Stock Market Participation: The Role of Human Capital

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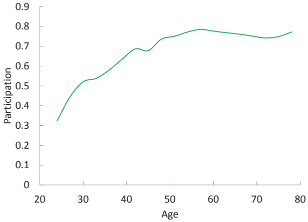
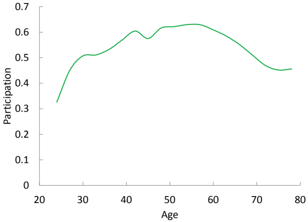
Background

- Large fraction of households do not participate in the stock market, especially when young.



(a) Cohort Effects



(b) Time Effects

- Has proved very difficult to explain without imposing nonstandard preferences, stock market participation costs, or imperfect information.

A casual observation: Stock market participation lowest when human capital accumulation is highest...

- **Q:** If you get human capital *investment* right (which we do by calibrating to earnings over the life-cycle under observed stock and bond returns), do you get participation right, given observed returns?
- **A:** Yes!

What We Do

- We show that once human capital investment is allowed for and quantitatively disciplined, stock market participation can be well-understood within an entirely standard setting.
  - Previous literature has a dichotomy where agents explicitly invest in financial, but *not* human, wealth.
- We embed the classic Ben-Porath (1967) model of time allocation between working ("earning") and human-capital accumulation ("learning") into a life-cycle consumption-savings model with uninsurable idiosyncratic labor income risk and financial portfolio choice.
- To our knowledge, we are the first to study stock market participation in such a setting.

Insight of earlier work: Borrowing to invest in equity, if costly, isn't a good idea

One (direct) cost: premium on borrowing

- Borrowing constraints prevent forward-looking households that would otherwise borrow and invest in equity from doing so. (DKW, 2006)
- Makes equity demand dependent on liquid wealth

BUT:

- In these settings, earnings are exog: households are implicitly endowed with human capital, no HC investment allowed
- Leaves equity as the sole investment option aside from risk-free assets

Build on this to show that once human capital investment is allowed for, there are further costs to borrowing to invest in equity–you'd (really!) forgo *consumption*...

What is the basic mechanism?

- Households allocate time to accumulating human capital vs working
  - Human capital investment requires forgoing current earnings
- Households have incentives to borrow to ease accumulation of *human* capital, not financial wealth
- Borrowing allows consumption to take place while learning early in life.
- But households also heterogeneously endowed with ability, initial human capital,wealth.
  - Creates *dispersion* in the level and slope of earnings
  - Leads many—but not all—households to not participate in the stock market early in life.

Related literature

- Participation
  - **Fixed cost of entry:** Cocco (2005); Campbell, Cocco, Gomes, and Maenhout (2001); Haliassos and Michaelides (2003)
  - **Nonstandard preferences:** Habit formation (Gomes and Michaelides, 2003; Polkovnichenko, 2007) or heterogeneous risk preferences (Gomes and Michaelides, 2005)
- Human capital
  - Ben-Porath (1967), Guvenen (2009), Huggett, Ventura and Yaron (2011)
  - Lindset and Matsen (2011), Roussanov (2010), Kim, Maurer and Mitchell (2013)
- Borrowing Constraints
  - Reduce the demand for equity and raise the equity premium (Constanindes, Donaldson, Mehra, 2002)
  - Make equity demand dependent on liquid wealth (Davis, Kubler and Willen, 2006)

Data

- Household-level data from U.S. Survey of Consumer Finances (SCF) – not a panel
- Differences in participation and shares across households may be the result of three factors:
  - aggregate fluctuations experienced by all households living in a particular year (time effects)
  - lifetime experiences that vary by year of birth (cohort effects)
  - getting older (age effects).
- We are interested in participation over the life cycle—need to distinguish age effects from cohort and time effects.

Estimation Strategy

- The three variables are perfectly collinear (age=year of birth–year of observation)
- We separately consider cohort and time effects

Estimation: Participation

- Controlling for cohort effects (following Poterba and Samwick, 1997)

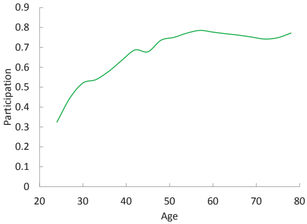
$$S_i^* = \alpha + \sum_{n=2}^{21} \beta_n age_{i,n} + \sum_{m=2}^{24} \gamma_m cohort_{i,m} + \epsilon_i$$

- Controlling for time effects (following Ameriks and Zeldes, 2004)

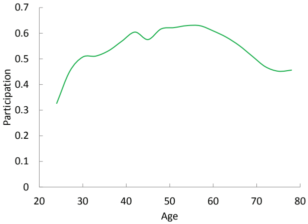
$$S_i^* = \delta + \sum_{n=2}^{21} \xi_n age_{i,n} + \sum_{t=2}^{8} \eta_t year_{i,t} + \mu_i$$

- $S_i = 1$ if $S_i^* > 0$ and 0 otherwise
- $age_{i,n}$: dummy variable indicating whether age of household head lies in one of 19 age categories ranging from 23–25 to 77–79
- $cohort_{i,m}$: dummy variable indicating whether household head belongs to one of 24 cohorts in the range 1919–1921 to 1988–1990.
- $year_{i,t}$: dummy variable indicating whether household head was surveyed in one of 9 SCF triennial surveys between 1989 and 2013.

