Early and Late Human Capital Investments, Borrowing Constraints, and the Family

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Motivation

Lots of studies on borrowing constraints at college ages:

- Most studies take earlier investments and family transfers as given
  - Cameron and Heckman (1998), Keane and Wolpin (2001), Carniero and Heckman (2002)
- These studies typically find that adolescent 'abilities' are very important
- We study the role of constraints and family transfers in determining these 'abilities' as well as later schooling choices and earnings

Importance of Early Borrowing Constraints

- Consumption studies suggest borrowing constraints more salient for younger families (e.g. Meghir and Weber 1996, Alessie, et al. 1997, Stephens 2008)
- Young parents may have large college debts and typically earn less when children are young
- No loans specifically for early investments in children
- Indirect evidence suggests early constraints may inhibit investment
  - many early interventions have large long-run impacts (e.g. Perry Preschool)
  - poor parents spend much less time and money investing in their children (e.g. Kaushal, et al. 2011)
  - early income has relatively large impacts on achievement and educational attainment

Effects of Early and Late Family Income

- Data from Children of NLSY
- Effects measured in $10,000 in average PDV ages 0-11 and 12-23
- Controls for maternal education

Education	Sample Size	Early Income	Late Income	Equal Effect (p-value)
Complete HS (ages 21-24)	1,483	**0.042** (0.007)	0.001 (0.008)	**0.003**
Att. College (ages 21-24)	1,483	**0.044** (0.008)	**0.019** (0.009)	0.096
Grad. College (ages 24-27)	828	**0.051** (0.009)	0.015 (0.010)	**0.039**

Objectives

We want to understand:

- The importance of borrowing constraints at different stages of development
- The extent of dynamic complementarity in investments and how it interacts with borrowing constraints
- Effects of policies at one stage of development on investments at other stages
- Intergenerational transfers and their implications for policy in the short- and long-run

Key Contributions

- Theoretical analysis highlights the role of ‘dynamic complementarity’ in investments
  - with sufficient complementarity, policies encouraging investment at one stage of development also increase investment at other stages
- Quantitative analysis using a dynastic OLG model with multiple human capital investment periods
  - use intergenerational micro data on education and wages/earnings to calibrate model
  - focus on ‘big picture’ lessons that require a fully specified economic model

(Most) Related Literature:

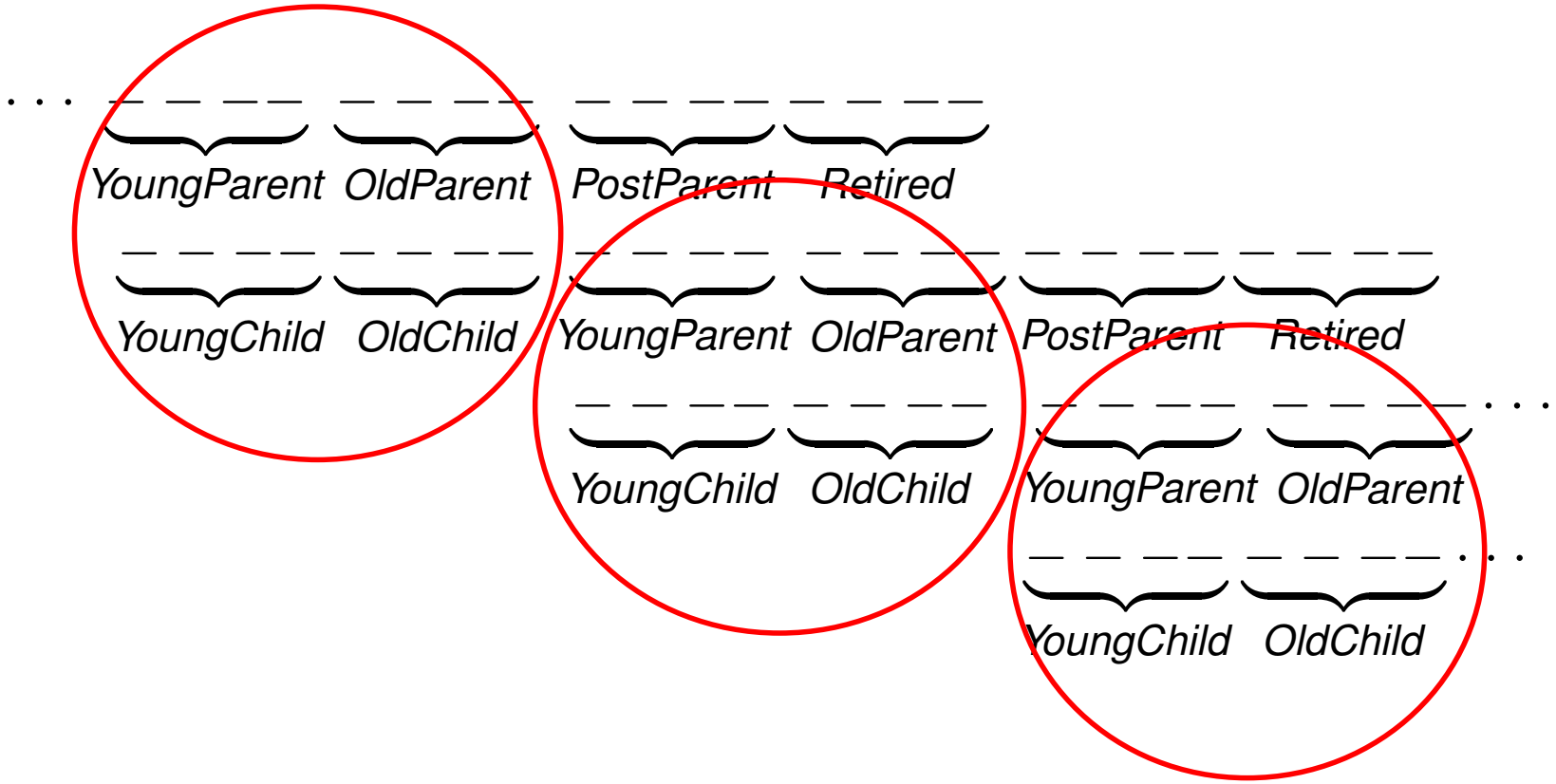
- Becker and Tomes (1979, 1986)
- Caucutt and Kumar (2003), Restuccia and Urrutia (2004)
- Keane and Wolpin (2001), Johnson (2010)
- Cunha and Heckman (2007), Cunha, Heckman and Schennach (2010),...

Quantitative Model: Environment

We construct a dynastic OLG model with 'early' and 'late' childhood human capital investment:

- Asset accumulation
  - Non-negative financial transfers from parents to children
  - Lifecycle borrowing constraints
- Heterogeneity in ability, assets, human capital/earnings
- Uncertainty in earnings

Six Life Stages



Human Capital Production

- Human capital upon labor market entry is:

$$h_3 = \theta f(i_1, i_2)$$

- f is increasing and concave in i_1 and i_2
- f_{12} represents the degree to which investments are complementary
  - strong dynamic complementarity $\rightarrow$ optimal i_1 and i_2 move together
  - later interventions may be ineffective
- Heterogeneous ability: θ (depends on parental ability)
- Consider free base public investment, p_1 and p_2, and investment subsidies, s_1 and s_2
- Human capital grows exogenously for adults

Other Details

- Consider shocks to earnings: $W(h_j, \epsilon_j) = wh_j + \epsilon_j$
- Allow for human capital-specific borrowing constraints:

$L_j(h_3) = \gamma \times$ (min. discounted future earnings from j on)

- We write the entire problem from the parent's perspective

Young Parent's Problem

$$V_3(h_3, \epsilon_3, A_3, \theta') = \max_{c_3, A_4, c_1', i_1'} \{u(c_3) + \rho u(c_1') + \beta E_{\epsilon_4} V_4(h_4, \epsilon_4, A_4, h_2', \theta')\}$$

subject to

$$\begin{aligned} i_1'(1 - s_1) + c_1' + c_3 + A_4 &= RA_3 + W(h_3, \epsilon_3) \\ A_4 &\geq -L_3(h_3) \\ h_2' &= p_1 + i_1' \\ h_4 &= \Gamma_4 h_3 \end{aligned}$$

