Household Finance and the Value of Life

Antoine Bommier[a], Daniel Harenberg[a],
François Le Grand[b,a]

[a]ETH Zurich [b]EM Lyon Business School

Netspar International Pension Workshop
January 18, 2017

Motivation

- Household finance
  - Life-cycle models
  - Savings and portfolio choices
  - Mortality exogenous
  - No explicit trade-off between consumption and life duration
- Value of life
  - Individual willingness to give up consumption for living longer
  - Cost-benefit analyses of public policies
  - Focus on estimating statistical value of life

$\Rightarrow$ This paper: import knowledge from value of life literature to household finance literature

Main results

1. Analytic result in stylized 2-period model: if value of life positive, more risk averse agents discount future more and save less
2. Quantitative results in calibrated life-cycle model: if value of life positive, more risk averse agents
   - save less
   - participate less in the stock market
   - if they do, hold smaller share in stock

   ⇒ Overturns important results in previous literature.
3. Empirical result: In SOEP data, more risk averse households save less

⇒ Highlights the importance of properly accounting for the value of life in life-cycle models.

Value of a statistical life

Definition

$$VSL_t = \frac{\frac{\partial U}{\partial p_t}}{\frac{\partial U}{\partial c_t}} = \begin{cases} \text{individual marginal rate of substitution} \\ \text{between survival and consumption at age } t \end{cases}$$

- VSL = individual willingness-to-pay for a small reduction in mortality risk
- To increase her survival probability by $0 < \varepsilon \ll 1$, an individual is willing to give up $\varepsilon \times VSL_t$ units of consumption.
- Scaled to one unit of death: $\frac{1}{\varepsilon}$ individuals would give up $\frac{\varepsilon VSL_t}{\varepsilon} = VSL_t$ units of consumption to increase the number of survivors by $\frac{1}{\varepsilon} \times \varepsilon = 1$.

The VSL in the economics literature

- A whole line of empirical literature estimates the VSL:
  - by looking at wage-risk trade-offs,
  - by measuring the willingness to pay for safer cars, homes,...
  - through questionnaires.
- The VSL is a central element:
  - for many cost-benefit analyses: for example, 85% of the benefits of the Clean Air Act are related to mortality risk reductions (EPA, 2011);
  - in the debate about the optimal level of public health expenditure.
- In the USA, the VSL $\approx$ 7 million USD

A two-period formal example

- Recursive preferences (Kreps-Porteus)

$$U(c_0, c_1, p_0) = u(c_0) + \beta\phi^{-1} E_{p_0}[\phi(U_1)],$$

- ϕ increasing and concave, controls risk aversion
- At $= 1$:
  - If alive, $U_1 = u(c_1)$
  - If dead, $U_1 = u_d$, a constant $\in [-\infty, +\infty]$
- VSL_0 governed by u_d:

Show formula

$$VSL_0 > 0 \;\Leftrightarrow\; u(c_1) > u_d$$

The discount rate

- Definition

$$\delta_0 = \left.\frac{\frac{\partial U}{\partial c_0}}{\frac{\partial U}{\partial c_1}}\right|_{c_0=c_1} - 1$$

- In our two-period model:

$$\delta_0 = \frac{1}{\beta p_0}\frac{\phi'\left(\tilde{u}\right)}{\phi'(u(c_1))} - 1,$$

where $\tilde{u}$ is a certainty equivalent

$$\tilde{u} = \phi^{-1}\left(p_0\phi(u(c_1)) + (1-p_0)\phi(u_d)\right)$$

Eg: Without mortality risk: $\delta_0 = \frac{1}{\beta} - 1$

Eg: For additively separable utility (affine ϕ): $\delta_0 = \frac{1}{\beta p_0} - 1$

The discount rate

- Definition

$$\delta_0 = \left. \frac{\frac{\partial U}{\partial c_0}}{\frac{\partial U}{\partial c_1}} \right|_{c_0 = c_1} - 1$$

- In our two-period model:

$$\delta_0 = \frac{1}{\beta p_0} \frac{\phi'(\tilde{u})}{\phi'(u(c_1))} - 1,$$

where $\tilde{u}$ is a certainty equivalent

$$\tilde{u} = \phi^{-1}\left(p_0 \phi(u(c_1)) + (1 - p_0)\phi(u_d)\right)$$

$\Rightarrow$ If $VSL > 0$: greater risk aversion $\Rightarrow$ $\delta_0 \uparrow \rightarrow$ savings $\downarrow$ ▸ Figure

Risk aversion with several simultaneous risks

- Mortality risk: greater risk aversion $\Rightarrow$ smaller savings, if $VSL > 0$
- Labor income risk: greater risk aversion $\Rightarrow$ greater savings (precautionary motive)
- Financial return risk: depends on IES (see Details)

$\Rightarrow$ Opposing effects and ambiguous overall impact

$\Rightarrow$ Consequences for stock market participation, portfolio choice?