Estimated Participation Rate over the Life Cycle (SCF)



(a) Cohort Effects: 1973–75



(b) Time Effects: 2013

Environment

- Life-cycle consumption savings model.
- Agents start life in the model as young adults.
- Endowed with human capital, h_1, immutable learning ability, a, and initial assets, x_1.
  - jointly drawn according to distribution $F(a, h, x)$
- Divide time between work and human capital accumulation (Ben-Porath, 1967).
- Consume and allocate any savings between risky asset s_t and risk-free asset b_t
- Can borrow using non-defaultable debt, $b_t \geq -\underline{b}$

Preferences

$$\max_{(\{c_t\}\in\Pi(\Psi_0))} E_0 \sum_{t=1}^{T} \beta^{t-1} u(c_t)$$

- $\Pi(\Psi_0)$ denotes the space of all feasible combinations $\{c_t\}_{t=1}^{T}$, given initial state Ψ_0.
- CRRA utility function
- Common discount factor β

Assets

- Interest rates
  - riskfree assets: R_f $(b_t > 0)$
  - risky asset: $R_{s,t+1} = R_f + \mu + \eta_{t+1}$ with $\eta_{t+1} \sim N(0, \sigma_\eta^2)$ iid
  - debt: $R_b = R_f + \phi$ $(b_t < 0)$
- Financial wealth $x_{t+1} = R_i b_{t+1} + R_{s,t+1} s_{t+1}$
- Human Capital

$$h_{t+1} = h_t(1-\delta) + a(l_t h_t)^\alpha$$

Income

- Labor income

$$\log(y_t) = G(w_t, h_t, l_t) + z_t$$

$$\begin{aligned} w_t &= (1+g)^{t-1} \\ z_{it} &= u_{it} + \epsilon_{it} \\ u_{it} &= \rho u_{i,t-1} + \nu_{it} \\ \nu_{it} &\sim N(0, \sigma_\nu^2) \\ \epsilon_{it} &\sim N(0, \sigma_\epsilon^2) \end{aligned}$$

- Means tested transfer income

$$\tau_t(t, y_t, x_t) = \max\{0, \underline{\tau} - (\max(0, x_t) + y_t)\}$$

Agent's Problem I

- Retirement (state t, a, h, b, s)

$$V^R = \sup_{b', s'} \left\{ \frac{c_t^{1-\sigma}}{1-\sigma} + \beta V^{R'} \right\}$$

s.t.

$$c + b' + s' \leq \phi(y_J) + R_i b + R_s s$$

- Working (state t, a, h, b, s, u, ν)

$$V = \sup_{l, h', b', s'} \left\{ \frac{c_t^{1-\sigma}}{1-\sigma} + \beta E_{u'/u} V' \right\}$$

s.t.

$$c + b' + s' \leq w(1-l)hz + R_b b + R_s s + \tau(t, y, x) \quad (1)$$

$$l \in [0,1] \quad (2)$$

$$h' = h(1-\delta) + a(hl)^{\alpha} \quad (3)$$

Calibration

- Standard parameters
  $\beta = 0.96$, $\sigma = 5$
- Wage and human capital accumulation parameters
  $g = 0.0014$, $\delta = 0.0114$, $\alpha = 0.7$
- Asset markets parameters
  $\mu = 0.06$, $R_f = 1.02$, $R_b = 1.11$, $\sigma_\eta = 0.157$
- Earnings process
  $\rho = 0.955$, $\sigma^2_\omega = 0.055$, $\sigma^2_\nu = 0.017$
- Distribution of initial unobservable characteristics
  Assumed log-normal and estimated to match statistics of the life-cycle earnings distribution in the CPS data

Earnings Calibration

- We compute J sets of statistics of age-earnings profiles from the CPS for 1969-2002 family files for heads of household using a synthetic cohort approach
- We compute mean real earnings, inverse skewness, and Gini of individuals of age j by averaging over the earnings of household heads between the ages of $j-2$ and $j+2$ for the appropriate year

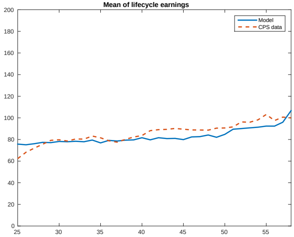
Calibration of the Initial Distribution (a,h)

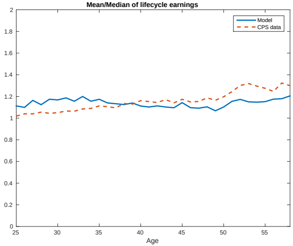
- We use a parametric approach: joint log-normal distribution characterized by the vector of parameters $\gamma = (\mu_a, \sigma_a, \mu_h, \sigma_h, \rho_{ah})$
  - Find γ that solves

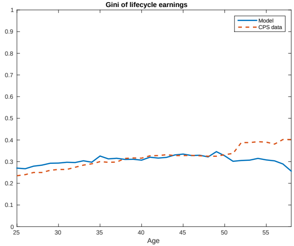
$$\min_{\gamma} \left(\sum_{j=1}^{J} |log(m_j/m_j(\gamma))|^2 + |log(g_j/g_j(\gamma))|^2 + |log(d_j/d_j(\gamma))|^2 \right)$$

- The model produces $\rho_{ah} = 0.65$.

