

Extending Life Cycle Models of Optimal Portfolio Choice:

Integrating Flexible Work, Endogenous Retirement, and
Investment Decisions with Lifetime Payouts

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The Unsolved Question

What is the impact on life cycle HH portfolio choice of allowing choice over

→ retirement;

→ work hours;

With *endogenous* saving, consumption, asset allocation (stocks/bonds), asset location (annuities/liquid saving).

Given:

- Bonds and risky stocks;
- Variable/Fixed payout life annuities; and
- Risky human capital.

3 Strands of Related Literature

❖ **Public finance** Laitner 2003. "Labor Supply Responses to Social Security."
MRRC WP 2003-050.

- Retirement/labor supply endogenous; seek to explain age 62 peak;
- Usually silent on optimal investment patterns.

❖ **Finance** Cocco/Gomes/Maenhout. 2005. "Consumption and Portfolio Choice over the Life Cycle," RFS.

- Endogenous asset allocation: bonds vs stocks;
- Work/retirement usually exogenous and no mortality risk;
- Often predict unreasonably high equity holdings.

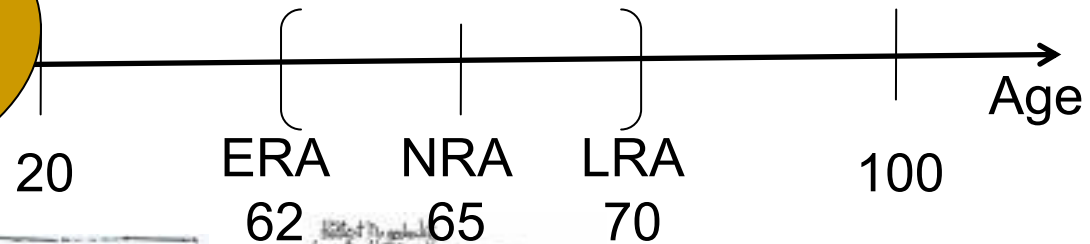
❖ **Insurance economics** Mitchell et al. 1999. "New Evidence on the Money Worth of Individual Annuities," *AER*

- Annuity: provides lifetime payout (hedge for mortality risk) in exchange for illiquidity;
- If alive, "survival credit" enhances payout;
- Fixed payout or variable (latter can include stock/bond mix).
- Understudied in finance/pub finance literature

The Multi-Period Life-Cycle Model

Female individual:
Rational CRRA utility
function (C-D form)

$$V_t = \frac{(C_t^{1-\alpha} L_t^\alpha)^{1-\rho}}{1-\rho} + \beta E_t(p_t^s V_{t+1})$$



SoSe rules

(more next slides)

Derive optimal consumption, leisure, investment portfolio (stocks, bonds, and payout annuities), labor supply, and retirement age over the life cycle (age 20-100) by numerical dynamic optimization.

Market Structure

❖ Capital market:

- Riskless bond pretax real annual return 2%
- Risky stocks: log return-> normally distributed with mean real return 6% p.a. and standard deviation 18%
- Asset income tax 20%

❖ Annuity market:

- Immediate fixed/variable payouts for life
- US female annuitant mortality;
- Insurers (industry practice): AIR = 2%, Loading 2.38%
- Annuity income tax 20%

❖ Housing expenditure: deterministic

Labor Income Process

- *When working*: wage rate * hours (1-leisure)
 - ✓ Working income stochastic
 - ✓ *Middle class worker*
- *When retire*: Social Security benefits depend on retirement age v.s. NRA, & earnings;
 - ✓ If retire < NRA: benefit permanently reduced;
 - ✓ If retire \geq NRA: benefit permanently increased
- Taxes: on pre-retirement labor income 30%, on Soc Sec benefits 15%.

Numerical Solution

- Four state variables: cash on hand, annuity payouts from previously purchased annuities (normalized by permanent labor earnings level), retirement age, and age;
- Optimization: backward induction (using Gaussian quadrature integration and cubic-splines interpolation);
- Simulation: 10,000 paths

Optimal Exp. Consumption, Labor Income, and Saving: Fix hours, endog ret, **no annuity** mkt.

