Coping with risk (1)

Doing it alone: Borrowing, Savings, and Income smoothing

BASIC MODEL

An individual faces a variable income process y_t, and a (potentially variable) interest rate r_t. Optimal saving and borrowing policy?

The utility at time t is defined as: $u_t = E_t[\sum_{k=t}^{T} v_k(c_k)]$

where $v_k(.)$ is the instantaneous utility of consumption in period k, viewed from period t.

Common example for $v_k(.)$ is $v_{t+a}(c_{t+a}) = (1+\delta)^{-a} v(c_t)$ for some utility function v (exponential discounting).

The individual faces a terminal condition ($A_T = 0$) an asset accumulation equation:

$$A_{t+1} = (1 + r_t)(A_t + y_t - c_t)$$

(the portion of "cash on hand" ($A_t + y_t$) that is withheld from today's consumption (saved), plus any interest that is earned on it, becomes tomorrow's assets).

To solve this problem, use the tools of dynamic programing (see Dixit's classic book). The value function of the problem indicates the expected utility of an individual who makes the optimal choice of savings, given a certain level of asset (the state variable).This is the Bellman equation.

$$V(A_t) = Max_{\omega}\{v_t(A_t + y_t - \quad) + E_t V_{t+1}[(1 + r_{t+1}) \quad]\}$$

$$V(A_t) = Max_\omega\{v_t(A_t + y_t - \quad) + E_t V_{t+1}[(1 + r_{t+1}) \quad]\} \qquad (1)$$

First order condition with respect to

$$v_t(c_t) = E_t[(1 + r_{t+1})V\ (A_{t+1})] \qquad (2)$$

We now need to express $V\ (A_{t+1})$ as a function of quantity we know. For this, derive the Bellman equation with respect to assets, at the optimal omega: $V\ (A_t) = v_t(c_t) = \quad_t(c_t)$

where $\quad_t(c_t)$ is just a notation for the marginal utility of consumption.

The derivative of $E_t V_{t+1}[(1 + r_{t+1}) \quad]$ with respect to A_t is 0, because at the optimum, the derivative of $E_t V_{t+1}[A_{t+1}]$ with respect to $\quad$ is 0 (envelope theorem).

We can now combine equations (2) and (3):

$$_t(c_t) = E_t[(1 + r_{t+1})\ \ _{t+1}(c_{t+1})] \tag{3}$$

This is the Euler equation, absolutely central in macroeconomics. It states that the marginal utility of consumption today must be equal to the marginal utility of consumption tomorrow, up to a discount factor.

Special Cases

Exponential utility + constant interest rate (r) simpler expression for the Euler equation:

$$(c_t) = \frac{1+r}{1+\delta} E_t(\ \ (c_{t+1}))$$

If in addition, $v(.)$ is a quadratic function ($V(c) = ac - bc^2$), and r=δ then the equation further simplifies to

$$c_t = E[c_{t+1}],$$

Consumption follows a martingale (Hall).

Empirical Test: Paxson

Euler equation implies that changes in *permanent* and *transitory* income should have different consequences on consumption.

In the simplest case a *permanent* change in income should be entirely consumed, while a transitory change in income should be entirely saved.

Does this correspond to what we observe? Paxson tests this using data from rice farmers in Thailand.

Key idea is that year-to-year variation in rainfall causes transitory variation in income. Does that translate into larger variation in savings than permanent source of variation in income (such as landownings)?

Estimating equation:

$$S_{irt} = \quad {}_1 Y_{irt}^P + \quad {}_2 Y_{irt}^T + \quad {}_3 VAR_{ir} + W_{irt} \quad {}_4 + \quad {}_{irt}$$

Traditional approach has been to find variable that affect permanent income, but not utility function (i.e. not consumption and savings directly).

$$Y_{irt}^P = X^{1irt} \quad {}_1 + \quad {}_{irt}$$

where X^{irt} are household characteristics.
Difficult to find convincing instruments.

This approach:

$$Y_{irt}^T = X^{2irt} \quad {}_2 + \quad {}_{irt}$$

where X^{2irt} are deviation from average value of rainfall in each four seasons.

TABLE 3—REDUCED-FORM INCOME AND SAVINGS EQUATIONS

Variable	Income		SAVE1		SAVE2		SAVE3	
	Estimate	t	Estimate	t	Estimate	t	Estimate	t
Intercept	2,455.6	(16.30)	767.30	(2.88)	1,062.0	(4.03)	358.38	(1.06)
Year = 1981	301.68	(6.39)	44.774	(0.54)	37.450	(0.45)	121.57	(1.15)
Year = 1986	−402.26	(4.85)	−616.08	(4.20)	−725.18	(5.00)	−229.02	(1.23)
Rainfall variables:								
$(R_1 - \bar{R}_1)$	1.9093	(2.52)	3.2338	(2.42)	2.9861	(2.26)	2.6737	(1.58)
$(R_1 - \bar{R}_1)^2$	−0.0450	(3.99)	−0.0654	(3.28)	−0.0493	(2.50)	−0.0388	(1.54)
$(R_2 - \bar{R}_2)$	1.2502	(5.55)	1.2077	(3.03)	1.2888	(3.27)	1.2698	(2.52)
$(R_2 - \bar{R}_2)^2$	0.0009	(0.66)	−0.0009	(0.40)	−0.0002	(0.09)	−0.0007	(0.23)
$(R_3 - \bar{R}_3)$	0.2282	(1.00)	−0.7973	(1.98)	−0.6963	(1.75)	0.6231	(1.23)
$(R_3 - \bar{R}_3)^2$	0.0004	(0.62)	0.0008	(0.63)	0.0009	(0.72)	0.0011	(0.66)
$(R_4 - \bar{R}_4)$	1.6097	(2.57)	0.5466	(0.49)	0.6314	(0.58)	2.7626	(1.97)
$(R_4 - \bar{R}_4)^2$	−0.0095	(2.85)	−0.0090	(1.53)	−0.0087	(1.50)	−0.0170	(2.29)
Sex/age/education variables:								
Number of people aged 0–5	37.693	(1.73)	−43.168	(1.12)	−56.465	(1.48)	26.942	(0.55)
Number of males aged 6–11	59.730	(2.29)	13.313	(0.29)	37.334	(0.82)	20.976	(0.36)
Number of females aged 6–11	79.547	(3.16)	9.2344	(0.21)	20.577	(0.47)	−74.5333	(1.32)
Number of males aged 12–17	220.57	(8.11)	−32.445	(0.68)	38.508	(0.81)	32.678	(0.54)
Number of females aged 12–17	192.98	(7.08)	−19.965	(0.41)	40.598	(0.85)	60.605	(1.00)
Number of males aged 18–64:								
Primary school or less	349.38	(13.14)	41.919	(0.89)	95.070	(2.04)	30.400	(0.51)
Secondary school	765.72	(8.20)	−131.55	(0.80)	76.724	(0.47)	−318.86	(1.53)
Postsecondary school	1042.9	(7.69)	23.487	(0.10)	302.51	(1.27)	−182.55	(0.60)
Number of females aged 18–64:								
Primary school or less	62.306	(1.62)	31.259	(0.46)	43.890	(0.65)	292.07	(3.39)
Secondary school	345.63	(2.59)	−257.59	(1.09)	−43.456	(0.19)	210.00	(0.70)
Postsecondary school	676.93	(3.32)	186.11	(0.52)	277.22	(0.78)	−429.96	(0.94)
Number of males aged 65 or more	135.52	(1.99)	−5.1721	(0.04)	−32.04	(0.27)	−48.097	(0.32)
Number of females aged 65 or more	159.68	(2.60)	−91.856	(0.85)	−53.10	(0.50)	27.394	(0.20)
Landownership dummies (omitted category is owns 40 rai or more):								
Renter	−1,338.8	(18.93)	−742.32	(5.93)	−938.24	(7.58)	−297.15	(1.88)
Owns less than 2 rai	−1,699.6	(5.46)	−281.72	(0.51)	−588.17	(1.08)	−24.900	(0.04)
Owns 2–4 rai	−1,769.4	(16.32)	−707.31	(3.69)	−924.65	(4.87)	−479.16	(1.98)
Owns 5–9 rai	−1,583.2	(20.97)	−641.01	(4.80)	−850.34	(6.44)	−440.61	(2.61)
Owns 10–19 rai	−1,368.3	(21.11)	−695.45	(6.07)	−841.95	(7.42)	−382.71	(2.64)
Owns 20–39 rai	−1,008.3	(15.99)	−559.39	(5.01)	−685.25	(6.21)	−367.25	(2.60)
R^2:	0.34		0.03		0.04		0.02	
F tests:[a]								
Test 1	0.0001		0.0008		0.0016		0.0090	
Test 2			0.4044		0.6180		0.9049	
Test 3			0.0001		0.0001		0.1432	