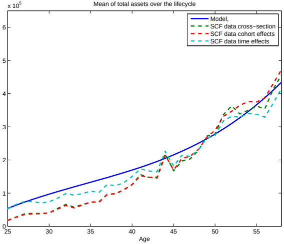
Model Fit

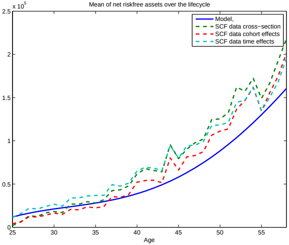

Mean of lifecycle earnings
Model
CPS data
200
180
160
140
120
100
80
60
40
20
0
25
30
35
40
45
50
55

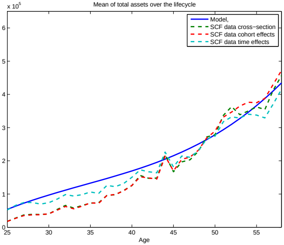

Mean/Median of lifecycle earnings
Model
CPS data
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
25
30
35
40
45
50
55
Age


Gini of lifecycle earnings
Model
CPS data
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
25
30
35
40
45
50
55
Age

Non-targeted wealth over the life-cycle



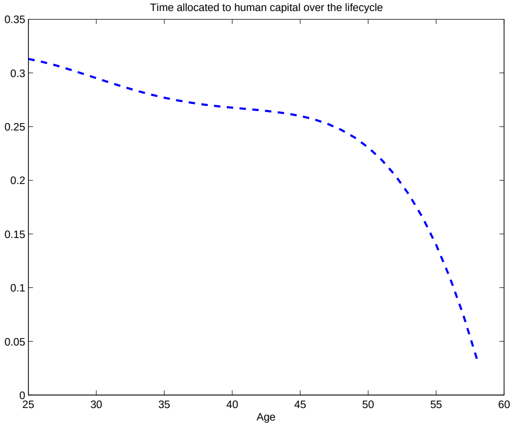




Time Allocated to Human Capital over the Life Cycle: Intuition

- Agents should want to allocate most time to human capital investment when young
  - Opportunity cost of doing so is low
  - Time horizon to recoup returns is long
  - Marginal returns are high for most given elasticity, initial human capital, and learning ability

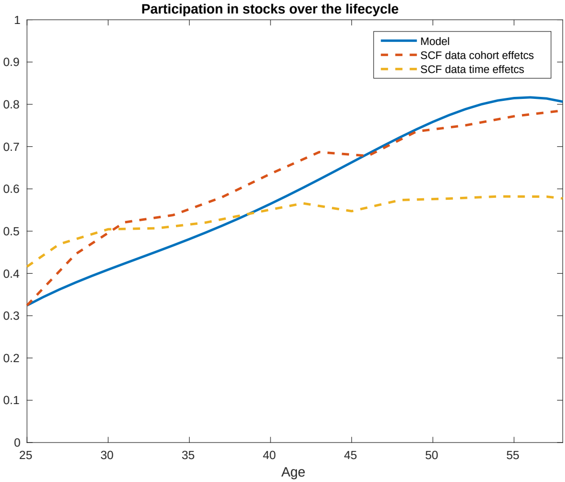
Time Allocated to Human Capital over the Life Cycle



Stock-Market Participation over the Life Cycle: Intuition

- Most agents allocate time to HC when young.
- As a result, they forgo current earnings.
- They borrow to smooth consumption and do not invest in equities when young.

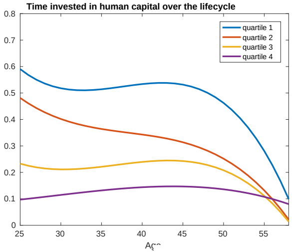
Stock Market Participation

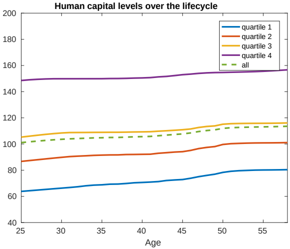


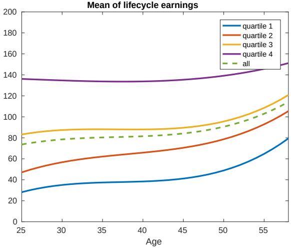
The Role of Ability and Initial Human Capital

- Want to see how each dimension matters separately
- Isolate by assuming correlation=0 (contrast with baseline=0.65)
- Break population up into quartiles

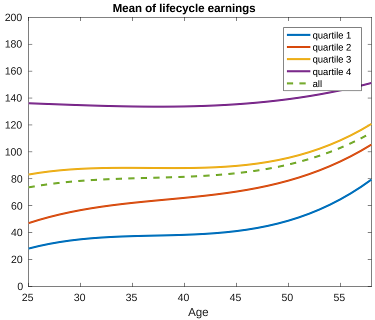
Initial Human Capital and the Life-Cycle: Time and Earnings

