Credit Shocks and Financial Literacy Accumulation

Daniel Jacobs

October 13, 2020

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Financial literacy is partly a *choice*.

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Individuals with low or no wealth can borrow.

My Questions

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1. What is the relationship between borrowing and financial literacy?
2. Does borrowing interest rate uncertainty encourage financial literacy accumulation?
3. Which policies would be most effective for raising financial literacy?

What I do

1. Document facts using the American Life Panel.
2. Build and calibrate a life cycle model with endogenous financial literacy choice and borrowing interest rate uncertainty.
3. Test a series of policy experiments: an interest rate cap and a financial literacy subsidy.

Outline

1. Econometric Analysis
2. Model
3. Policy Experiments
4. Conclusion

Econometric Model - Variables

For individual i in MSA j in year t:

- $\Delta FinancialLiteracy_{ijt}$: Change in the number of correctly answered questions out of 12.
  - Constructed using the American Life Panel (ALP)
- $\Delta LoanReserve_{jt}$: Change in the Loan-Loss Reserve Ratio.
  - This is proxy for the local cost of credit.
  - Only multi-state banks from FDIC.
  - Weighted by deposit-share in MSA

Dep. Variable:

▸ Ex. Questions

Econometric Model - Panel Regression

$$\Delta FinancialLiteracy_{ijt} = \alpha_i + \beta_1 \Delta LoanReserve_{jt} + \gamma \Delta X_{ijt} + \delta_t + \Delta \varepsilon_{ijt} \quad (1)$$

- $\Delta FinancialLiteracy_{ijt}$ is the change in the number of correctly answered questions out of 12 (normalized).
- $\Delta LoanReserve_{jt}$ is the change in the Loan-Loss Reserve ratio.
- α_i is an individual fixed effect.
- ΔX_{ijt} is the change in a vector of controls (e.g. income).
- δ_t is a year-fixed effect

▸ Summary Statistics

Main Regression Results

$$\Delta FinancialLiteracy_{ijt} = \alpha_i + \beta_1 \Delta LoanReserve_{jt} + \gamma \Delta X_{ijt} + \delta_t + \varepsilon_{ijt}$$

Variables	**1**
$\Delta LoanReserve_{jt}$	0.27^{**}
	(.13)
N	1482
Adj. R^2	0.6826

- 0.27 of a standard deviation is approximately a 6% change in financial literacy.

Robustness

- Mortgage
- MSA Rank
- FinLit-Asset Relationship

Life Cycle Effects

Does financial literacy increase at the same rate during all parts of the lifecycle? ▸ Life Cycle Plot

$$\Delta FinancialLiteracy_{ijt} = \alpha_i + \beta_1 \Delta LoanReserve_{jt} + \beta_2 \overline{Age^2_{ijt}} + \gamma \Delta X_{ijt} + \delta_t + \Delta \varepsilon_{ijt},$$

By Education Life Cycle Plots:

▸ High School Age-Plot

▸ College Age-Plot

Regression Results

$$\Delta FinancialLiteracy_{ijt} = \alpha_i + \beta_1 \Delta LoanReserve_{jt} + \beta_2 \overline{Age^2_{ijt}} + \gamma \Delta X_{ijt} + \delta_t + \Delta \varepsilon_{ijt}$$

Variables	**1**	**2**	**3**	**4**
$\Delta LoanReserve_{jt}$	.27**	.29**	.30**	.33**
	(.13)	(.13)	(.12)	(.13)
$\overline{Age}^2_{ijt}$		−.003*	−.008*	−.008*
		(.003)	(.004)	(.004)
$\Delta LoanReserve_{jt} \times \overline{Age}_{ijt}$			-.012	-.012
			(.012)	(.012)
$\Delta LoanReserve_{jt} \times \overline{Age}^2_{ijt}$				-.0002
				(.0002)
N	1482	1482	1482	1482
Adj R^2	0.6826	0.6842	0.6849	0.6851

Takeaway from Empirical Results

- Positive effect of increase in loan-loss ratio on financial literacy. Why?

    1. Higher interest rates raises the marginal utility of consumption next period (Carroll and Kimball 2001).

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My model will include:

- Life Cycle Component
- Endogenous Financial Accumulation
- Borrowing Interest Rate Shock

▸ FinLit-Asset Relationship

Life-Cycle Model

Individuals maximize utility over J years. Utility is CRRA.

$$\max_{\{c_t\}_{t=1}^{J}} E\left[\sum_{t=1}^{J} \beta^{t-1} \frac{c_t^{1-\gamma}}{1-\gamma}\right] \quad . \tag{2}$$

Income Process

$$y_t = w \cdot e_t \cdot exp(\eta_t) \quad , \tag{3}$$

where

- w is a normalized wage
- e_t is the age-earnings profile
- $\eta_t = \rho_\eta \eta_{t-1} + \varepsilon_t$ and $\varepsilon_t \sim N(0, \sigma_\varepsilon^2)$.

Interest Rate Structure

Individuals can invest in their financial literacy stock (Φ_t) to raise their saving rate of return.

$$r(\Phi_t) = A \cdot \Phi_t^{\alpha} + r_{base} \tag{4}$$

- α is the elasticity of financial literacy investment, where $\alpha \in (0, 1)$.
- A is the productivity of financial literacy.
- r_{base} is the lower-bound return on savings.

Empirical Evidence:

- FinLit-Asset Relationship
- Life Cycle Plot

Financial Literacy Path

Law of Motion

$$\Phi_{t+1} = (1-\delta)\Phi_t + \ell_{t+1} \tag{5}$$

where Φ_t is their stock of literacy, δ is the depreciation of this stock and ℓ_{t+1} is their investment in financial literacy. Each unit of stock costs p.

Literacy choice set constraint:

$$\ell_{t+1} \geq 0 \tag{6}$$

The return on savings, s_t, from financial literacy is then

$$(1 + r(\Phi_t))s_t \cdot \mathbb{1}\{s_t \geq 0\} \tag{7}$$

Borrowing Constraint and Interest Rate Shock

The borrowing interest rate follows a log-normal AR(1) process:

$$\iota_t = \rho_r \iota_{t-1} + \nu_t \tag{8}$$

where $r^b(\iota_t) = exp(\iota_t)$.

At the time of borrowing, individuals do not know the borrowing rate at which they will have to pay back their loan.

The natural borrowing constraint is:

$$s_{t+1} \geq \sum_{t}^{J} \frac{-y_{min}}{1 + r_b^{max}} \tag{9}$$

Saving Asset Path

Individual's wealth, X_t, is subject to two cases.

If $s_t \geq 0$:

$$X_t = (1 + r^s(\Phi_t))s_t + y_t \tag{10}$$

If $s_t < 0$

$$X_t = (1 + r^b(\iota_t))s_t + y_t \tag{11}$$

▸ Interest Cap

What I am going to match

Age Group	**41-51**	**52-62**	**63-73**	**74-84**
Δ FinLit^{Data} (%)	3.7	6.3	4.9	-3.2

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Moments are matched to calibrate:

$$A\Phi_t^{\alpha} \quad \text{and} \quad \delta\Phi_t$$

1. α: elasticity of financial literacy investment
2. A: productivity of financial literacy
3. δ: depreciation rate of financial literacy stock

Fixed Parameters: Preferences, income process, credit shock process

▸ Calibration ▸ Method ▸ Optimization Problem

Data used for Calibration

From the American Life Panel (ALP):

- Financial Literacy scores (out of 12).
- Liquid Savings (cash, checking, savings, stocks, etc.).

