Household Saving Behavior and Social Security Privatization

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Standard model of saving:

- all households earn common rate of return

Data:

- heterogeneity in financial choices and outcomes

Questions:

- what are the causes and consequences of heterogeneity in financial decisions?
- how does this heterogeneity impact our thinking about social security reform?

Desired model features:

- financial outcomes are endogenous
- optimizing intermediaries also respond to policy
- bad financial outcomes reflect lack of information
- realistic wealth distribution
- general equilibrium (social security reform is big!)

Abstracting from:

- risky assets and diversification
- long-lived matches between households and intermediaries

Implementation:

- life-cycle Bewley-Huggett-Aiyagari model
- search to learn about investment opportunities
- offer distribution is endogenous

heterogeneity in wealth, income, age

$\Rightarrow$ heterogeneity in search effort

$\Rightarrow$ heterogeneity in financial outcomes

Predictions:

- increasing search effort as retirement approaches
- 60% asset market participation rate
- wealth associated with higher returns
- additional skewness in distribution of wealth

Application: social security privatization

Two perspectives:

1. privatization will undermine the social safety net
2. fixed costs of portfolio management lead social security to be more distortionary

Experiment:

- simulate a partial privatization of social security and compute welfare impact of policy announcement
- compare to same experiment without search friction

Application: social security privatization

Results:
In response to privatization:

- households increase search effort
- asset market participation rate rises
- degree of competition in asset market rises slightly
- larger response in capital, labor supply

Welfare analysis:

- privatization produces welfare loss without search friction (0.9% of consumption)
- search friction leads to additional welfare loss (1.1% of consumption)

The model

Population:

Continuum of households that follow a life cycle.

Life cycle:

- born at age 21
- age-dependent mortality risk
- retire at 66
- die for sure at 110

At death, replaced by children that inherit assets.

Population growth: household of age i replaced by $(1+\gamma)^i$ children.

Preferences

Parents are altruistic.

Dynastic preferences:

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{\left[c_t^{\chi} \left(1 - n_t - s_t\right)^{1-\chi}\right]^{1-\rho}}{1-\rho}$$

Endowments

Time endowment used for:

- labor (while young)
- leisure
- search

Labor productivity depends on

- age (i)
- discrete idiosyncratic shock

Household's exogenous state: $\epsilon \equiv (i, \tilde{\epsilon})$ follows a Markov chain.

Labor productivity given by $y(\epsilon)$.

Technology

Production:

- $k^{\alpha}\ell^{1-\alpha} + (1-\delta)k$
- only operated by firms

Storage:

- zero net return
- can be used by households

Market structure

Firms rent capital and labor services from households (mass μ_t of firms).

Labor market:

- Walrasian market
- cleared by wage w_t
- labor input chosen after capital is in place
- $\Rightarrow$ common marginal product of capital: A_t

Market for capital services

Firms pay a fixed cost ψ to post a return (full commitment).

Households choose search effort $s \geq 0$.

Effort s generates a stochastic number of meetings

$$\text{Prob}\left[\text{j meetings}|s\right] = \frac{\left(\theta\left(s\right)\right)^{j} e^{-\theta(s)}}{j!},$$

with

$$\theta(s) = \theta_1 \times \log\left(1 + \theta_2 \times s\right).$$

Market for capital services

With each meeting, household gets a draw from $F_t(r)$.

Households choose the highest return of those encountered.

Matches last for one period.

Comments:

Risky assets are not modeled explicitly.

Savings decision is made before search outcome realized.

Social insurance

Social security:

- benefit depends on final labor productivity: $B(\epsilon)$
- funded through tax on labor income: τ_t^y

Household's problem

$$V_t(a,\epsilon) = \max_{c,a^+,s,n} \left\{ u\left(c, 1-n-s\right) + \beta E_t\left[V_{t+1}(a',\epsilon')\right] \right\}$$

such that

$$\begin{aligned} c &= a + (1-\tau_t-\tau_t^y) n y(\epsilon) w_t + B_t(\epsilon) - a^+ \\ a^+ &\geq 0 \\ a' &= \left[1 + r\left(1-\tau_{t+1}\right)\right] \times a^+ \\ r &\sim G_t(\cdot; s, \epsilon) \end{aligned}$$

Firm's problem

$$\max_{r} \sum_{\epsilon} \int \frac{A-1-r}{A} h(a,\epsilon) \left\{ \mu^{-1} \theta \left(s\left(a,\epsilon\right) \right) e^{\theta(s(a,\epsilon))[F(r)-1]} \right\} \Phi(da,\epsilon)$$

Household decision rules:
$h\left(a,\epsilon\right)$ for a^{+}
$s\left(a,\epsilon\right)$ for s

Households are weighted by their savings.

Firm equilibrium

Partial equilibrium concept.

Definition

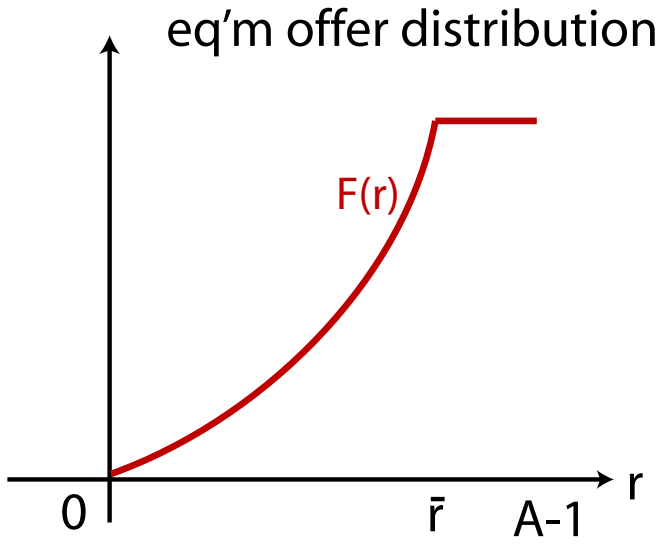
A firm equilibrium is an offer distribution $F(\cdot)$ and a profit level π^* such that

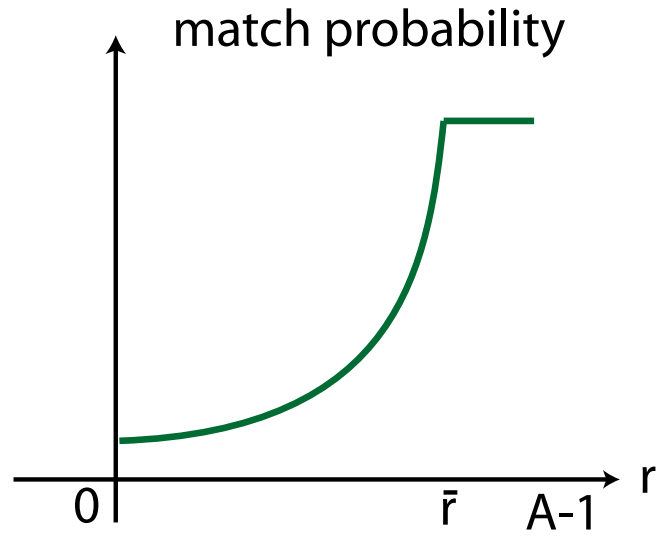
1. for all r in the support of $F(\cdot)$, $\pi(r) = \pi^*$
2. for all r outside the support of $F(\cdot)$, $\pi(r) \leq \pi^*$.

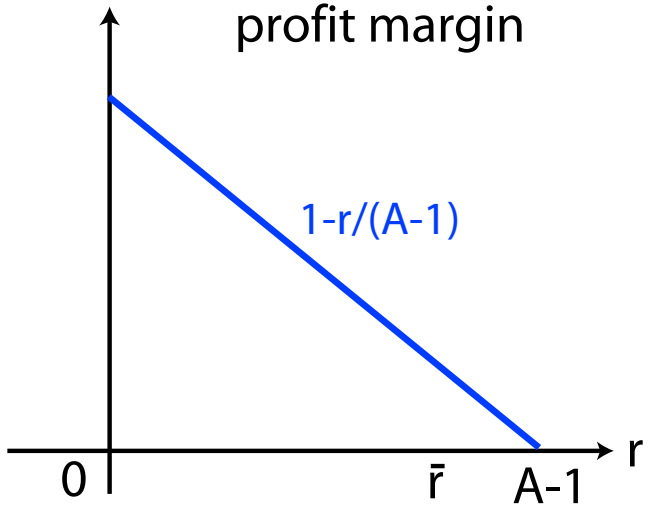
In equilibrium with search, $F(r)$ will

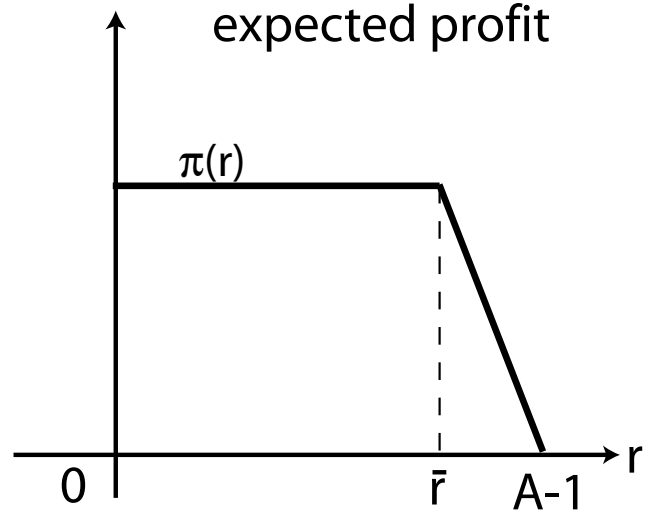
- have support $[0, \bar{r}]$
- be continuous

Firm equilibrium









Calibration

5 year model period.

Population growth and survival probabilities from US data.

Labor productivity

$$\log y(\epsilon) = \log \bar{y}_i + \zeta_t$$

Life-cycle component from PSID.

ζ_t follows discretized AR(1)

Intergenerational transmission of productivity:

- correlation of parent's and child's earnings

Social security

Benefits chosen to broadly match US system.

9.3% payroll tax to clear social security budget.

