Emotions, Cognition, and Savings: Theory and Policy (Preliminary Notes)*

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1 Introduction

Background: .

- Wide interest in how environment (e.g., marketing and interest rates), institutions (e.g., in-store instant credit), and policy (e.g., 401(k) plans) affect savings.

- Savings literature can be divided into two strands: (1) studies which assume that individuals make optimal choices, and (2) studies which assume (implicitly or explicitly) that individuals make mistakes.

- A significant fraction of the savings policy literature belongs to the second strand. The interest in policies such as saving subsidies, 401(k)s, and mandatory savings is predicated on two hypothesis: (1) individuals 'undersave', and (2) welfare improving policies increase savings.

- We acknowledge that the debate about the extent to which (if at all) individuals make saving mistakes is still ongoing. However, significant body of evidence suggests that this is indeed the case.

- Given this, it is important to develop tractable and plausible models of savings in which individuals can make mistakes. This will help in:

(1) Comparing the two views (for example by deriving new testable implications)

(2) Institutional and policy analysis.

- In the last few years Quasi-Hyperbolic Discounting (QHD) has emerged as the leading alternative model of savings.

Goal of the paper: .

- Construct a new simple model of savings in which individuals can make mistakes that is, a priory, *at least* as plausible as existing ones.

- Use it to study the impact on savings and welfare of changes in the environment, institutions, and policy.

- Show that this alternative formulation leads to conclusions that are at odds with some of the pre-suppositions of the previous literature. In particular, even though individuals make mistakes involving overconsumption, we show that:

(1) One cannot presuppose that there is under-saving. Paradoxically, in our model individuals aware of their self-control problem can end up oversaving.

(2) Once cannot presuppose that welfare improving policies increase savings. In fact, we show that for plausible ranges of parameters welfare increasing changes in the environment, institutions, and policies can decrease savings.

2 Background

To be completed.

3 Basic Model

3.1 Environment

- Large group of identical decision-makers (DMs) who live for T periods.
- High-frequency decision-making: periods are short (e.g., a concrete decision in a store, or at most a day). Thus T is large.
- $w_t \equiv$ exogenous income in period t
- $a_t \equiv$ assets at end of period t
- Initial assets a_0 exogenously given
- $1 + r_t \equiv$ asset returns from period t to $t + 1$
- $R_t \equiv (1+r_t)a_{t-1} + NPV_t(w_k|k \geq t) =$ remaining life-time resources at beginning period t
- $B_t \equiv$ budget or available resources in period t if there are liquidity constraints.
- To simplify the notation, in the analytic results we assume that $\beta_t = 1 + r_t = 1$.

3.2 Welfare

- Life-time utility or welfare of consumption path: $\sum_t \beta_t u(c_t)$.
- $u(.)$ satisfies standard properties and $u'(0) = \infty$
- DM recognizes this as his true welfare ranking over consumption paths from any perspective (prospective, retrospective, introspective, ...)
- Policy objective: max $E[\sum_t \beta_t u(c_t)]$

3.3 Decision Making

- Each period, when confronted with a particular decision, the DM's brain acts in two modes:

  - With probability$1 - \gamma_t$ it is in a *good mode*

  - With probability γ_t it is in a *faulty mode*

- Decisions are made differently in each mode
- **Good mode:** the brain deploys an appropriate combination of deliberative and emotional mechanisms, and appropiately weights present and future gains to make the choice at hand
- **Faulty mode:** the brain is overtaken by emotional mechanisms and makes the choice at hand on impulse ('without thinking', 'loosing control')
- Environmental cues (e.g., advertisements and sales tactics), internal states (e.g. anxiety or anger), and previous choices (e.g., satiation) affect how the brain makes decisions at any instant.
- **Assumption 1.** DMs are sophisticated about their self-control problem: in the good mode they know the probabilities and consequences of entering the faulty mode in the future.
- By contrast, in the faulty mode individuals are mechanistic and impulsive. In particular, they have a limited ability to weight the consequences of their choices

3.3.1 Decisions with Immediate Outcomes

- In the basic savings problem, the DM faces a single choice every period: how much to consume, denoted by c_t.
- s_t - state variable that keeps track of all that is relevant for the decision problem (in both modes of operation)
- In the faulty model choices are mechanistic and given by a function $c_t^f(s_t)$ that summarizes the brain's ability to make choices when overtaken by charged emotional states.
- Liquidity constraints can limit the ability of an individual to follow his impulses
- Special cases of interest:
  - Proportional binging: $c_t^f(s_t) = \min\{\phi_t R_t, B_t\}$, with $\phi_t \in (0,1)$
  - Constant binging: $c_t^f(s_t) = \min\{c, B_t\}$
  - Income dependent binging: $c_t^f(s_t) = \min\{\phi_t w_t, B_t\}$, with $\phi_t \in (0,1)$
  - Wealth dependent binging: $c_t^f(s_t) = \min\{\phi_t(w_t + a_t), B_t\}$, with $\phi_t \in (0,1)$
- Natural to assume that $\phi_t(r_t)$ with $\phi_t' \leq 0$. (Although, with the exception of capital taxation, in most of the experiments considered in the paper, the interest rate remains constant).