From the Survey of Consumer Finance 2010:

$$Borrowing(\%)_t = LiquidWealth_t - CreditCardDebt_t$$

Initial Distribution: joint distribution of financial literacy, income and liquid net worth for individuals ages 30–40 from ALP.

▸ Calibration ▸ Method ▸ Optimization Problem

Model Fit

Validation:

▸ Untargeted

	41-51	52-62	63-73	74-84
Targeted				
Δ FinLit^{Data} (%)	3.7	6.3	4.9	-3.2
Δ FinLit^{Model} (%)	5.7	3.1	-1.0	-1.6

Alternative fixed parameters:

▸ Double Longevity

▸ Model Fit - Base Change

Policy Experiment 1: Interest Rate Cap

A common proposal made to ameliorate low financial literacy: an interest rate cap.

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Trade-off: More cash-on-hand for financial literacy or consumption?

First experiment: Cap borrowing interest rates at 15%.

Interest Rate Cap: Results

	r(Φ)(%)		Savings ($)		$\frac{Debt}{income}$(%)		Δ Welfare
Age	41	63	41	63	41	63	
No Cap	3.65	3.67	67371	90166	6.52	2.64	0.00
Int. Cap	3.65	3.67	67238	90166	7.18	3.47	0.04

▸ Group - No Ration

Interest Rate Cap−Rationing

If lenders are prohibited from charging more than 15%, they will likely ration credit.

Re-run experiment with 10% credit rationing

Interest Rate Cap: Results

	r(Φ)(%)		Savings ($)		$\frac{Debt}{income}$(%)		Δ Welfare
Age	41	63	41	63	41	63	
No Cap	3.65	3.67	67371	90166	6.52	2.64	0.00
Int. Cap	3.65	3.67	67238	90166	7.18	3.47	0.04
10% Ration	3.65	3.67	68707	90174	5.04	8.42	-0.05

▸ Group ($\zeta = 10\%$) ▸ Contour - High/Low ▸ Contour - Low/Low ▸ Contour - Low/High ▸ Persistence

Policy Experiment 2: Financial Literacy Subsidy

- Financial Education is most effective when the receiver is financially distressed (Fernandes et al. 2014).

Policy Experiment: Provide subsidy to population and examine effects by group.

Subsidized investment choice

$$X_t - s_{t+1} - p(1-\tau) \cdot \ell_{t+1} \tag{12}$$

where $\tau \in [0, 1]$.

Experiment 2: Subsidy Results

$$X_t - s_{t+1} - p(1-\tau) \cdot \ell_{t+1}$$

	r(Φ)(%)		Savings		Fin.Lit (%)		Δ Welfare
Age	41	63	41	63	41	63	
Baseline	3.65	3.67	67371	90166	74	75	0.00
10% subsidy	3.68	3.69	67376	90232	75	77	0.06
30% subsidy	3.73	3.74	67374	90241	78	81	0.19

▸ Subsidy Group ▸ Contour - Low/High ▸ Contour - Low/Low ▸ Contour - High/Low ▸ Contour - High/High
▸ Subsidy - Young Only

Conclusions

1. Early life borrowing experience has an effect on latter life outcomes and life cycle welfare.
2. Interest rate caps can discourage financial literacy accumulation.
3. Financial literacy subsidies can be effective, especially for groups who are highly leveraged.

▸ Model Extension

Effect of Loan Reserve Ratio on Mortgage Rates

Variables	Contract	Contract	Contract
$\overline{LoanReserve}_{st}$	.06*	.07***	.07***
	(.04)	(.02)	(.02)
R^2	0.0159	0.7597	0.9204
State Fixed Effects?	N	N	Y
Year Dummies?	N	Y	Y
Observations	150	150	150

▸ Stylized ▸ Regression ▸ Summary Statistics ▸ Results

Liquid Wealth Regression

Table: Dependent Variable: Residuals from Liquid Wealth Regression

Variables	Full Population	Old (> 50)	Young (≤ 50)
$FinLit_{ijt}$	2.14^{***}	1.16^{***}	0.79^{**}
	(0.40)	(0.28)	(0.36)
R^2	0.050	0.028	0.023
Observations	1820	1317	503

Standard errors in parentheses, clustered at the MSA level.

▸ Stylized ▸ Data ▸ Summary Statistics ▸ Interest Rate Structure ▸ Results ▸ Takeaway

Factor Analysis

▸ Stylized ▸ Data

Variable	Uniqueness (1-Communality)
Compound	0.80
Inflation	0.76
Risk Diversification	0.64
Interest Rates & Bonds	0.82
Money Illusion	0.91
Time Value of Money	0.80
Highest Return	0.62
Highest Fluctuation	0.72
Highest Spread	0.61
Early IRA Withdrawal	0.83
Traditional vs Roth	0.79
Minimum Withdrawal	0.74

Questions

Basic " Suppose you had $100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow"

Economic Concepts "Assume a friend inherits $10,000 today and his sibling inherits $10,000 but 3 years from now. Who is richer today because of the inheritance?"

▸ Background ▸ Stylized ▸ Data

Method

1. Model is solved through Value Function Iteration
    1. Saving Grid points: 160 (80 points negative)
    2. Literacy Grid Points: 17
    3. Income Shock Grid Points: 5
    4. Interest Rate Shock Grid Points: 4
    5. Ages: 6 (approx. 10 years between ages)

2. Given the policy functions and the distribution of the shocks, I solve for the joint asset distribution, $f(s, \Phi)$, induced by the policy function.

▸ What I Match ▸ Calibration

Loan Reserve

$$LoanReserve_{jt} = \frac{LoanLossReserves}{TotalAssets} \tag{13}$$

- Increases in loan loss provisioning associated with tighter bank lending (Balasubramanyan, Zaman and Thomson 2017)
- Loan Loss provisions are meant to cover "expected losses" (Majnoni, Miller, and Powell, 2004)
- Positively associated with net interest margin (Montoro and Moreno 2011; Islam and Nishiyama 2016)

▸ Stylized ▸ Data ▸ Mortgage

Low Credit Rate Persistence

Table: Change by subgroup - Low Borrowing Rate Persistence

State	Δ FinLit Invest (%)	Δ Savings (%)	Δ Welfare (%)
Young	7.8	22.3	-–2.5
Low Income, Young	7.8	75.6	17.7
Retirement	7.2	22.0	–1.4
Low Income, Retirement	8.4	44.9	1.6

Young = Initial Age; Retirement = 63-73; Low Income ($< \$40,000$)

▸ Expectations

Double Credit Rate Variance

Table: Change by subgroup - Double Credit Rate Variance

State	Δ FinLit Invest (%)	Δ Savings (%)	Δ Welfare (%)
Young	0.004	0.040	-–0.030
Low Income, Young	0.000	0.005	–0.130
Retirement	0.000	0.000	–0.000
Low Income, Retirement	0.000	0.000	–0.001

Young = Initial Age; Retirement = 63-73; Low Income ($< \$40,000$)

▸ Expectations

Policy Experiment: Interest Cap (0% rationing)

Table: Change by subgroup - Interest Cap, 0% rationing

State	Δ FinLit Invest (%)	Δ Savings (%)	Δ Welfare (%)
Young	0.000	–0.036	0.038
Low Income, Young	0.000	–0.001	0.135
Retirement	0.000	0.000	0.000
Low Income, Retirement	0.000	0.000	0.002