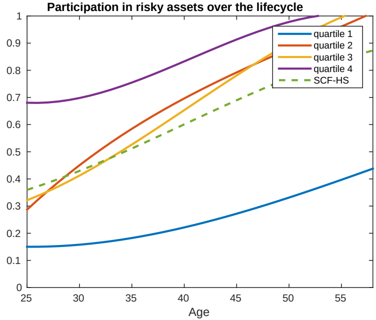




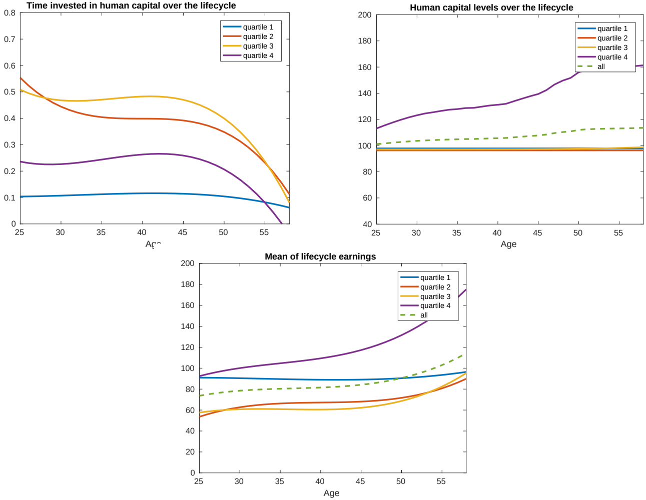


Initial Human Capital and the Life-Cycle: Earnings and Participation

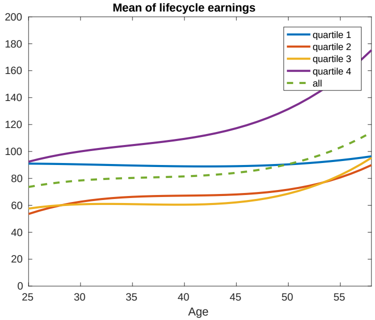


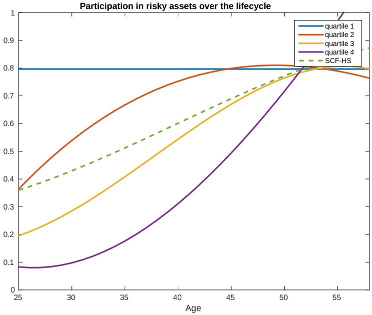


Ability and the Life-Cycle: Time and Earnings

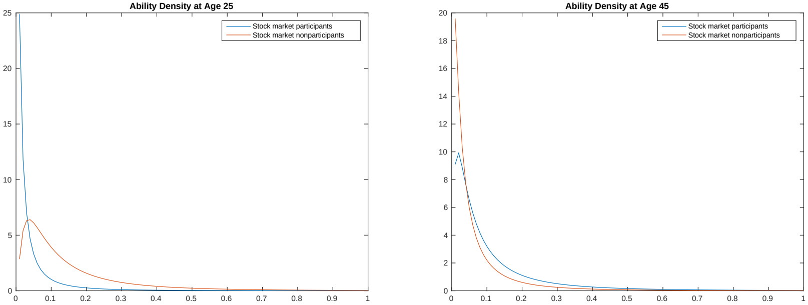


Ability and the Life-Cycle: Earnings and Participation

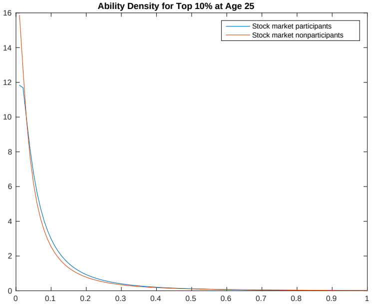


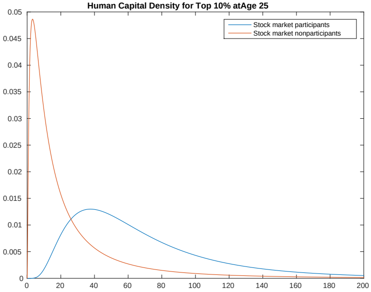


Participants vs. Non-Participants

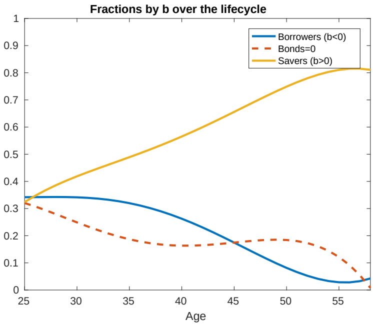


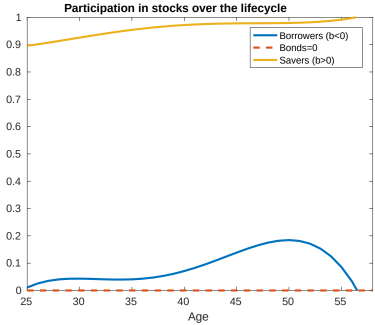
Wealthy Participants vs. Non-Participants



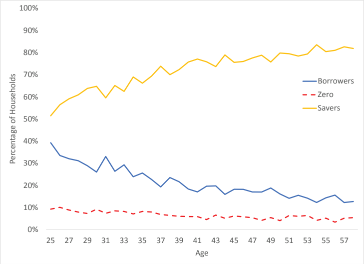


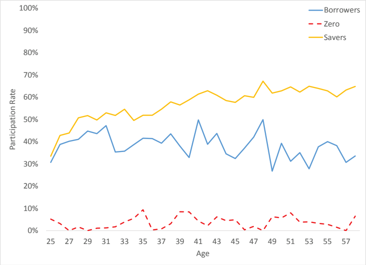
Borrowers and Savers: Model





Borrowers and Savers: Data





Role of Ability and Human Capital: Discussion

- Higher ability agents and agents with relatively low initial human capital have the most incentive to invest in human capital and forego earnings.
- This generates a greater “tilt” in these agents’ life-cycle earnings.
- They borrow to finance consumption and not stock market investment early in life.
- Later in life, higher earnings enable them to participate in the stock market at higher rate
- As a result, life-cycle participation also exhibits a steep profile for these agents.
- The reverse holds for lower ability agents or agents with relatively high initial human capital

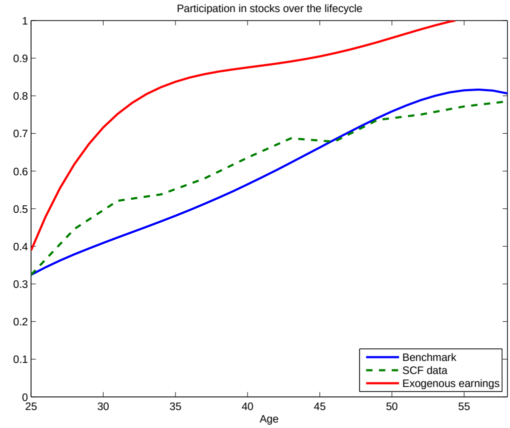
Why is human capital *investment* important?