Old Parent's Problem

$$V_4(h_4, \epsilon_4, A_4, h_2', \theta') = \max_{c_4, A_5, c_2', i_2', A_3'} \{u(c_4) + \beta V_5(h_5, A_5) + \rho[u(c_2') + \beta E_{\theta'', \epsilon_3'}(V_3(h_3', \epsilon_3', A_3', \theta'')|\theta')]\}$$

subject to

$$\begin{aligned} i_2'(1 - s_2) + c_2' + c_4 + A_3' + A_5 &= RA_4 + W(h_4, \epsilon_4) + W_2 \\ i_2'(1 - s_2) + c_2' + A_3' &\geq W_2 \\ A_5 &\geq -L_4(h_4) \\ A_3' &\geq -L_2(h_3') \\ h_3' &= \theta' f(h_2', p_2 + i_2') \\ h_5 &= \Gamma_5 h_4 \end{aligned}$$

Post-Parenthood

$$V_5(h_5, A_5) = \max_{A_6}\{u(RA_5 + W(h_5) - A_6) + \beta u(RA_6)\}$$

- Can easily solve for $V_5(h_5, A_5)$ and plug into old parent's problem

Assumptions for Computation

- Human capital accumulation:

$$f(i_1, i_2) = (a i_1^b + (1 - a) i_2^b)^{d/b}$$

- Discrete number of early investments, $i_1 \in I_1$
- Four levels of late investments, $i_2 \in I_2$, corresponding to HS dropout, HS graduate, some college, college graduate and beyond
- Two ability levels, θ: high and low
  - Intergenerational Markov process: π_{hh} and π_{ll}
- Distribution of earnings shocks: $\ln(\epsilon) \sim N(m, s)$
- Utility: $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$, $\sigma \geq 0$

Some Standard Parameters/Normalizations

We assume:

- Six twelve-year periods beginning at birth
- $R = 1.7959$ implies a 5% annual return
- $\beta = R^{-1}$
- $\sigma = 2$
- normalize $w = 1$ (everything in 2008 dollars deflated by the CPI-U)

Parameters We Set/Estimate Ex Ante

- We estimate W_2 and i_2 amounts based on (foregone) earnings levels in NLSY79 and direct costs from Digest of Educ. Statistics
- Assume grid for i_1 of 7 points from 0 to \$21,000
- We set (p_1, p_2) and (s_1, s_2) based on per capita public schooling expenditures, tuition levels, and total costs
- Γ_4 and Γ_5 are set to match growth rates in earnings in NLSY79 and 2006 March CPS

Parameters We 'Calibrate' via SMM

We simultaneously 'calibrate' remaining parameters using SMM:

$$a,\ b,\ d,\ \theta_1,\ \theta_2,\ \pi_{hh},\ \pi_{ll},\ m,\ s,\ \rho,\ \gamma$$

We match the following moments in NLSY79/CNLSY:

- Unconditional education distribution
- Distribution of annual earnings for men ages 24-35 and 36-47: mean, variance, and skewness
- Child education conditional on mother's education and parental income quartiles (early and late)
- Average child wages (ages 24-35) conditional on own education, mother's education, and parental income quartile (early)

Key Calibrated Parameters

- elasticity of substitution between i_1 and i_2 is 0.37
- modest persistence in ability
  - $\pi_{hh} = 0.49$
  - $\pi_{ll} = 0.59$
- individuals can borrow about $1/2$ the minimum of their future lifetime income ($\gamma = 0.48$)

Steady State Characteristics

Education Distribution

Level	Model	Data
High school dropout	.20	.18
High school graduate	.43	.40
Some college	.23	.23
College graduate and beyond	.14	.20

Steady State Characteristics

Average Baseline Investment Amounts by Parental Education

Parental Education	Average i_1	Average i_2
All Levels	2,013	6,587
High School Dropout	685	2,813
High School Graduate	1,934	6,286
Some College	2,792	8,882
College Graduate	2,891	9,190