Young = Initial Age; Retirement = 63-73; Low Income ($< \$40,000$)

▸ Interest Cap - Base ▸ Contour - High/Low ▸ Contour - Low/Low ▸ Contour - Low/High

Policy Experiment: Interest Cap (10% rationing)

Table: Change by subgroup - Interest Cap, 10% rationing

State	Δ FinLit Invest (%)	Δ Savings (%)	Δ Welfare (%)
Young	—0.024	1.847	-–0.050
Low Income, Young	0.000	0.037	—0.070
Retirement	0.000	0.000	–0.001
Low Income, Retirement	0.000	0.000	0.000

Young = Initial Age; Retirement = 63-73; Low Income ($< \$40,000$)

▸ Interest Cap ▸ Contour - High/Low ▸ Contour - Low/Low ▸ Contour - Low/High

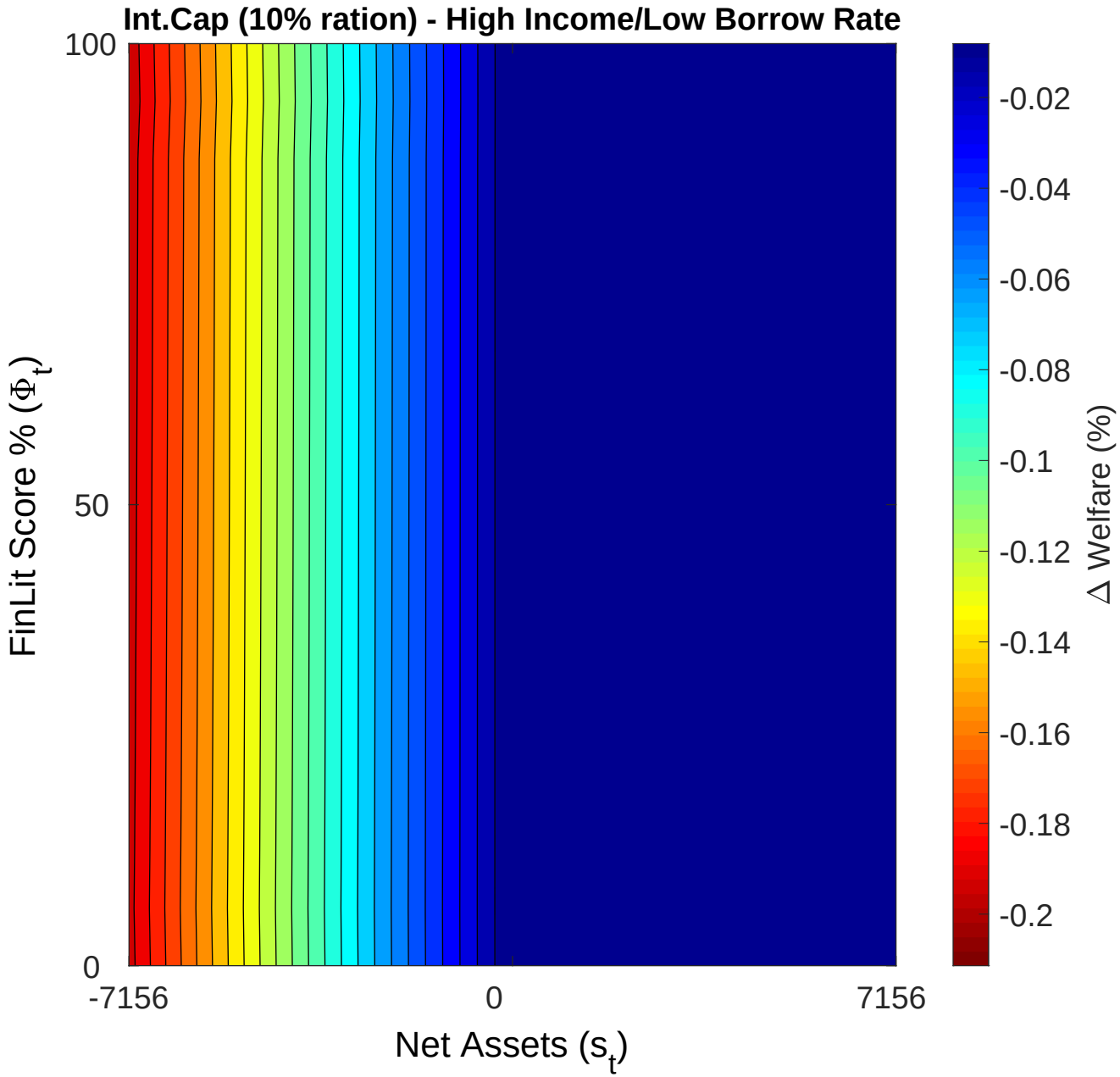
Policy Experiment: Financial Literacy Subsidy (10%)

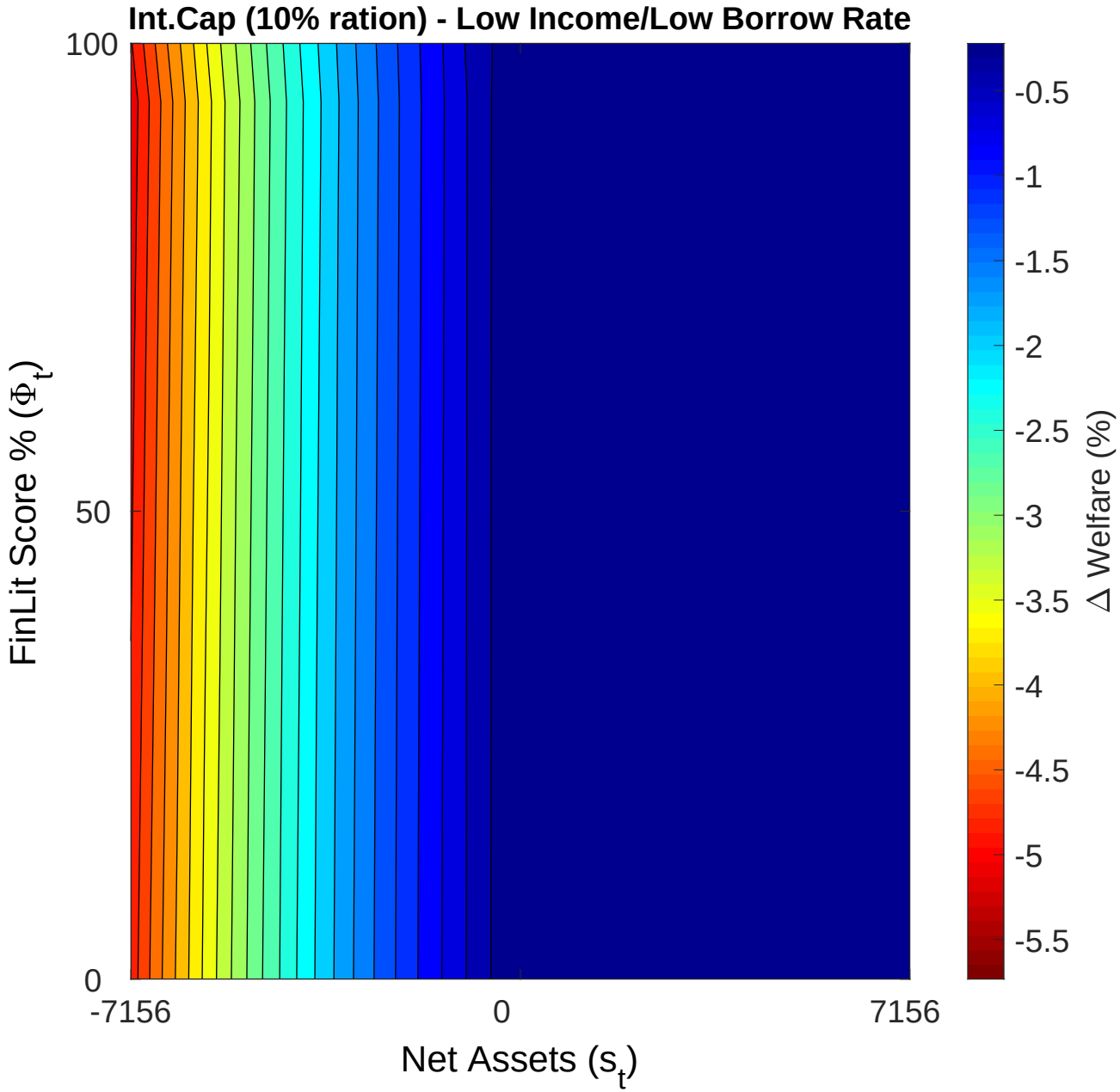
Table: Percent change in decisions by Group - Financial Literacy Subsidy