$\Rightarrow$ A quantitative analysis is needed

A quantitative life-cycle model

1. Endowments ▸ Show details
   a) Adult life, annual periods
   b) Mortality profiles
   c) Deterministic age-productivity profiles
   d) Idiosyncratic labor income shocks: transitory and persistent
   e) Social security retirement income
2. Asset markets ▸ Show details
   a) Risk-free bond and risky stock
   b) Stock market participation cost
   c) Stock return correlated with labor income shocks
   d) No short-selling

Preferences

- Felicity from consumption: $u(c) = \frac{c^{1-\sigma}-1}{1-\sigma}$
- Felicity from bequests:

$$v(w) = \frac{\theta}{1-\sigma}\left[(\bar{w}+w)^{1-\sigma} - \bar{w}^{1-\sigma}\right] - \bar{v}$$

- Kreps-Porteus recursive preferences

General recursion

$$\begin{aligned} U_t^A =& (1-\beta)u(c_t) \\ & + \beta\Phi^{-1}\left(p_t\mathbb{E}_t\left[\Phi\left(U_{t+1}^A\right)\right] + (1-p_t)\mathbb{E}_t\left[\Phi\left(U_{t+1}^D\right)\right]\right) \end{aligned}$$

$$U_t^D = (1-\beta)\,v(w_t) + \beta v\,(0)$$

Epstein-Zin and risk-sensitive preferences

- Both Kreps-Porteus class ▸ Why both?
- Epstein-Zin preferences (EZ), γ controls risk aversion

$$\Phi(u) = \frac{1}{1-\gamma}(1 + (1-\sigma)u)^{\frac{1-\gamma}{1-\sigma}} - \frac{1}{1-\gamma}, \qquad \text{if } \gamma, \sigma \neq 1$$

  - γ controls risk aversion

- Risk-sensitive preferences (RS)

$$\Phi(u) = -\frac{1}{k}\left(\exp(-ku) - 1\right) \qquad \text{if } k \neq 0$$

  - k controls risk aversion

- Limit cases ($k = 0$, $\gamma = 1$, $\sigma = 1$) by continuity

Calibration of preferences

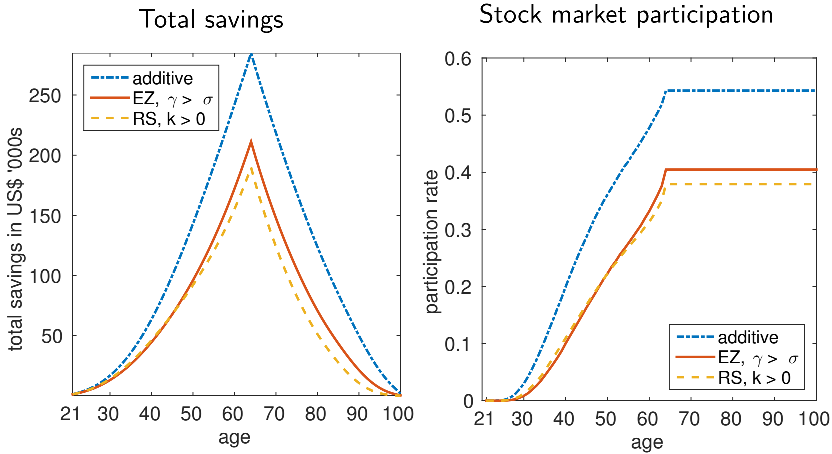
1. Calibrate additive agent to empirical savings, VSL, and bequests
2. Increase risk aversion for EZ agent
3. Calibrate risk aversion of RS agent to match savings of EZ agent

Parameter	Value	Source/ counterpart/ target
Inverse IES, σ	2.0	
Exog. endowment, $\bar{w}$	1	Net wage $\bar{y}$ = US$ 21'756
Discount factor, β	*0.93*	$Assets_{45}^{add}$ = US$ 100'000
Life-death gap, $\bar{v}$	*32.3*	VSL_{45}^{add} = US$ 6.5m
Bequest motive, θ	5.3	$Bequests_{90}^{add}$ = US$ 50'000†
Risk aversion, EZ, γ	3.0	
Risk aversion, RS, k	*0.09*	$Assets_{45}^{RS} = Assets_{45}^{EZ}$

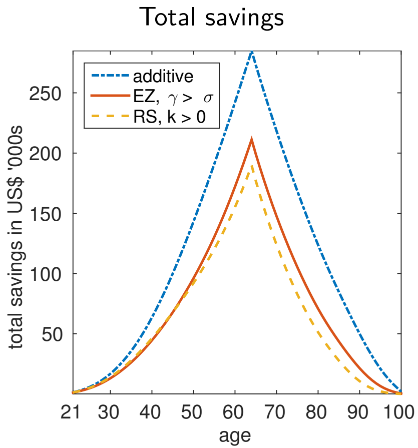
Parameterization of endowments and asset markets

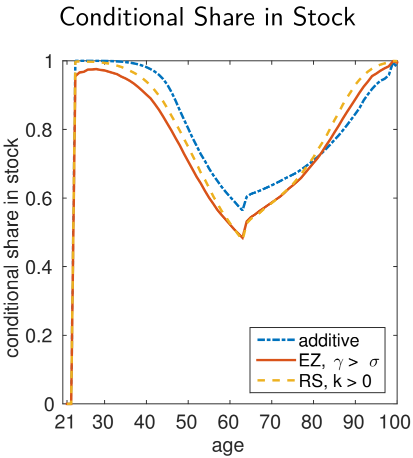
Parameter	Value	Source/ counterpart/ target
Working age, retirement age, maximum age		21, 65, 100
Survival rates, p_t	$\{p_t\}_1^T$	U.S. mortality 2007, HMD
Age productivity, μ_t	$\{\mu_t\}_1^{\tilde{T}}$	Earnings profiles 2007, PSID
Average wage, $\bar{y}$	21 756 USD	Net compensation 2007, SSA
Pensions, y^R	$33\% \times \bar{y}$	Social security replacement rate
Autocorrelation, ρ	0.95	Storesletten, et al. (2004)
Var. persistent shocks, σ_υ^2	0.03	Storesletten, et al. (2004)
—Correlation with stock, κ_υ	0.15	Gomes and Michaelides (2005)
Var. transitory shocks, σ_ϑ^2	0.12	Storesletten, et al. (2004)
—Correlation with stock, κ_ϑ	0.30	Gomes and Michaelides (2005)
Inheritance, w_0	0.0	
Gross risk-free return, R^f	1.02	
Equity premium, ω	0.03	
Stock volatility, σ_ν	0.18	
Participation cost, F	3620 USD	