- In the good mode, the individual solves:

$$c_t^g(s_t) \equiv \max_{c\in[0,B_t]} u(c) + \beta V_{t+1}((1+r_t)(R_t - c)),$$

where $V_{t+1}(R_{t+1})$ is the continuation value function

- Value function defined recursively as follows

$$\begin{aligned} V_t(s_t) \equiv & (1-\gamma_t)[u(c_t^g(s_t)) + \beta V_{t+1}((1+r_t)(R_t - c_t^g(s_t)))] + \\ & \gamma_t[u(c_t^f(s_t)) + \beta V_{t+1}((1+r_t)(R_t - c_t^f(s_t)))] \end{aligned}$$

- Everything is consumed in the last period: $V_T(s_T) = u(R_T)$

- **Assumption 2.** The DM is a profligate: $c_t^f(s_t) \geq c_t^g(s_t)$ for all s_t.

- Many of our results extend to misers in the natural way (will not discuss this today)

3.3.2 Decisions with Future Outcomes

- In other problems, the DM makes decisions in the present regarding future consumption.

- Example: With lock-in savings accounts, DM chooses:

  (1) How much to consume today.

  (2) What fraction of assets to place in a lock-in account

- When there is more than one choice, the DM can make a probabilistic mistake in each of the dimensions

- Details described below in each application

Three general principles:

- **Assumption 3.** Profligate DMs make mistakes in decisions involving precommimtments for consumption.

  Ex: Purchase a Porsche to be delivered in a month.

  Justification:

  - Anticipation of future goods can trigger visceral decision-making, just as immediate consumption does.

- **Assumption 4.** Profligate DMs do not make mistakes involving pre-commitments for future savings.

  Ex: Chose a contribution rate to 401(k) for future job

  Justification:

  - Visceral DM involves viscerally charged items. Saving pre-commitments do not have this feature.

- **Assumption 5.** Profligate DMs make consumption decisions first, and savings decisions afterwards.

  Ex: Optimal savings pre-commitments are made given resources left after buying the Porsche

  Justification:

  - Deliberative choices about savings possible as long as they do not conflict with visceral impulses about consumption.

3.4 Discussion and Relationship with Existing Models

Note: .

- Model can be solved using standard dynamic programming techniques, and has a unique solution.

- It is solved as a maximization problem, not a game.

- When $1 - \gamma_t = 1$ for all t, it reduces to the standard model.

- In simplest formulation, just two additional parameters are needed: a constant probability of entering the faulty mode γ, and a parameter ϕ measuring the magnitude of the mistake.

- Model generates stochastic consumption and savings with 2^T possible paths

- Well defined notion of welfare and mistakes

Note: .

- Model makes testable predictions about consumption paths and about timing and size of mistakes.

- Mistakes can in principle be measured using appropriately designed questionnaires

About the interpretation of the model: .

- This is a model about high-frequency decision-making.

- This is important in interpreting the model

- Common for individuals to 'loose their mind' for a short-time and a concrete decision.

- Year long 'visceral binges' much less likely (albeit not impossible)

Difference with Rational Model: .

- DMs make probabilistic and systematic mistakes (their magnitude can depend on past choices).

Difference with QHD: .

- QHD can be reinterpreted as a special case of our model in which the brain is always in the faulty mode, and in which $c_t^f(B_t)$ is the strategy of a sophisticated self with (β, δ)-preferences. (For example, with CARRA preferences, this function takes a functional form that looks like proportional mistakes.)

- By contrast, mistakes in our model are probabilistic and mechanistic. This reflects our view about the nature of mistakes, and makes the model much easier to solve both analytically and computationally.

- The QHD model assumes that immediacy of consumption is the sole determinant of mistakes. In our theory, the trigger for a mistake is an emotionally charged cue that need not be associated with immediacy. As a result, the DMs can overconsume goods, like a Porsche, that are delivered in the future.

- Some of our results have parallels in the QHD literature. Others could be derived although, to our knowledge, they have not appeared in the literature. Finally, others are incompatible with the predictions of the QHD model.

4 Benchmark Case: No Liquidity Constraints

- In this section we derive some basic comparative statics about the impact of mistakes in behavior and well-being in the absence of liquidity constraints (LCs); i.e., when $B_t = R_t$.

- In this case, the value function in every period depends on R_t and on whatever variables affect behavior in the faulty mode (income, accumulated assets, ...)