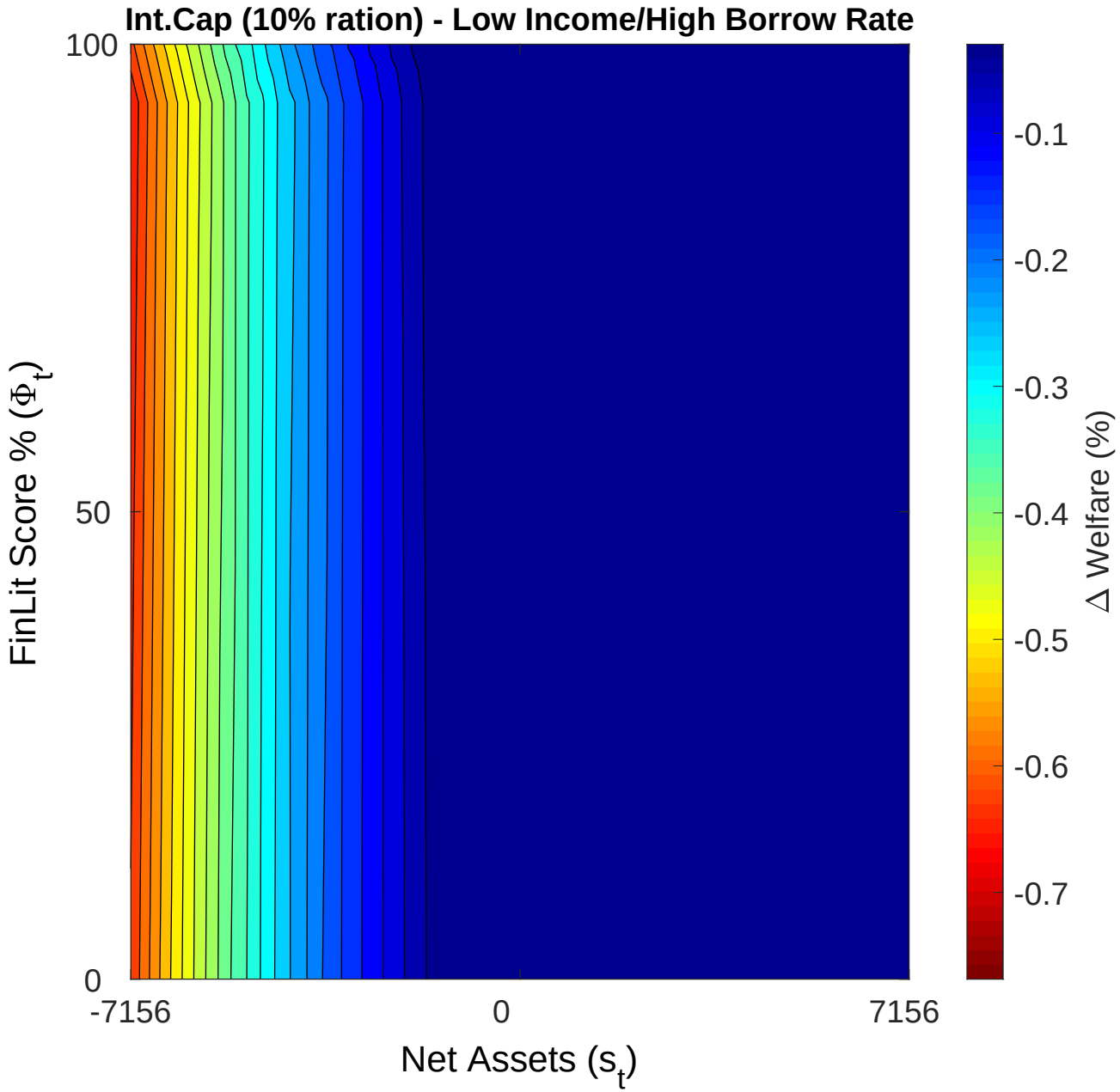
State	Δ FinLit Invest (%)	Δ Savings (%)	Δ Welfare (%)
Young	2.238	0.008	0.060
Low Income, Young	1.926	0.080	0.121
Retirement	2.130	0.031	0.037
Low Income, Retirement	2.107	0.148	0.069

Young = Initial Age; Retirement = 63-73; Low Income ($< \$40,000$)

▸ Subsidy Results


Int.Cap (10% ration) - High Income/Low Borrow Rate
100
50
0
FinLit Score % (Φ_t)
-7156
0
7156
Net Assets (s_t)
-0.02
-0.04
-0.06
-0.08
-0.1
-0.12
-0.14
-0.16
-0.18
-0.2
Δ Welfare (%)


Int.Cap (10% ration) - Low Income/Low Borrow Rate
100
50
0
FinLit Score % (Φ_t)
-7156
0
7156
Net Assets (s_t)
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
-4.5
-5
-5.5
Δ Welfare (%)