Calibration: search process

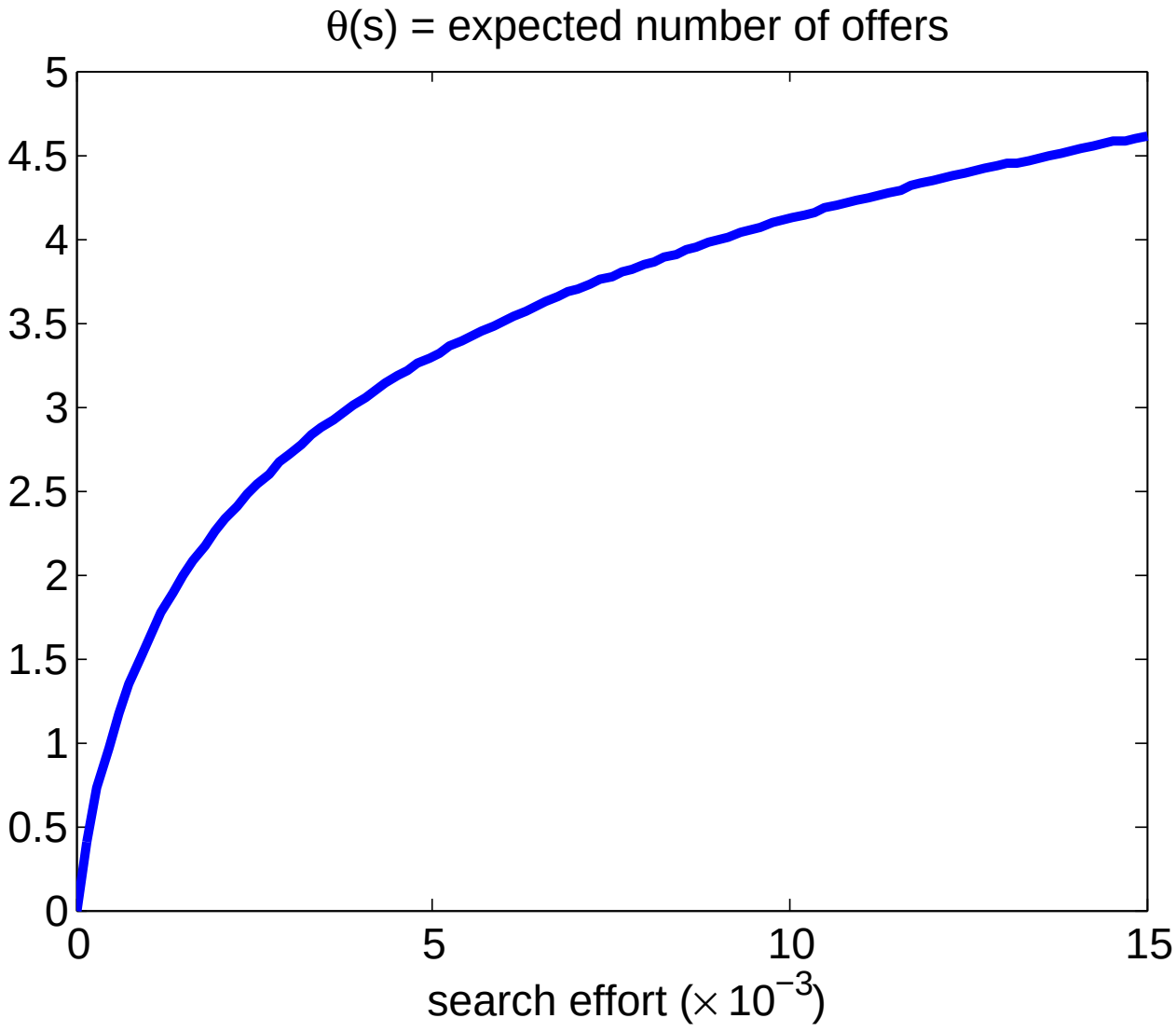
θ_1 and θ_2 chosen to match

- average time spent on search
- median intermediation spread $A - (1 + r)$

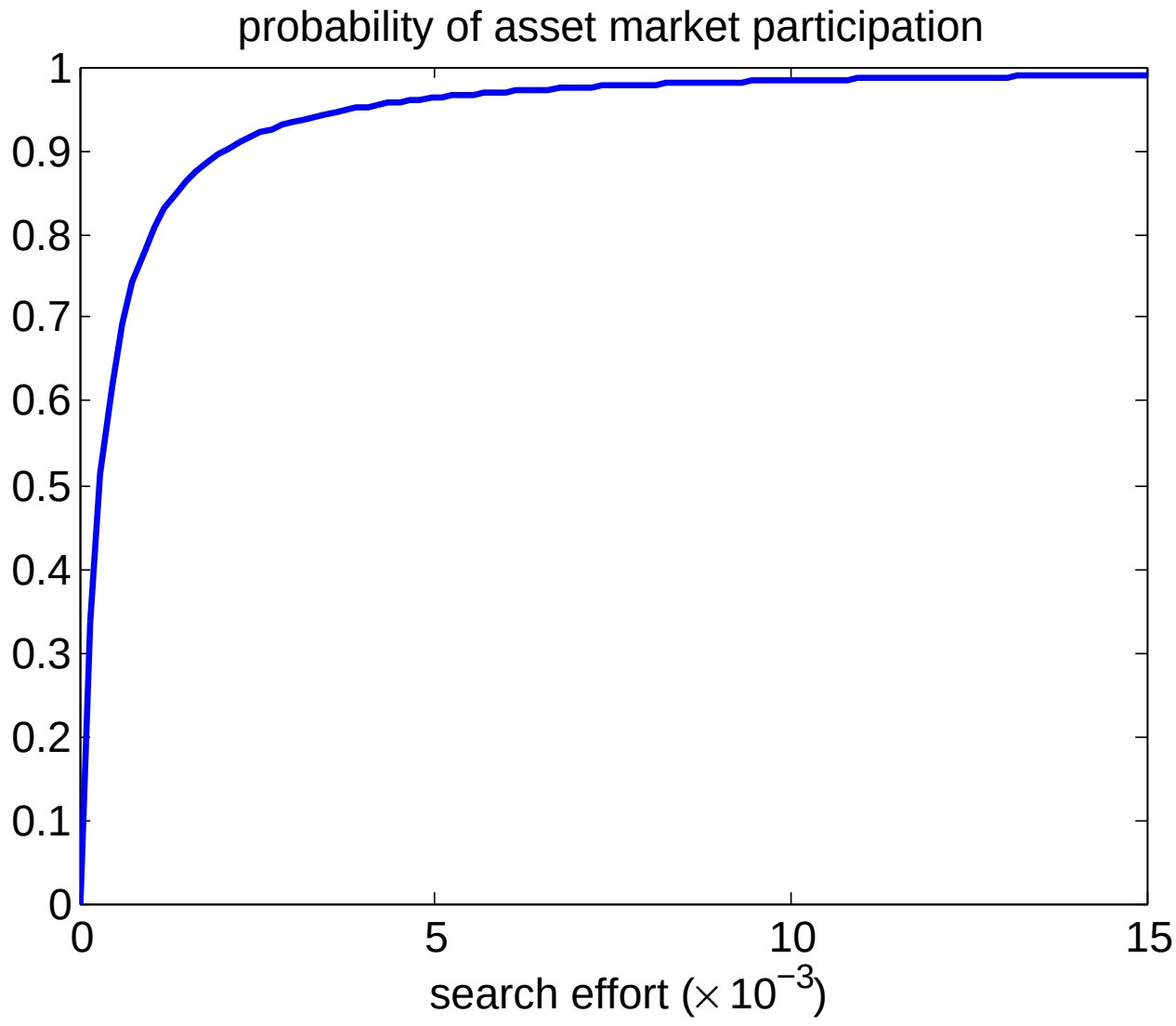
Data:

- average time spent on finances in ATUS (3 minutes per day)
- median fee on S&P 500 index funds

