Loss Aversion, Inefficiencies and Policy Interventions

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Common Preference Assumptions in Macroeconomics

- Preferences include only allocations, such as individual consumption, leisure and public goods.
- Possibly omit some components which may play a role in the welfare.

One Example of Nonstandard Utility

- People feel excited if they gain in the investment;
- A loss affects a person more than the same amount of gain;
- Called "loss aversion".

Loss Aversion

- Kahneman and Tversky (1979, Ecta) propose loss aversion as a part of prospect theory.
- Economic agents evaluate decisions based on a reference point.
- Utility generated from both the absolute value and the change of assets.

Loss Aversion

- $-U(-x) > U(x)$, gain $x > 0$ and $U(0) = 0$.

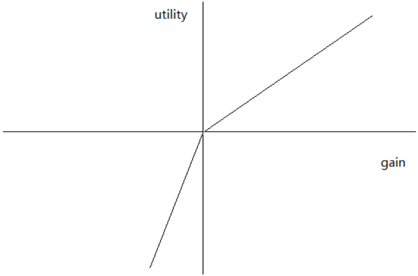

Figure: Example of Loss Aversion

- Empirical evidence:
  - Pope and Schweitzer (AER, 2011): Tiger Woods shows loss aversion.
  - Camerer et al (1997): Drivers are afraid of falling below a target income, consistent with loss aversion.

Application of Loss Aversion

- Often employed in finance and behavioral economics.
  - E.g. Benartzi and Thaler (1995): explain the equity premium puzzle.
- Still rare in macroeconomics.
  - A model without loss aversion may misunderstand agents' behaviors and lead to an inefficient policy.

Questions

- Does a model with loss aversion behave differently in the competitive equilibrium?
- Is the competitive equilibrium efficient?
- What is the optimal policy?

What I Do

- Construct a model with loss averse agents in RBC;
- Derive competitive equilibrium and show its inefficiency compared to social optimum;
- Carry on quantitative analysis;
- Obtain optimal fiscal policy.

Related Literature

- Business cycle and policy analysis:
  - Schmitt-Grohé and Uribe (2004a, 2004b), Chugh (2006) and Arseneau and Chugh (2012)...;
  - None of them incorporate exotic preferences.
- Exotic preferences in a business cycle model:
  - Angeletos and Calvet (2006), Angeletos (2007), Croce et al (2012): Epstein-Zin preferences
  - Above researches never apply loss aversion preferences.

Related Literature

Loss aversion in general equilibrium:

- Barberis, Huang and Santos (2001): asset pricing.
  - Explain the high mean, excess volatility and predictability of stock returns;
  - Solve equity premium puzzle by loss aversion.
- Barberis and Huang (2001), and Berkelaar and Kouwenberg (2009): equilibrium firm-level stock returns with loss aversion.
- Pagel (2013): explain empirical observations about life-cycle consumption using the expectation-based reference-dependent preference.
- Never in production economy; not policy analysis.

Economy

- An infinitely-lived representative household;
- Endowed with one unit of labor.

Economy

- Single good: produced with labor n_t and capital k_t; affected by stochastic productivity Z_t,

$$\ln Z_{t+1} = \rho_z \ln Z_t + \sigma_{\epsilon^z} \epsilon^z_{t+1}.$$

- Product and factor markets: competitive.

- Output Y_t: consumed by household or used to augment the capital stock

$$c_t + k_{t+1} = Y_t + (1 - \delta) k_t.$$

Firm

- A representative firm;
- takes as given wage rate w_t and rental rate r_t
- maximizes profit

$$\Pi_t = Z_t F(k_t, n_t) - r_t k_t - w_t n_t.$$

Household

$$E_0 \sum_{t=0}^{\infty} \beta^t U_t,\ \beta \in (0,1),$$

s.t.

$$c_t + k_{t+1} + a_{t+1} = w_t n_t + r_t k_t + (1-\delta)k_t + R_t^f a_t.$$

a_t: non-state-contingent private bonds traded among individuals;

R_t^f: gross return of private bonds from $t-1$ to t.

Preference Specification

Instantaneous utility:
consumption c_t and ...
...potential gain in investment markets X_{t+1} (Barberis, Huang and Santos, 2001 QJE)

$$U_t = u(c_t) + \eta\beta E_t v(X_{t+1}),$$

where u is strictly increasing, concave and two times continuously differentiable in c,
and v reflects loss aversion.
η: relative weight on the utility from expected gain compared to consumption.

Preference Specification

$$v(X_{t+1}) = \begin{cases} X_{t+1}, & \textit{if } X_{t+1} \geq 0; \\ \lambda X_{t+1}, & \textit{if } X_{t+1} < 0. \end{cases}$$

λ: loss aversion degree; $\lambda > 1$.