- Experiment: What is the impact of increasing the probability and/or size of the mistakes on (1) good mode (or intended) savings and (2) actual average savings?

- Since this is a model in which mistakes lead to under-saving, intuition might suggest that the larger/more likely the mistakes, the lower the savings. Things are more subtle than this.

- $A_t \equiv$ average savings in period t.

4.1 Results

Proposition 1: *Well-being decreases with the probability of making a mistake, and with the size of the mistakes, in any period.*

- Intuition: mistakes are a departure from optimization, and thus decrease welfare.

- Now consider the impact of mistakes on saving in a given period t.
- For the analytic results we assume that $V_{t+2}(.)$ is strictly concave and continuously differentiable.
- Notation: For any period t,

$$V_t(s_t) = (1-\gamma_t)V_t^g(s_t) + \gamma_t V_t^f(s_t),$$

where

$$V_t^g(s_t) \equiv u(c_t^g(s_t)) + V_{t+1}(R_t - c_t^g(s_t))$$

denotes the continuation welfare if the brain is in the good mode, and

$$V_t^f(s_t) \equiv u(c_t^f(s_t)) + V_{t+1}(R_t - c_t^f(s_t))$$

is the continuation welfare if the brain is in the faulty mode.

- The FOC for the savings problem in the good mode are standard and given by

$$u'(c_t^g(s_t)) = V'_{t+1}(R_t - c_t^g(s_t)).$$

- It follows that the impact of any parameter θ on intended savings is determined by the sign of $\frac{\partial}{\partial\theta}(\frac{\partial V_{t+1}}{\partial R_{t+1}})$.

Proposition 2: .

(i) Increases in γ_t reduce average savings in period t, but have no impact on intended savings.

(ii) Increases in γ_{t+1} increase intended and average savings in period t if the marginal value of resources at $t+1$ is larger in the faulty mode than in the good mode ($\frac{\partial V_{t+1}^f}{\partial R_{t+1}} > \frac{\partial V_{t+1}^g}{\partial R_{t+1}}$), and decrease them otherwise.

Intuition:

- Part i) The brain in the good mode does not care about γ_t, but average savings decrease with the likelihood of making a mistake

- Part ii) $\frac{\partial}{\partial\gamma_{t+1}}(\frac{\partial V_{t+1}}{\partial R_{t+1}}) = \frac{\partial V^f_{t+1}}{\partial R_{t+1}} - \frac{\partial V^g_{t+1}}{\partial R_{t+1}}$.

  - This reflects the fact that an increase in next period mistakes has two effects:

  –> waste effect: savings might be wasted (by being consumed too early)

  –> self-insurance effect: with mistakes there is a need to save more to make sure that, even after the binges, there is sufficient consumption in old age

  - If self-insurance effect dominates, $\frac{\partial V^f_{t+1}}{\partial R_{t+1}} > \frac{\partial V^g_{t+1}}{\partial R_{t+1}}$ and intended savings go up.

  - If waste effect dominates, $\frac{\partial V^f_{t+1}}{\partial R_{t+1}} < \frac{\partial V^g_{t+1}}{\partial R_{t+1}}$ and intended savings go down.

  - The result on average savings then follows since γ_{t+1} has no impact on faulty consumption.

Proposition 3: *Suppose that consumption in the faulty mode is given by* $c^f_t(s_t) = \min\{R_t, \alpha_t + \beta_t R_t\}$. *Then, as long as the life-time resource constraint is not binding, savings in period t decrease with* α_t *and* α_{t+1}.

Intuition:

- Increases in α_t have no effect on intended savings, and decrease faulty mode savings.

- Increases in α_{t+1}:

–> leave the self-insurance effect unchanged (since β_t is constant)

–> increase the waste effect (by increasing $\frac{\partial V^g_{t+1}}{\partial R_{t+1}}$)

–> As a result, intended savings go down.

- The results provide an insight about the forces at work. However, it is hard to sign the impact on savings of the size of mistakes for some of the other cases.

- Since the model is computationally friendly, we use simulations to carry out more general experiments

4.2 Simulations

To be completed.

4.3 Discussion

- Both the analytic results and the simulations show that, paradoxically, the possibility of mistakes can lead to increased savings.

- This happens when a sophisticated DM understands that the self-insurance effects generated by future mistakes, which increases the attractiveness of saving, dominate the waste effects, that decrease it.

- As shown in the simulations, an increase in savings is more likely when the individual is more risk-averse.

- Note that sophistication plays a key role in the result. With naive agents, who do not anticipate the possibility of future mistakes, the introduction of mistakes always leaves intended savings unchanged and decreases average savings.

4.4 Cognitive Public Policy

- Significant fraction of marketing and sales practices seem designed to put agents in faulty modes (i.e., to increase γ_t) and to increase the size of the mistakes made in those modes (i.e., to increase $c_t^f(\cdot)$).