Lifecycle profiles (1/3)

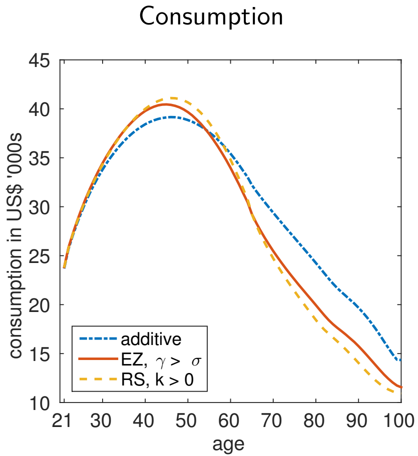


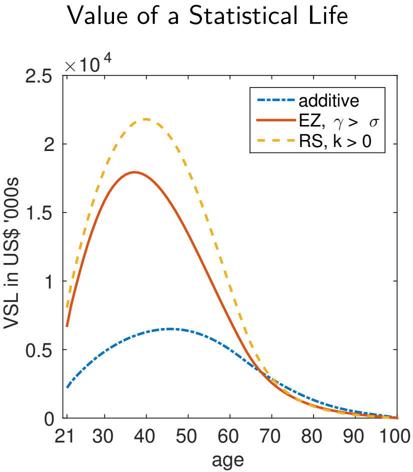
Lifecycle profiles (2/3)





Lifecycle profiles (3/3)





Typical Epstein-Zin specification in household finance

$$V_t = \left((1-\beta) c_t^{1-\sigma} + \beta E_t \left[p_t V_{t+1}^{1-\gamma} \right]^{\frac{1-\sigma}{1-\gamma}} \right)^{\frac{1}{1-\sigma}}$$

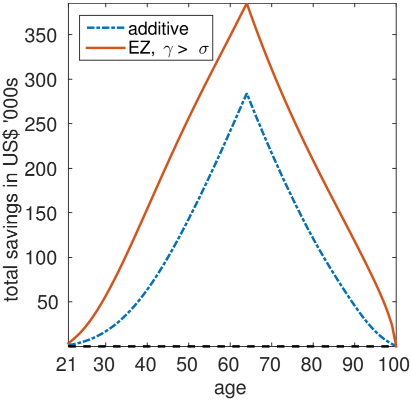
- Main advantage: homothetic
- But if $\gamma > 1$, VSL negative:

$$\frac{\partial V_t}{\partial p_t} = \frac{\beta}{1-\gamma} E_t[V_{t+1}^{1-\gamma}] E_t \left[p_t V_{t+1}^{1-\gamma} \right]^{\frac{\gamma-\sigma}{1-\gamma}} V_t^{\sigma} < 0$$

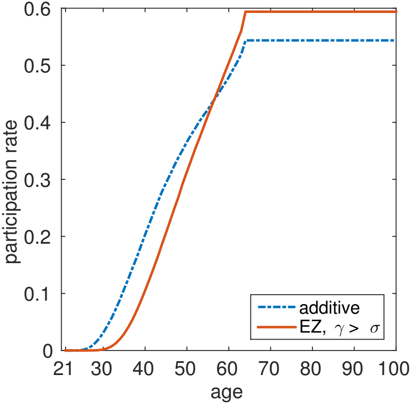
- Adding a bequest motive does not change much.

Profiles for typical Epstein-Zin specification

Total savings



Stock market participation



Supporting evidence

- Empirical analysis based German SOEP
- Self-declaration about risk aversion, *RA*
  - 0 ("very willing to take risk") to 10 ("not at all willing to take risk")
  - Dohmen, et al. (2011):
    - *RA* good predictor of risky behavior
    - E. g., smoking, investing in stock, but not savings
    - Validate with field experiment (N=450)
- Our econometric analysis similar to Fuchs-Schündeln and Schündeln (2005), but with *RA* as explanatory variable for savings

Empirical Findings (dependent variable = log(savings))

Explanatory variables	W/o interactions	With interactions
risk aversion (RA)	**-0.013^{***}**	**-0.016^{***}**
	(0.004)	(0.006)
RA $\times$ income risk		**0.033**
		(0.026)
RA $\times$ mortality		**-0.191^{*}**
		(0.118)
log(wealth)	0.088^{***}	0.088^{***}
	(0.004)	(0.004)
log(permanent income)	-0.005	-0.018
	(0.208)	(0.208)
income risk	0.285^{***}	0.111
	(0.081)	(0.157)
demographic controls	Show	Show
Nb of observations	22973	22973

Conclusion

- With positive value of life, risk aversion
  - Amplifies effect of mortality on discounting
  - Decreases lifecycle savings and stock market participation
- Mortality = main risk in life
  - Death is a state where you loose (part of) your savings
  - Saving is risk-taking behavior
- Observed low levels of saving may be rational and explained by higher risk-aversion