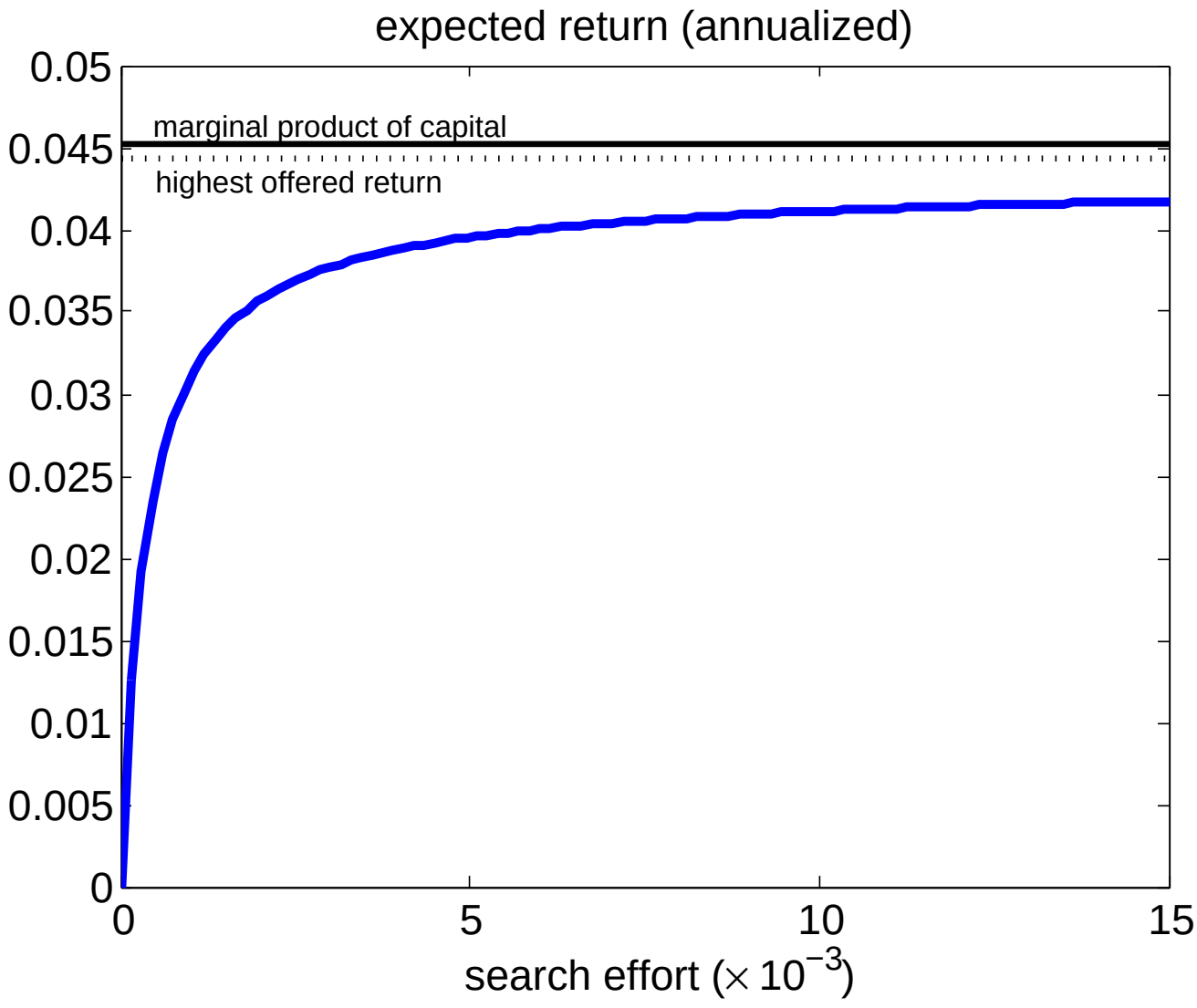
Search mechanics



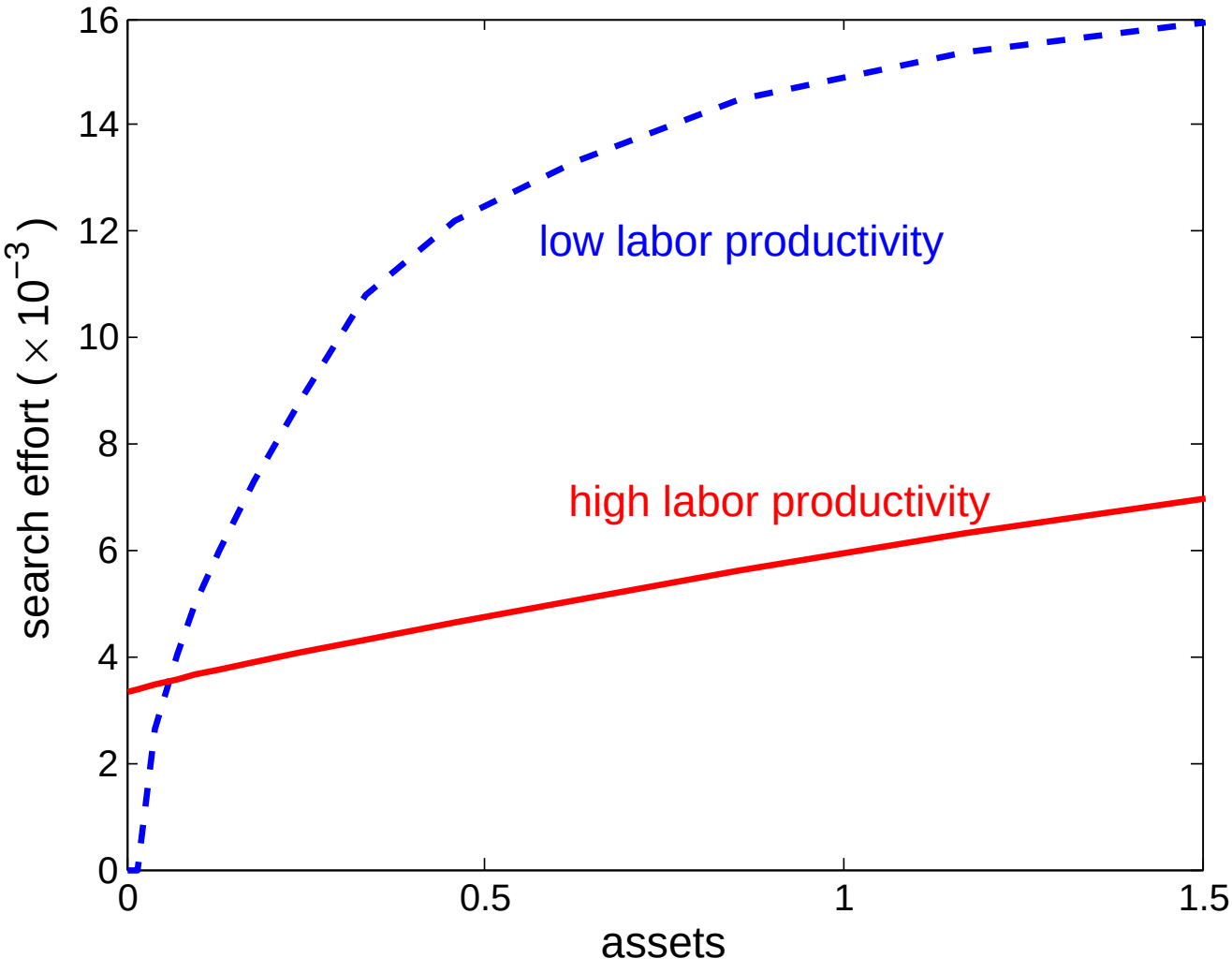
Search mechanics



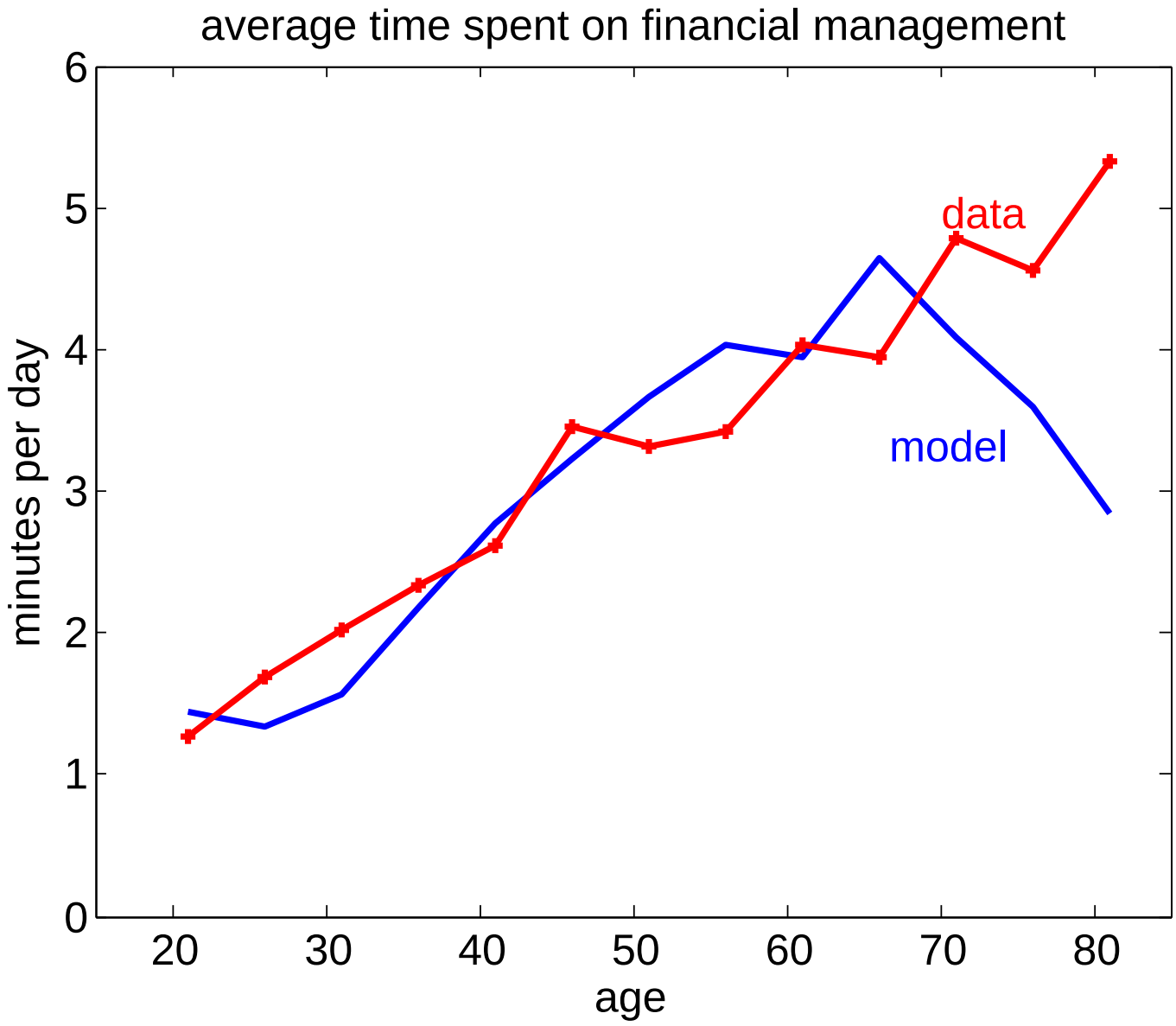
Search mechanics



Search decision rules



Life-cycle profile of search effort



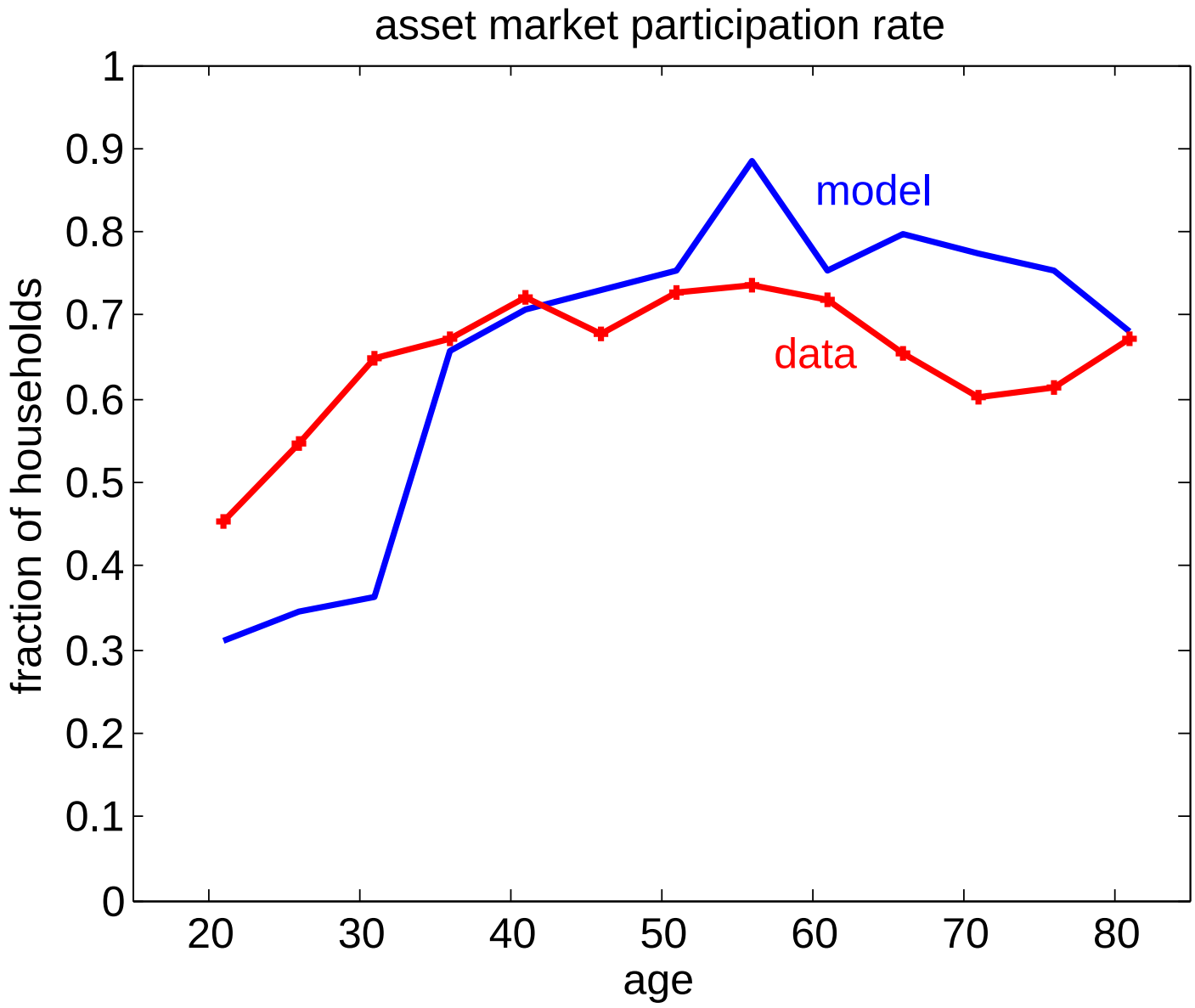
Asset market participation

60% of model households participate.