Notes: The numbers in parentheses are t statistics. The table shows ordinary least-squares estimates of income and savings equations. The number of observations is 4,855. In addition to the variables listed, the regressions included dummy variables for 20 regions and two years. Means and standard deviations for all variables are given in the Appendix. Definitions of variables: SAVE1 is income minus expenditure on all goods; SAVE2 is income minus expenditure on nondurable goods; SAVE3 is the change in assets.

[a]Table entries for F tests are P values. Test 1: rainfall variables jointly insignificant. Test 2: effect of rain on income equals effect of rain on savings. Test 3: landownership variables jointly insignificant.

TABLE 4—TWO-STEP AND MAXIMUM-LIKELIHOOD ESTIMATES OF SAVINGS EQUATIONS

	Two-step			Maximum likelihood		
Variable	SAVE1	SAVE2	SAVE3	SAVE1	SAVE2	SAVE3
$\hat{Y}^P$ (α_1)	0.2773	0.4400	0.1824	0.2514	0.4210	0.1649
	(5.40)	(8.94)	(2.73)	(4.86)	(8.51)	(2.45)
$\hat{Y}^T$ (α_2)	0.7362	0.8039	0.7340	0.7546	0.8015	0.8294
	(4.28)	(4.87)	(3.21)	(4.32)	(4.84)	(3.50)
$\hat{\varepsilon}$	0.6015	0.6925	0.3801			
	(24.89)	(29.71)	(11.91)			
Number of people aged 0–5	−33.627	−52.854	29.147	−32.634	−52.186	29.439
	(0.92)	(1.51)	(0.61)	(0.89)	(1.49)	(0.62)
Number of people aged 6–11	3.3521	7.8316	−43.575	5.2934	9.2304	−41.756
	(0.11)	(0.26)	(1.07)	(0.17)	(0.31)	(1.03)
Number of people aged 12–17	−83.585	−49.733	1.1948	−76.071	−44.321	5.7906
	(2.34)	(1.45)	(0.03)	(2.11)	(1.29)	(0.12)
Number of people aged 18–64	−42.556	−38.812	55.067	−32.092	−31.225	62.543
	(1.08)	(1.03)	(1.08)	(0.81)	(0.82)	(1.22)
Number of people aged 65 or more	−104.31	122.77	−56.013	−96.869	−117.38	−49.628
	(1.54)	(1.89)	(0.64)	(1.43)	(1.80)	(0.56)
STD.DEV(R_1)	2.3958	1.7377	−3.6314	3.0425	2.1041	−3.1111
	(0.76)	(0.58)	(0.89)	(0.96)	(0.70)	(0.76)
STD.DEV(R_2)	−3.4154	−3.0750	−0.7963	−3.4043	−3.0948	−1.1993
	(1.99)	(1.88)	(0.36)	(1.97)	(1.89)	(0.53)
STD.DEV(R_3)	4.1747	4.0070	−2.1694	4.2644	4.0898	−1.7891
	(1.80)	(1.81)	(0.72)	(1.83)	(1.84)	(0.59)
STD.DEV(R_4)	3.7522	3.4730	−1.9300	4.1689	3.7832	−1.4476
	(1.73)	(1.67)	(0.68)	(1.91)	(1.82)	(0.51)
t test, $\alpha_2 = \alpha_1$:	2.50	2.06	2.26	2.69	2.14	2.64
t test, $\alpha_2 = 1$:	1.53	1.19	1.16	1.40	1.20	0.72
Overidentification test, $X^2_{[36]}$ [significance level]:				97.59 [0.0001]	87.39 [0.0001]	70.88 [0.0001]

Notes: The number of observations is 4,855. The numbers in parentheses are t statistics. $\hat{Y}^P$, $\hat{Y}^T$, and $\hat{\varepsilon}$ for the two-step estimates are based on estimates of the income equation shown in Table 3. The savings equations contained, in addition to the variables shown, a time-varying intercept. Definitions of variables: SAVE1 is income minus expenditure on all goods; SAVE2 is income minus expenditure on nondurable goods; SAVE3 is the change in assets.

permanent income (0.16 for the maximum-likelihood estimates).

As discussed in Section I, it is difficult to interpret the estimates of the marginal propensity to save out of unexplained income ($\hat{\varepsilon}$). Since estimates of ε contain both permanent and transitory components, the estimated propensity to save out of $\hat{\varepsilon}$ is likely to be a mixture of the propensities to save out of permanent and transitory income. Furthermore, measurement error in income will bias up the estimated propen-

LIQUIDITY CONSTRAINT

Suppose we add the additional constraint that the individual cannot borrow: $A_t \quad 0$, or $c_t \quad A_t + y_t$.