Int.Cap (10% ration) - Low Income/High Borrow Rate
100
50
0
FinLit Score % (Φ_t)
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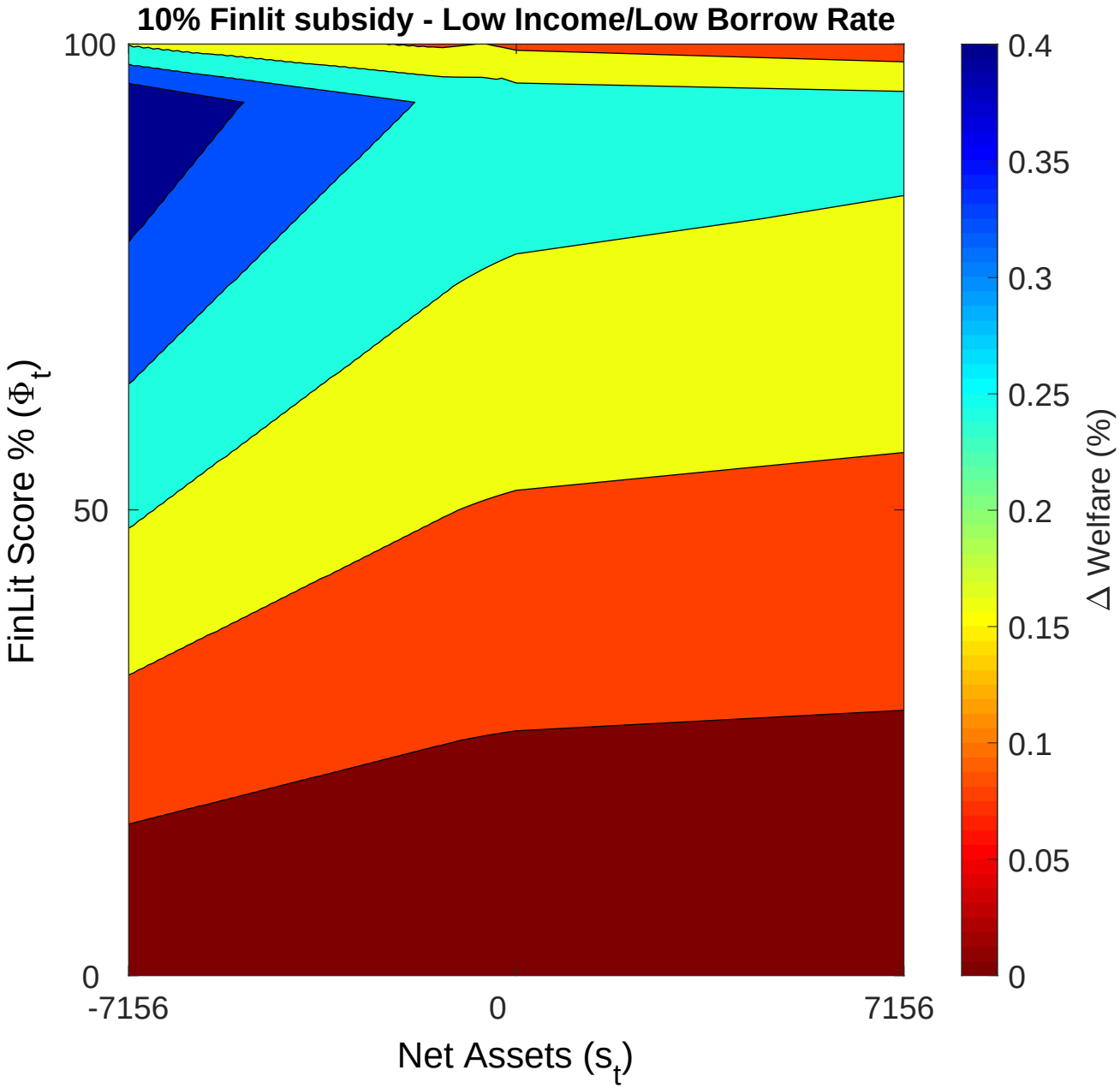