Steady State Characteristics

Borrowing constraints:

- No old children are constrained
- 41% of young parents are constrained
- 31% of old parents are constrained

General Issues for Policy Experiments

- Relax borrowing constraints
  - effects of constraints at different ages
  - short-term vs. long-term effects
- Education subsidies
  - effects of early vs. late subsidies
  - how do early investments respond to late subsidies, and what do we miss by ignoring this margin?
- Income transfers vs. loans for young parents
  - ‘current’ and ‘future’ effects of policy and one-time vs. permanent policies

Increasing Borrowing Limits for Young Parents by $2,500

- % Change in Short-Run

Parent Educ.	Avg. i_1	HS +	College	Avg. W_3
All	7.9	4.3	7.0	0.6
HS grad.	2.5	7.4	3.7	0.3
College grad.	15.2	0	18.3	1.5

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- % Change in Long-Run

Parent Educ.	Avg. i_1	HS +	College	Avg. W_3
All	-0.7	3.1	-3.5	-0.1
HS grad.	-6.9	4.5	-9.0	-0.5
College grad.	7.9	0	9.6	0.8

Increasing Borrowing Limits for Young Parents by $2,500

- Long-Run Changes in Fraction Constrained

Parent Educ.	Young parents	Old parents	Old kids
All	-.04	.06	.05
HS grad.	-.02	.04	.04
College grad.	-.03	0	0

Increasing Borrowing Limits for Young Parents by $2,500

- Long-Run Changes in Fraction Constrained

Parent Educ.	Young parents	Old parents	Old kids
All	-.04	.06	.05
HS grad.	-.02	.04	.04
College grad.	-.03	0	0

- Increasing borrowing limits for young parents causes those that are constrained to borrow more
  - increases investment in the short-run
  - in long-run, asset distributions shift left, constraints bind again, and there is slightly less overall human capital investment
  - initial generations capture most of the benefits

Relaxing Borrowing Constraints at Older Ages

- Increasing borrowing limits for old parents or old kids has little effect on human capital investment
  - old children are unconstrained

Subsidizing Education

Compare increasing s_1 from 0 to .12 vs. increasing s_2 from .5 to .55

- Both policies cost about $750 per capita
- 60% of costs for early subsidy are delayed
  - increased costs associated with late subsidy

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Short-Run Effects (% Changes)

	Avg. i_1	Avg. i_2	HS+	Coll. Grad	W_3
Increase s_1	**21.3**	**9.3**	0	23.4	**1.5**
Increase s_2	**2.6**	**9.7**	9.7	13.0	**0.4**
– i_1 fixed	0.0	5.2	9.7	0.2	0.1

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– i_1 fixed	**0.0**	**5.2**	9.7	0.2	**0.1**

Why are Later Subsidies Less Effective?

- Dynamic complementarity implies that early and late investments should co-move
- Costly to increase early investment in response to later subsidies when early borrowing constraints bind
  - lack of early investment response makes it less valuable to make later investments (especially college)
  - problem is dynamic complementarity coupled with early borrowing constraints

Transfers vs. Loans for Young Parents

Compare $2,500 income transfer and loan

- Loan policy only provides liquidity, while transfer also generates wealth effects

Effects of Permanent Policy (% Changes)

Policy	Avg. i_1	Avg. i_2
Transfer	3.5	2.1
Loan	7.9	3.7

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Effects of Permanent Policy (% Changes)

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Transfer	3.5	2.1
Loan	7.9	3.7

- Why do loans increase investment more than transfers?

Transfers vs. Loans for Young Parents

Transfer policy has

- larger 'current' effects from increasing the child's parental resources (one-time policy)
- more negative 'future' effects by increasing the child's resources when he becomes a parent

Effects (% Changes)

Policy	Avg. i_1	Avg. i_2
Transfer	3.5	2.1
'Current' Effect	9.3	4.4
'Future' Effect	-3.6	-2.7
Loan	7.9	3.7
'Current' Effect	7.9	2.0
'Future' Effect	-.3	1.8

Conclusions

- Due to dynamic complementarity in human capital production, policies in one period affect decisions in other periods
  - difficult to make up for early investment deficits with later policies
  - dynamic complementarity $+$ early borrowing constraints $\rightarrow$ early subsidies have a bigger impact than late subsidies
  - ignoring early investment responses underestimates impacts of later policies (by a lot!)