There are now two regimes:
- Unconstrained: $(c_t) = \frac{1+r}{1+} E_t(\ \ (c_{t+1}))$
- Constrained: $c_t = A_t + y_t$ and $\ \ (c_t) > \frac{1+r}{1+} E_t(\ \ (c_{t+1}))$

(the marginal utility of consumption is higher in the constrained state, since you cannot consume as much as you would like to).

Putting the two cases together, we get:

$$(c_t) = Max\{\ \ (A_t + y_t), \frac{1+r}{1+\delta} E_t(\ \ (c_{t+1})\}$$

Deaton (1990, 1991) shows that the solution can be characterized by a consumption function $c_t = f(A_t + y_t)$, that is the consumption is a function of total "cash on hands".

With $v(c) = c$, it can be shown that the optimal rule has the form:
-If $A_t + y_t$ $\overline{X_t}$, $c_t = A_t + y_t$.
-If $A_t + y_t > \overline{X_t}$, save a fraction of the difference between cash in hands and $\overline{X_t}$.

The individual will constitute a "buffer stock", by saving in good time. The propensity to consume out of assets will be smaller when assets are high than when they are low (when they are low, asset will be completely depleted if the next realization of income is low).

How much consumption smoothing an individual can achieve by building a buffer stock in isolation?

Simulate an income path and the path of consumption and asset that follows from applying the optimal rule.

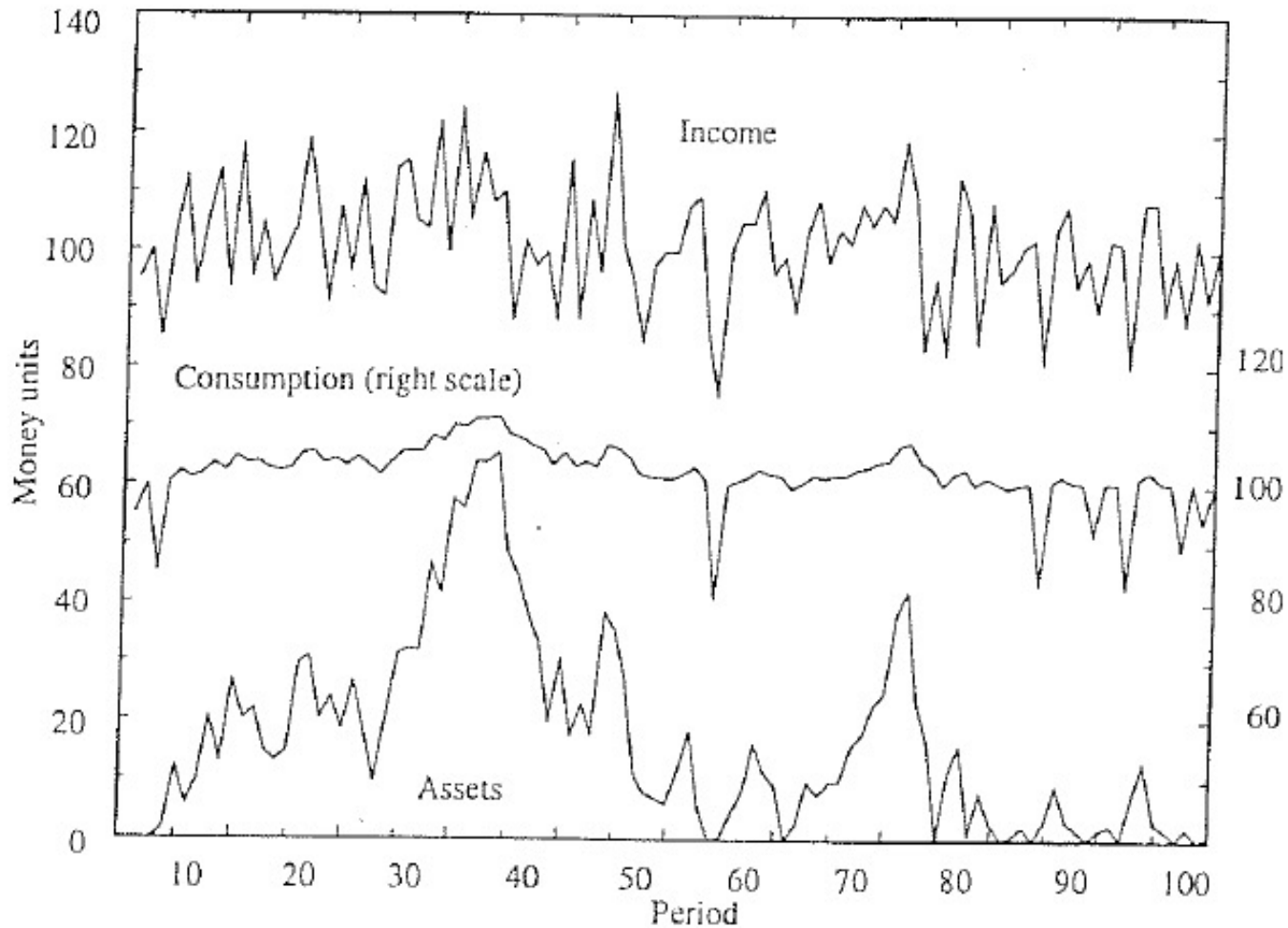
In some cases, the optimal rule can be approximated with a very simple rule of thumb:

Suppose income is iid with mean 100 and standard deviation 10, and see how much smoothing you can achieve with the simple rule of thumb:

$$c_t = (A_t + y_t) - 0.7 \quad (A_t + y_t - 100) \quad \mathbf{1}(A_t + y_t \quad 100)$$