- Saving until 47; assets peak at 55
- Labor income hump-shaped until 65, then most claim Soc. Sec.
- Consump. drops post retirement
- But F smoother because of more leisure (depends on leisure + cons.)

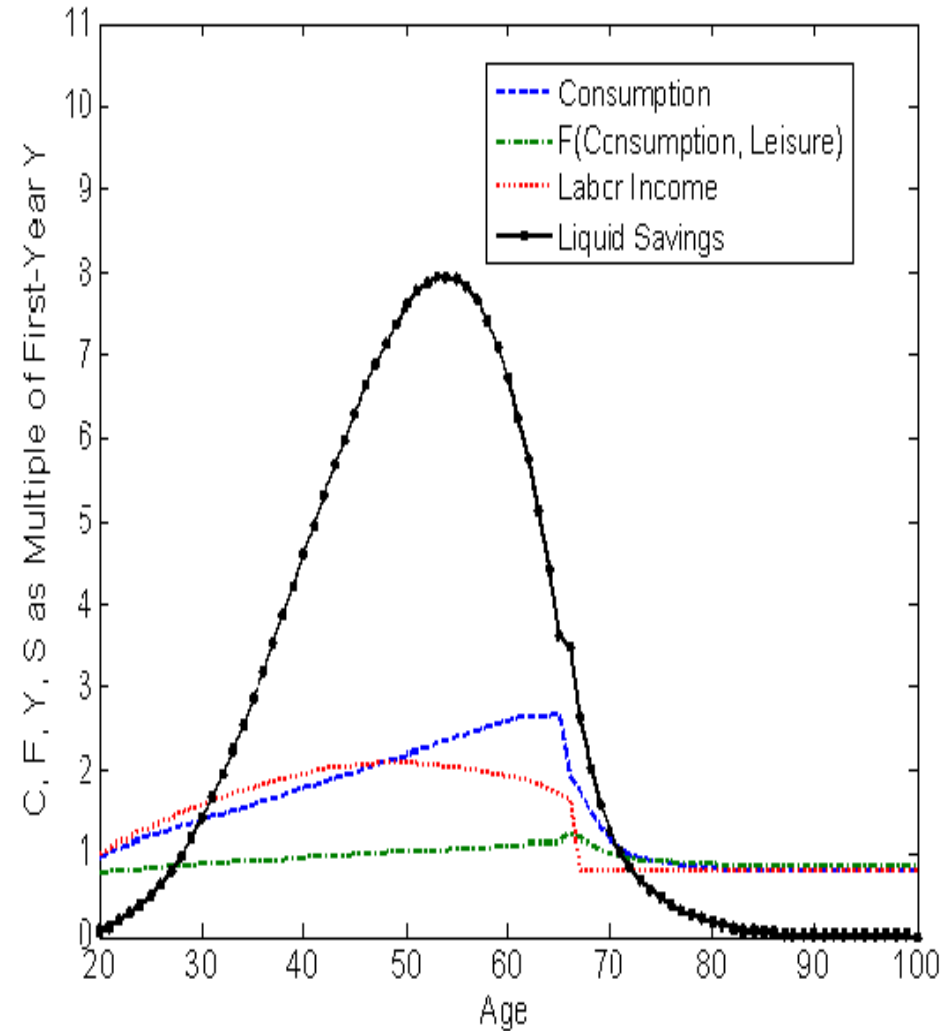


Fig. 1

Optimal Exp. Consumption, Labor Income, and Saving: Flexible hours, endog ret, **no annuity** mkt.

- ✓ Labor income hump-shaped to 65.
- ✓ Most take Soc Sec benefits > 65.
- ✓ Saving until 47; assets peak at 55.
- ✓ Consump. drops post-retirement.
- ✓ But F smoother because of more leisure (depends on leisure + cons.)