- We've shown that the tilt in earnings and its dispersion matter for participation.
- Endowments determine dispersion in the value of human capital.
- People's choices in response determine their earnings path.
- This opens the door for an additional role for borrowing: financing consumption, not stocks.
- How important is this?

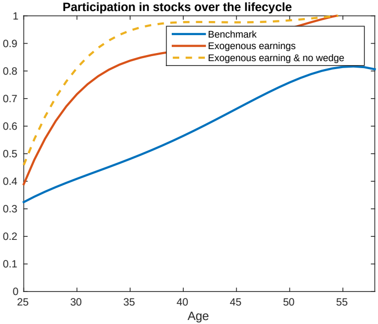
Why is human capital *investment* important?, con't.

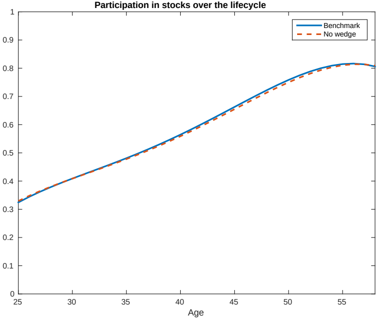
- DKW (2006)–if borrowing is *cheap*, people will borrow to invest in stocks
- Constantindes et al. (2002)–if borrowing is *allowed*, junior will borrow (and invest in stocks)
- But when you have to work to earn, you borrow to *learn* (and not invest in stocks)

Life-Cycle Stock Market Participation Under Exogenous Earnings



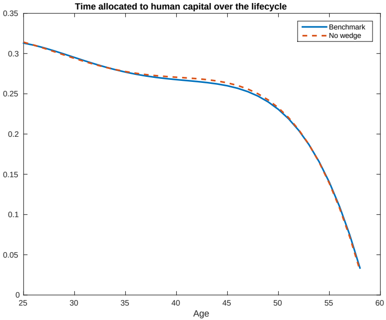
How does exogenous HC/Earnings inform us about the role of borrowing costs?

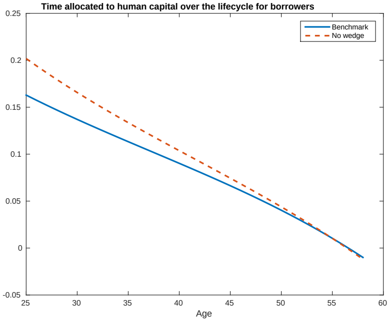




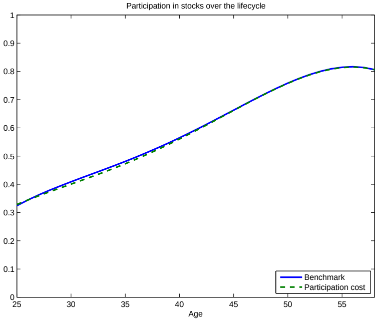
- Exog earnings: Borrow to finance stocks
- Endog earnings: Borrow to finance consumption

Human Capital and Borrowing Costs

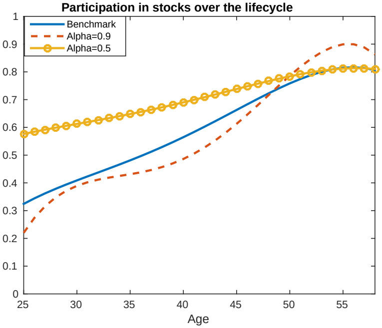




Human Capital and Participation Costs



Role of Elasticity of Human Capital



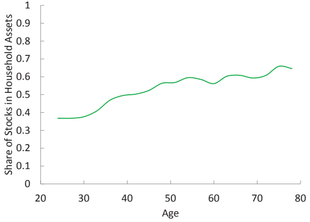
Role of Elasticity of Human Capital: Discussion

- $\alpha = 0.5$ makes human capital technology less productive
- Makes earnings path flatter, all else equal.
- Decreases agents incentive to invest in human capital
- Results in a lower and flatter path for earnings, higher and flatter path for participation

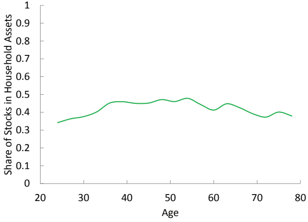
Model's Implication for Shares

- What you're using borrowing to fund is participation story
- But the model also has predictions for the share of risky assets in the household's portfolio

Estimated Average Share of Stocks in Portfolio Conditional on Participation (SCF)