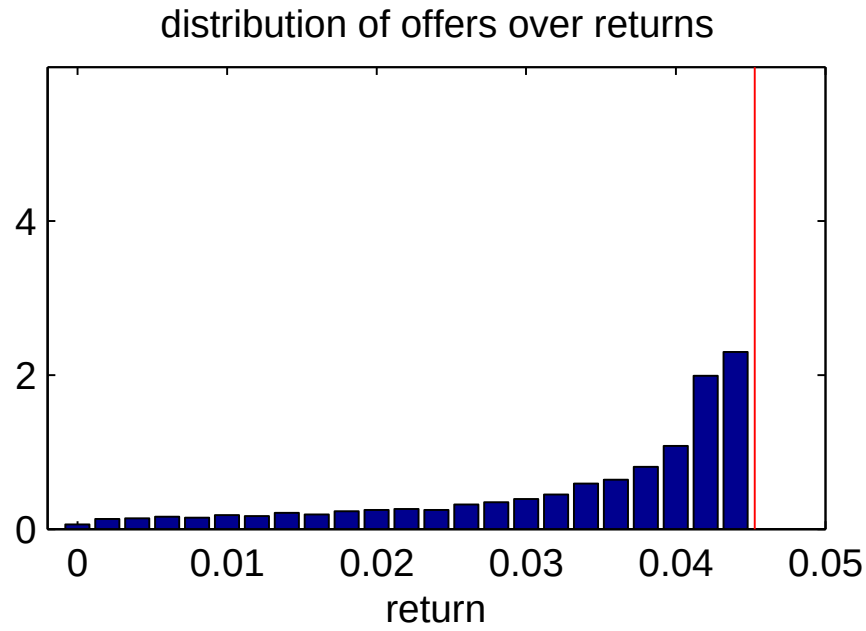
Data:

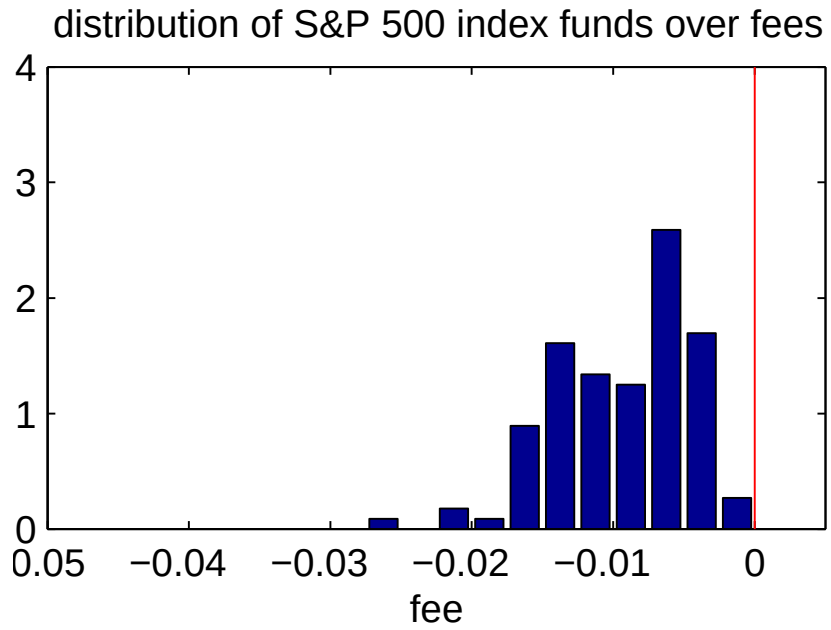
- 50% hold equities (including indirect holdings)
- 65% hold some financial assets other than checking or savings accounts.

Life-cycle profile of participation

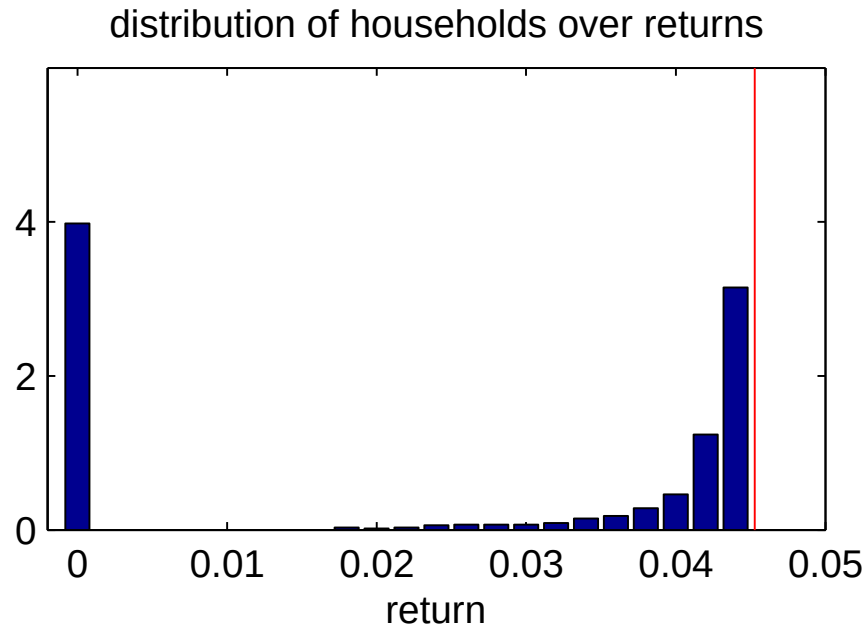


The distribution of offered returns

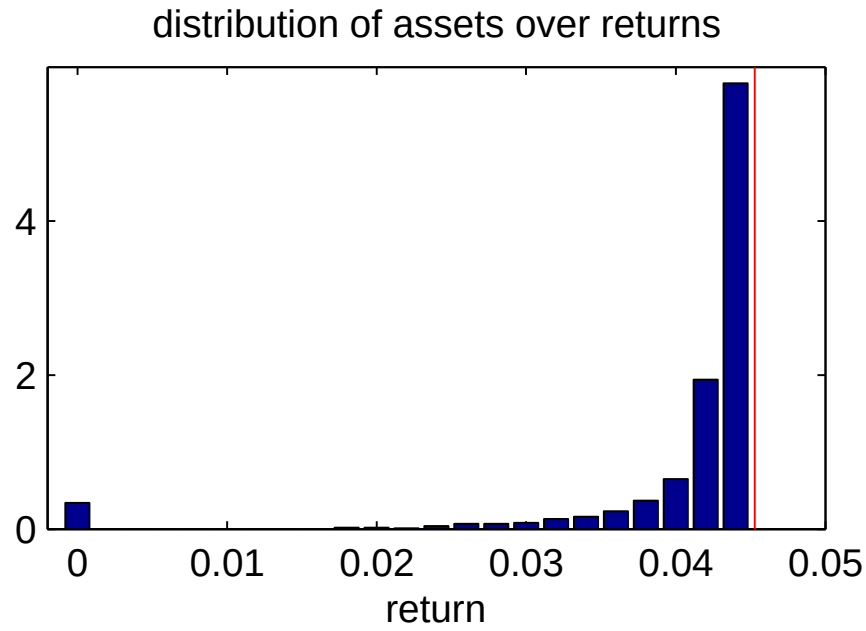


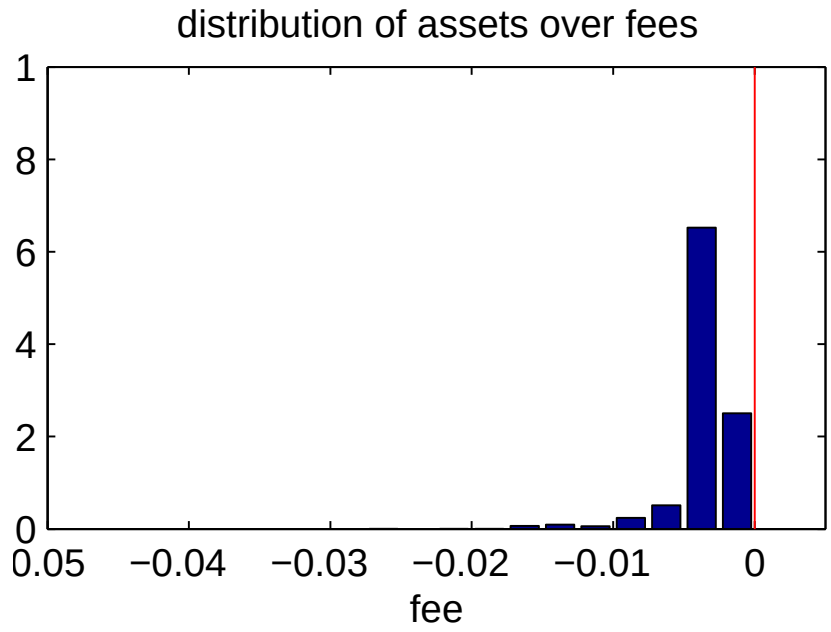


The distribution of households over returns



The distribution of assets over returns





The distribution of wealth

Wealthy are more likely to participate in asset market...

...and earn higher returns (on average) conditional on participation.

Marginal effect of one st. dev. increase in wealth:

- participation rate increases by 17 percentage points,
- return increases by 13 basis points.

The distribution of wealth

	Gini	Top Groups		
		1%	5%	20%
Data	0.80	34.7	57.8	81.7
Without Search Friction	0.74	14.6	40.6	77.4
With Search Friction	0.78	16.5	45.0	81.9

Data notes: Calculations by Budria Rodriquez et al. (2002) using 1998 SCF.

Impact of the offer distribution

Experiment: solve the model with an exogenous offer distribution.

Use distribution of fees on S&P 500 index funds.

Recalibrate to same moments.

Savings, search effort, participation, and realized return distribution are not much different.

Social security

Privatizing social security

A partial privatization experiment:

- benefits are gradually cut to 50% of initial levels
- payroll tax reduced immediately by more than 50%
- transition costs are funded by consumption tax
- income taxes fall as economy expands

Privatization vs. phase-out.