Appendix Table of Contents

Literature 1/2

Risk aversion	*...increases savings*	*...decreases savings*
Income risk	E.g., BCL	
Investment risk	Kihlstrom and Mirman (1974) and BCL if IES<1	Kihlstrom and Mirman (1974) and BCL if IES>1
Mortality risk	HPSA if IES <1	Bommier (2006, 2013), BCL, Drouhin (2015), HPSA if IES>1
All three risks	Gomes and Michaelides (2005, 2008),... ▸ more	

- BCL: Bommier, Chassagnon, and LeGrand (2012)
- HPSA: Hugonnier, Pelgrin, and St-Amour (2012)

Literature 1/2

Risk aversion	*...increases savings*	*...decreases savings*
Income risk	E.g., BCL	
Investment risk	Kihlstrom and Mirman (1974) and BCL if IES<1	Kihlstrom and Mirman (1974) and BCL if IES>1
Mortality risk	**HPSA if IES** <1	Bommier (2006, 2013), BCL, Drouhin (2015), HPSA if IES>1
All three risks	**Gomes and Michaelides (2005, 2008)**,... ▸ more	This paper

- BCL: Bommier, Chassagnon, and LeGrand (2012)
- HPSA: Hugonnier, Pelgrin, and St-Amour (2012)

Literature 2/2

- Epstein-Zin preferences:
  - With bequests: Gomes and Michaelides (2005), Inkman, Lopez, and Michaelides (2011), Horneff, Maurer, and Stamos (2008a, 2008b)
  - Without bequests: Gomes and Michaelides (2008), Gomes, Michaelides, and Polkovnichenko (2009), Fehr and Habermann (2008), Fehr, Habermann, and Kindermann (2008) Fehr, Kallweit, and Kindermann (2013)
- Risk aversion and savings:

  Bommier (2006, 2013), Bommier, Chassagnon, LeGrand (2012), Bhamra and Uppal (2006)
- Value of a statistical life:

  Kaplow (2005), Viscusi and Aldy (2003), Bommier and Villeneuve (2012), Córdoba and Ripoll (2013)

Go Back

VSL in two-period model

- Utility

$$U(c_0, c_1, p_0) = u(c_0) + \beta\phi^{-1}\left(p_0\phi(u(c_1)) + (1 - p_0)\phi(u_d)\right).$$

- Applying the definition $VSL_t = \frac{\frac{\partial U}{\partial p_t}}{\frac{\partial U}{\partial c_t}}$ yields

$$VSL_0 = \frac{\beta\left(\phi(u(c_1)) - \phi(u_d)\right)}{u'(c_0)\phi'\left(\phi^{-1}\left(p_0\phi(u(c_1)) + (1 - p_0)\phi(u_d)\right)\right)}.$$

Go Back

Discount rate and risk aversion

- $VSL_0 > 0 \Leftrightarrow u(c_1) > u_d$ ▸ Show VSL formula

$\Rightarrow$ $u_d < \tilde{u} < u(c_1)$

$\Rightarrow$ $\phi'(u_d) > \phi'(\tilde{u}) > \phi'(u(c_1))$, because ϕ concave

$\Rightarrow$ $\frac{\phi'(\tilde{u})}{\phi'(u(c_1))} > 1$

$\Rightarrow$ amplifies effect of mortality: $\delta_0 = \frac{1}{\beta p_0} \frac{\phi'(\tilde{u})}{\phi'(u(c_1))} - 1,$

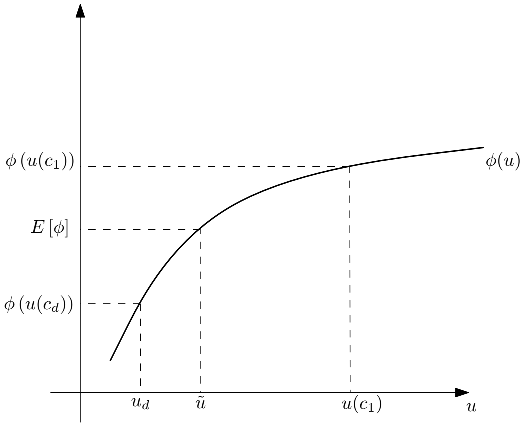
- Risk aversion $\uparrow \Rightarrow$ more concave $\phi \Rightarrow$ stronger amplification

  $\Rightarrow$ discount rate $\uparrow \Rightarrow$ savings propensity $\downarrow$

▸ Show graphical proof ▸ Show mathematical proof

Discount rate and risk aversion, graphical proof, 1/2

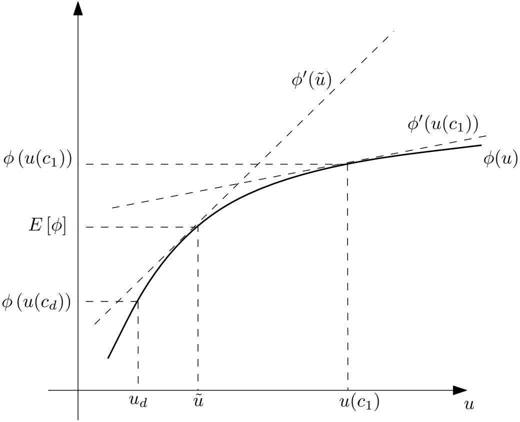
Consider $VSL_0 > 0 \Leftrightarrow u(c_1) > u_d$ ▸ Show VSL formula