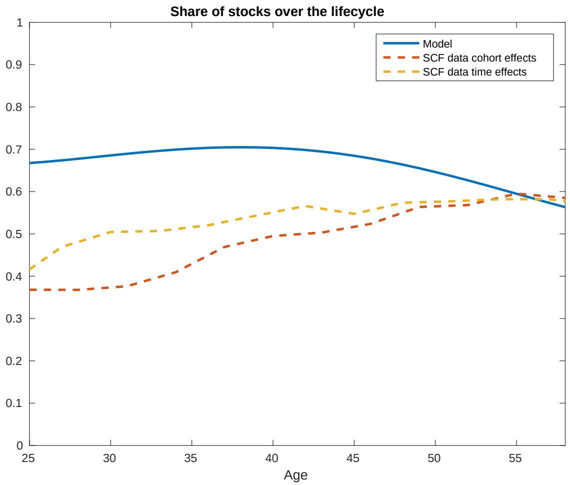


(a) Cohort Effects

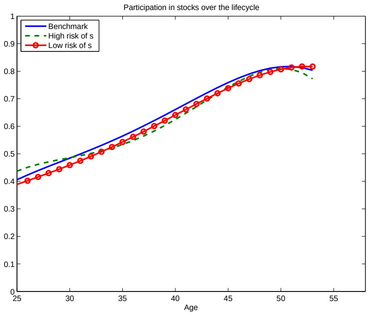


(b) Time Effects

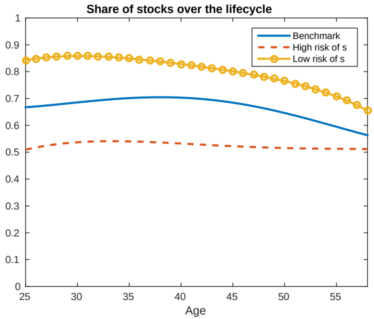
Stock Market Investment: Shares



Stock Market Investment with Low and High Stock Market Risk

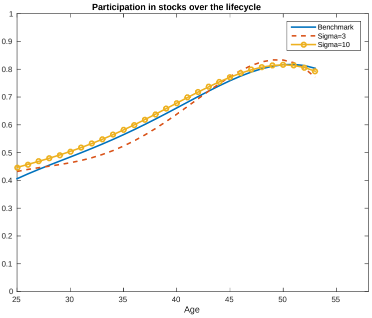


(a) Participation

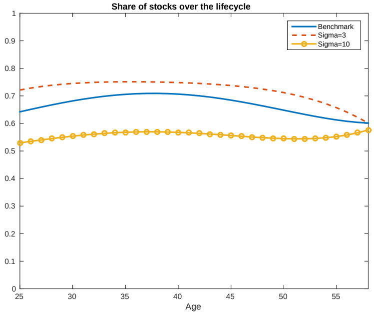


(b) Shares

Effect of Changing Risk Aversion on Stock Market Investment

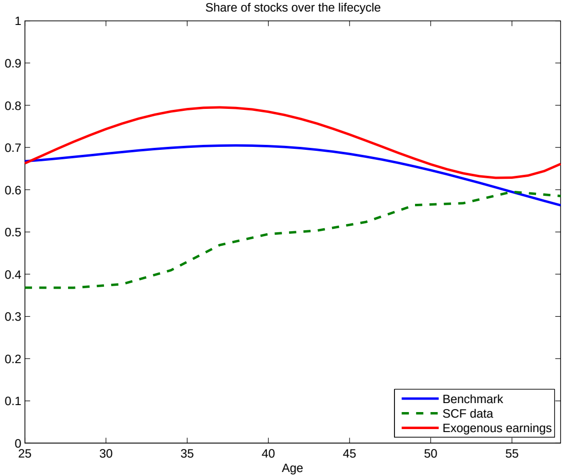


(a) Participation



(b) Shares

Life-Cycle Stock Market Shares Under Exogenous Earnings



Shares: Summary of Findings

- Unlike participation, shares not sensitive to time invested in human capital
- Shares sensitive to riskiness of stocks and risk aversion
- **Forces driving shares differ from forces driving participation**.

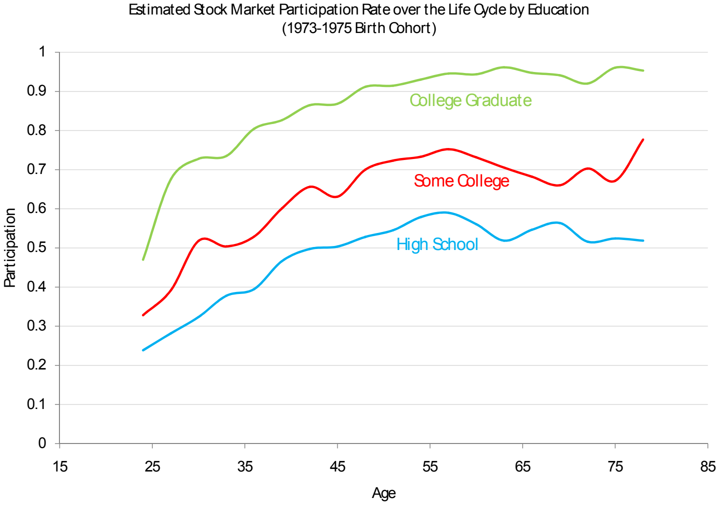
Concluding Remarks

- Stock market participation over the life-cycle limited, hard to explain.
- Contribute by acknowledging that human capital investment is also being done.
- Show that once we allow for investment in human capital, can largely understand stock market participation.

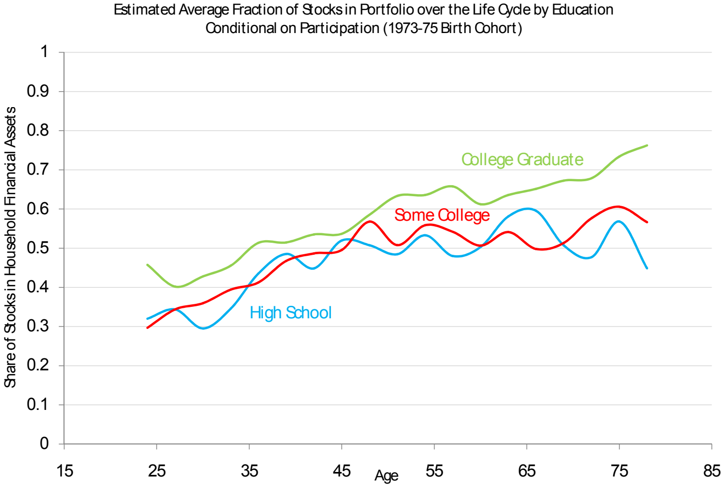
Preview of Related Work

How does college, as an available investment option, affect household balance sheets over the life cycle?