Perform the experiment with and without the search friction.

Welfare impact of policy announcement

Welfare metric: change in average expected utility.

Average expected utility falls by 1.1% of consumption.

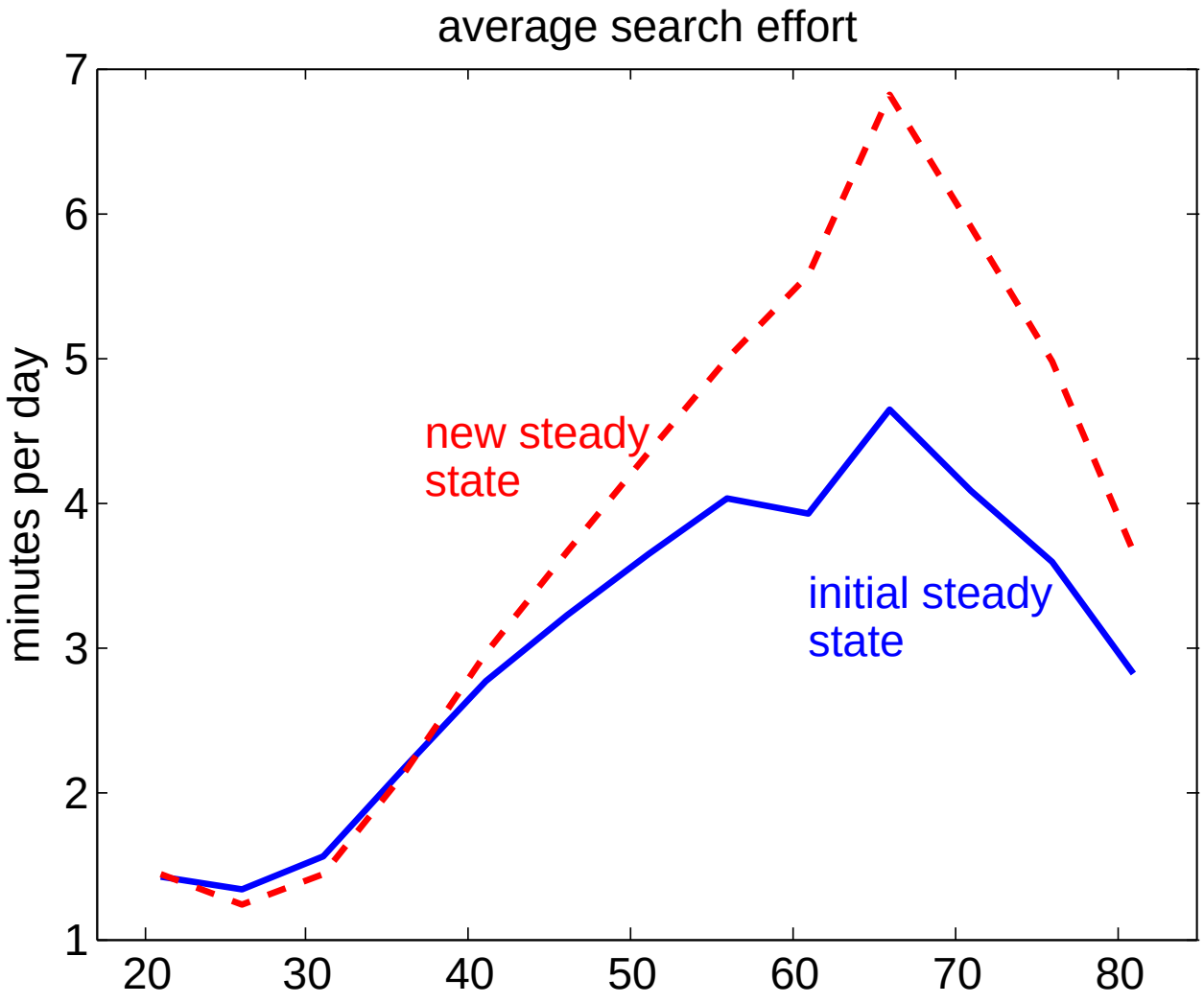
falls by 0.9% without the search friction.

Search friction reduces welfare across the state space.

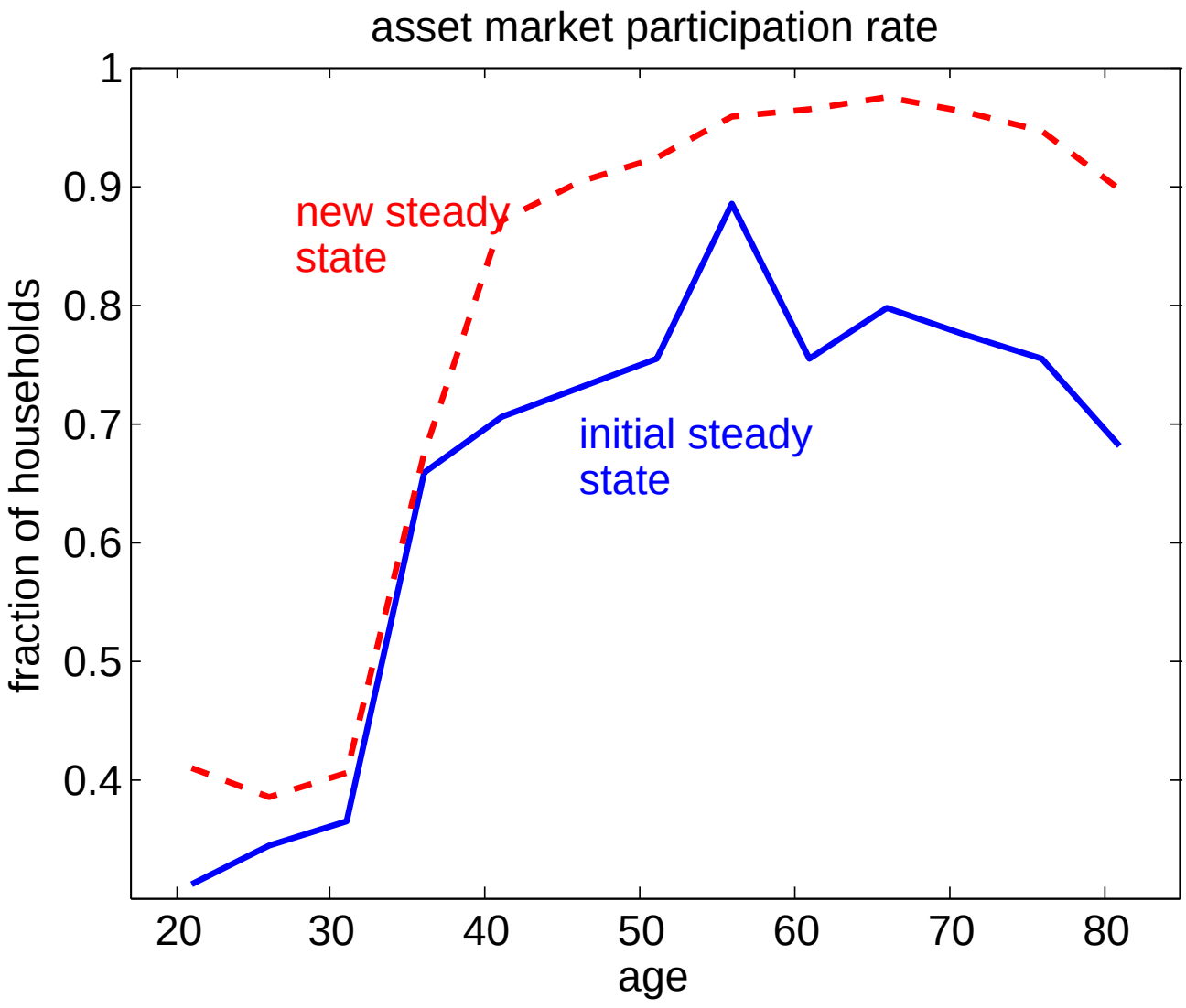
Long-run response of aggregates

	with search friction	without search friction
output	4.94%	4.81%
capital	10.47%	10.26%
labor supply	3.60%	3.49%
average search effort	19.3%	–
asset market participation	11.7%	–
change in median fee	-4 BPS	–

Change in search effort



Change in participation



Long-run welfare impact

	with search friction	without search friction
average welfare at birth	6.08%	6.69%

Conclusions

Saving behavior:

Modeled endogenous heterogeneity in rates of return across households.

Plausible explanation of:

- limited asset market participation
- wealthier and higher income households more likely to participate/earn higher returns
- some skewness in distribution of wealth

Social security privatization:

Search friction leads to additional welfare loss of 0.2% of consumption.

Appendix

How does social security affect welfare?

$$U(s) = (a-\tau)\underbrace{\left[A-(A-1)\,e^{-s\theta}\,(1+s\theta)\right]}_{E[1+r|s]} - ws + b(\tau)$$

Search externality:

$$\left.\frac{\partial}{\partial s}U(s)\right|_{s=s^*} = w$$

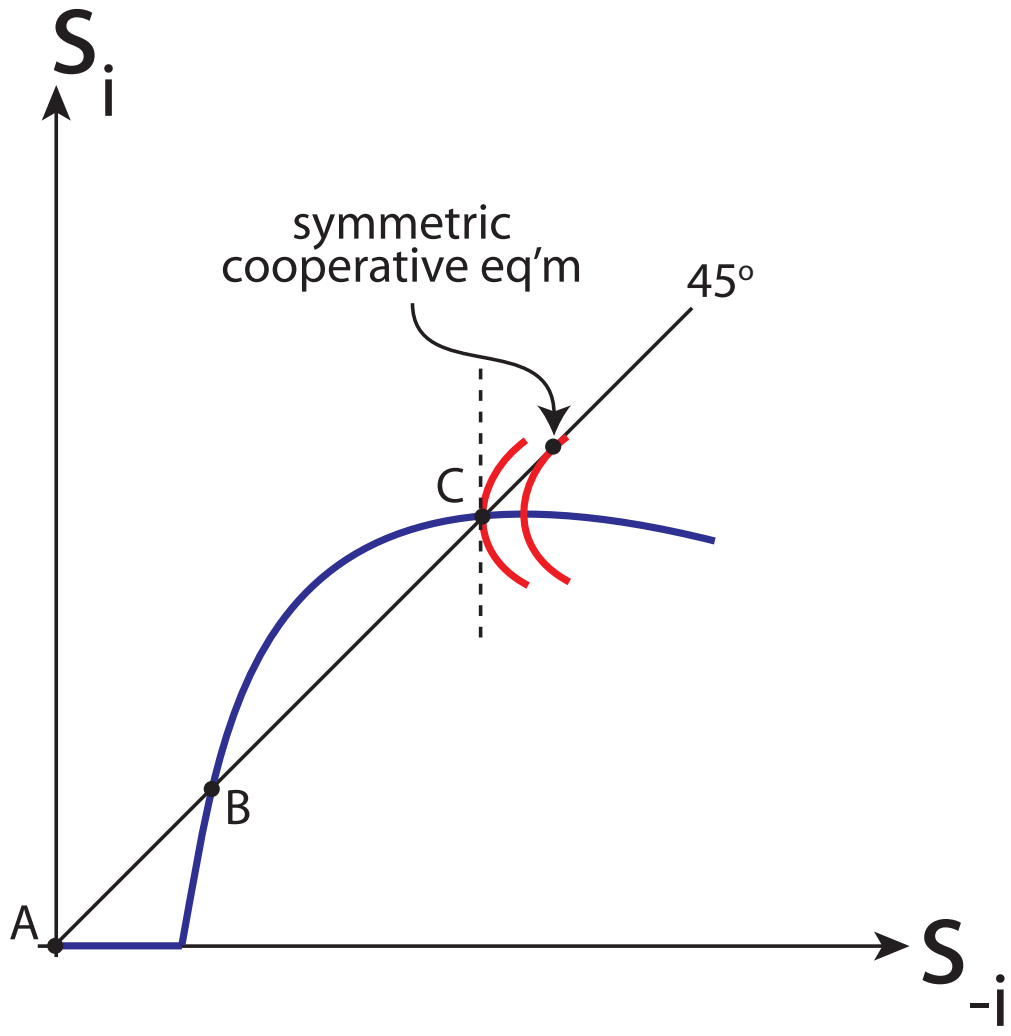
Marginal benefit of social security:

$$\begin{aligned}\frac{d}{d\tau}\,U(s)|_{s=s^*} &= \frac{\partial}{\partial\tau}U(s) + \frac{\partial}{\partial s}U(s)\,\frac{\partial s}{\partial\tau}\\ &= \left[\frac{\partial b}{\partial\tau} - A\right] + \left[A - E(1+r|s)\right] + w\frac{\partial s}{\partial\tau}\end{aligned}$$

Welfare impact of policy announcement

	total impact				
full model	-1.19%				
benchmark model	-0.99%				
	across ages				
	21 - 25	41 - 50	56 - 65	66 - 75	81 - 95
full model	0.89%	-3.31%	-2.52%	0.13%	0.82%
benchmark model	1.09%	-3.02%	-2.41%	0.25%	1.01%
	across asset levels (percentile)				
	0 - 20	40 - 60	80 - 100		
full model	-1.22%	-0.98%	-2.03%		
benchmark model	-0.62%	-1.08%	-1.83%		
	across income levels (shock)				
	1, 2	3, 4, 5	6, 7		
full model	-2.25%	-1.14%	-1.36%		
benchmark model	-2.09%	-0.94%	-1.04%		

Search externality



Robustness to firm heterogeneity

Firm equilibrium relies heavily on homogeneity and exact indifference across support of $F(\cdot)$.

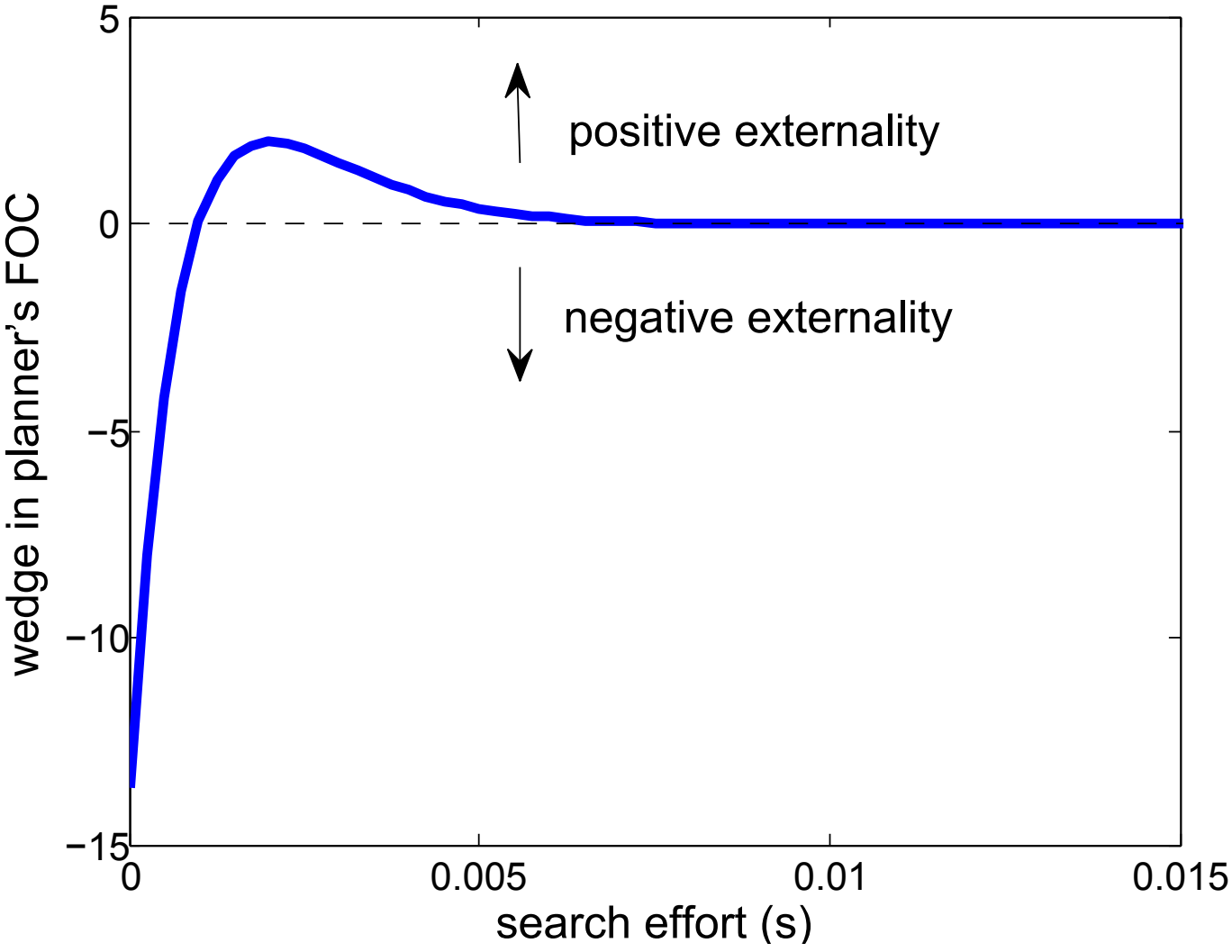
What if firms are heterogeneous?

Suppose $A_j \in \left[\underline{A}, \overline{A}\right]$.

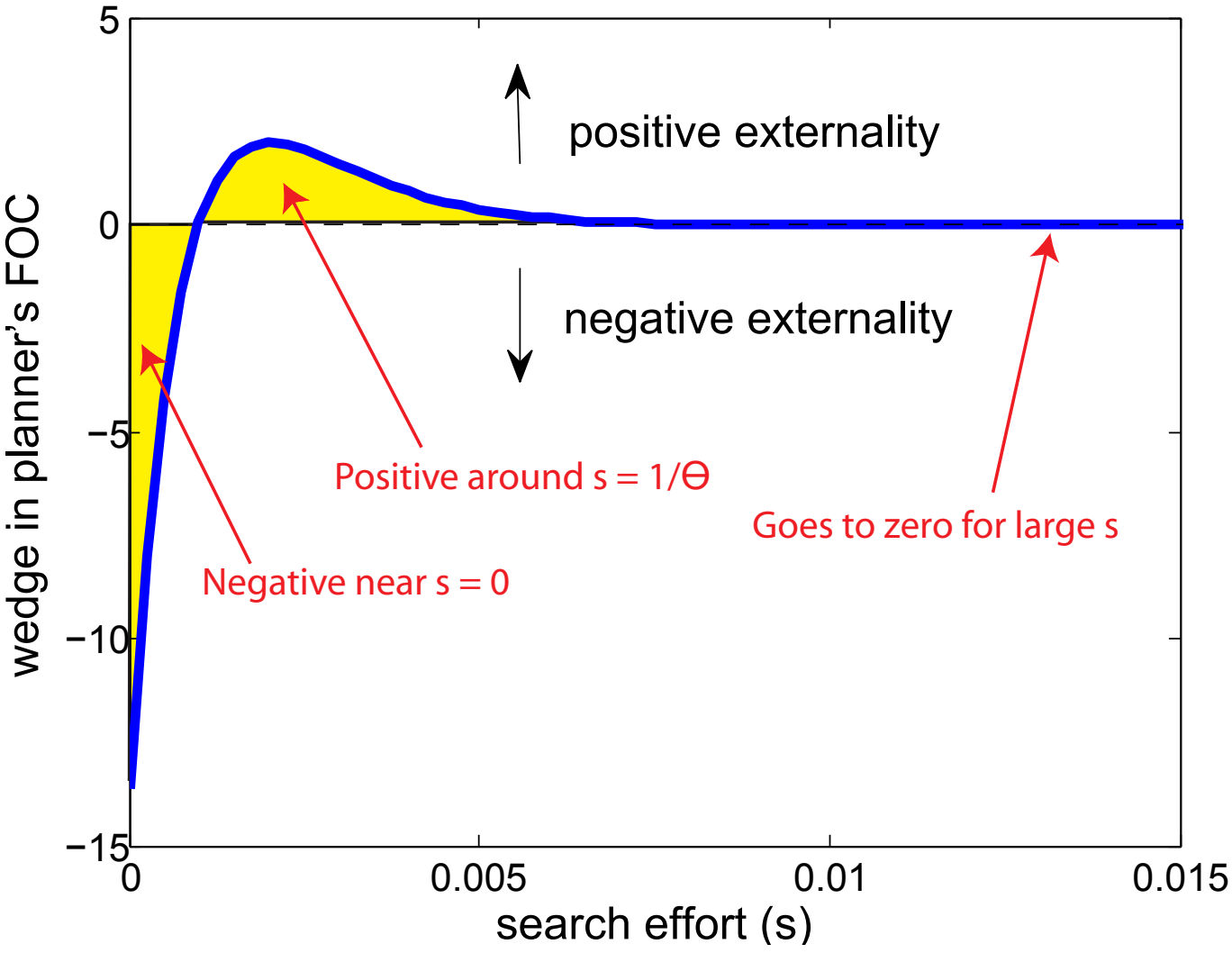
As $\left\{\underline{A}, \overline{A}\right\} \to A$, distribution of offered returns converges point-wise to $F(\cdot)$.

Take away: the equilibrium would not be too different with a small degree of heterogeneity among firms.

