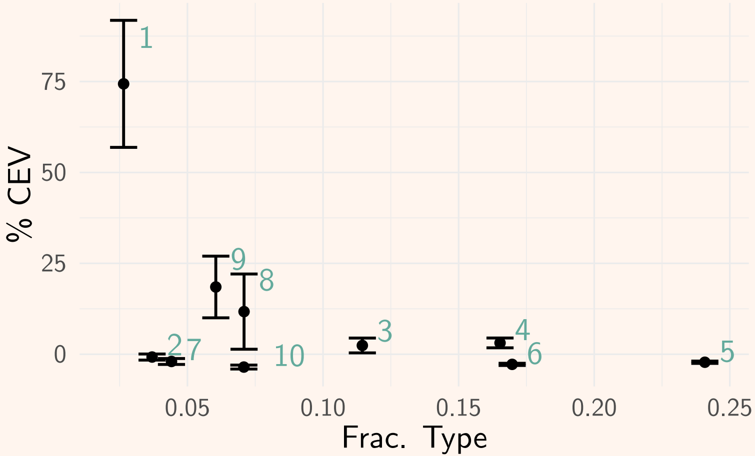
- Reform $\rightarrow$ lots of redistribution over types
- Reform $\rightarrow$ sizeable losses in skill for minority of children
  - Average: \$1,860 in NPV per kid
- Getting heterogeneity right matters: <u>ex-ante</u> vs <u>ex-post</u> heterogeneity $\rightarrow$ gains from insurance

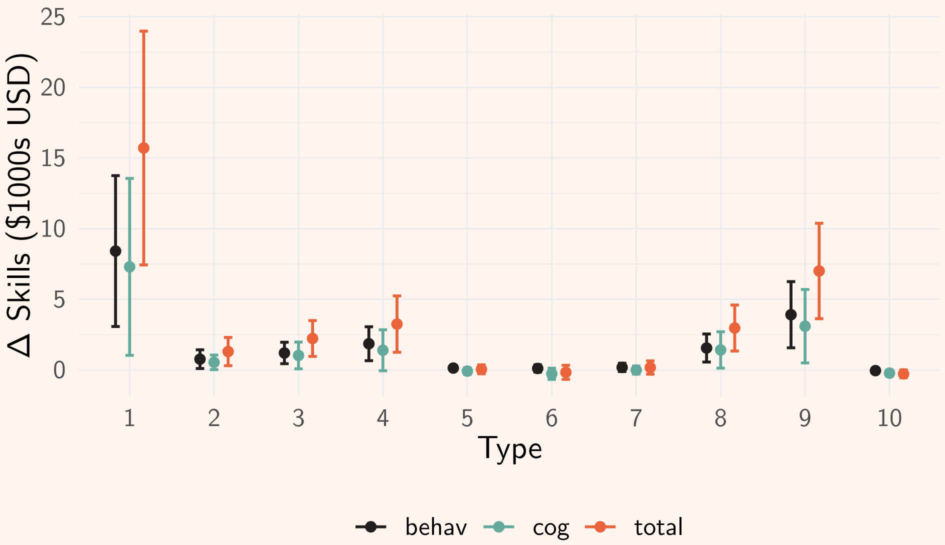
	$K = 2$	$K = 10$
CEV:	7.47%	3.35%

Undoing reform: welfare effects



- Lots of redistribution
- Reform → big losses for small fraction of population, small gains for majority
- What determines losses/gains? graph

Undoing reform: effect on child skills



Motivating Facts

(1) Time and money matter for skill development

(2) Skills shape life-cycle outcomes

(3) Increasing skills/economic resources in childhood has large long-run benefits

go back

Motivating Facts

(1) Time and money matter for skill development

Duncan, Morris, and Rodrigues (2011); Dahl and Lochner (2012); Akee, Copeland, Costello, and Simeonova (2018); Bernal and Keane (2010, 2011)

(2) Skills shape life-cycle outcomes

Cunha, Heckman, and Schennach (2010); Heckman, Stixrud, and Urzua (2006); Heckman, Pinto, and Savelyev (2013)

(3) Increasing skills/economic resources in childhood has large long-run benefits