Stock market participation varies with college experience



Fraction of stocks in portfolio varies with college experience



The Idea

- College experience separates people early, and permanently (in earnings and financial assets)
- College is risky: risks vary across individuals
- College is costly: costs vary across individuals
- Observed relationship between education and financial investment hinges on risks and net-returns, and their dispersion across households

Introduce College

- No heterogeneity in preferences or in any other dimensions (except for human capital and earnings parameters).
- Recalibrate the economy to match earnings statistics over the life-cycle (as in Ben-Porath - step 1) *and* college enrollment and completion by initial assets (step 2).
- Study the implications of college structure and related polcies for financial portfolios.

College

- Youth
  - Decide to invest in college at $t = 1$
  - If college, individuals face completion probability $\pi(h_5(h_1, a, l^*_{1,\dots,4}))$ realized at end of college period
  - Finance education with wealth or non-defaultable debt, d_t student loans and $b_t \geq -\underline{b}$, consumer credit
- Adults
  - Start adult life with human capital h^i, with $i = HS, SC,$ or CG
  - Once college is done (or no college is chosen) back to Ben-Porath

◂ College Investment

College

- Working after College (state t, a, h, b, s, u, ν)

$$V^i = \sup_{l,h',b',s'} \left\{ \frac{c_t^{1-\sigma}}{1-\sigma} + \beta E_{u'/u} V^{i'} \right\}$$

s.t.

$$\begin{aligned} & (1)\text{-}(3) && \text{for} \quad t = P+1, .., J-1 \\ c + b' + s' \le w(1-l)hz + R_j b + R_s s + \tau(t,y,x) - p(x_1) & && \text{for} \quad t = 5, .., P \end{aligned}$$

- College

$$V^C(5,a,h,b,s,u,\nu) = \pi(h_5)V^{CG}(5,a,h,b,s,u,\nu) + (1-\pi(h_5))V^{SC}(5,a,h,b,s,u,\nu)$$

$$V^C = \max_{l,h',b',s',d} \left[\frac{c^{1-\sigma}}{1-\sigma} + \beta V^{C'} \right]$$

s.t.

$$\begin{aligned} c + b' + s' &= w_{col}(1-l) + t(a) + R_b b + R_s s + \frac{d}{4} - \hat{d} \\ &(2)\text{–}(3) \\ d \in D &= [0, \max(d_{max}, \overline{d} - x)] \text{ for } t = 1 \end{aligned}$$

- Education decision

$$\max[V^C(1,a,h,x), V^{HS}(1,a,h,x)]$$

College Investment

College parameters

- Total college cost, $\overline{d} = \$53,454$ and tuition, $\hat{d} = \$28,320$
- Limit and interest rate on student loans, $d_{max} = \$23,000$ and $R_g = 1.09$
- Scholarship for college, $t(a) = 33\%$ of college cost, on average (NCES data)
- Wage during college, $w_{col} = \$17,700$ (NCES data)
- Probability of college completion, $\pi(h_5)$ based on completion rates by cumulative GPA in BPS data
- Distribution of initial assets (expected family contribution for college in NCES data): $(\$22,656, \$25,488)$

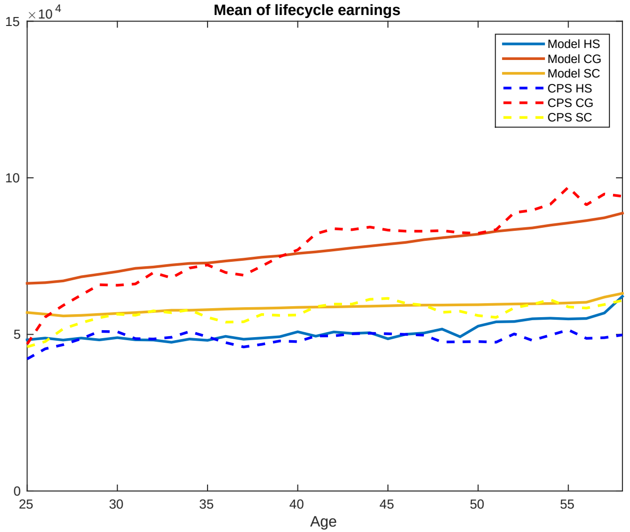
Note: Values are given in 2014 dollars.

College Investment

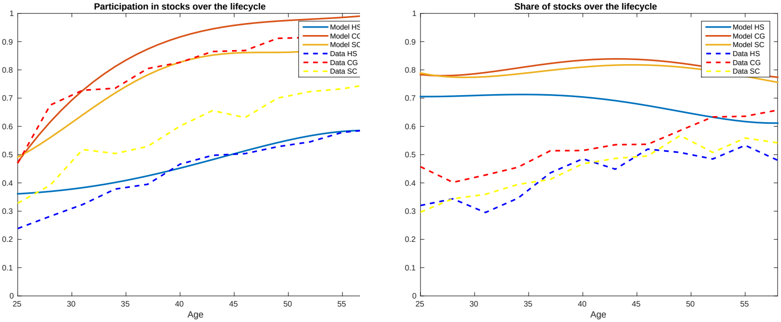
College Investment

Characteristic	College Enrollment	College Completion
Ability		
Low	29	48
Medium	44	54
High	71	59
Human Capital		
Low	38	42
Medium	47	54
High	59	68