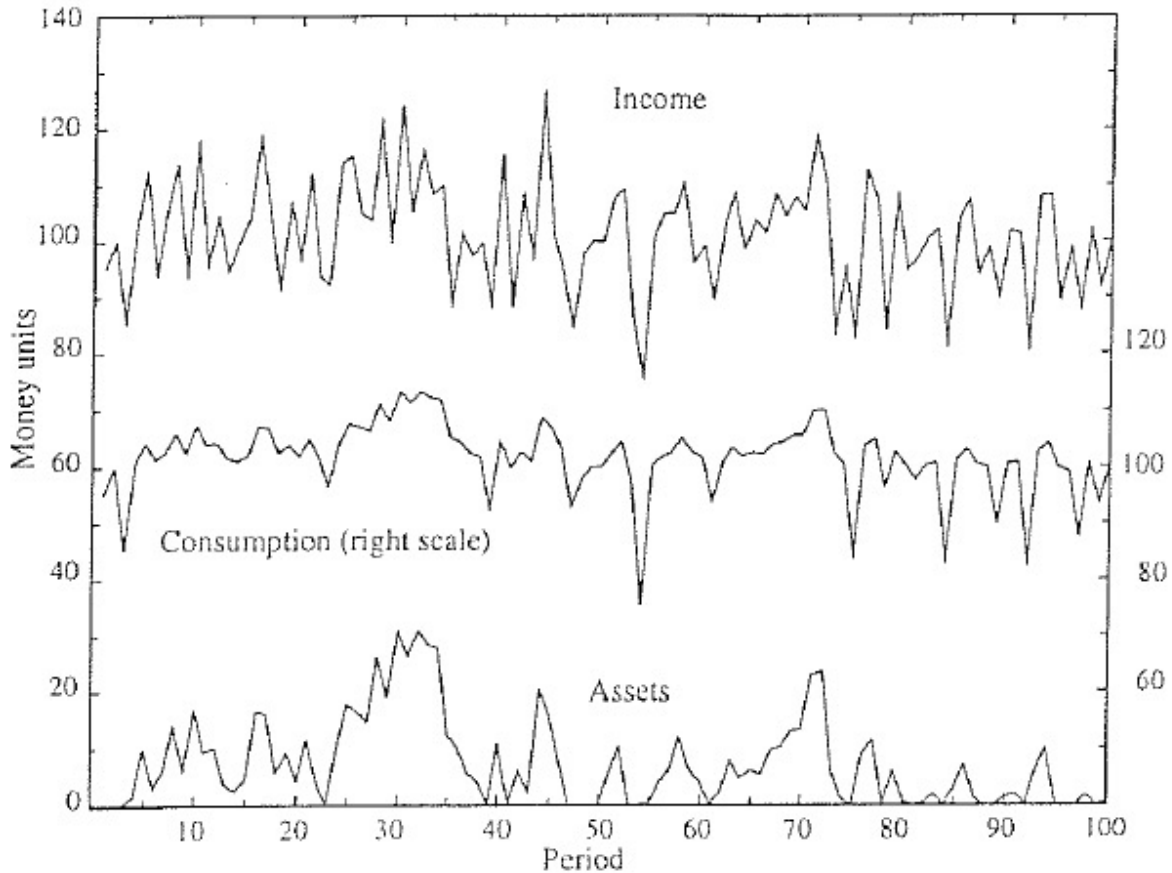
Consumption is much smoother than income, but can fall pretty low. Individual can smooth consumption more by saving more, but they will hold huge assets in some periods.

Figure 6.9. The effects of a conservative saving policy



Source: Author's calculations as described in the text.

Figure 6.8. Simulation of income, consumption, and assets



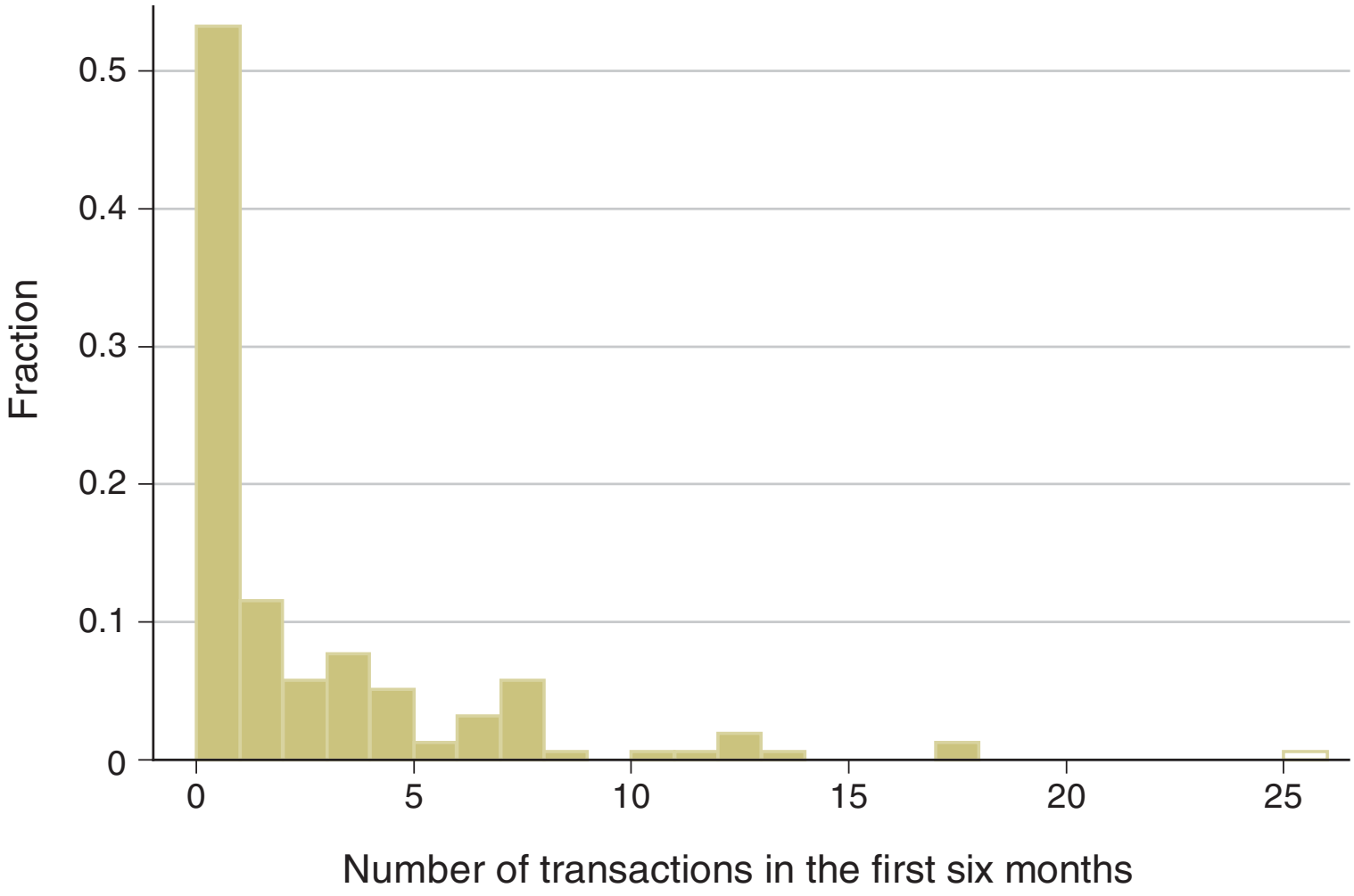
Implications

- Risk averse households should be saving a whole lot.
- Even if they don't have great savings options (they can save in their own business), but particularly if they do
- (Very) Large returns to savings : Dupas-Robinson 2013, Schaner 2015
- But... experiment after experiment, very low take up of saving option. Dupas, Robinson, Karlan, Ubfal (2018) replicate Dupas-Robinson in Uganda, Malawi, Chile Find that 17%, 10% and 3% of people used account.
- And people fall back quickly into debt
- The models we have seen so far do not rationalize savings behavior