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- The effects of policy can be very different in the SR and the LR due to shifts in asset distributions

Conclusions

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  - difficult to make up for early investment deficits with later policies
  - dynamic complementarity $+$ early borrowing constraints $\rightarrow$ early subsidies have a bigger impact than late subsidies
  - ignoring early investment responses underestimates impacts of later policies (by a lot!)
- The effects of policy can be very different in the SR and the LR due to shifts in asset distributions
- One-time loans/transfers have stronger positive effects on investment than their permanent counterparts

"Sufficient Complementarity"

Condition 1: $\frac{f_{12}}{f_1 f_2} > -\frac{v''(-RL_2+wh_3\chi)}{v'(-RL_2+wh_3\chi)} w\chi$

Assuming:

- CES human capital production function:

$$f(i_1, i_2, \theta) = \theta(a i_1^b + (1-a) i_2^b)^{c/b}$$

- CIES utility

$$u(c) = \frac{c^{1-\sigma}}{1-\sigma}, \quad \sigma \geq 0.$$

Then, if $c > b$, Condition 1 simplifies to:

$$\underbrace{\frac{1}{1-b}}_{\text{e. of sub.}} < \underbrace{\frac{1}{\sigma}}_{\text{CIES}} \underbrace{\left(1 - \frac{RL_2}{w\chi h_3}\right)}_{1\text{-}\frac{\textit{maximum debt}}{\textit{lifetime income}}} \left(\frac{c-b}{c(1-b)}\right)$$

Back

Effects of Early and Late Family Income

- Controlling for child/family background and maternal education

Education	Sample Size	Early Income	Late Income	Equal Effect (p-value)
HS Dropout	1,422	**-0.041**	-0.001	**0.006**
(ages 21-24)		(0.008)	(0.009)	
Att. College	1,422	**0.037**	0.018	0.211
(ages 21-24)		(0.008)	(0.009)	
Grad. College	802	**0.047**	0.012	**0.048**
(ages 24-27)		(0.010)	(0.010)	

Steady State Characteristics

Distribution of annual earnings for men 24-35 and 36-47

Quantity	Model	Data
Mean when young	43,194	41,380
SD when young	20,851	23,252
Skewness when young	1.41	1.04
SD when old	40,335	42,860
Skewness when old	.84	1.71

Steady State Characteristics

Table 1: Educational Attainment by Parental Education (Initial Steady State)

	Model			NLSY Data		
Parental Education	High School Graduate or More	Some College or More	College Gradaute	High School Graduate or More	Some College or More	College Gradaute
High School Dropout	0.55	0.17	0.02	0.59	0.24	0.05
High School Graduate	0.75	0.35	0.13	0.76	0.41	0.14
Some College	0.98	0.48	0.21	0.80	0.49	0.19
College Graduate	1.00	0.52	0.21	0.91	0.74	0.33

Steady State Characteristics

Intergenerational Correlation of Education

Measure	Model	Data
Years	.32	.27
Dollars	.21	.24

Subsidizing Education

Compare increasing s_1 from 0 to .12 vs. increasing s_2 from .5 to .55

- Both policies cost about \$750 per capita
- 60% of costs for early subsidy are delayed (from increased costs associated with late subsidy)

Effects (% Changes)

	Avg. i_1	Avg. i_2	HS+	Coll. Grad	h_3
1. Increase s_1					
SR	21.3	9.3	0	23.4	1.5
LR	28.3	13.7	0.2	32.5	1.9
2. Increase s_2					
SR	2.6	9.7	9.7	13.0	0.4
LR	5.2	11.3	9.9	17.4	0.6
SR (i_1 fixed)	0.0	5.2	9.7	0.2	0.1