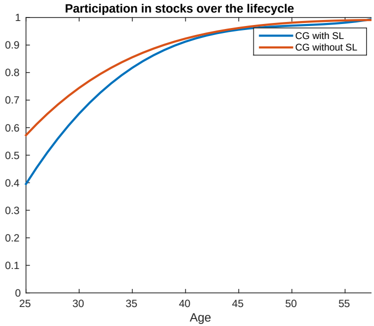
Earnings by education groups

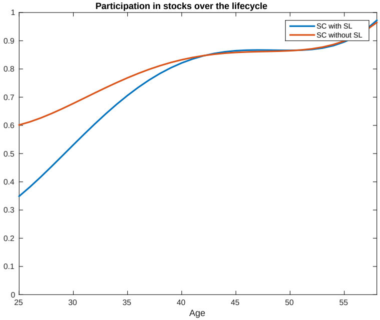


Investment in stocks by education groups

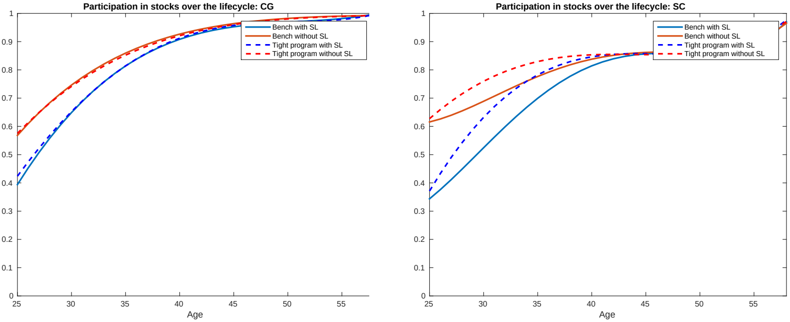


Effects of student loans





Policy analysis: tight student loan program



Earnings Data

- We compute 102 statistics of age-earnings profiles for each education group from the CPS for 1969-2002 family files for heads of household using a synthetic cohort approach
- We distinguish between the three education groups in our model, namely, those with 12 years of schooling (high-school), those with at least 12 years but less than 16 years of completed schooling (some college) and those with at least 16 years of completed schooling (college graduates)
- We compute mean real earnings, inverse skewness, and Gini of individuals of type (j, k) by averaging over the earnings of household heads between the ages of $j - 2$ and $j + 2$ in education group k for the appropriate year

◂ Data

Earnings Process

- The stochastic part of the labor income for household i at time j is:

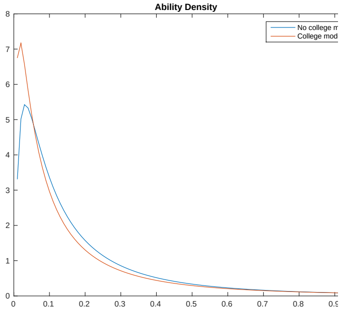
$$
\begin{aligned}
z_{ij} &= u_{ij} + \epsilon_{ij} \\
u_{ij} &= \rho u_{i,j-1} + \nu_{ij}
\end{aligned}
$$

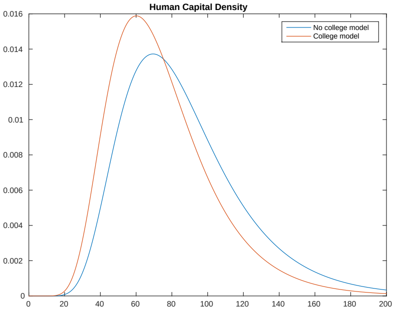
  where ϵ_{ij} $N(0, \sigma_\epsilon^2)$ and ν_{ij} $N(0, \sigma_\nu^2)$

- We set$\rho = 0.955$, $\sigma_\omega^2 = 0.055$, and $\sigma_\nu^2 = 0.017$ for high-school graduates and $\rho = 0.945$, $\sigma_\omega^2 = 0.052$, and $\sigma_\nu^2 = 0.02$ for college graduates

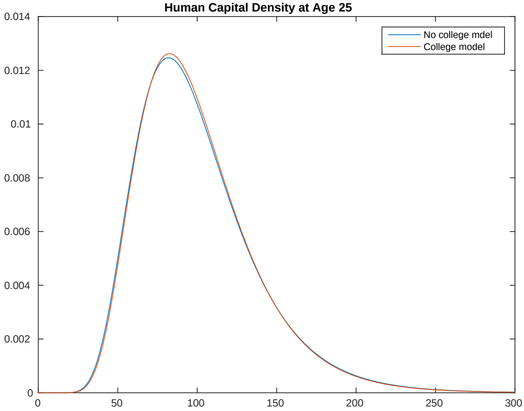
◂ Calibration

Change in the initial distribution of (a, h_1)





Human Capital: Catch-up by Age 25



Calibration of the Initial Distribution (a,h)

- We use a parametric approach: joint log-normal distribution characterized by the vector of parameters $\gamma = (\mu_a, \sigma_a, \mu_h, \sigma_h, \rho_{ah})$
  - Find γ that solves

$$\min_{\gamma} \left(\sum_{j=5}^{J} |log(m_j/m_j(\gamma))|^2 + |log(g_j/g_j(\gamma))|^2 + |log(d_j/d_j(\gamma))|^2 \right)$$

- The model produces $\rho_{ah} = 0.65$ and the fit is 8.5%

Calibration

Estimation: Shares

- Controlling for cohort effects

$$Y_i = \alpha + \sum_{n=2}^{21} \beta_n age_{i,n} + \sum_{m=2}^{24} \gamma_m cohort_{i,m} + \epsilon_i$$

- Controlling for time effects (following Ameriks Zeldes, 2004)

$$Y_i = \delta + \sum_{n=2}^{21} \xi_n age_{i,n} + \sum_{t=2}^{8} \eta_t year_{i,t} + \mu_i$$

- $Y_i = \ln \frac{\frac{s}{s+b}}{1-\frac{s}{s+b}}$
- s: Risky assets
- b: Risk-free assets