Evidence: Dupas-Robinson 2013

- Dupas, Robinson (2013) Open free savings account for small business owners at a local bank (waive the opening fee, which is normally \$7 (for business owners who make on average about \$2 a day). The accounts have no interest and a withdrawal fee of 50 cents for transfers below \$8, 80 cents for withdrawals between \$8 and \$15 and \$1.5 above.
- At baseline, 2% of people had an account.
- Researchers did a baseline with 300 people, and randomly selected half of them, to whom they offered to pay the opening fees for a savings account.
- After 6 months, they had people fill daily log-books on business activities and expenditures, for about 3 months.
- Usage: See conditional distribution function of savings. What is the main finding?

Usage


0.5
0.4
0.3
0.2
0.1
0
Fraction
0
5
10
15
20
25
Number of transactions in the first six months

Savings

TABLE 2—I CTS ON S VINGS

	Active bank account usage (" rst-stage")		Bank savings (Ksh)		Animal savings (Ksh)		ROSCA contributions (Ksh)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. Intention-to-Treat Estimates (ITT)								
Sampled for savings account	0.41 (0.05)***	0.40 (0.06)***	9.36 (3.43)***	11.39 (4.42)**	16.79 (10.05)*	23.26 (14.03)*	7.81 (7.02)	12.57 (10.08)
Sampled for savings account *Boda*		0.06 (0.11)		12.43 (6.06)**		20.00 (17.85)		12.56 (14.10)
Observations	250	250	250	250	250	250	250	250
p-value for overall effect = 0	0.01***		0.01***		0.1*		0.27	
p-value for effect for female vendors = 0		0.01***		0.01**		0.1*		0.21
p-value for effect for *bodas* = 0		0.01***		0.82		0.75		1.00
Panel B. Instrumental Variable Estimates (ToT)								
Account is active			22.82 (8.51)***	28.77 (11.41)**	40.91 (24.41)*	58.37 (35.09)*	19.03 (17.08)	31.42 (25.11)
Account is active *boda*				29.35 (13.88)**		49.40 (40.88)		30.57 (31.87)
Observations			250	250	250	250	250	250
p-value for overall effect = 0			0.01***		0.1*		0.27	
p-value for effect for female vendors = 0				0.01**		0.1*		0.21
p-value for effect for bodas = 0				0.95		0.67		0.96

Business Outcomes

TABLE 3—I CTS ON BUSINESS OUTCOMES

	Total hours worked		Business investment (no trimming)		Business investment (top 5% trimmed)		Business revenues (no trimming)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. Intention-to-Treat Estimates (ITT)								
Sampled for savings account	0.15	0.31	179.71	203.23	87.37	90.43	129.32	116.46
	(0.37)	(0.44)	(105.17)*	(147.63)	(46.91)*	(61.38)	(100.32)	(133.34)
Sampled for savings account *boda*		0.58		97.03		30.08		3.28
		(0.88)		(222.92)		(84.45)		(203.17)
Observations	249	249	244	244	244	244	241	241
p-value for overall effect = 0	0.69		0.09*		0.06*		0.20	
p-value for effect for female vendors = 0		0.49		0.17		0.14		0.38
p-value for effect for *bodas* = 0		0.72		0.50		0.34		0.46
Panel B. Instrumental Variable Estimates (ToT)								
Account is active	0.36	0.77	425.20	503.85	206.72	224.49	304.44	289.71
	(0.91)	(1.12)	(248.32)*	(365.57)	(112.18)*	(154.02)	(236.81)	(331.59)
Account is active *boda*		1.31		258.45		86.73		41.68
		(1.94)		(490.29)		(187.01)		(438.13)
Observations	249	249	244	244	244	244	241	241
p-value for overall effect = 0	0.69		0.09*		0.07*		0.20	
p-value for effect for female vendors = 0		0.49		0.17		0.15		0.38
p-value for effect for *bodas* = 0		0.74		0.44		0.28		0.41

Business Outcomes

TABLE 4—I CTS ON EXPENDITURES

	Daily total expenditure		Daily food expenditure		Daily private expenditure		Net transfers outside the household	Net transfers to spouse
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. Intention-to-Treat Estimates (ITT)								
Sampled for savings account	23.93	31.17	10.67	14.46	8.94	7.77	18.84	4.16
	(15.81)	(19.59)	(6.41)*	(8.47)*	(3.75)**	(3.98)*	(20.86)	(7.06)
Sampled for savings account *boda*		9.70		7.78		5.18	17.81	4.01
		(44.42)		(15.61)		(11.63)	(22.65)	(9.71)
Observations	250	250	250	250	250	250	249	202
p-value for overall effect = 0	0.13		0.1*		0.02**			
p-value for effect for female vendors = 0		0.11		0.09*		0.05*	0.37	0.56
p-value for effect for *bodas* = 0		0.58		0.60		0.24	0.86	0.20
Panel B. Instrumental variable estimates (ToT)								
Account is active	58.33	77.97	26.00	36.20	21.79	19.61	47.32	11.50
	(38.50)	(48.81)	(15.46)*	(21.02)*	(9.40)**	(10.18)*	(53.01)	(19.48)
Account is active male vendor		141.64		57.83		0.22	56.99	63.07
		(114.10)		(39.79)		(28.80)	(59.72)	(75.94)
Account is active *boda*		30.73		21.09		8.62	43.53	4.69
		(96.51)		(33.92)		(26.12)	(54.54)	(23.65)
Observations	250	250	250	250	250	250	249	202
p-value for overall effect = 0	0.13		0.09*		0.02**			
p-value for effect for female vendors = 0		0.11		0.09*		0.06*	0.37	0.56
p-value for effect for *bodas* = 0		0.56		0.57		0.25	0.75	0.22

Results

- Few people use accounts, but for those who do:
- Increase in in investment in the business.
- Some increase in consumption
- Decrease in sensitivity to shocks.