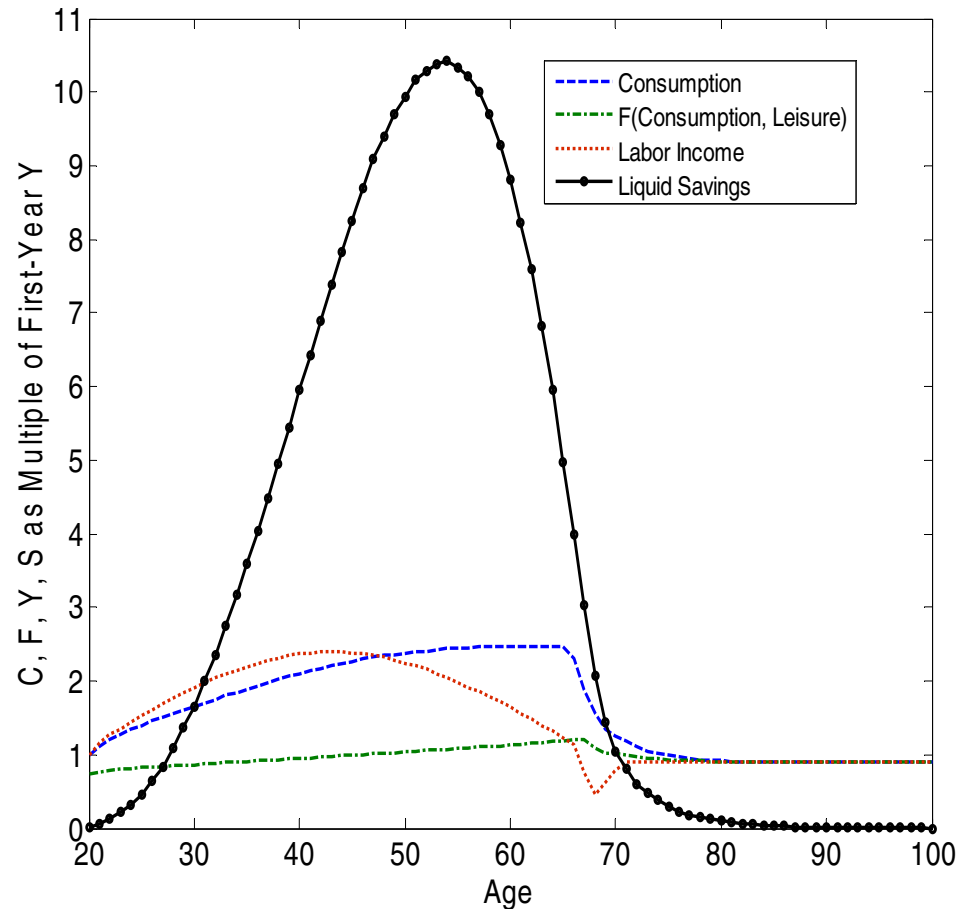


Fig. 4

Optimal Exp. Consumption, Labor Income, and Saving: Flexible hours, endog ret, **variable** annuities.

- ✓ As before, labor income hump-shaped & most take Soc Sec > 65.
- ✓ Liquid saving has new shape...
- ✓ Annuities bought from age 40 → 67; buying peaks in late 40's.
- ✓ Variable ann's help support consumption prior to Soc Sec.