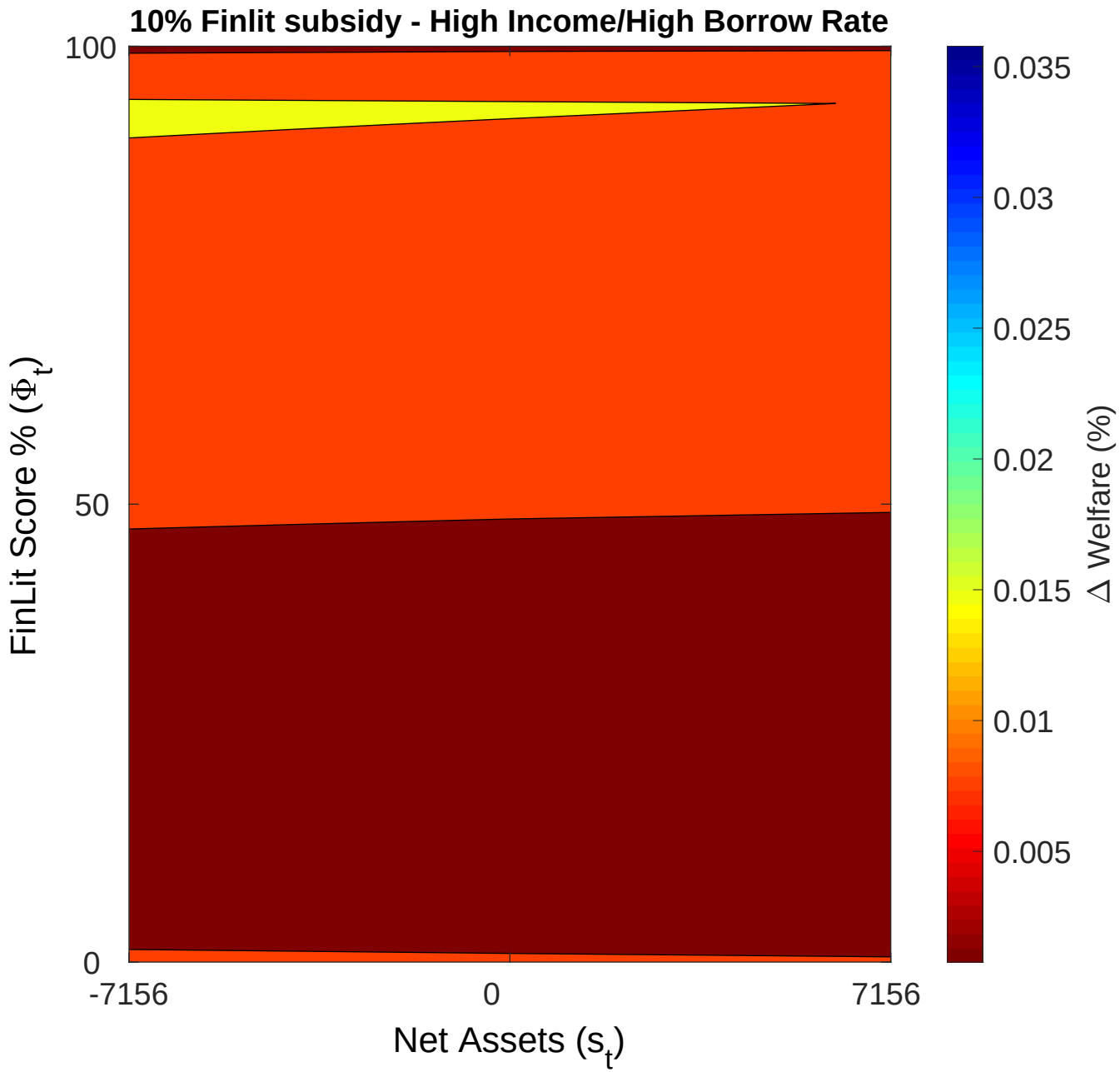
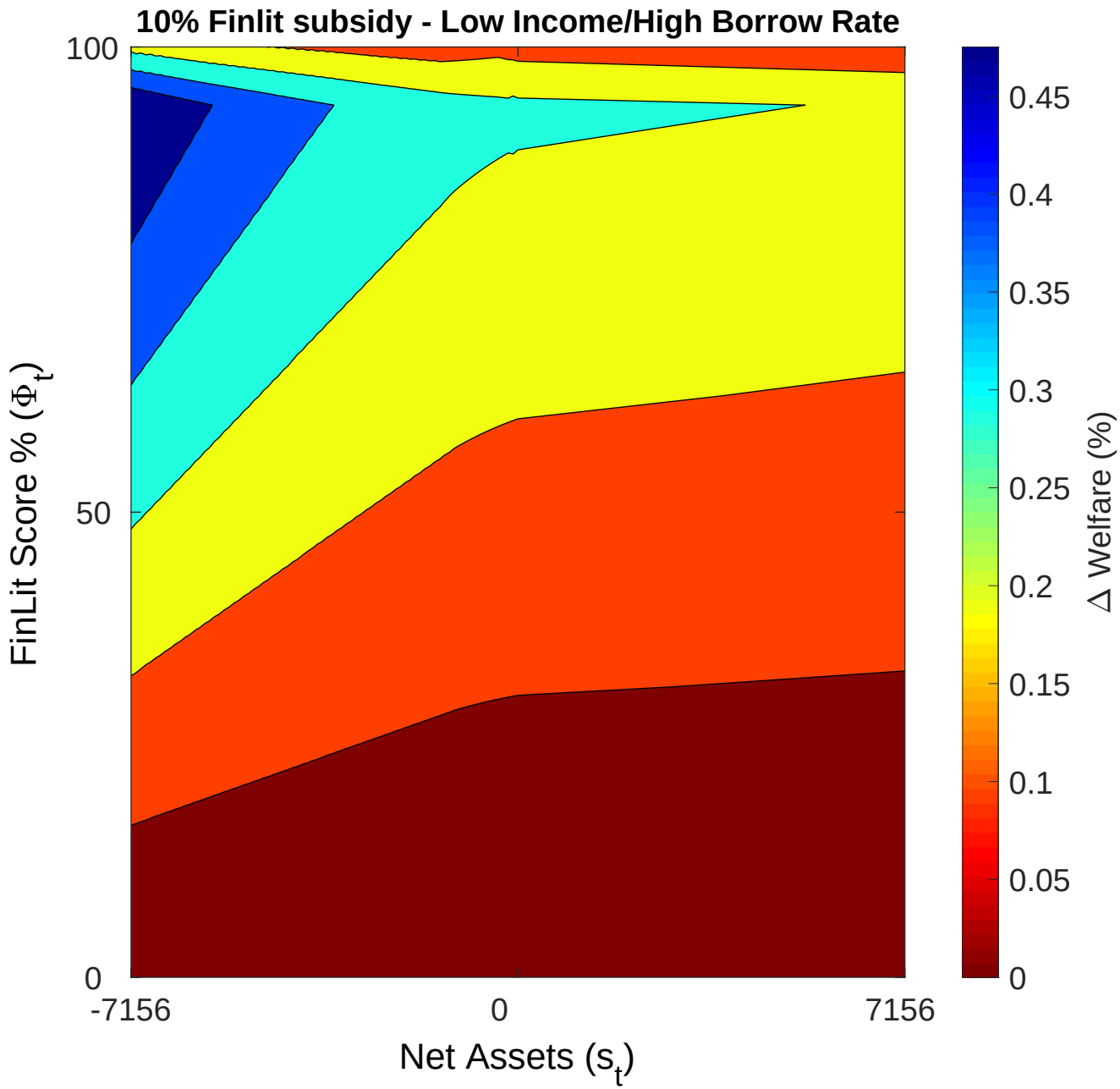
0
7156
Net Assets (s_t)
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
Δ Welfare (%)