- We refer to a cognitive public policy as an intervention that is able to decrease the probability and size of mistakes.

- Examples include education and the regulation of advertisement and sales.

- **Lesson:** One cannot judge the success of these policies by their impact on savings. Depending on the parameters of the economy, a welfare improving cognitive policy may *decrease* savings.

5 The Impact of Liquidity Constraints

- In this section we study the effect of introducing liquidity constraints (LC) into the economy.

- $B_t \equiv (1 + r_t)a_{t-1} + w_t =$ available resources in period t .

- Note that the value function in this case depends on B_t, R_t, and whatever other variables influence consumption in the faulty mode.

- Consider the impact on period-t savings of introducing LCs in the standard model. There are two forces leading towards (weakly) higher savings:

  1) The LC in period t increases savings mechanically

2) If future LCs bind, they increase the marginal utility of future income, which leads to higher savings.

- In addition, in the standard model the LCs (weakly) decrease welfare.

- By contrast, in this model LCs can reduce savings while improving welfare

5.1 Results

- Consider an individual who, in the good mode, is trying to save in periods t and $t+1$.

- This is the case of interest. By the usual reasons, when the DM is trying to borrow in the good mode, LCs can increase savings and decrease welfare.

- For the analytic results, we assume as before that the value function $V_{t+2}(\cdot)$ is strictly concave and continuously differentiable, and then consider the impact on savings at time t of introducing LCs in periods t and $t+1$. (The impact of introducing LCs in every period is explored in the simulations and leads to similar results).

Proposition 4: *Consider an individual who, in the absence of LCs, is trying to save in the good mode in periods t and $t+1$. There exists a cut-off level of assets $\overline{B}_t$ such that:*

(i) If $w_t + a_{t-1} < \overline{B}_t$ the introduction of LCs decreases intended savings but increases welfare.

(ii) If $w_t + a_{t-1} > \overline{B}_t$ the introduction of LCs leaves savings and welfare unchanged.

Intuition:

- The LCs can be valuable for the DM if they help to reduce mistakes without restricting good mode consumption.

- Since the LCs are not binding in the good mode in period t, the level of intended savings (with and without LCs) is given by the FOC:

$$u'(R_t - a_t^g(s_t)) = V'_{t+1}(a_t^g(s_t))$$

- It follows that the impact of the LCs on savings depends on how it affects the marginal benefit of savings $V'_{t+1}(.)$

- Figure 1 depicts the marginal impact benefit of savings as a function of $B_{t+1} = w_{t+1} + a_t$ for the case in which the DM saves a positive amount in the good mode in period $t+1$ even if $a_t = 0$. (The proof needs to consider also the case in which the individual borrows in the good mode in period $t+1$ if a_t is sufficiently small. This other case generates similar conclusions.)

- Recall that $R_{t+1} = B_{t+1} + NPV\{w_k|k > t+1\}$.

- Note that the marginal benefit of an additional unit of savings goes down at low levels of savings. Why?

  - At low $w_{t+1} + a_t$ the DM in period $t+1$ is constrained in the faulty mode.

  - Then, each additional unit of savings is fully 'wasted' in the faulty mode.

- The marginal benefit level of savings is unaffected at high levels of savings. Why? At high levels of savings the individual is not constrained in period $t+1$ in either mode.

- The figure also depicts the marginal cost of savings given by $u'(R_t - a_t^g(s_t))$ for an individual with low assets R_t^L, and for an individual with high assets R_t^H

- The intended level of savings is given by the intersection of both curves. Point A is the choice for an individual with high assets with and withouth LCs. by contrast, for an individual with low assets, the introduction of LCs decreases savings from point B to point C.

- The results follow immediately.

- **Case 1**: An individual with high assets is not affected because, since it is optimal for him to save a large amount, he knows that in period $t+1$ he will never find himself constrained in the hot mode. As a result, his incentives to save do not change.

- **Case 2:**

  - Consider a DM who is trying to save, but who knows that if he 'binges' tomorrow he will wipe out his savings.

  - For this DM, the value of saving an additional unit is lower because, with some probability, it will be wasted in a binge

  - The DM reduces its savings to reduce the waste that takes place in future faulty modes.

  - In other words, although the original level of savings is still feasible, it pays to cut savings to reduce future mistakes

- Note the difference between the two cases. Both individuals can reduce future mistakes by reducing savings so that they are constrained in period $t+1$ in the faulty mode. The difference is the cost of achieving this form of 'pre-commitment'. An individual with low assets can achieve this by reducing his savings by a small amount. An individual with a high level of assets would have to deviate from the ideal level of savings too much to achieve the desired effect.

- Figure 2 plots savings in period t, with and without LCs, for an individual who is trying to save in periods t and $t+1$. Depending on the parameters of the model $\overline{s}$ is either zero or positive.