Spill-overs from search effort



Spill-overs from search effort



Explanation of match probability

$$\text{Prob}\left\{\text{match}|a,\epsilon,r\right\}$$

$$\sum_{j=0}^{\infty}\text{Prob}\left\{\text{j meetings and match}|a,\epsilon,r\right\}$$

$$\sum_{j=0}^{\infty}\text{Prob}\left\{\text{j meetings}|a,\epsilon,r\right\}\times\text{Prob}\left\{\text{match}|\text{j meetings},a,\epsilon,r\right\}$$

$$\sum_{j=0}^{\infty}\mu^{-1}j\frac{[\theta s(a,\epsilon)]^{j}e^{-\theta s(a,\epsilon)}}{j!}\times[F(r)]^{j-1}$$

$$\mu^{-1}\theta s e^{\theta s[F(r)-1]}$$

Solution algorithm for steady state

Typical BHA model:

- For a given capital-labor ratio, calculate w and A.
- Solve household problem and simulate.
- Check capital-labor ratio.

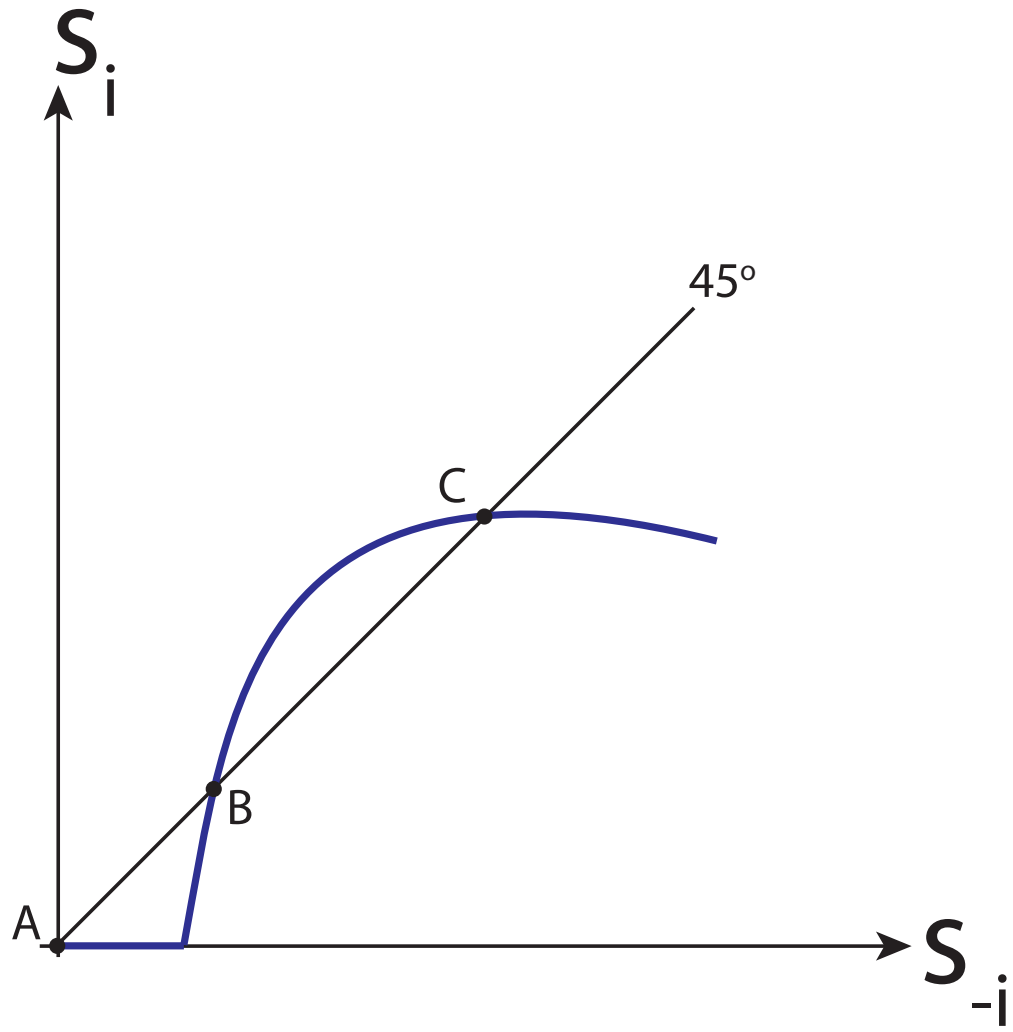
Solution algorithm for steady state

Iterative procedure with two nested loops:

- For a given capital-labor ratio calculate w and A
    - Given an $F(\cdot)$, derive $G(r; s)$ and solve the consumer's problem.
    - Simulate using the policy rules, $F(\cdot)$ and Γ to find the stationary distribution Φ.
    - Using Φ and policy rules, the firm profit equation gives a new $F(\cdot)$
- Check capital-labor ratio.

Solving for $F(\cdot)$:
$\frac{\partial \pi}{\partial r} = 0$ on support of $F(\cdot)$. ODE w/ initial condition $F(0) = 0$.

Multiple equilibria?



Stationary recursive equilibrium

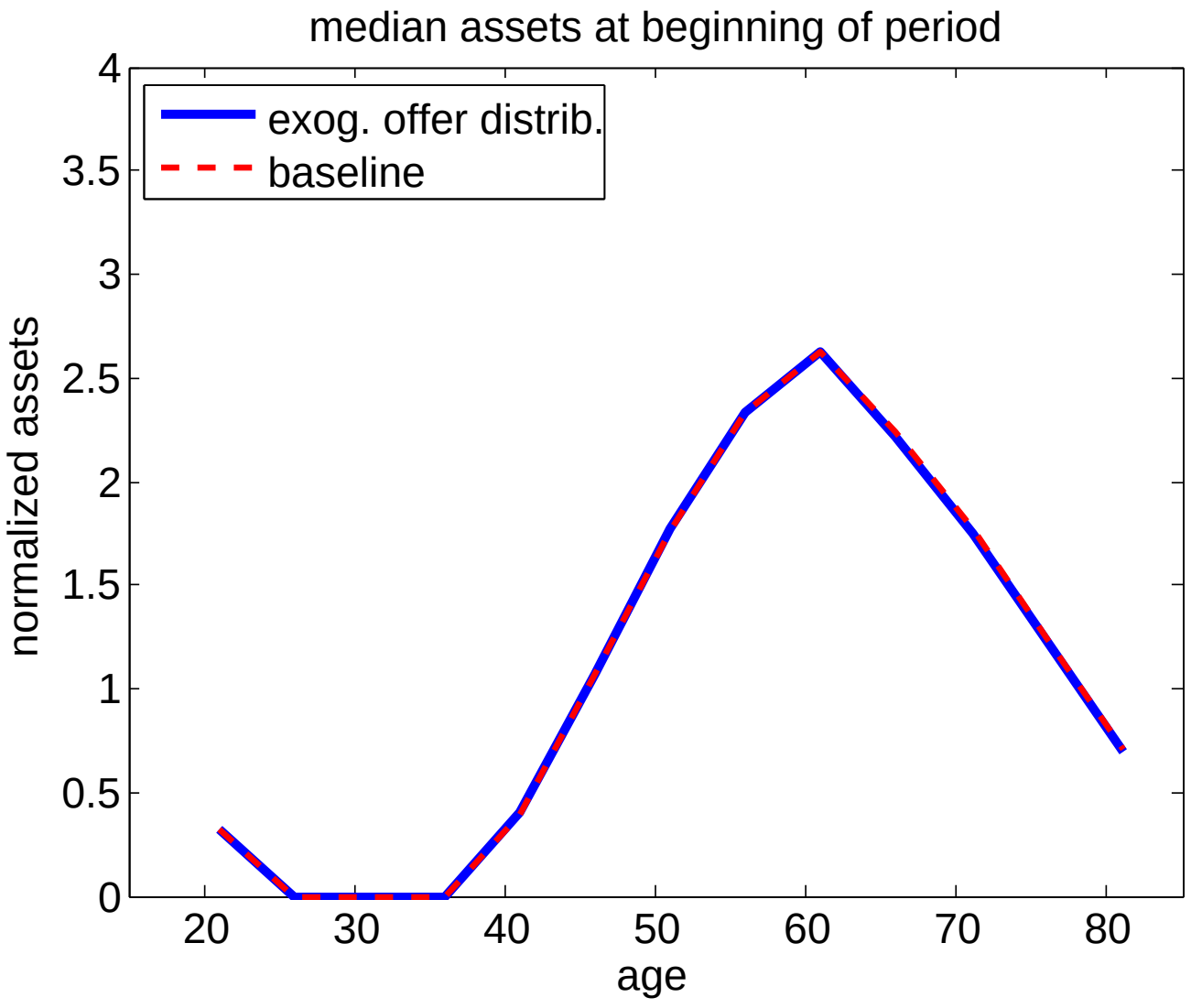
Modify definition from standard BHA model to include:

- given A, h, s, and Φ, $\{F(\cdot), \pi^*\}$ is a firm equilibrium
- firms have no incentive to enter or exit: $\pi^* = \psi$
- given $G(r, s)$ and w, V solves household's problem
- $G(r, s)$ is consistent with $F(r)$
- $K = \sum_\epsilon \int h(a, \epsilon) \left[1 - q\left(0; a, \epsilon\right)\right] \Phi(da, \epsilon) - \mu\psi$
- $\Phi(\mathcal{A}, \epsilon') =$
  $\sum_\epsilon \Gamma(\epsilon'; \epsilon) \int \int_{(1+r)\times h(a,\epsilon)\in\mathcal{A}} G(dr; s(a, \epsilon), \epsilon)\Phi(da, \epsilon)$