10% Finlit subsidy - Low Income/Low Borrow Rate
100
50
0
FinLit Score % (Φ_t)
-7156
0
7156
Net Assets (s_t)
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Δ Welfare (%)


10% Finlit subsidy - High Income/High Borrow Rate
100
50
0
FinLit Score % (Φ_t)
-7156
0
7156
Net Assets (s_t)
0.035
0.03
0.025
0.02
0.015
0.01
0.005
Δ Welfare (%)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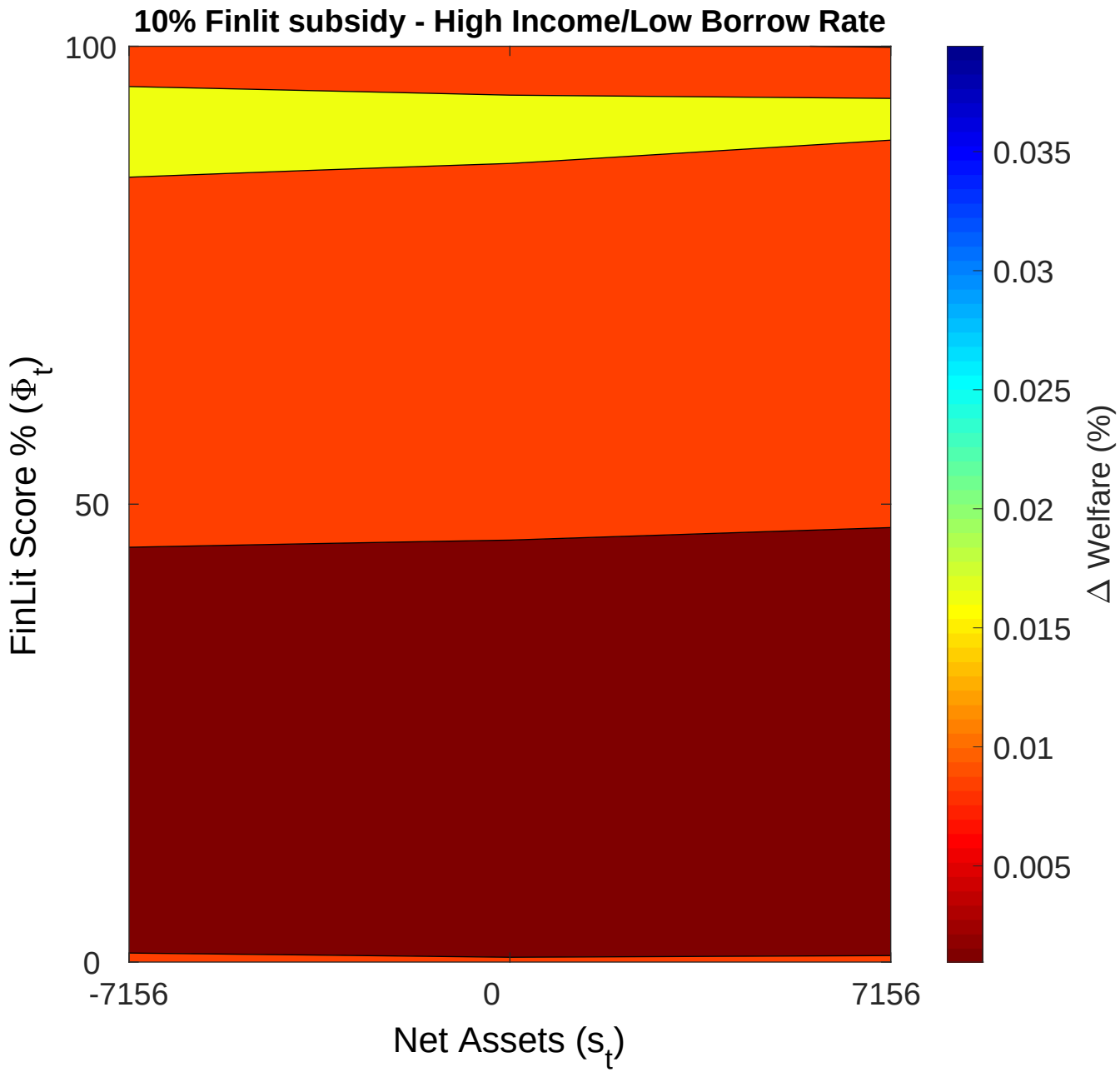
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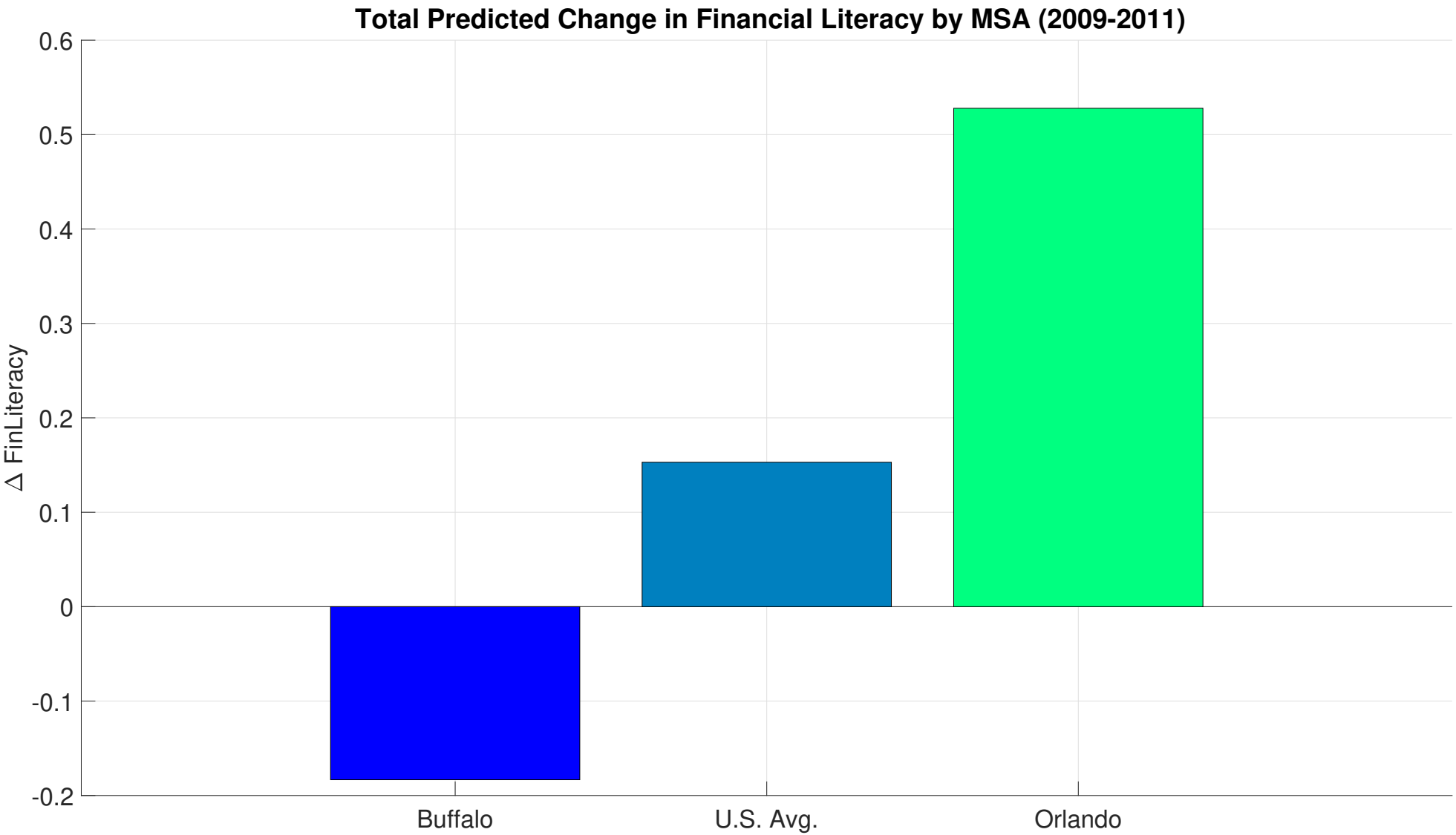

Total Predicted Change in Financial Literacy by MSA (2009-2011)
Δ FinLiteracy
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
Buffalo
U.S. Avg.
Orlando

Expectations - Additional Results

	Fin. Lit %		Savings ($)		$\frac{wealth}{income}$	
Age	41	63	41	63	41	63
Baseline $\rho_r = .7037.$	74	75	67371	90166	1.17	2.04
Low Credit Persistence $\rho_r = 0.2$	79	81	87453	119586	2.00	3.17
Double Shock Variance $\sigma_r^2 = 0.272$	74	75	68562	90174	1.17	2.04

▸ Interest Rate Cap

Double Longevity

	35	**41**	**47**	**53**	**59**	**65**	**71**	**77**
FinLit(%)	74	81	83	86	89	90	92	93
Savings ($)	62424	115925	151211	189917	218613	239539	245554	210276
Base:								
FinLit(%)		74		76		75		74
Savings ($)		67371		87320		90166		57945

▸ Model Fit ▸ Double Longevity ▸ Model Fit - Additional

Financial Literacy on Borrowing Extension

Table: Change by subgroup - Financial Literacy on Borrowing

State	Δ FinLit Invest (%)	Δ Savings (%)	Δ Welfare (%)
Young	0	–0.35	.039
Low Income, Young	0	–0.018	0.079
Retirement	0	0	0.003
Low Income, Retirement	0	0	0.006

Young = Initial Age; Retirement = 63-73; Low Income ($< \$40,000$)

▸ Expectations ▸ Model Extension

Model Fit - Untargeted Moments

	41-51	52-62	63-73	74-84
Untargeted				
Negative NetWorth^{Data} (%)	18.4	15	10.7	7.2
Negative NetWorth^{Model} (%)	16.5	13	1.0	0.0
Untargeted				
Wealth-to-Income^{Data}	0.53	1.47	2.93	3.11
Wealth-to-Income^{Model}	1.17	1.54	2.04	2.13

▸ Shut Down ▸ Model Fit ▸ Double Longevity

Experiment 2: One-time Subsidy

	r(Φ)(%)		Savings		Fin.Lit (%)		Δ Welfare
Age	41	63	41	63	41	63	
Baseline	3.65	3.67	67371	90166	74	75	0.00
10% subsidy (Young)	3.70	3.69	67378	90233	76	77	0.02
10% subsidy (Retirement)	3.65	3.67	67373	90166	74	75	0.01
30% subsidy (Young)	3.75	3.72	67307	90232	81	79	0.06
30% subsidy (Retirement)	3.65	3.67	67364	90166	75	76	0.05

Young = Initial Age (30-40); Retirement = 63-73

▸ Subsidy Group ▸ Contour - Low/High ▸ Contour - Low/Low ▸ Contour - High/Low ▸ Contour - High/High ▸ Contour - Full ▸ Subsidy Results

Model Extension

$$c_t = X_t - p\ell_{t+1} - s_{t+1}\mathbb{1}\{s_{t+1} \geq 0\} - (1 + r_{b,t} - 0.05\overline{\Phi_t})s_{t+1}\mathbb{1}\{s_{t+1} < 0\}$$

where $\overline{max\Phi} = 1$.