- Note two features:

  1) Savings do not increase with assets at low levels of $w_t + a_{t-1}$.

  2) Savings increase discontinuously at $\overline{B}_t$.

Discussion: Same lesson as before. Even though mistakes always lead to excessive consumption, the introduction of LCs can reduce savings and increase welfare for individuals who are trying to save but have not managed to accumulate enough assets.

5.2 Simulations: Low Asset Traps

To be completed

6 Tax Policy

6.1 Optimal Capital Taxation

- A natural policy to consider in this context is a tax τ per unit of savings. The case of a capital subsidy ($\tau < 0$) is particularly interesting since it has often been proposed as a way to boost savings.

- To study the extent to which the mistakes made by profligates provide a case for a capital subsidy consider the following experiment:

  - Suppose that there is a continuum of individuals with mass one.

  - Consider the introduction of a small tax τ per unit of assets (i.e., a_{t-1}) in every period $t > 2$.

  - The proceeds raised by the tax every period are returned in that same period using an identical lump-sum transfer.

- Note that the tax redistributes from individuals with above average asset holdings to individuals with below average asset holdings.

Proposition 5: .

1) Suppose that there are no liquidity constraints. Then:

-> A capital tax is optimal when consumption in the faulty mode is sufficiently price inelastic.

-> A capital subsidy is optimal when consumption in the faulty mode is sufficiently price elastic.

2) If the DM is liquidity constrained in the faulty mode, but not in the good mode, a capital tax is always optimal.

- Intuition:

  - For the usual reasons, the optimal tax is zero in the case of no mistakes. Since there are no market failures, taxes generate a dead-weight loss.

  - Things are rather different with mistakes. The introduction of a capital tax (or subsidy) has three effects:

  1) A distortion effect. Since there are no mistakes in the good mode, the tax generates a distortion for individuals making decisions in that mode.

  2) An incentive effect. If consumption in the faulty mode is price responsive, a savings subsidy reduces the size of the binge.

  3) An insurance effect. Individuals face an uninsurable risk in this model; namely, the risk of going on a binge. Ex-ante everyone is identical. Ex-post, the size of an individual's assets decrease with the frequency of his binges. As a result, a capital tax redistributes from those with good realizations to those with bad ones, and thus provides some insurance against this risk.

  - It follows that a capital tax is optimal, instead of a subsidy, when consumption in the faulty mode is sufficiently price inelastic, since in this case the incentive effect is non-existent.

  - By contrast, a capital tax could be optimal when subsidies have a sufficiently large impact on curtailing binges.

  - Without liquidity constraints, the elasticity of savings in the faulty mode depends on the functional form of the binges.

  - When the individual is liquidity constrained in the faulty mode, the elasticity of savings in that mode is zero. As a result, a capital tax is always optimal in that case.

- Proposition 5 stands in sharp contrast to some recent results in the QHD literature. O'Donahue and Rabin [2003] have studied a related question in the QHD framework and concluded that the equivalent of a capital subsidy is always optimal. Their result can be understood as a special case of Proposition 5. With QHD the individuals always make decisions in the faulty mode, which implies that the insurance effect is not present. Also, QHD model assumes that behavior in the faulty mode is always sufficiently price inelastic, which implies that the incentive effect is large.

- The point of this paper is not to argue that a capital tax is optimal, but to emphasize that the answer depends on the nature of the binges. Hopefully, future empirical work will be able to determine which specification of the model has the highest explanatory value.

6.2 Optimal Timing of Taxes

To be completed

6.3 Optimal Assignment of Taxes and Regulations

- Public economists have derived a series of important neutrality results using the rational model of individual choice.

- Consider several prominent examples:

  1) With perfect competition, it does not matter whether medical benefits are paid by the employer or purchased independently by the employee, as long as both purchase the same service. Wages adjust so that wages plus benefits remain constant. As a result, this choice should have no impact on the economy.

  2) Mandatory withholding of estimated income taxes by employers (as opposed to the case in which no taxes are due until tax day) has no effect as long as it is actuarially fair. Without withholding, rational agents anticipate the future tax bill and save accordingly.

  3) The capital income tax studied in the previous section is equivalent to an appropiately chosen consumption subsidy in which the necessary revenue is raised using an identical head tax.

- All of these neutrality results have a common logic: changes in the law that leave budget constraints unchanged have no effect on behavior.

- A similar logic applies to the QHD model.

- By contrast, in our model these equivalences break down when the size of the binges (i.e., consumption in the faulty mode) depends on things other than budget constraints.

- Consider, for example, the case in which consumption in the faulty mode depends on after tax (or take home) pay. To motivate this case, think of a worker who gets paid every Friday and who may end up 'drinking its paycheck' at the local bar.