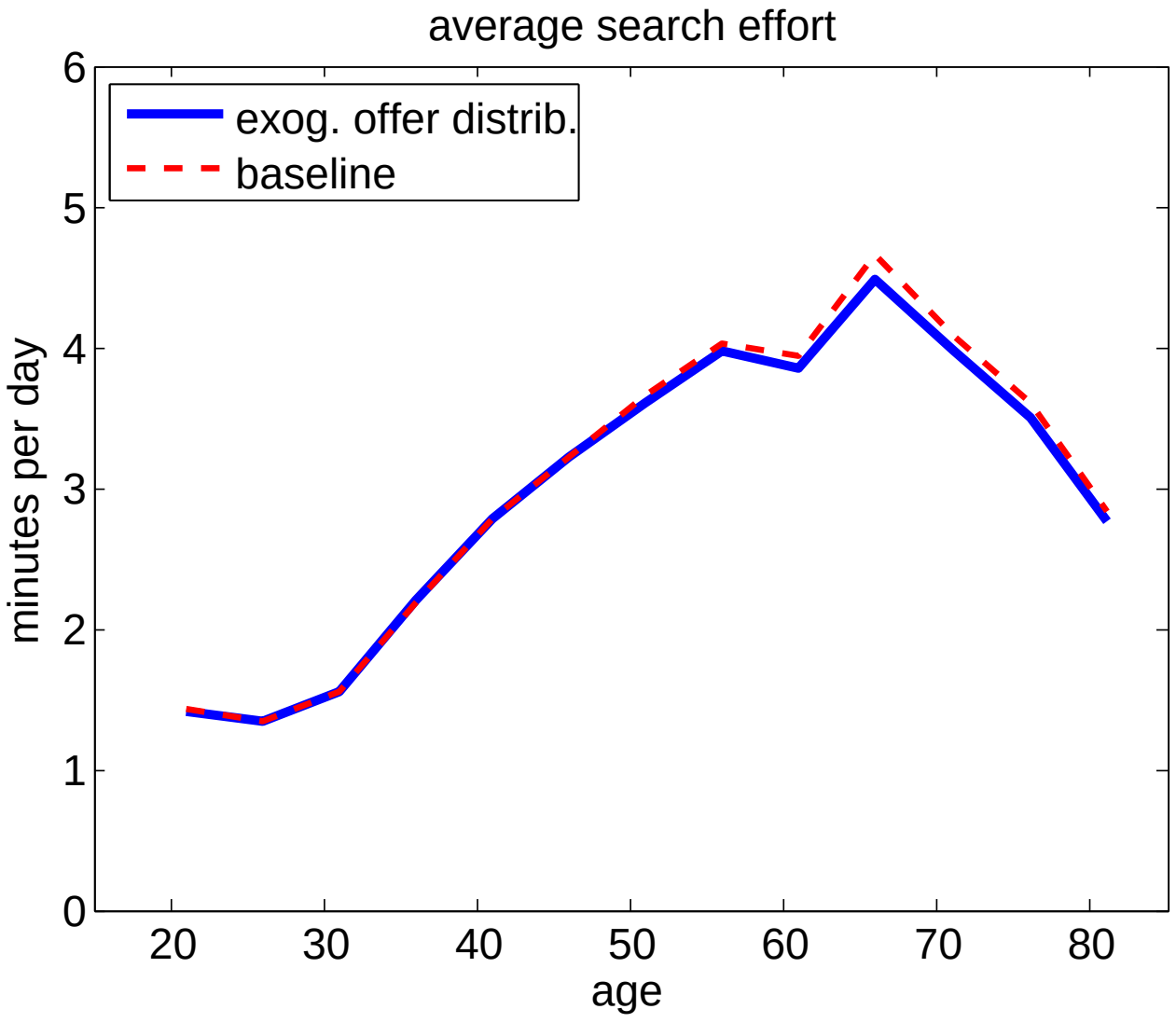
Other parameters:

symbol	description	value	target
β	discount factor (yearly)	0.97	capital-output ratio
α	Cobb-Douglas parameter	0.36	capital share
δ	depreciation rate (yearly)	0.067	investment rate
ρ	risk aversion	2	–
χ	labor supply parameter	0.373	average hours
ψ	fixed cost	1	normalization
τ	income tax rate	0.194	avg. marg. tax rate
τ_c	consumption tax rate	0.0	–
τ_y	payroll tax	0.093	s.s. budg. balance

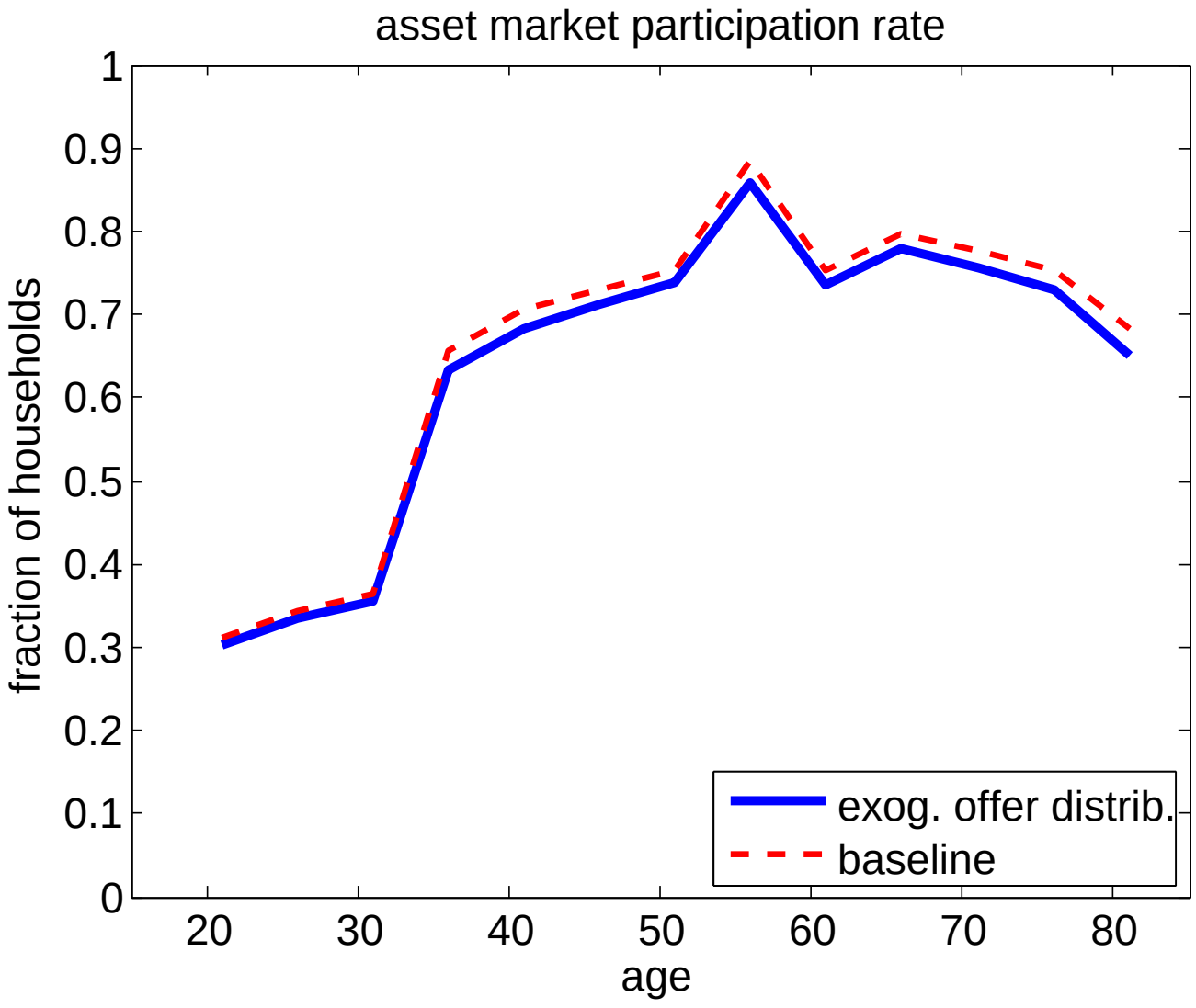
Fixed offer distribution: median asset profile



Fixed offer distribution: average search effort profile

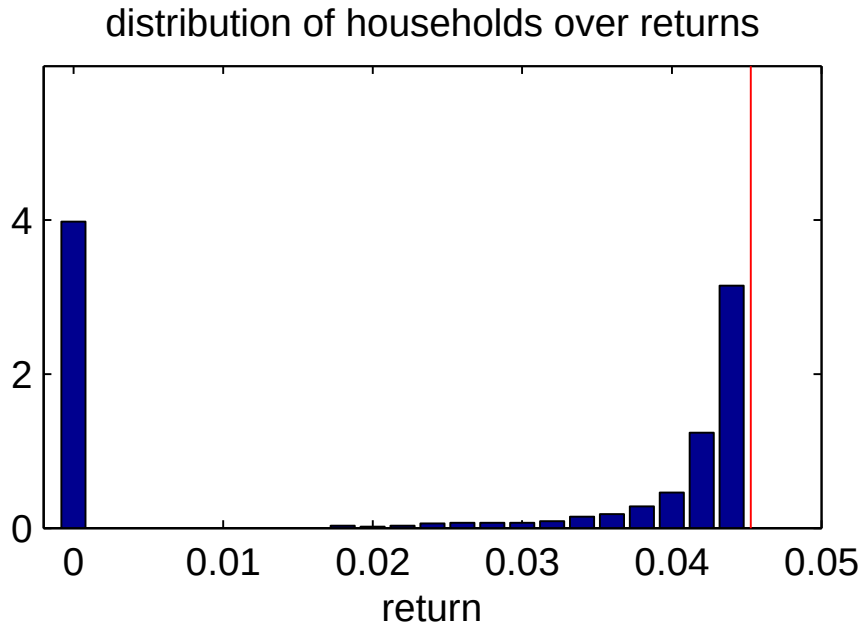


Fixed offer distribution: financial participation rate

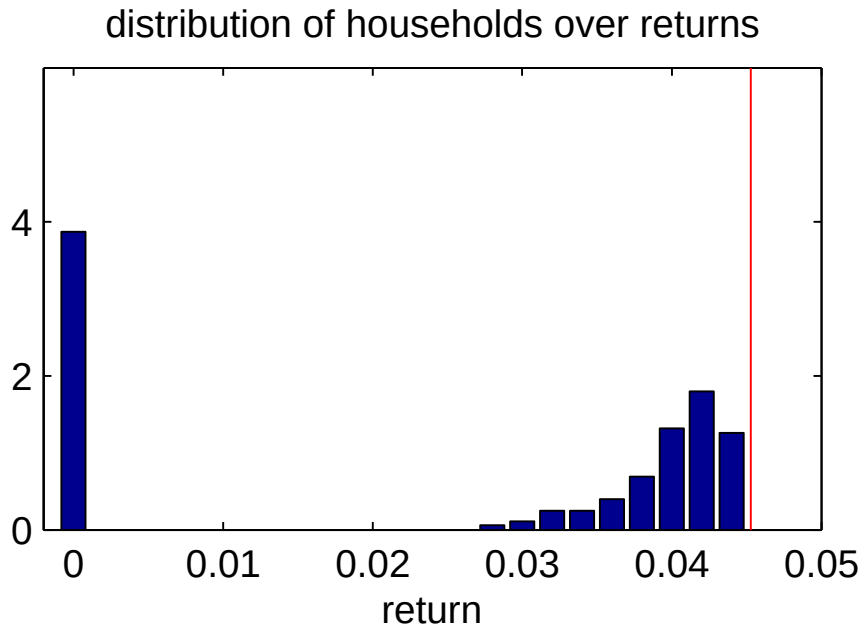


The distribution of households over returns

baseline



exog. dist.



Household's problem

When household searches s, the highest return is drawn from

$$\begin{aligned} G(r;s) &\equiv \sum_{j=0}^{\infty} \frac{(\theta(s))^j e^{-\theta s}}{j!} [F(r)]^j \\ &= e^{\theta(s)[F(r)-1]}. \end{aligned}$$