Define gross return of capital rental as $R_t^k = r_t + 1 - \delta$.

$$X_{t+1} = k_{t+1} R_{t+1}^k - k_{t+1} R_{t+1}^f.$$

$v(X_{t+1}) = k_{t+1} v(D_{t+1})$, where $D_{t+1} = R_{t+1}^k - R_{t+1}^f$.

Competitive Equilibrium Characterization

- $n_t = 1$.
- Production function:

$$Y_t = Z_t f(k_t).$$

- Factor Prices:

$$r_t = Z_t f_k(k_t),$$

$$w_t = (1-\alpha) Z_t f(k_t).$$

Competitive Equilibrium Characterization

- Representative household holds zero bond.
- Budget constraint:

$$c_t + k_{t+1} = w_t + r_t k_t + (1 - \delta) k_t.$$

- Euler equations:

$$u'(c_t) = \beta E_t[R^k_{t+1} u'(c_{t+1})] + \eta \beta E_t v(D_{t+1}),$$

$$u'(c_t) = \beta R^f_{t+1} E_t[u'(c_{t+1})].$$

Inefficiency of Competitive Equilibrium

Proposition

Competitive equilibrium is inefficient when agents are loss averse.

Intuition:

- consider prices as exogenous;
- prices enter into utility.

Inefficiency of Competitive Equilibrium

loss aversion contributes to less investment on capital. Two welfare effects:

1. guarantee a smaller amount of loss in a bad situation;
2. less capital lowers next period's output and consumption.

The latter effect dominates the former.

Steady State

Proposition

At the deterministic steady state of the competitive equilibrium, with and without loss aversion the representative household determines the same consumption and investment allocations.

Intuition: formulation of loss aversion in intertemporal environment is based on uncertainty...
... and deterministic steady state rules out unsure shocks.

Functional Form Assumptions

- CRRA function, $u(c_t) = \frac{c_t^{1-\theta}}{1-\theta}$, $\theta > 0$;
- Cobb-Douglas production function, $Y_t = Z_t k_t^{\alpha} n_t^{1-\alpha}$;
- Gross return of capital, $R_t^k = r_t + 1 - \delta = \alpha Z_t k_t^{\alpha-1} + 1 - \delta$.

Functional Form Assumptions

- Indifferent threshold of investment: $z_{t+1}^{idf} = \frac{R_{t+1}^{f} - 1 + \delta}{\alpha k_{t+1}^{\alpha-1}}$
- Expected utility from next period's investment gain conditional on t's information (in the spirit of Köszegi and Rabin, 2009 AER):

$$E_t v(X_{t+1}) = k_{t+1} E_t v(D_{t+1}) =$$
$$= k_{t+1}[\int_0^{z_{t+1}^{idf}} \lambda(R_{t+1}^{k} - R_{t+1}^{f}) d\mathrm{F}_{\mathrm{Z_{t+1}|Z_t=z_t}}(z_{t+1}) +$$
$$+ \int_{z_{t+1}^{idf}}^{\infty} (R_{t+1}^{k} - R_{t+1}^{f}) d\mathrm{F}_{\mathrm{Z_{t+1}|Z_t=z_t}}(z_{t+1})],$$

where $\mathrm{F}_{\mathrm{Z_{t+1}|Z_t=z_t}}(z_{t+1})$ is the conditional cumulative distribution function of shock Z_{t+1} in period t.

Parameter Values

Table: Parameter values for baseline model

Parameter Name	Value	Description
α	0.32	capital share
β	0.98	discounted rate
θ	6	risk aversion degree
δ	0.1	annual depreciation rate
ρ_z	0.81	persistence of productivity
σ_{ϵ^z}	0.04	standard deviation of innovation on productivity
λ	2.5	baseline loss aversion degree
η	1	baseline relative weight of psychological utility over consumption

λ and η are varied from 2 to 3, and from 0 to 1, respectively with the interval of 0.1.