Heckman, Hyeok, Pinto, Peter, Moon, Savelyev, and Yavitz (2010); García, Heckman, Leaf, and Prados (2020); Bailey, Sun, and Timpe (2021); Kline and Walters (2016); Chetty, Friedman, Hilger, Saez, Schanzenbach, and Yagan (2011); Hoynes, Schanzenbach, and Almond (2016); Aizer, Eli, Ferrie, and Lleras-Muney (2016); Bailey, Hoynes, Rossin-Slater, and Walker (2020)

go back

Identification/Estimation

Data - PSID-CDS

Panel Study of Income Dynamics:

- Panel of work, income, program participation, fertility, and marriage.
- Select: women who are unmarried at time of first birth

Child Development Supplement (1997,2002,2007):

- Cognitive skills (Woodcock-Johnson Letter Word and Applied Problems)
- Behavioral skills (externalizing and internalizing behaviors)
- Earnings and criminal behavior in young adulthood

go back

The Effect of Skills on Economic Resources

$$\mathcal{Y}(\theta) = \gamma_{\mathcal{Y},0} + \gamma_{\mathcal{Y},C} \log(\theta_C) + \gamma_{\mathcal{Y},B} \log(\theta_B)$$

Skill	Earnings	Crime	Total
Cognitive	$\gamma_{E,C} = \$93,000$	$\gamma_{CR,C} = 0$	$\gamma_{\mathcal{Y},C} = \$93,000$
Behavioral	$\gamma_{E,B} = \$47,500$	$\gamma_{CR,B} = \$9,000$	$\gamma_{\mathcal{Y},B} = \$55,500$
Source	CPS + CDS	Heckman et al. (2013) + CDS	

- PSID-CDS shows effect of skills on earnings/crime in young adulthood
- Use auxiliary data to extrapolate over life-cycle
- Use coefficients for anchoring skills (NPV of 1sd)

go back

Panel data + policy variation gives us identification

Grouped heterogeneity ($k(m) \in \{1, 2, ..., K\}$):

$$(\alpha_{\theta,m}, \mu_{\theta,m}, \alpha_{H,m}, \alpha_{A,m}, \gamma_{0,m}, \gamma_{1,m}) = (\alpha_{\theta,k(m)}, \mu_{\theta,k(m)}, \alpha_{H,k(m)}, \alpha_{A,k(m)}, \gamma_{0,k(m)}, \gamma_{1,k(m)})$$

In two stages:

(1) Panel + policy variation $\rightarrow$ indirect utility (Bonhomme et al., 2016; Kasahara and Shimotsu, 2009)

(2) Use Z_m as instruments to get $\boldsymbol{\delta}$ (strict IV)

(2a) Use X_m as instruments to get $\boldsymbol{\delta}$ (model IV)

go back

Panel data + policy variation gives us identification

Grouped heterogeneity ($k(m) \in \{1, 2, ..., K\}$):

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In two stages:

(1) Panel + policy variation $\rightarrow$ indirect utility (Bonhomme et al., 2016; Kasahara and Shimotsu, 2009) $\leftarrow$ MLE via E-M

(2) Use Z_m as instruments to get $\boldsymbol{\delta}$ (strict IV) $\leftarrow$ GMM

(2a) Use X_m as instruments to get $\boldsymbol{\delta}$ (model IV) $\leftarrow$ GMM