Schaner, 2015

- Look at the long run effect of short run savings incentives
- For 6 months, offered households in Kenya higher interest rate (randomly varied between 0, 4, 12 or 20 percent)
- Follow up immediately and 2.5 years after the subsidies have expired

Short run impact

Table 2. Short-Run (6-Month) Impacts on Bank Account Use

	Use of Individual Accounts				Use of Joint Accounts				All Experimental Accounts		
	Opened	Used	Total Deposits	Average Balance	Opened	Used	Total Deposits	Average Balance	Used (Any Acct.)	Total Deposits	Average Balance
Panel A - No Baseline Controls											
Individual Interest	0.176***	0.089***	1172***	141***	-0.081***	-0.027	-1068*	-193	0.047	104	-52.2
	(0.034)	(0.020)	(389)	(39.8)	(0.032)	(0.029)	(563)	(118)	(0.030)	(685)	(125)
Joint Interest	-0.137***	-0.007	-228	-29.5	0.182***	0.113**	-309	215	0.082*	-537	186
	(0.052)	(0.027)	(374)	(49.8)	(0.052)	(0.050)	(1494)	(172)	(0.046)	(1535)	(178)
P-value: Indiv.=Joint	0.000***	0.004***	0.010***	0.002***	0.000***	0.013**	0.586	0.142	0.525	0.667	0.399
P-value: Indiv.=Joint=0	0.000***	0.000***	0.009***	0.001***	0.000***	0.045**	0.146	0.258	0.057*	0.909	0.511
Panel B - Baseline Controls											
Individual Interest	0.168***	0.083***	1122***	138***	-0.082***	-0.033	-1234*	-195*	0.036	-112	-56.7
	(0.033)	(0.020)	(392)	(37.5)	(0.031)	(0.029)	(694)	(119)	(0.030)	(797)	(124)
Joint Interest	-0.142***	-0.016	-274	-44.4	0.179***	0.109**	-452	211	0.072	-726	167
	(0.052)	(0.026)	(368)	(50.4)	(0.052)	(0.050)	(1541)	(180)	(0.046)	(1574)	(186)
DV Mean (0% Ind.)	0.303	0.058	101	22.1	0.738	0.300	2033	295	0.353	2135	317
DV Mean (4% Joint)	0.461	0.110	669	102	0.603	0.219	1658	128	0.329	2328	230
N	1417	1417	1417	1417	1417	1417	1417	1417	1417	1417	1417

Notes: Robust standard errors clustered at the couple level in parentheses. All regressions control for individual and spousal cash prize selection. Baseline controls include all variables listed in Table 1. ***, **, and * indicate significance at the 1 5, and 10 percent levels respectively.

Long run impact

Table 3. Long-Run (3-Year) Impacts on Key Outcomes

	Active Experimental Account	Bank Account at Endline	Raw Values				Top-Coded (99th Percentile) Values				Logged Values*	
			Bank Savings	Total Assets	Total Debt	Monthly Income	Bank Savings	Total Assets	Total Debt	Monthly Income	Total Assets	Monthly Income
Panel A - No Baseline Controls												
Individual Interest	0.034*	0.089***	1082	15400***	-1241	1603**	934*	7106**	-104	1473***	0.536***	0.322***
	(0.019)	(0.031)	(863)	(5961)	(4276)	(747)	(549)	(3056)	(2084)	(569)	(0.150)	(0.123)
Joint Interest	0.009	0.072*	-140	12769	11755**	874	-468	6393	5111*	586	0.107	0.099
	(0.029)	(0.039)	(935)	(8379)	(5756)	(892)	(627)	(3911)	(3035)	(646)	(0.201)	(0.152)
P-value: Indiv.=Joint	0.477	0.727	0.412	0.809	0.077*	0.491	0.113	0.889	0.164	0.287	0.105	0.244
P-value: Indiv.=Joint=0	0.196	0.005***	0.431	0.007***	0.123	0.083*	0.204	0.015**	0.243	0.027**	0.001***	0.029**
Panel B - Baseline Controls												
Individual Interest	0.032*	0.073***	762	14596***	-3805	1131*	538	6489***	-1811	1121**	0.493***	0.246**
	(0.019)	(0.031)	(802)	(6194)	(4017)	(665)	(520)	(2722)	(1823)	(503)	(0.142)	(0.110)
Joint Interest	-0.002	0.056	-490	10534	7801*	669	-789	3628	2940	511	0.023	0.068
	(0.028)	(0.037)	(909)	(8509)	(4123)	(780)	(593)	(3574)	(2215)	(536)	(0.193)	(0.140)
P-value: Indiv.=Joint	0.315	0.714	0.376	0.703	0.072*	0.615	0.110	0.528	0.111	0.384	0.060*	0.319
P-value: Indiv.=Joint=0	0.246	0.025**	0.623	0.028**	0.149	0.207	0.276	0.034**	0.279	0.064*	0.002***	0.073*
DV Mean (0% Ind.)	0.080	0.664	2502	31042	14101	5849	1918	26566	9661	5187	9.95	8.35
DV Mean (4% Joint)	0.081	0.675	2687	35462	8717	6399	2410	29186	7239	5755	10.2	8.57
N	1417	1413	1236	1051	1394	1279	1236	1051	1394	1279	1051	1279

Notes: Robust standard errors clustered at the couple level in parentheses. Winsorized variables are top-coded at the 99th percentile. *To accomodate zeros, log values are an inverse hyperbolic sine transformation of the level value. All regressions control for individual and spousal cash prize selection. Baseline controls include all variables listed in Table 1. ***, **, and * indicate significance at the 1 5, and 10 percent levels respectively.

Entrepreneurship

Table 4. Impact of Interest Subsidies on Entrepreneurial Activity

			Raw Values		Top-Coded Values	
	Any Business Profits or Capital	Main Occupation Entrepreneurial	Non-Farm Business Capital	Non-Farm Business Profits	Non-Farm Business Capital	Non-Farm Business Profits
Panel A - No Baseline Controls						
Individual Interest	0.108***	0.079***	5434	735**	3015**	723***
	(0.036)	(0.032)	(4976)	(347)	(1312)	(249)
Joint Interest	0.011	0.023	-15688	223	507	270
	(0.045)	(0.042)	(11480)	(375)	(1601)	(274)
P-Value: Individual=Joint	0.083*	0.285	0.082*	0.196	0.261	0.204
P-Value: Indiv.=Joint=0	0.013**	0.043**	0.191	0.102	0.056*	0.011**
Panel B - Baseline Controls						
Individual Interest	0.099***	0.074***	4896	700**	2838**	695***
	(0.035)	(0.031)	(5215)	(321)	(1279)	(240)
Joint Interest	0.017	0.029	-15428	195	241	315
	(0.042)	(0.038)	(11324)	(353)	(1558)	(262)
P-Value: Individual=Joint	0.123	0.359	0.095*	0.201	0.239	0.272
P-Value: Indiv.=Joint=0	0.017**	0.043**	0.234	0.092*	0.072*	0.009***
DV Mean (0% Ind.)	0.361	0.284	4264	1192	4039	953
DV Mean (2% Joint)	0.460	0.355	19781	1486	5930	1295
N	1338	1417	1379	1368	1379	1368

Notes: Robust standard errors clustered at the couple level in parentheses. Top-coded variables top-coded at the 99th percentile. All regressions control for individual and spousal cash prize selection. Baseline controls include all variables listed in Table 1. ***, **, and * indicate significance at the 1 5, and 10 percent levels respectively.