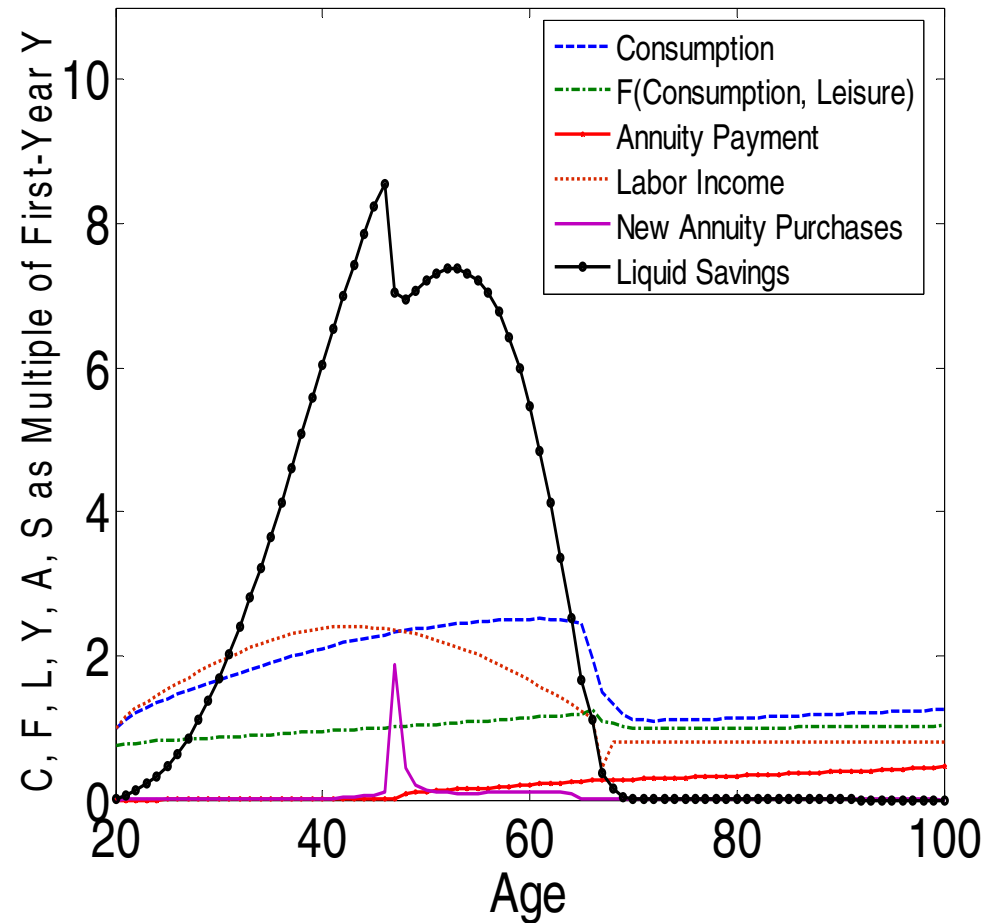


Fig. 7b

Asset Allocation and Market Nonparticipation

No annuity, flexible work hrs

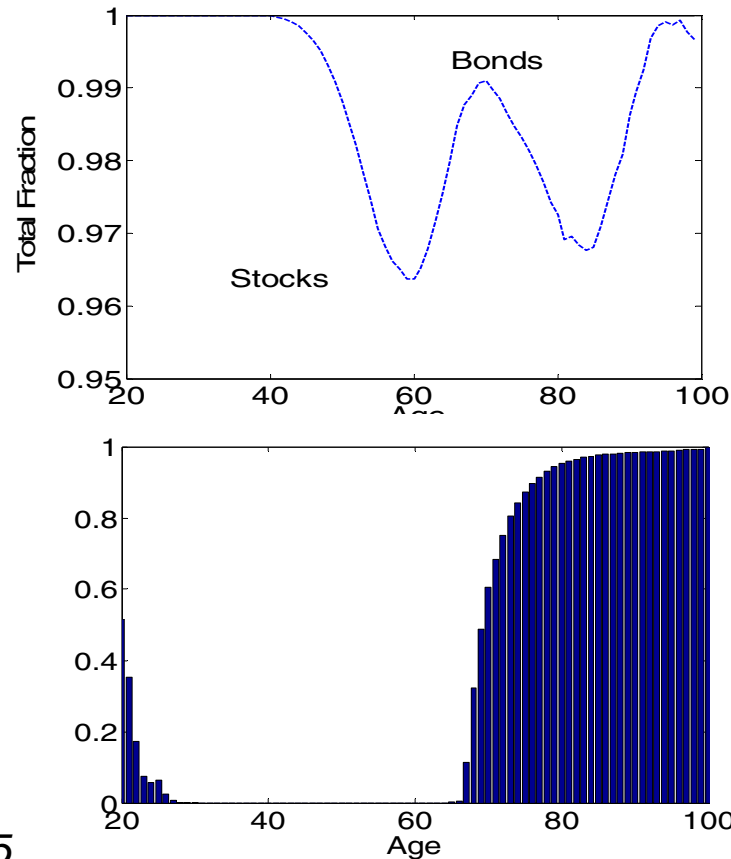


Fig 5

With variable annuities, flex work hrs

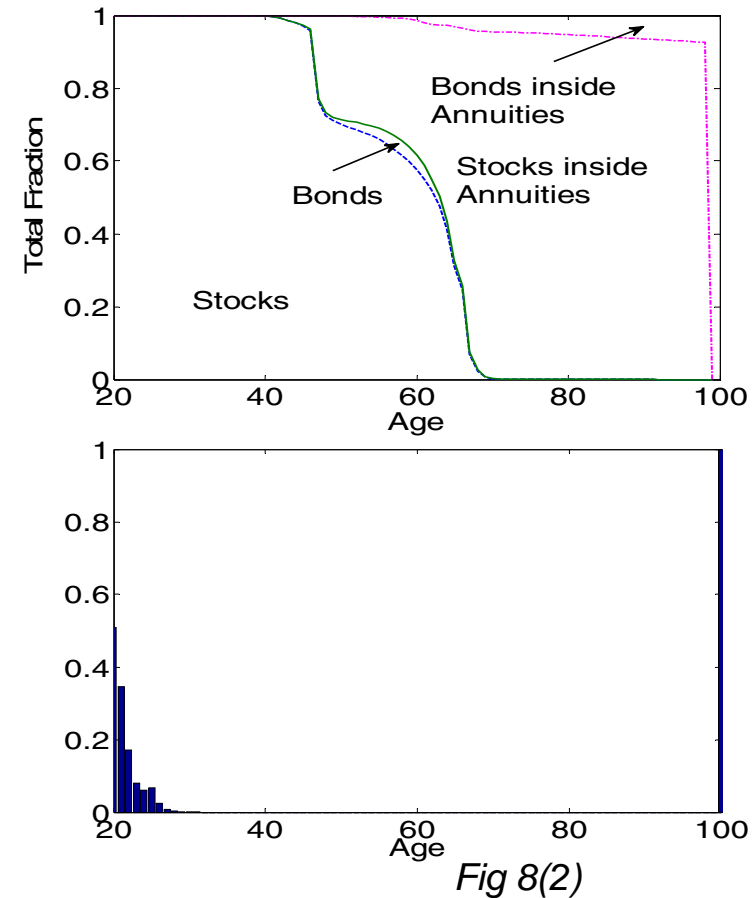


Fig 8(2)

- ✓ Fig 5: **Implausibly high equity exposure** at age 80 due to endogenous retirement;
- ✓ Fig 8: **More plausible**: liquid equity % falls in midlife; buy annuities from 45, hold little liquid wealth, and receive substantial Soc Sec supplement.

Welfare analysis of more flexibility and annuity access (computed from age 20)

Work Hours	Retirement Age	Annuity Market	Relative Utility Gain (%) (a)	Welfare Gain: % of 1st yr Labor Income (b)
(0) <i>Fixed</i>	<i>Fixed</i>	<i>No</i>	<i>Reference</i>	<i>Reference</i>
(1) Fixed	Flexible	No	4.4	49.5
(2) Flexible	Flexible	No	6.6	61.3
		:		
(4) Flexible	Flexible	Yes	7.0	62.4

- ✓ Large welfare gains from flexible work and flexible retirement age.
- ✓ Access to annuity markets less important given flexible hours.