- The worker is better off with maximum withholding and with employer provided benefits since, by reducing take home pay, they also decrease the size of the binges.

- Similarly, suppose that consumption in the faulty mode depends on current prices, but not on asset returns. This could be justified if in the visceral mode the individual only takes into account variables that are immediate to the decision at hand. In this case a consumption subsidy can affect behavior in the faulty mode, whereas a capital tax cannot.

7 The Impact of Saving Precommitments

- In order to develop intuition for the results in this section, note that in order to save optimally every period the DM must be able to:

  1) Stop himself from using accumulated assets to finance binges.

  2) Stop himself from borrowing against future income to finance binges.

  3) Generate the optimal amount of new savings.

7.1 Benchmark Case: Full Savings Precommitment

- Consider first the case of a full savings pre-commitment institution in which, every period t, the DM chooses c_t and commits to a maximum level of consumption $(\overline{c}_{t+1})$ for the next period.

- In practice, this institution could be implemented as follows:

  - Each period t the individual places a ceiling on total expenditures for the next period

  - A centralized credit agency is required to approve all withdrawals from savings accounts and all credit card transactions.

  - Withdrawals and purchases are allowed only if they do not exceed the pre-chosen expenditure ceiling.

Proposition 8: *Except for the first period, the full precommitment institution generates the same consumption path as if there were no mistakes.*

- Intuition: The DM cannot control the binge in period 1. However, since choices about abstract future expenditures (such as constraints in total expenditures) do not trigger the visceral mode, the DM chooses the optimal level of savings in every future period, which fully stops future binges.

- Note that, by allowing the individual to put a ceiling on total consumption next period, the institution helps him to carry out the three operations needed for optimal saving.

- This institution is informationally demanding, and thus unlikely to be feasible in practice. In order to implement the expenditure ceiling, a centralized institution that can monitor all possible sources of funds in any given period is needed.

7.2 Other Voluntary Saving Precommitment Institutions

- In this section we compare the value of the following saving pre-commitment institutions, some of which are used in some countries:

  1) **Simple lock-in savings accounts:**

  - l_t = amount of assets in the lock-in account at end of period t

  - Funds in l_t cannot be spent in period $t+1$

  - Furthermore, at the end of period $t+1$ these funds are automatically transferred to a regular savings account (and thus are available to be spent in period $t+2$) unless the individual decides to do otherwise.

  - Lock-in accounts cannot have negative balances.

  2) **Lock-in savings accounts with advanced contribution rules:**

  - In addition to the previous rules, these accounts allow each period t to specify a minimum amount of wage contributions, denoted $\overline{d}_{t+1}$, that are automatically placed in the lock-in account in period $t+1$.

  3) **Voluntary credit ceilings:**

  - Every period t, the DM places a credit ceiling $\overline{b}_{t+1}$ on his ability to borrow in period $t+1$

- We assume that all of the forms of saving pay the same rate of return.

- Notation:

  - u_t – unlocked savings at the end of period t

- $a_t = u_t + l_t$

- The problem of the DM when lock-in accounts with advanced contributions and credit ceilings are present is given by

$$\max_{c_t, u_t, l_t, \overline{d}_{t+1}, \overline{b}_{t+1}} u(c_t) + \beta V_{t+1}(u_t, l_t, \overline{d}_{t+1}, \overline{b}_{t+1})$$

subject to

$$\begin{aligned} c_t &\leq w_t - \overline{d}_t + u_{t-1} \\ -\overline{b}_{t+1} &\leq u_t \\ c_t + u_t + l_t &= w_t + a_{t-1} \\ \overline{d}_t &\leq l_t \end{aligned}$$

- The decision problem for any other combination of institutions is defined analogously.

- LCs play an important role in this class of institutions because a DM in the faulty mode could attempt to use borrowing to go around the pre-commitment constraints. For example, an individual could try to sell his future social security benefits in exchange for consumption in the present.

- If such transactions were allowed, the precommitment institutions studied here would have no effect on savings.

- We thus impose the following institutional assumption: balances in mandatory savings and lock-in accounts cannot be used as borrowing collateral. More concretely, if an individual defaults on a loan made in period t, the creditors maximum claim on the agent's asset is

$$L_t = NPV[w_k | k > t]$$

Thus, this is the maximum amount that creditors are willing to lend in period t.

- This defines three cases of interest:

1) No LCs, where $B_t = w_t + u_{t-1} + L_t$.

2) Full LCs, where $B_t = w_t + u_{t-1}$.

3) Partial LCs, where $B_t \in (w_t + u_{t-1}, w_t + u_{t-1} + L_t)$. This is the most realistic case. It captures the fact that, in practice, credit markets are willing to lend only up to a fraction of future income.