▸ Go back

Discount rate and risk aversion, graphical proof, 1/2

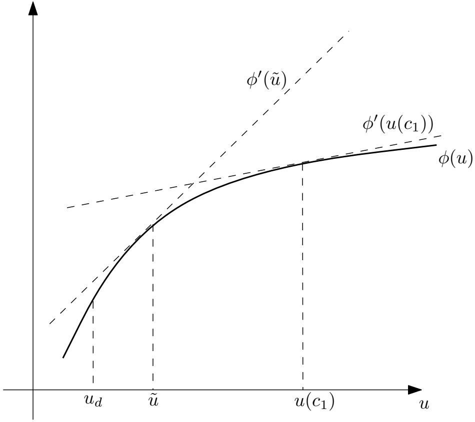
Consider $VSL_0 > 0 \Leftrightarrow u(c_1) > u_d$ ▸ Show VSL formula



▸ Go back

Discount rate and risk aversion, graphical proof, 1/2

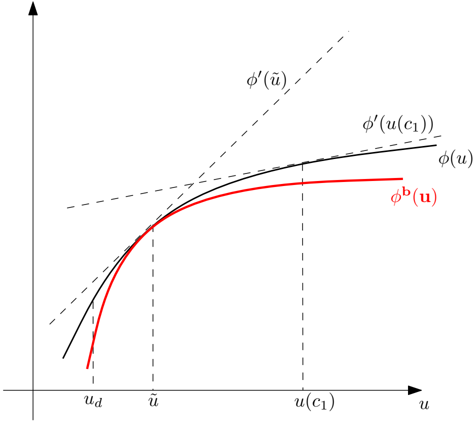
Consider $VSL_0 > 0 \Leftrightarrow u(c_1) > u_d$ ▸ Show VSL formula



▸ Go back

Discount rate and risk aversion, graphical proof, 1/2

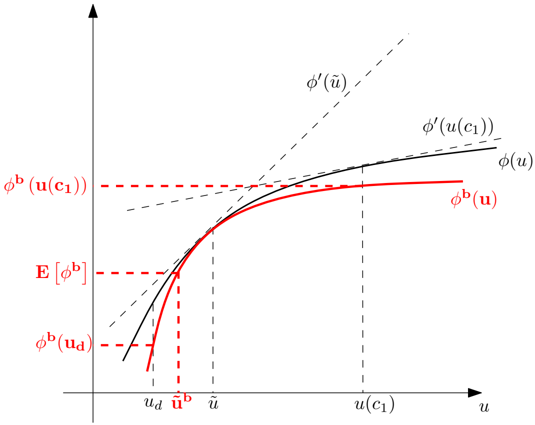
Consider $VSL_0 > 0 \Leftrightarrow u(c_1) > u_d$ ▸ Show VSL formula



▸ Go back

Discount rate and risk aversion, graphical proof, 1/2

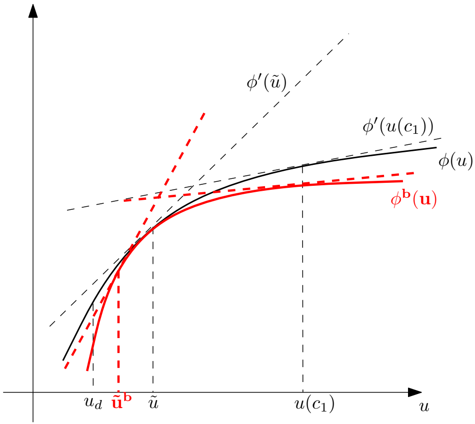
Consider $VSL_0 > 0 \Leftrightarrow u(c_1) > u_d$ Show VSL formula



Go back

Discount rate and risk aversion, graphical proof, 1/2

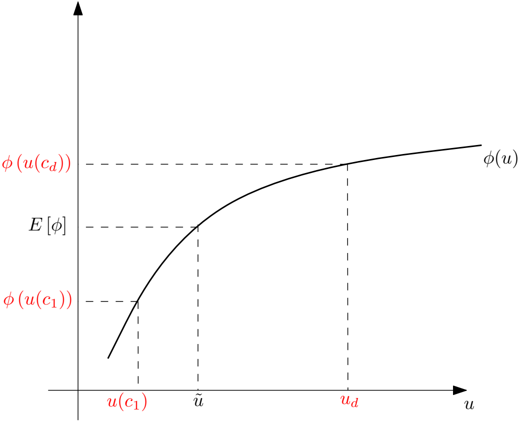
Consider $VSL_0 > 0 \Leftrightarrow u(c_1) > u_d$ ‣ Show VSL formula



‣ Go back

Discount rate and risk aversion, graphical proof, 2/2

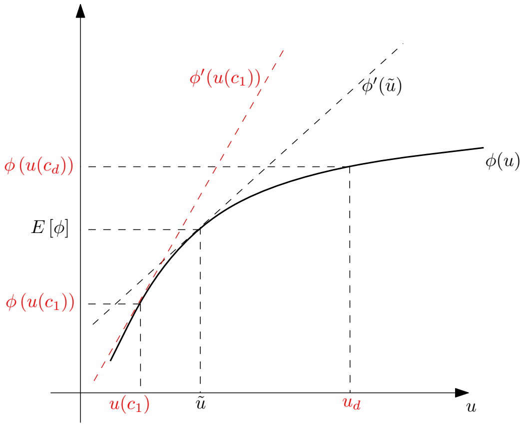
Consider $VSL_0 < 0 \Leftrightarrow u(c_1) < u_d$ ▸ Show VSL formula