Impact of Annuities given Flexible Hours and Endogenous Retirement

Age	Retirement Rate (%)	
	<i>No Annuities</i>	<i>With Annuities</i>
62	0	5.0
63	0	3.4
64	0	6.0
65	0	3.8
66	10.5	40.2
67	32.5	41.6
68	24.5	0
69	17.1	0
70	15.5	0

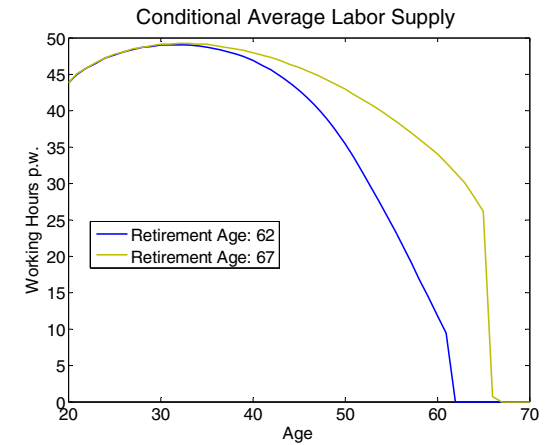
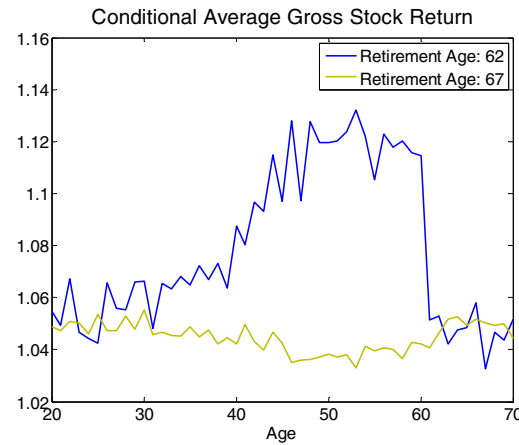
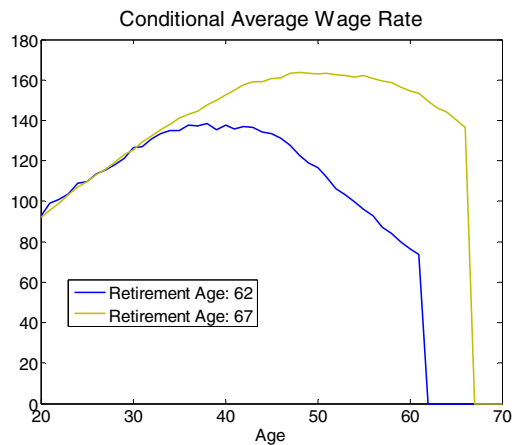
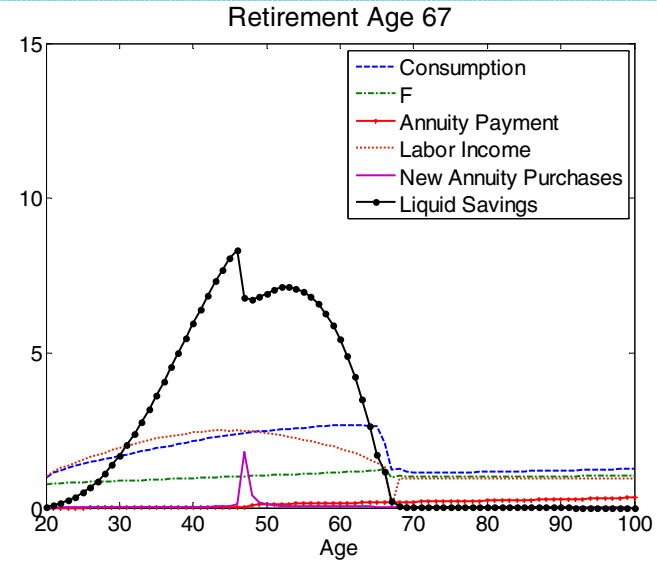
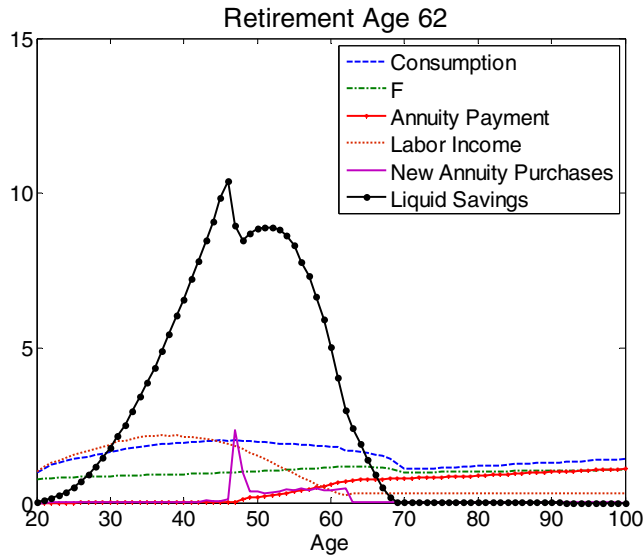
Access to private annuity markets allows households to retire much earlier.