7.3 Voluntary Precommitments with NLCs

- Consider first the case of NLCs.
- The following result shows that in this case simple lock-in accounts are capable of generating the same protection as the stronger full savings precommitment institution.

Proposition 9: *In the absence of LCs, unlimited lock-in accounts are equivalent to full-precommitment. They generate the first-best, except for period 1.*

- Intuition:

  - Let c_t^* be the optimal path of consumption, and for $t > 1$, let $c_t^*(R_t)$ be the optimal level of consumption conditional on reaching that period with R_t units of remaining life-time resources.

  - In period 1 the individual consumes the optimal amount, or binges, depending on the mode that he is in.

  - However, conditional on that, he wants to achieve the optimal level of savings on future periods.

  - The DM can accomplish this by borrowing all his future income, and setting the balance of locked and unlocked savings accounts equal to

  $$l_1^g = R_1 - (c_1^* + c_2^*) \text{ and } u_1^g = c_2^*$$

  in the good mode, and

  $$l_1^f = R_1 - (c_1^f + c_2^*(R_1 - c_1^f)) \text{ and } u_1^f = c_2^*(R_1 - c_1^f)$$

  in the faulty mode.

  - This insures that consumption in period 2 is optimal in either case.

  - Afterwards, every period he just transfers from the locked to the unlocked account the amount required to consume optimally in the next period.

  - The individual repays the debt in a way that keeps him liquidity constrained in every period.

- More intuition: Note how this institution achieves the three operations that are required to save optimally:

  - old savings are protected by keeping them in locked accounts until it is optimal to consume them.

  - new savings are generated in a dramatic way: all future income is borrowed in period 1 and all future savings are committed at that time

- undesired borrowing is stopped (except perhaps in period 1) by keeping total debt at L_t in every period.

- Important: For the result to work, the DM must be able to borrow all of his future income. If this is not the case, he will not be able to fully control future binges. Therefore, the result relies heavily on the unrealistic assumption that there are no LCs at all.

7.4 Voluntary Precommitments with Partial and Full LCs

- Now consider the case of partial LCs, where $B_t \in (w_t + u_{t-1}, w_t + u_{t-1} + L_t)$.

Proposition 10: *Suppose that there is a partial LC that is not binding in the absence of mistakes. Then:*

i) A combination of lock-in accounts with advanced contributions and voluntary credit ceilings is equivalent to the case of NLCs and no mistakes, except for the first period (i.e., it almost generates the first best).

ii) Lock-in accounts with advanced contributions are better than simple lock-in accounts. Neither generates the almost first best.

iii) Voluntary credit ceiling by themselves are better than nothing if and only if the binges are sufficiently large. Furthermore, they do not generate the almost first-best outcome.

iv) Simple lock-in accounts are better than nothing if and only the binges are sufficiently large. Furthermore, they do not generate the almost first best.

- This result shows that, even though each of the precommitment institutions can improve welfare by itself, the ideal institution requires using a combination of lock-in accounts with advanced contributions and voluntary credit ceilings.

- To see how the result works, consider the impact of the different institutions on an individual who has identical income from periods 1 to R, and no income from periods $R+1$ to T. Since $\beta_t = 1 + r_t = 1$, the individual would like to save a constant amount on periods 1 to R. Let c^* be the optimal constant consumption and a_t^* denote the implied level of assets.

- Intuition for part i:

  - Consider the case of lock-in accounts with advanced contributions and voluntary credit ceilings.

  - Suppose that the DM is in the good mode in period $t \leq R-1$, and that so far he has consumed optimally. Then he can continue to do so in period $t+1$

by choosing: (1) a zero borrowing constraint ($\overline{b}_{t+1} = 0$), (2) locking all of his accumulated savings plus new savings ($u_t = 0$ and $l_t = a_t^*$), and (3) committing to save optimally the next period by setting ($\overline{d}_{t+1} = w - c^*$).

- Once the DM reaches retirement, he can consume optimally by keeping a zero borrowing constraint and unlocking c^*units of savings one period at a time.

- As long as the DM is in the good mode in the first period, this plan generates the first-best consumption plan. If he enters the faulty mode in the first period, the appropiately modified plan implements the first-best continuation plan.

- Note the role played by the different parts of the institution:

1) the lock-in account is crucial to protect the accumulated savings.

2) the advanced contribution is needed to make sure that the optimal amount of new savings takes place.

3) the voluntary credit constraint is needed to stop sub-optimal borrowing.

- Intuition for part ii:

  - Consider a lock-in account with advanced contributions, but no credit ceilings. The DM can no longer achieve the first-best because he can no longer stop sub-optimal borrowing in the faulty mode.

  - To see why, consider what happens when a DM enters the faulty mode in period t. Optimal use of the institution would have allowed to protect the accumulated savings, by putting them in a lock-in account, and to commit to save optimally in period t. However, since the consumer can borrow against future income, he can finance at least part of the binge.