▸ Go back

Discount rate and risk aversion, graphical proof, 2/2

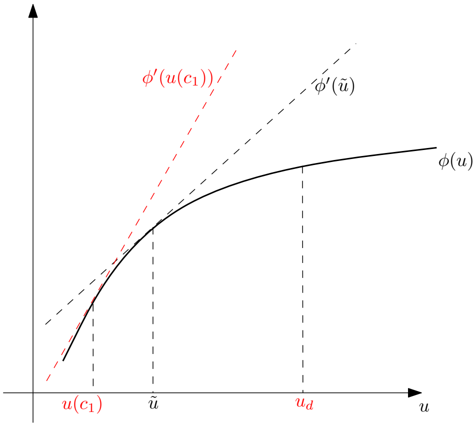
Consider $VSL_0 < 0 \Leftrightarrow u(c_1) < u_d$ ▸ Show VSL formula



▸ Go back

Discount rate and risk aversion, graphical proof, 2/2

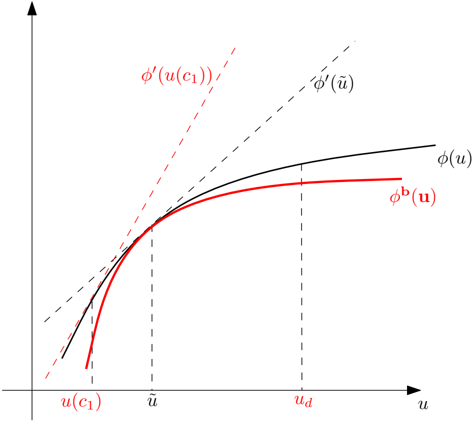
Consider $VSL_0 < 0 \Leftrightarrow u(c_1) < u_d$ Show VSL formula



Go back

Discount rate and risk aversion, graphical proof, 2/2

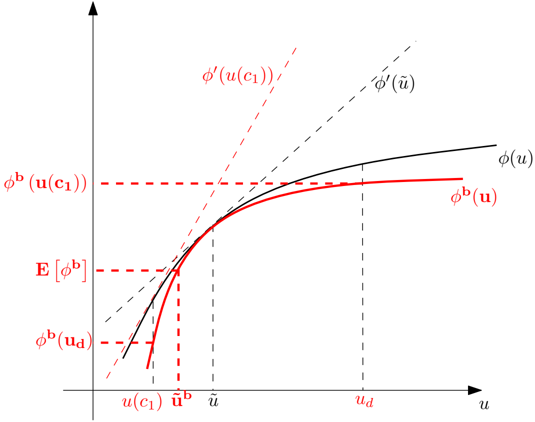
Consider $VSL_0 < 0 \Leftrightarrow u(c_1) < u_d$ ‣ Show VSL formula



‣ Go back

Discount rate and risk aversion, graphical proof, 2/2

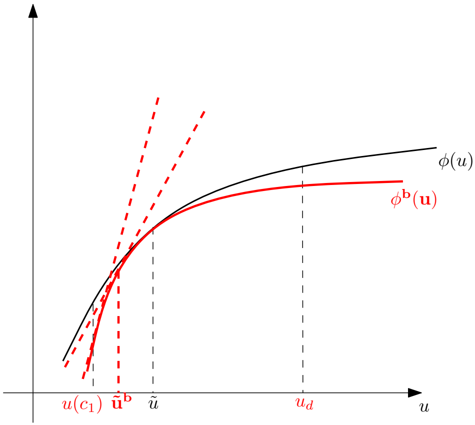
Consider $VSL_0 < 0 \Leftrightarrow u(c_1) < u_d$ ▸ Show VSL formula



▸ Go back

Discount rate and risk aversion, graphical proof, 2/2

Consider $VSL_0 < 0 \Leftrightarrow u(c_1) < u_d$ ▸ Show VSL formula



▸ Go back

Discount rate and risk aversion, math proof

- $\delta_0 = \frac{1}{\beta p_0} \frac{\phi'(\tilde{u})}{\phi'(u(c_1))} - 1$, can be rewritten as

$$\delta_0 = \frac{1}{\beta p_0} \exp\left(\int_{\tilde{u}}^{u(c_1)} \omega_\phi(u) du \right) - 1$$

  where $\omega_\phi(u) = -\frac{\phi''(u)}{\phi'(u)}$ is a measure of the concavity of ϕ

- Consider $VSL_0 > 0 \Leftrightarrow u(c_1) > u_d$ Show VSL formula
  - Integral increases in concavity ω_ϕ and mortality $(1 - p_0)$ through lower bound $\tilde{u}$
  - In addition, ω_ϕ increases integrand directly
  - Enters exponential

  $\Rightarrow$ risk aversion has strong positive effect on discount rate

Go back

Savings with uncertain asset returns (go back)

Two periods / two states of the world that determine the asset return.

- Bad state = low return; Good state = high return .
- If IES<1,
  - income effect dominates,
  - $s_B > s_G$
  - Risk aversion *increases* savings.
- Else if IES>1,
  - substitution effect dominates,
  - $s_B < s_G$,
  - Risk aversion *decreases* savings.