Results highlights

- Relatively low short run impacts
- But very high long run impacts
- Non convexity in production? Seems unlikely due to other treatment: a cash prize drawing. That increased savings a lot in the short run, but has no long run effect.
- Who knows what it may be....

The core puzzle

- The poor borrow at rates upto 100% or more
- The Euler equation says

$$\frac{U'(C_t)}{U'(C_{t+1})} \qquad R_t$$

with $= \frac{1}{1+}$ and $R_t = 1 + r_t$

- With CRRA preferences this is equivalent to

$$\frac{C_{t+1}}{C_t} \quad (\ R_t)^{\frac{1}{\theta}},$$

where θ is the coe cient of relative risk aversion.

- Suppose $r_t = 2, \quad = 0.95, \theta = 3$, then $\frac{C_{t+1}}{C_t}$ 112.5%. Fast consumption growth for the poor. Real incomes should be doubling every five years or so.

An interesting experiment

Karlan-Mullainathan-Roth (2019)

- Vegetable vendors:
  - Simple production function Purchase fruit in the early morning Sell through day
  - Key features of this production function: Continuous Daily Need for working capital. How do they finance it?

An interesting experiment

Karlan-Mullainathan-Roth (2019)

- Vegetable vendors:
  - Simple production function Purchase fruit in the early morning Sell through day
  - Key features of this production function: Continuous Daily Need for working capital. How do they finance it?
  - The borrow daily at 5% a day.
- Why are people borrowing at these rates?
- And not saving.
- Different way to frame it: All borrowers have access to a high return "investment": use money to borrow less

KMR: Benefits of saving

- Hard to comprehend what 5% a day actually means
- Consider the following strategy Drink one less cup of tea every day (or some thing else small). Reinvest this money back into business
- Compounding implies: in 30 days will have doubled income.
- Why don't they?

KMR:Why don't they?

- Mismeasuring 'true cost' of the loan
  - Desire to keep relationship with money lender
  - Default rates high Can't borrow a little less
- Conceptual explanations
  - Inability to cut back on consumption (Stone-Geary)
  - Vendors discount the future a lot
  - Vendors don't understand compounding
  - Vendors don't have access to savings
  - Vendors face within family conflicts that lower returns to savings
  - Vendors face self-control problems

KMR: Experiment

- Two treatments. Cross-cut
- Buyout Give a cash grant enough for individuals to buyout their debt
  - Working capital on a good day (gotten from the baseline survey). As high as 3000Rs.
- Training Half day class where they:
  - Worked out how much they've spent in total on interest rate
  - Benefits of cutting down: illustration
  - Discussed what they could have done with the money
  - Brainstorm on ways to cut down

KMR: Potential hypotheses

- Training is to pick up the effect of financial literacy
- If they cannot cut back consumption then the buyout should put them on a path to save
- If they cannot save, they should be able to stay where they are unless they get hit by a big shock
- If they are impatient/self-control problems, they should fall back fast.

KMR: Data and Results

- Philippines:
  - Follow up surveys occur 2 weeks 6 weeks 10 weeks
- India:
  - Follow up surveys occur 3 months 6 months 12 months
- No impact of financial education
- People fall back relatively rapidly in the repayment treatment.

TABLE 1—PRIMARY TREATMENT EFFECT ESTIMATES, INDIA 2007

	Any moneylender debt (1)	Amount moneylender debt (USD) (2)	Coped via savings (3)	Coped via borrowing (4)	Coped via cutting consumption (5)	Household monthly total expenditures (USD) (6)	Any savings (7)	Take-home profit typical day (USD) (8)
Only payoff in 1st follow-up (2–4 months)	0.17	8.35	0.12	0.06	0.06	26.51		0.04
	(0.04)	(1.99)	(0.05)	(0.06)	(0.03)	(21.44)		(0.15)
Only payoff in 2nd follow-up (5–8 months)	0.06	0.31	0.08	0.08	0.00	14.50		0.18
	(0.04)	(2.09)	(0.05)	(0.05)	(0.03)	(18.49)		(0.16)
Only payoff in 3rd follow-up (9–10 months)	0.03	0.51	0.06	0.02	0.00	8.62	0.00	0.03
	(0.04)	(2.14)	(0.04)	(0.06)	(0.02)	(19.10)	(0.03)	(0.17)

Missed opportunities

- People do not invest in fertilizer despite the fact that it has high returns, divisible (Duflo, Kremer, Robinson)
- Stock-out in cell-phone cards in shops (Beaman, Robinson)
- Very limited inventory in most grocery stores
- etc.

What is discounting

- Standard model conceptualizes it as low
- Growing literature suggests more nuanced view Individuals have inconsistent time preferences
- Can be both myopic and farsighted

Goods or money

- Subjects given opportunity to choose a movie video from a set of 24 titles
- Four Weddings and a Funeral
- Schindler's List
- When choosing for today: 56% choose low-brow
- When choosing for next Monday, 37% choose low-brow
- When choosing for second Monday, 29% choose low-brow

x_{n}

A model

Banerjee-Mullainathan: A model of temptation goods

- Within each period maximize

$$u(x) + v(z)$$

  subject to $x + z = y$. x and $z$are indices of two types of goods.
- Intertemporal preferences maximize $u(x_0) + v(z_0) + \sum_1^T {}^t u(\mathrm{x}_t)$:
- subject to $w_{t+1} = F(w_t \quad x_t \quad z_t)$, F concave
- "Reduced form" for the case where the person maximizes $u(x_0^1, ..., x_0^n) + \sum_1^T {}^t v(x_t^1, ...x_t^n)$
- Commitment problems in a two period model

Features of the model

- Commitment problems in a two period model
- Nests the Hyperbolic model
- Set $u(x) = \frac{x^{1-}}{1-}$ and $v(z) = A\frac{z^{1-}}{1-}$
  - then $z = \quad x$
  - $u(x_0) + v(z_0) = \frac{x_0^{1-\sigma}}{1-\sigma} + A\frac{z_0^{1-\sigma}}{1-\sigma} = (1 + A^{\ 1-\sigma})u(x_0)$
  - $u(x_0) + v(z_0) + \sum_1^T {}^t u(x_t) = (1 + A^{\ 1-\sigma})u(x_0) + \sum_1^T {}^t u(x_t)$
- Yields Modified Euler Equation

$$u'(x_t) = (\ F')(u'(x_{t+1}(c_{t+1}))[1 \quad z'(c_{t+1})]$$

Parametrizing $z'(c)$

Claim: Assume that the u function is given and is increasing and concave. Let $z(c)$ and $x(c)$ be a pair of non-negative valued, strictly increasing functions such that $z(c) + x(c) = c$. Then there exists an increasing, differentiable and strictly concave function v such that the assumed $z(c)$ and $x(c)$ functions are the result of maximizing $u(x) + v(z)$ subject to a budget constraint $x + z = c$, and the conditions $(x \quad 0, z \quad 0)$

Proof: Define the function $g(z) = x(h(z))$ where the function $h(z)$ is the inverse of the function $z(c)$,which exists because of the strict monotonicity of z. Then define

$$V(z) = \int_0^z U'(g(y))dy$$

Clearly $V'(z) = U'(g(z)) > 0$. It is concave because when z increases $g(z)$ increases and $U'(g(z))$ decreases.