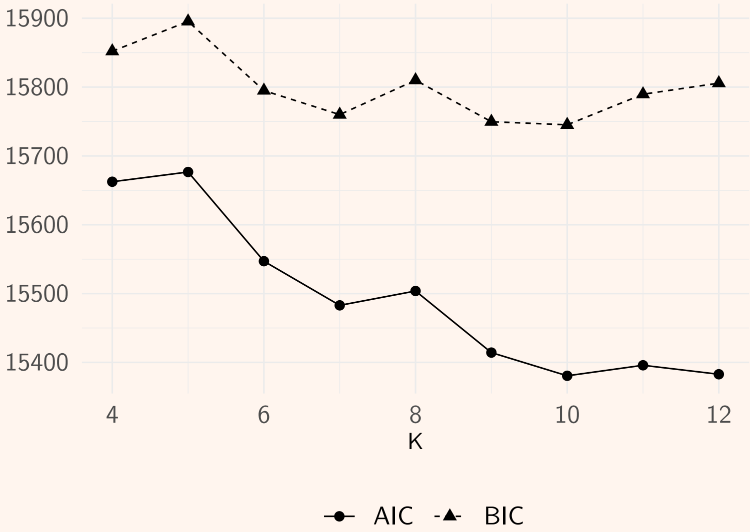
go back

Landscape of Government Assistance back

- Welfare:
    - Aid to Families with Dependent Children (AFDC)
    - 1996: Personal Responsibility and Work Opportunity Reconciliation Act (PRWORA)
    - $\Rightarrow$ Temporary Assistance for Needy Families (TANF)
    - $\approx$ \$20b, 2015
    - **Time limits**, benefit restructuring
- Taxes:
    - Earned Income Tax Credit (EITC)
    - Several expansions through 90s
    - $\approx$ \$60b, 2015
- Food Stamps
    - Supplemental Nutrition Assistance Program (SNAP)
    - $\approx$\$70b, 2015