Endowments

- Working age $t = 1$, retirement age $\tilde{T}$, max age T
- Mortality risk: survival probability p_t
- Labor income $(1 \leq t < \tilde{T})$

$$
\begin{aligned}
y_t^L =& \bar{y} \exp(\mu_t + \pi_t + \vartheta_t) \\
\pi_t =& \rho \pi_{t-1} + \upsilon_t \\
\vartheta_t \overset{iid}{\sim}& \mathcal{N}\left(0, \sigma_\vartheta^2\right), \quad \upsilon_t \overset{iid}{\sim} \mathcal{N}\left(0, \sigma_\upsilon^2\right)
\end{aligned}
$$

- Social security pension income $(\tilde{T} \leq t \leq T)$, $y^{\tilde{T}}$
- At $t = 1$, inherit w_0

Go back

Asset markets

- Bond: risk-free gross return R^f
- Stock: risky gross return

  $\ln R_t^s = \ln \left(R^f + \omega \right) + \nu_t, \quad \nu_t \overset{iid}{\sim} \mathcal{N} \left(0, \sigma_\nu^2\right)$
- ν_t correlated with both labor income shocks with κ_ϑ and κ_υ
- No short selling
- Stock-market participation cost, $F \geq 0$, paid once in life

Go back

Choices and constraints

- Choices $\{c_t, s_t, b_t, \eta_t\}$
- Constraints

$$c_t + b_t + s_t + F1_{\eta_{t=1}} 1_{\eta_{t-1=0}} = y_t + R^f b_{t-1} + R^s_t s_{t-1},$$

$$s_t = 0 \text{ if } \eta_t = 0,$$

$$y_t = \begin{cases} y^L_t & \text{if } t < \tilde{T}, \\ y^{\tilde{T}} & \text{else,} \end{cases}$$

$$c_t > 0, \quad b_t \geq 0, \quad s_t \geq 0$$

and bequests are $w_t = R^f b_{t-1} + R^s_t s_{t-1}$.

General Kreps-Porteus Recursion

- Recursion

$$U_t = (1-\beta)u_t + \beta\Phi^{-1}\left(\mathbb{E}_t^{\mathcal{F}\times\mathcal{G}}\left[\Phi\left(U_{t+1}\right)\right]\right),$$

$$\text{with } u_t = \begin{cases} u(c_t) & \text{if alive at } t \\ v(w_t) & \text{if dead at } t \end{cases}$$

Go Back

Epstein-Zin and risk-sensitive preferences (2/2)

- EZ: homothetic but not monotone (with respect to FSD)
- RS: non-homothetic but monotone.

$\Rightarrow$ Not monotone, what does that mean? ▸ Numerical Example

- RS: the only KP preferences that are monotone and disentangle risk aversion from IES
  - Working paper by Bommier and LeGrand (2014), work in progress by Bommier, Kochov, and LeGrand (2016))
- In our setting:
  - Non-monotonicity little impact
  - Homotheticity has to be given up, because of VSL modelling

▸ Go Back

Numerical Example of Non-Monotonic Preferences

- Consider EZ utility: $V(c_0, \tilde{c}_1) = c_0^{\frac{1}{2}} + (\mathbb{E}[\tilde{c}_1^{-\frac{1}{2}}])^{-1}$.
- Lotteries $i = \ell_1, \ell_2$ paying off (c_0^i, c_d^i) or (c_0^i, c_u^i) (50%–50%):

Lottery	c_0^i	c_d^i	c_u^i	$V(c_0^i, c_d^i)$	$V(c_0^i, c_u^i)$
$i = \ell_1$	4	1	7	9.00	21.58
$i = \ell_2$	2	2.5	9	8.97	19.49

$\Rightarrow$ ℓ_1 always pays off more than ℓ_2.

- BUT, ex ante, $V(c_0^{\ell_1}, \tilde{c}_1^{\ell_1}) = 11.91 < 12.15 = V(c_0^{\ell_2}, \tilde{c}_1^{\ell_2})$!

Go Back

Value of a Statistical Life

- Marginal rate of substitution between survival rate and consumption

$$VSL_t = \frac{\frac{\partial U_t^A}{\partial p_t}}{\frac{\partial U_t^A}{\partial c_t}}$$

$\Rightarrow$ how much consumption to give up for increasing the likelihood to live another year

Computation

- Reformulate model
  - Cash-at-hand, $x_t = R^f b_{t-1} + R^s_t s_{t-1} + y_t$
  - Total savings, a_t, and share in stock $\alpha \in [0, 1]$
- Persistent productivity, π_t: continuous state variable
- State space (x_t, π_t, η_t, t)
- Not differentiable
- Standard VFI infeasible

$\Rightarrow$ Use 3D cubic B-spline to interpolate expected continuation value

- Calibration: consider 3 agents: *add*, *EZ*, *RS*

Re-calibration Without Mortality

Parameter	Value	Source/ counterpart/ target
Inverse IES, σ	2.0	
Exog. endowment, $\bar{w}$	1.5	
Discount factor, β	*0.96* $\rightarrow$ *0.95*	$Assets_{45}^{add}$ = US\$ 100'000
Life-death gap, $\bar{v}$	*30.0* $\rightarrow$ *30.3*	VSL_{45}^{add} = US\$ 6.5m
Bequest motive, θ	20.0	$Bequests_{85}^{add}$ =?
Risk aversion, EZ, γ	**3.0** $\rightarrow$ **7.0**	
Risk aversion, RS, k	**0.08** $\rightarrow$ **0.58**	$Assets_{45}^{RS} = Assets_{45}^{EZ}$

Go Back

EZ in Gomes and Michaelides 2005

$$V_t = \left((1-\beta p_t) c_t^{1-\frac{1}{\varepsilon}} + \beta E_t \left(p_t V_{t+1}^{1-\rho} + (1-p_t) b \frac{(X_{t+1}/b)^{1-\rho}}{1-\rho} \right)^{\frac{1-\frac{1}{\varepsilon}}{1-\rho}} \right)^{\frac{1}{1-\frac{1}{\varepsilon}}}$$