Sensitivity analysis: Impact on Retirement Ages of Age-Dependent Leisure Preferences (health declines) and Lower Risk Aversion

Age	Retirement Rate (%)		
	No annuities	With Annuities	With Annuities, Age-dependent α , $\rho=3$
62	0	5.0	49.6
63	0	3.4	24.6
64	0	6.0	12.8
65	0	3.8	6.5
66	10.5	40.2	3.3
67	32.5	41.6	1.7
68	24.5	0	1.5
69	17.1	0	0
70	15.5	0	0

Note: Retirement age peaks at 62 consistent with evidence. Also sensible dispersion of retirement ages.

Interaction between Retirement Age, Labor Supply, Stock Return: Flexible hours, endog ret, **variable annuities**.



Conclusions/Contributions

First to explore interactions between *asset location, asset allocation, work hours, and retirement behavior* in life cycle context with annuities and capital market.

We show:

- Making labor supply endogenous increases work effort of the young and raises older persons' equity share.
- Investment decisions important for labor supply and retirement behavior and vice versa.
- Participation ratio in capital markets for elderly low, if no access to annuity markets
- Introducing annuities permits earlier retirement and higher participation by the elderly in financial markets.
- Substantial lifetime welfare gains of 7% (> 60% of first-year earnings).

Future Research

- More on preferences:
 - ✓ Age-dependent parameters to model health declines.
 - ✓ Habit formation, “less rational”, participation cost, etc.
- More detail on Social Security benefits and taxes (def. annuities / def. taxation)
- Housing
- Role of product development and interaction with financial literacy.

And what do “real people” do...



Henry Allingham, for one month, the oldest living man in the world (age 113).

His portfolio: "cigarettes, whiskey and wild, wild women."

http://www.bbc.co.uk/southerncounties/content/image_galleries/allingham_gallery.shtml?11