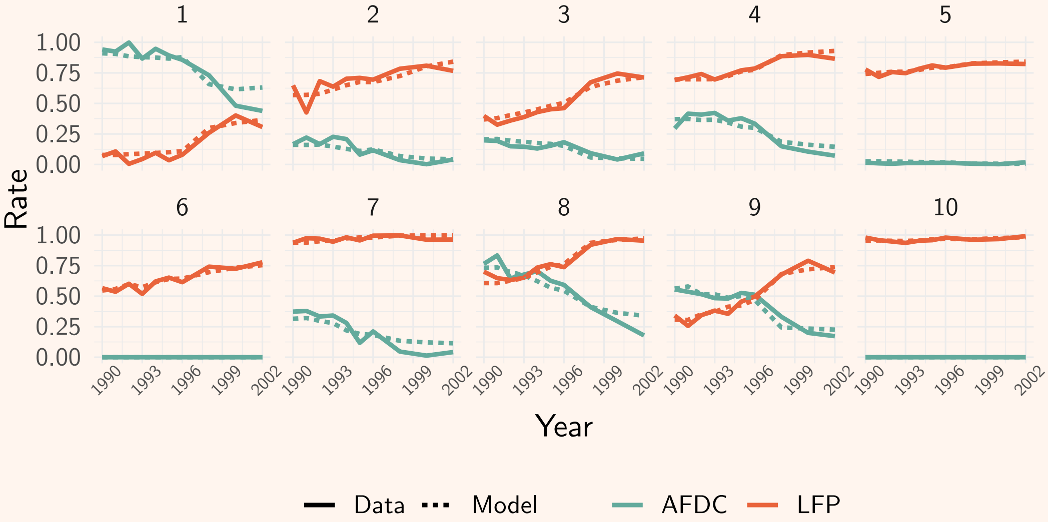
Heterogeneity

back



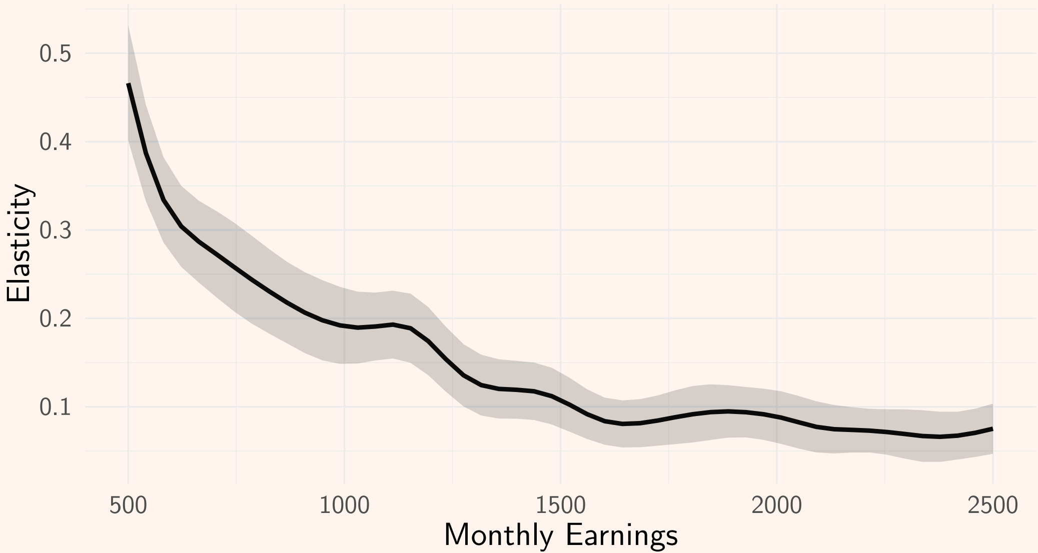
Model Fit

back



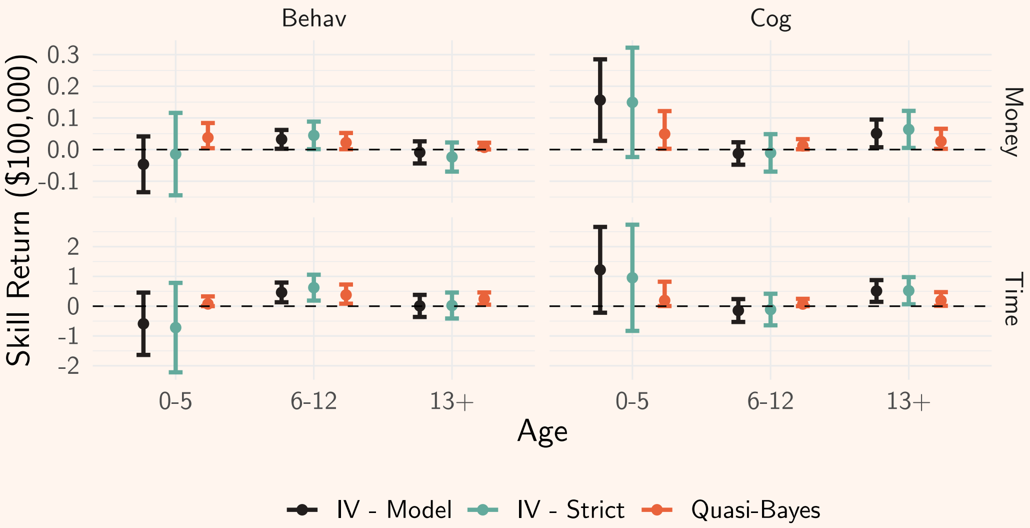
Elasticities

back



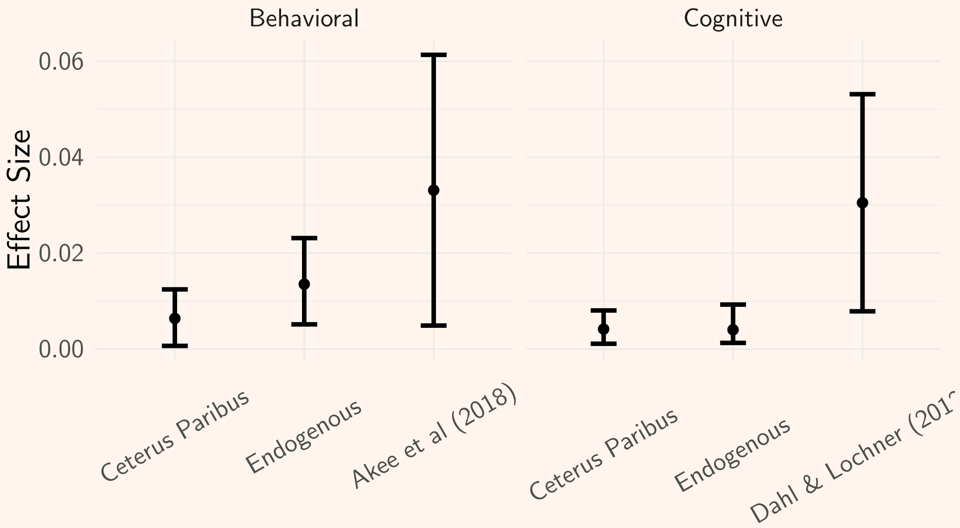
Production Estimates

back



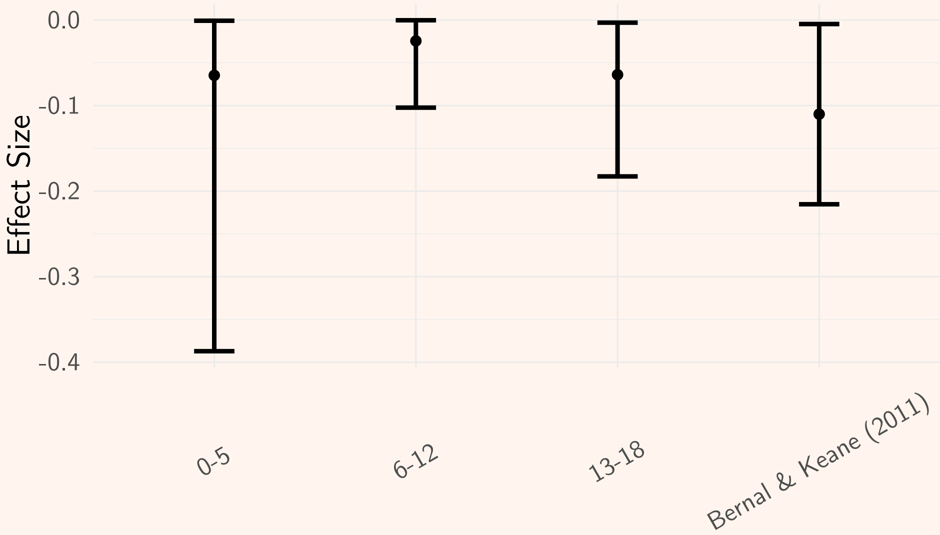
Benchmarking Production Estimates

back



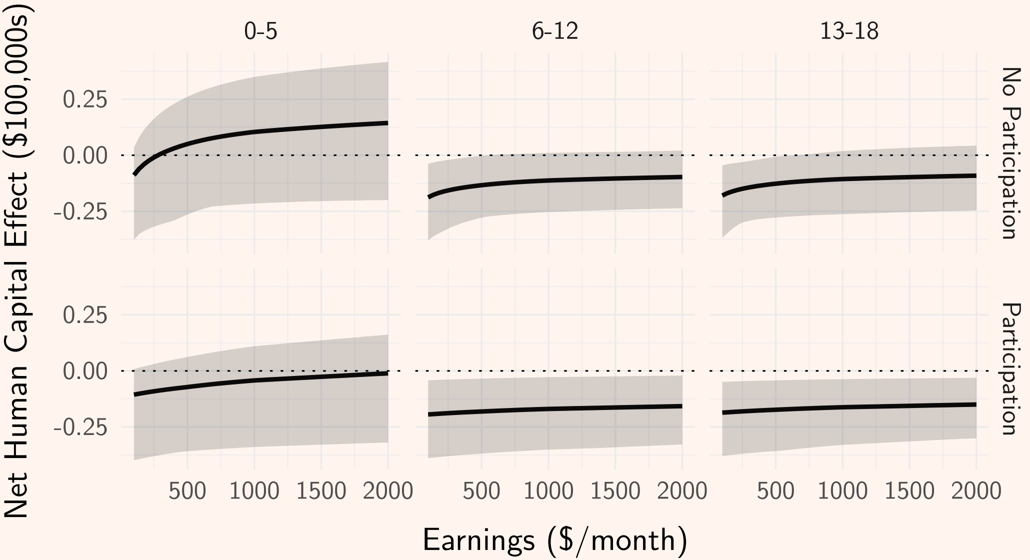
Benchmarking Production Estimates

back



Net Effect of Employment

back



Returns to Experience back

v is difference between observed and model predicted wage:

Specification:

$$v_{m,t} = \beta_0 + \beta_1 \text{Exp}_{m,t} + \epsilon_{mt}$$

	(1)	(2)	(3)
Exp	-0.001	0.002	-0.00005
	(0.001)	(0.001)	(0.001)
Individual FE	-	✓	✓
Age FE	-	-	✓
Observations	6,058	6,058	6,058
R^2	0.0001	0.0002	0.015
Note:			*p<0.1; **p<0.05; ***p<0.01