Implications of MEE

- Two important cases:
- $z'(c)$ decreasing with c: declining temptation (DT)
- $z'(c)$ increasing with c or constant: Non-declining temptation (NDT)
- Turns out despite the fact there is always a self-control problem, the second case turns out to be much like the case without self-control problems.
- Identical CRRA preferences for x and z fall into this case: Hyperbolic discounting.
- Interesting case is when there is declining temptation: Intuition?

Implications

- Savings may go up when future income goes up with DT but not with NDT. Hope of a substantially better future matters.
- Poverty trap: Non-quasi-concave maximization problem with DT with not with NDT
  - Richer people will save. Poorer people will not
- No precautionary saving with DT even under the standard third derivative condition: not with NDT
- May prefer a large size low return project rather than a small size and high return project.
- May have a preference for a micro-finance type loan rather than a credit card loan: Consumption transformation

Evidence: Ashraf, Karlan and Yin.

- If people have these types of preferences and are at least in part aware of this, they should demand commitment devices, to tie their own hands. Moreover, those who get the option to tie their own hand should be able to save more.
- These conjectures were tested in a randomized experiment in the Philippines.
- Work with 1,700 clients of a microfinance institution in the Philippines, which offers savings account. Introduce a new savings product with a commitment feature.

Questions

- Will anybody take it up?
- Will individuals identified as hyperbolic be more likely to take it up? Will it result in increased savings (for those offered/for those who take up)
- Can we make sure it is the effect of the commitment and not something else?

Experimental design

- 1,700 existing clients are randomly assigned to one of three groups:
- Treatment group (offer of commitment savings product is made during home visits)
- Marketing group (value of commitment is extolled during home visits but no product is offered).
- Control group: nothing is offered.

Experimental design

- Commitment Treatment: Individuals can choose to set either a time goals (I will leave the money in the account until X date) or a amount goal (I will not take the money out until I have reached a particular sum). They are given a certificate and a lockbox to put accumulate their savings before they go deposit it to the bank (low barrier comitment).
- Marketing treatment: Individuals receive a home visit, and they are encourage to set themselves a goal (either time or an objective). They are given a similar certificate However, they are not offered an account with commitment features. (they are not allowed to open one even if they hear about it).

Results

- Did any body take this up?
  -202 accounts were opened
  -50% of the account stayed at the minimum deposit after 12 months
  -Half of clients did more than one contribution.
  -Fewer people (62) chose the amount goal than the time goal (147)
  - Those who did the amount goal saved much more
  - Nobody tried to withdraw before maturity
  - Accounts who reach time or amount maturity all rolled over.

Results

- Did the people who are hyperbolic take it up?
  Survey questions try to elicit preference reversal that could indicate hyperbolic behavior.
  - Would you prefer P200 today or P300 guaranteed in a month?
  -Would you prefer P200 in 6 months or P300 guaranteed in 7 months?
- Does reversal predict take up of the product? Yes for females, not for males.
- Savings: Balances after 6 months are significantly higher in commitment savings group Large effect in proportion (savings in control groups are rather small). Effect may be due to commitment: there is no significant increase in balance for the marketing group (though the estimate is large too...)

Effects on Savings

TABLE VI
IMPACT ON CHANGE IN SAVINGS HELD AT BANK
OLS, PROBIT

INTENT TO TREAT EFFECT	OLS				Probit			
Length	6 months		12 months		12 months			
Dependent variable:	Change in total balance	Change in total balance	Change in total balance	Change in total balance	Binary outcome = 1 if change in balance > 0%	Binary outcome = 1 if change in balance > 0%	Binary outcome = 1 if change in balance > 20%	Binary outcome = 1 if change in balance > 20%
Sample	All (1)	Commitment & marketing only (2)	All (3)	Commitment & marketing only (4)	All (5)	Commitment & marketing only (6)	All (7)	Commitment & marketing only (8)
Commitment treatment	234.678*	49.828	411.466*	287.575	0.102***	0.056**	0.101***	0.064***
	(101.748)	(156.027)	(244.021)	(228.523)	(3.82)	(0.026)	(0.022)	(0.021)
Marketing treatment	184.851		123.891		0.048		0.041	
	(146.982)		(153.440)		(1.56)		(0.027)	
Constant	40.626	225.476*	65.183	189.074**				
	(61.676)	(133.405)	(124.215)	(90.072)				
Observations	1777	1308	1777	1308	1777	1308	1777	1308
R^2	0.00	0.00	0.00	0.00				

Robust standard errors are in parentheses. * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent. The dependent variable in the first two columns is the change in total savings held at the Green Bank after six months. Column (1) regresses change in total savings balances on indicators for assignment in the commitment- and marketing-treatment groups. The omitted group indicator in this regression corresponds to the control group. Column (2) shows the regression restricting the sample to commitment- and marketing-treatment groups. Columns (3) and (4) repeat this regression, using change in savings balances after twelve months as a dependent variable. The dependent variable in columns (5)–(8) is a binary variable equal to 1 if balances increased by x percent. One hundred and fifty-four clients had a preintervention savings balance equal to zero. Twenty-four of them had positive savings after twelve months. These individuals were coded as "one," and those that remain at zero were coded as zero for the outcome variables for columns (5) through (8). Exchange rate is 50 pesos for U.S. $1.

Comments

- Effects are large from from relatively few people
- The time goal generate little savings
- Nothing in here forces people to put the money in (unlike in 401k). This may be the problem...

Evidence: Duflo, Kremer, Robinson

- Offer households a small discount (free delivery on fertilizer) to commit now to use later.
- Find large impact on take up, (as large as 50%) from subsidy
- Also consistent with (partially naive) hyperbolic discounting.
- (Propose a very tractable model where people are stochastically present bias (with some probability they are and with some they are not) and they underestimate the probability)

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14.771: Development Economics

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