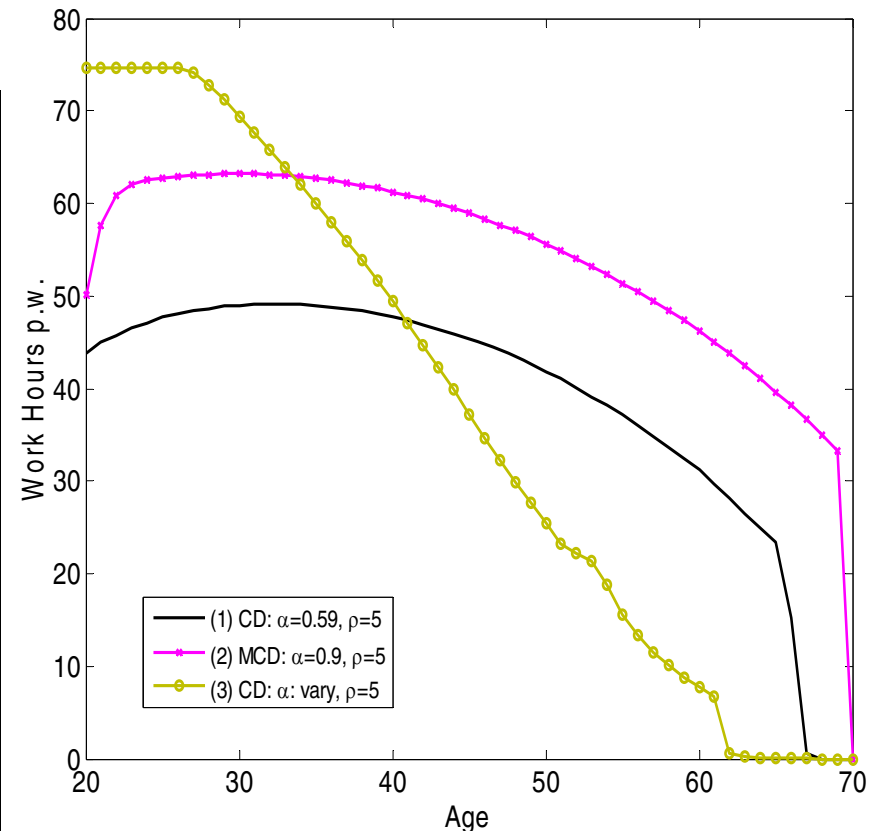
Thank you.

Questions or comments?

Backups

Sensitivity: Leisure and risk preferences

		Asset Allocation (%)								
Age	Fraction	(1)			(2)			(3)		
		α	ρ	CD	α	ρ	MCD	α	ρ	CD
		0,6	5		0,9	5		vary	3	
35	Stocks		100				98			99
	Bonds		0				2			0
	Annuities		0				0			1
50	Stocks		99			59				79
	Bonds		1			5				10
	Annuities		0			37				11
65	Stocks		95			32				59
	Bonds		0			0				0
	Annuities		5			68				41
80	Stocks		2			1				4
	Bonds		0			0				0
	Annuities		98			99				96



Gomes et al. '08 AER MCD utility: portfolio mix OK but retirement pattern implausible. Our age-dependent α and plausible ρ yield reasonable portfolios & retirement patterns.

Labor Income: Pre-retirement

With retirement between 62 and 70 (choice):

$$Y_t = (1 - h(t))(1 - t^l)(1 - L_t)\exp(w(t))E_t u_t,$$

- Y: disposable labor earnings after-tax after-housing expenditures (as % of pretax income);
- 1-L: work hours as % of available worktime;
- w: deterministic function allows for (empirically observed) hump-shape earnings profile.
- E: permanent labor earnings component with innovation $n(t)$; $n(t)$ permanent shock uncorrelated with transitory $u(t)$.

$$E_t = E_{t-1} n_t,$$

- Log of n and $u \sim N(0, \sigma_n$ and $\sigma_u)$.
- Zero correlation between labor and stock market shocks.

Labor Income: Post-retirement

- After-tax Social Security real benefits:

$$Y_t = (1 - h(t)) (1 - t^r) \left(\frac{\sum_{t=1}^K (1 - \bar{L}) \exp(w(t))}{K} \right) E_K \zeta F_{\tau, NRA}$$

Where

$1 - \bar{L}$ = average fraction of time worked;

K = years worked;

ζ = Soc. Sec. repl. rate fn of normal retirement age (NRA);

$F_{\tau, NRA}$ = actuarial reduction (*increase*) factor for retiring before (*working after*) the NRA.

Model Calibration

Calibration

- Life Span: 20->100;
- Leisure preference: $\alpha = 0.59$ in the base case; (mean of the age-dependent profile used in Buchinsky et.al. 2000 and close to Laitner 2003 's value)
- One-period survival rate: US 1996 population 2000 table for female;
- Deterministic component of the wage rate process; (Fehr et.al. 2006)
- Wage Rate Shocks; (Gomes et.al.'08 AER);
- Replacement ratio: $\zeta = 0.55$. (Mitchell and Phillips '06)