Model Extension

$$c_t = X_t - p\ell_{t+1} - s_{t+1}\mathbb{1}\{s_{t+1} \geq 0\} - (1 + r_{b,t} - 0.05\overline{\Phi_t})s_{t+1}\mathbb{1}\{s_{t+1} < 0\}$$

where $\overline{max\Phi} = 1$.

	r(Φ)(%)		Savings		$\frac{Debt}{Income}$ (%)		Δ Welfare
Age	41	63	41	63	41	63	
No Effect	3.65	3.67	67261	90166	6.52	2.64	0.00
Extension	3.65	3.67	67261	90166	7.62	3.41	0.04

▸ Subsidy Group ▸ Contour - Low/High ▸ Contour - Low/Low ▸ Contour - High/Low ▸ Contour - High/High
▸ Contour - Full ▸ Extension Group ▸ Conclusion

Model Fit - Change Base Rate

	41-51	52-62	63-73	74-84
Δ FinLit$^{base=1\%}$ (%)	6.4	2.7	–0.2	–2.0
Δ FinLit$^{base=0\%}$ (%)	7.4	2.0	0.4	–2.0

▸ Model Fit ▸ Double Longevity ▸ Model Fit - Additional

Parameter Values

Fixed

Parameter	Value
β	0.960
γ	3.000
p	0.060
ρ_η (Income)	0.911
σ^2_ε	0.225
ρ_r (Credit)	0.703
σ^2_ν	0.136

Moment-Matched

Parameter	Value
α	0.500
A	0.019
δ	0.064

Optimization Problem

At each age t, the value function has the form:

$$V_t(s_t, \Phi_t, y_t, r_{b,t}) = \max_{\ell_{t+1}, c_t, s_{t+1}} u(c_t) + E_t[\beta V_{t+1}(s_{t+1}, \Phi_{t+1}, y_{t+1}, r_{b,t+1})|y_t, r_{b,t}]$$

s.t

$$s_{t+1} = (1 + r(\Phi_t))s_t \cdot \mathbb{1}\{s_t \geq 0\} + (1 + r_{b,t})s_t \cdot \mathbb{1}\{s_t < 0\} + y_t - c_t - p\ell_{t+1} \quad (14)$$

$$\ell_{t+1} \geq 0 \quad (15)$$

▸ Calibration Data ▸ What I Match

Borrowing Rate Expectations

What is the role of borrowing rate expectations on financial literacy investment?

Borrowing Rate Expectations

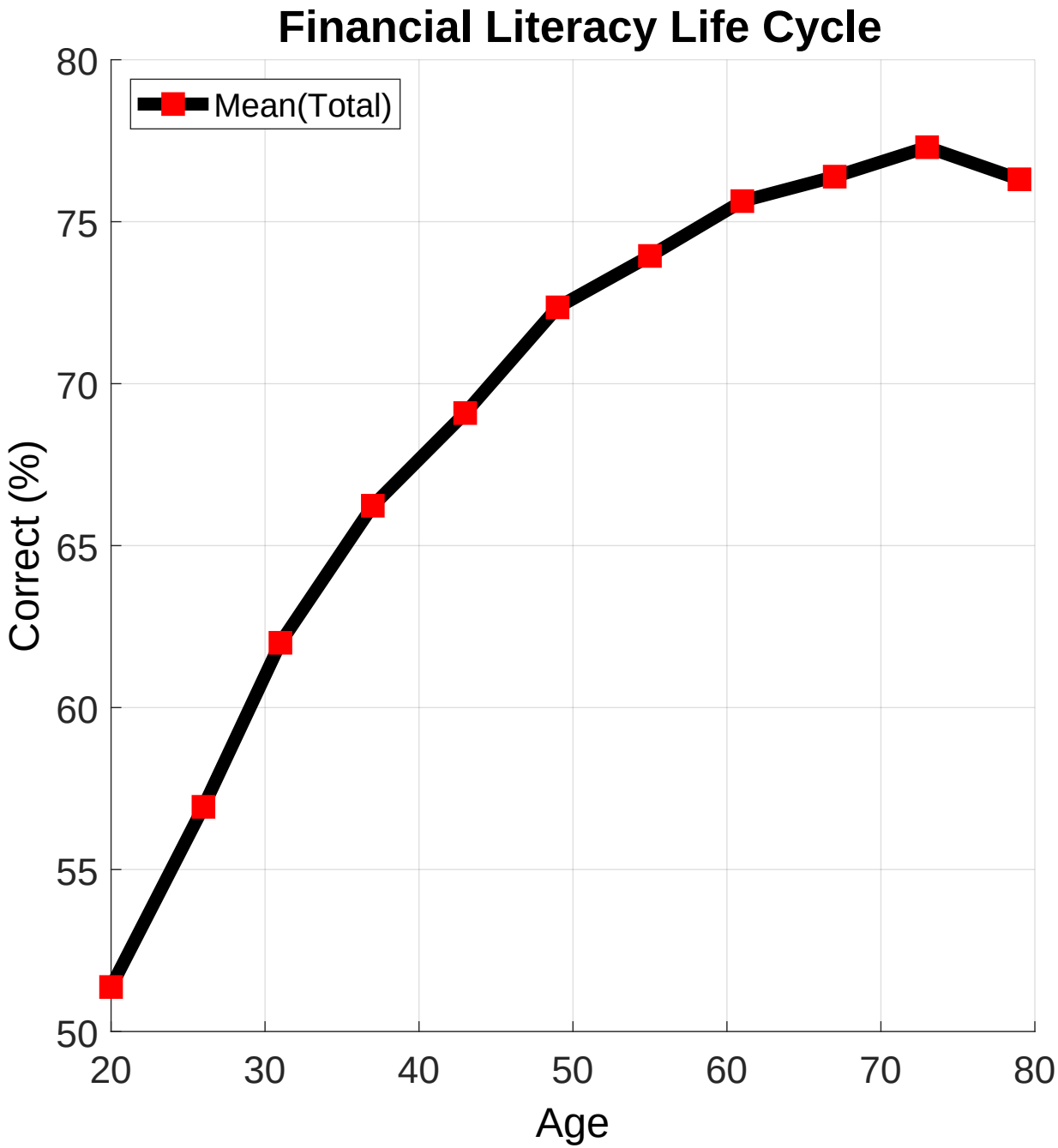
What is the role of borrowing rate expectations on financial literacy investment?

First Counterfactual: Change in persistence (ρ_r) or variance (σ_r^2) of credit rate shock.

Expectations - Results

	r(Φ)(%)		$\frac{Debt}{income}$(%)		Δ Welfare
Age	41	63	41	63	
Baseline					
$\rho_r = .7037.$	3.65	3.67	6.52	2.64	0.00
Low Credit Persistence					
$\rho_r = 0.2$	3.68	3.72	6.47	5.29	-2.60
Double Shock Variance					
$\sigma_r^2 = 0.272$	3.65	3.67	5.08	6.39	-0.03

▸ Additional Outcomes ▸ Persistence-Group ▸ Double Variance-Group ▸ Double Longevity ▸ Interest Rate Cap


Financial Literacy Life Cycle
Mean(Total)
Correct (%)
Age
80
75
70
65
60
55
50
20
30
40
50
60
70
80