Sibling Pair Test of Investment

back

Specification:

$$\log(\tau^{o}_{mkt}) = \mu_{mt} + \gamma_{a_{kt}} + \beta_1 \mathrm{LW}_{mkt} + \beta_2 \mathrm{BPE}_{mkt} + \epsilon_{mkt}$$

	Active Time		Total Time	
	OLS	IV	OLS	IV
LW	0.002	−0.065	0.017	0.001
	(0.040)	(0.079)	(0.027)	(0.049)
BPE	−0.008	−0.017	−0.002	−0.014
	(0.012)	(0.024)	(0.009)	(0.017)
Age Dummies	✓	✓	✓	✓
Mother × Year FE	✓	✓	✓	✓
Observations	1,463	1,437	1,549	1,522
R^2	0.100	0.086	0.073	0.061

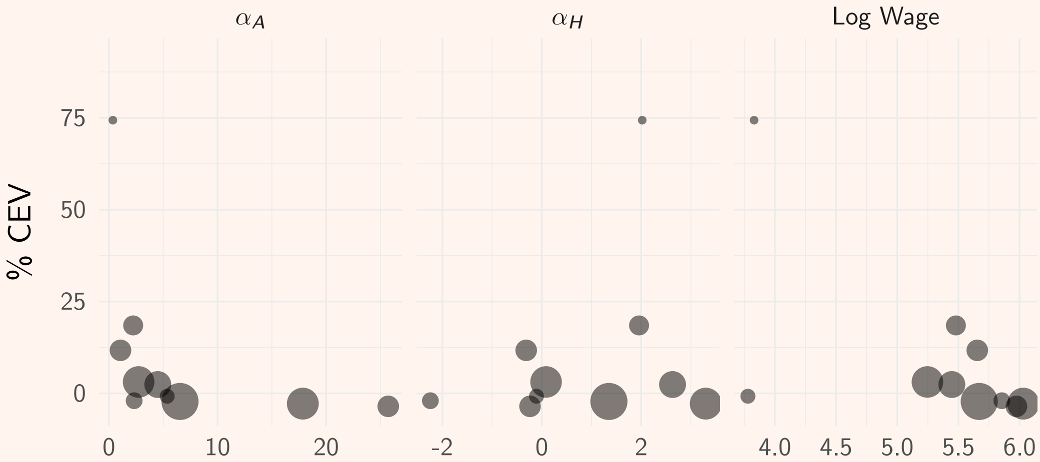
Regression Test of Substitution Patterns back

Specification:

$$\upsilon_{\phi,m,t} = \beta_0 + \beta_1 \log(Y_{m,t}) + \beta_2 \log(112 - H_{m,t}) + \epsilon_{m,t}$$

	(1)	(2)
$\log(Y_{m,t})$	0.004	0.037
	(0.011)	(0.033)
$\log(112 - H_{m,t})$	-0.137	-0.412
	(0.129)	(0.427)
Observations	1,237	1,237
Mother FE	-	✓
R^2	0.007	0.031
Note:		$^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Undoing reform: effect on welfare back



Optimal Tax Formulae

First best allocations:

$$\boldsymbol{y}^*(e) = \mathbb{E}[\boldsymbol{w}(s,e)|e, d=1]$$

Optimal shape:

$$\boldsymbol{y}(e) = \boldsymbol{y}^*(e) + \frac{\mathbb{E}\left[\eta(s,e)\left(e + \boldsymbol{y}(0) - \boldsymbol{y}^*(0) + \mathcal{D}(s,e)\right)|e, d=1\right]}{1 + \mathbb{E}[\eta(s,e)|e, d=1]}$$

Work credit is $\lim_{e\to 0} \boldsymbol{y}(e) - \boldsymbol{y}(0)$:

$$\text{work credit} = \frac{\boldsymbol{w} - \boldsymbol{y}(0) + \lim_{e\to 0} \mathbb{E}[\eta(s,e)\mathcal{D}(s,e)|e, d=1]}{1 + \lim_{e\to 0} \mathbb{E}[\eta(s,e)|e, d=1]}$$

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