Results

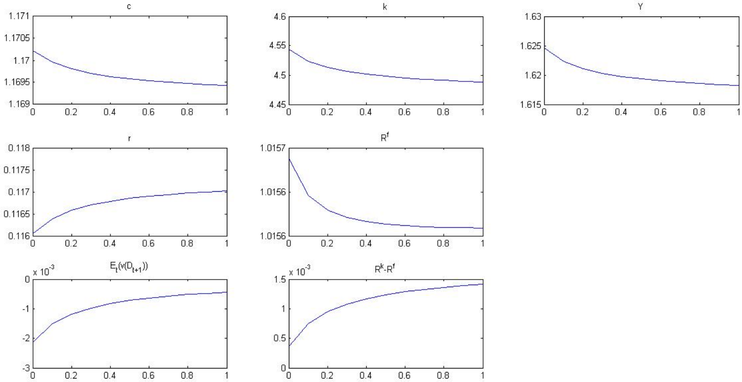

Figure: Means with Relative Weight

Results

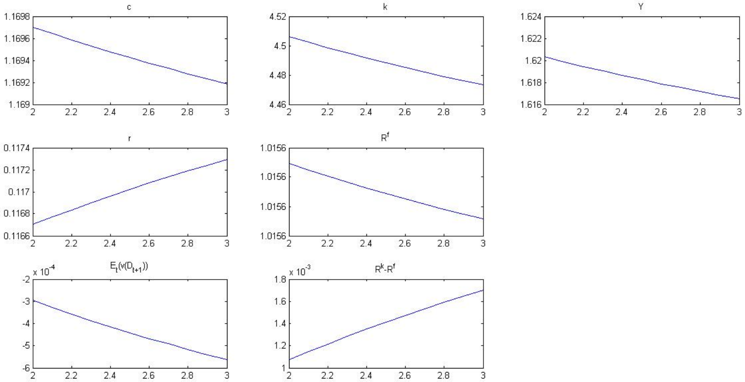

Figure: Means with Loss Aversion Degree

Economy

Feasibility condition

$$c_t + k_{t+1} + g_t = Y_t + (1-\delta)k_t.$$

Government purchases g_t

$$\ln g_{t+1} = (1-\rho_g)\ln \bar{g} + \rho_g \ln g_t + \sigma_{\epsilon^g}\epsilon^g_{t+1}.$$

Government

Government finances its expenditure by levying distortionary taxes on earnings from capital at rate τ_t^k and a lump-sum tax T_t.

$$T_t + \tau_t^k r_t k_t = g_t.$$

Household

Household budget constraint

$$c_t + k_{t+1} + a_{t+1} = w_t n_t + (1 - \tau_t^k) r_t k_t + (1 - \delta) k_t + R_t^f a_t.$$

Gross return of capital net of taxation $R_t^k = (1 - \tau_t^k) r_t + 1 - \delta$. Indifferent threshold of investment: $z_{t+1}^{idf} = \frac{R_{t+1}^f - 1 + \delta}{(1 - \tau_{t+1}^k) \alpha k_{t+1}^{\alpha - 1}}$

Ramsey Policy

Table: Moments results

Variable	Means	Std.Dev.	Auto corr	Corr(x,Y)	Corr(x,g)	Corr(x,z)
$\eta = 0$						
Consumption	0.88	0.07	0.97	0.92	-0.37	0.59
Capital	4.75	0.83	0.99	0.78	-0.17	0.31
Output	1.65	0.17	0.92	1	-0.10	0.83
Interest rate	0.11	0.02	0.93	-0.35	0.17	0.22
Bond gross return	1.01	0.01	0.96	-0.52	0.21	0.03
Capital income tax rate	-0.38	0.00	0.39	-0.01	0.07	-0.21
Lump-sum tax	0.29	0.04	0.88	-0.10	1.00	0.00

The rows of capital income tax rate are measured in percentage points while others are in levels.

Ramsey Policy

Table: Moments results

Variable	Means	Std.Dev.	Auto corr	Corr(x,Y)	Corr(x,g)	Corr(x,z)
$\eta = 1$						
Consumption	0.89	0.06	0.97	0.92	-0.38	0.59
Capital	5.26	0.95	1.00	0.79	-0.14	0.25
Output	1.71	0.18	0.92	1	-0.09	0.78
Interest rate	0.10	0.02	0.94	-0.42	0.13	0.22
Bond gross return	1.01	0.02	0.77	-0.14	0.21	0.37
Capital income tax rate	-8.25	13.85	0.73	-0.38	0.10	-0.40
Lump-sum tax	0.34	0.09	0.78	0.28	0.58	0.33

The rows of capital income tax rate are measured in percentage points while others are in levels.

Impulse Response to Productivity Innovation

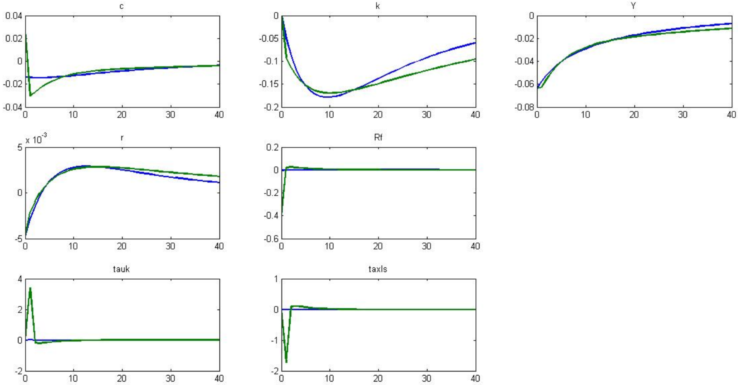

Figure: IMPULSE RESPONSE TO PRODUCTIVITY SHOCK

Summary

1. Provide a framework of modeling prospect theory in RBC;
2. Competitive equilibrium is inefficient as long as the agent is loss averse;
3. Government should subsidize capital accumulation.

Thank you!