- Derivative ambiguous if $\rho > 1$ and $\varepsilon < 1$

Go Back

Re-calibration for 'typical' EZ Specification

Parameter	Value	Source/ counterpart/ target
Inverse IES, σ	2.0	
Exog. endowment, $\bar{w}$	1.5	
Discount factor, β	0.96	$Assets_{45}^{add}$ = US$ 100'000
Life-death gap, $\bar{v}$	**30.0 → 0.0**	***not targeted***
Bequest motive, θ	**20.0 → 0.0**	***exogenous***
Risk aversion, EZ, γ	**3.0 → 7.0**	
Risk aversion, RS, k	**0.08 → 0.71**	$Assets_{45}^{RS} = Assets_{45}^{EZ}$

Go Back

Controls in estimation

- age, age^2, education, education^2, gender, marital status (6 values), household size, number of children, current residence (East or West Germany), year dummies
- $R^2 = 21.56$

Go Back

Bhamra, H. S. and R. Uppal (2006): "The role of risk aversion and intertemporal substitution in dynamic consumption-portfolio choice with recursive utility," *Journal of Economic Dynamics and Control*, 30, 967–991.

Bommier, A. (2006): "Uncertain Lifetime and Intertemporal Choice: Risk Aversion as a Rationale for Time Discounting," *International Economic Review*, 47, 1223–1246.

——— (2013): "Life Cycle Preferences Revisited," *Journal of European Economic Association*, 11, 1290–1319.

Bommier, A., A. Chassagnon, and F. Le Grand (2012): "Comparative Risk Aversion: A Formal Approach with Applications to Saving Behaviors," *Journal of Economic Theory*, 147, 1614–1641.

Bommier, A., A. Kochov, and F. LeGrand (2016): "On Monotone Recursive Preferences," mimeo, ETH Zurich.

Bommier, A. and F. LeGrand (2014): "A Robust Approach to Risk Aversion," Working paper, ETH Zurich.

Bommier, A. and B. Villeneuve (2012): "Risk Aversion and the Value of Risk to Life," *Journal of Risk and Insurance*, 79, 77–104.

Córdoba, J. C. and M. Ripoll (2013): "Beyond Expected Utility in the Economics of Health and Longevity, *Working Paper*," .

Dohmen, T., A. Falk, D. Huffman, U. Sunde, J. Schupp, and G. G. Wagner (2011): "Individual risk attitudes: Measurement, determinants, and behavioral consequences," *Journal of the European Economic Association*, 9, 522–550.

Drouhin, N. (2015): "A Rank-Dependent Utility Model of Uncertain Lifetime," *Journal of Economic Dynamics and Conctrol*, 53, 208–224.

Fehr, H. and C. Habermann (2008): "Risk Sharing and Efficiency Implications of Progressive Pension Arrangements," *Scandinavian Journal of Economics*, 110, 419–443.

FEHR, H., C. HABERMANN, AND F. KINDERMANN (2008): "Social security with rational and hyperbolic consumers," *Review of Economic Dynamics*, 11, 884–903.

FEHR, H., M. KALLWEIT, AND F. KINDERMANN (2013): "Should pensions be progressive?" *European Economic Review*, 63, 94–116.

FUCHS-SCHUENDELN, N. AND M. SCHUENDELN (2005): "Precautionary Savings and Self-Selection: Evidence from the German Reunification "Experiment"," *Quarterly Journal of Economics*, 120, 1085–1120.

GOMES, F. AND A. MICHAELIDES (2005): "Optimal Life-Cycle Asset Allocation: Understanding the Empirical Evidence," *The Journal of Finance*, 60, 869–904.

GOMES, F., A. MICHAELIDES, AND V. POLKOVNICHENKO (2009): "Optimal savings with taxable and tax-deferred accounts," *Review of Economic Dynamics*, 12, 718–735.

Gomes, F. J. and A. Michaelides (2008): "Asset Pricing with Limited Risk Sharing and Heterogeneous Agents," *The Review of Financial Studies*, 21, 415–448.

Horneff, W., R. H. Maurer, and M. Z. Stamos (2008a): "Optimal gradual annuitization: Quantifying the costs of switching to annuities," *Journal of Risk and Uncertainty*, 75, 1019–1038.

Horneff, W. J., R. H. Maurer, and M. Z. Stamos (2008b): "Life-cycle asset allocation with annuity markets," *Journal of Economic Dynamics and Control*, 32, 3590–3612.

Hugonnier, J., F. Pelgrin, and P. St-Amour (2012): "Health and (Other) Asset Holdings," *The Review of Economic Studies*, 80, 663–710.

Inkmann, J., P. Lopes, and A. Michaelides (2011): "How Deep Is the Annuity Market Participation Puzzle?" *Review of Financial Studies*, 24, 279–319.

Kaplow, L. (2005): "The value of a statistical life and the coefficient of relative risk aversion," *Journal of Risk and Uncertainty*, 23–34.

Kihlstrom, R. E. and L. J. Mirman (1974): "Risk Aversion with many Commodities," *Journal of Economic Theory*, 8, 361–388.

Storesletten, K., C. I. Telmer, and A. Yaron (2004): "Consumption and Risk sharing over the Life Cycle," *Journal of Monetary Economics*, 51, 609–633.

Viscusi, W. K. and J. E. Aldy (2003): "The Value of a Statistical Life: A Critical Review of Market Estimates Throughout the World," *The Journal of Risk and Uncertainty*, 27, 5–76.