  - Now consider the simple lock-in account. In addition to the inability to stop undesired borrowing, the institution also lacks the ability to secure the optimal level of new savings. As a result, it is dominated by lock-in accounts with advanced contributions.

- Intuition for part iii: Now consider the impact of having voluntary credit ceilings, but nothing else.

  - If the mistakes are sufficiently small, so that no borrowing is required to over-consume, the institution has no effect.

  - By contrast, if binging requires borrowing, at least some of the time, the institution helps by curtailing some sub-optimal borrowing.

  - However, it cannot generate the first-best because it cannot protect accumulated assets nor generate optimal new savings.

- Intuition for part iv: Finally, consider the impact of having simple lock-in accounts, but nothing else.

  - If the mistakes are sufficiently small, the individual can always finance the binges through a combination of present income and borrowing. In this case the institution has no effect.

  - By contrast, the institution matters when it is necessary to dip into the accumulated asset in order to finance the binge. This is likely to happen when mistakes are large.

  - The institution cannot generate the first-best outcome because it cannot stop sub-optimal borrowing, nor generate optimal new savings.

- The lock-in accounts that we have studied thus far do not limit the size of the accounts. By contrast, lock-in accounts such as IRAs and 401(k)s put ceilings on contributions. These ceilings limit the ability of these institutions to generate optimal savings:

  (1) If the limits cannot accommodate the optimal level of asset accumulation, then the combination of lock-in accounts with advanced contributions and voluntary credit ceilings can no longer generate the first-best. Since some of the assets will have to be placed in unlocked accounts, they would be available for binging during the faulty mode.

  (2) For a similar reason, limits in simple lock-in accounts increase the likelihood that they be neutral.

- Proposition 10 is easily extended to the case of NLCs. Since in that case sub-optimal borrowing cannot take place, it immediately follows that the introduction of credit ceilings play no role. As a result, it is straightforward to show that lock-in accounts with advance contributions are equivalent to full savings pre-commitments. Both institutions generate the (almost) first best if and only if the LCs do not bind in the good mode.

7.5 Mandatory Savings

- Most countries around the world have made **mandatory savings programs** a central part of their savings policy.

- Mandatory savings programs are a form of pre-commitment that is imposed, instead of voluntary.

- A commonly provided rationale for having a social security system is that it can insure that individuals save a minimum amount for retirement (see, for example, Feldstein [] and Diamond []).

- Here we consider an idealized social security system. The government imposes a path m_t of wage contributions and withdrawals (when negative) to a mandatory savings account. Let μ_t be the balance at the end of period t.

- To isolate the role of social security system on inducing optimal savings we assume that the path of contributions and withdrawals is actuarially fair.

- For the same reasons as before, the commitment provided by social security is helpful only if the DM cannot finance his binges by borrowing against the balance in his account.

- We assume that mandatory savings cannot be used as collateral. As a result, the maximum amount that an individual could borrow in period t is given by

$$L_t = NPV[w_k - \max\{m_k, 0\}|k > t].$$

Proposition 11: *Suppose that there are partial LCs and that they do not bind in the good mode.*

i) A mandatory savings program improves welfare only if is large enough sot that consumption in the faulty mode is binding in some states.

ii) A mandatory savings program cannot generate the almost first-best allocation.

- To see how the result works, consider again the impact of mandatory savings on an individual who has identical income from periods 1 to R, and no income from periods $R + 1$ to T.

- Intuition part i: If the required contribution every period is less than $w - c^*$, then an amount $w - m_t$ is available for binging in periods 1 to R. The individual can then finance sufficiently small mistakes through a combination of current income and borrowing.

- Intuition for part ii:

  - Suppose that the government requires a contribution every period equal to the optimal amount of savings (i.e., $m_t = w - c^*$ for $t \leq R$), and gives a benefit in retirement equal to c^*.

  - With partial LCs, this cannot stop all binging because the individual can borrow against future income. In fact, as long as the borrowing does not exceed L_t, the DM is not constrained in his ability to binge.

- Note, however, that this system generates the optimal amount of consumption in retirement. All the overconsumption takes place within the working years.

- Many social security systems require that individuals annuatize their accumulations at retirement. In this model, this feature can provide valuable self-control.

7.6 Discussion

- We have shown that the ideal precommitment institution is a combination of voluntary credit ceilings and lock-in accounts with advance contributions. A comparison with the full precommitment case illustrates how this works. To achieve the first best, the individual needs to select its consumption one period in advance. The full precommitment institution allows for this directly. The other one achieves it by providing tools to limit how much can be borrowed (the credit ceilings), how much must be saved (the advance contribution), and what fraction of old assets can be spent (the lock-in provision).

- What are the advantages of using voluntary credit ceilings and lock-in accounts with advance contributions instead of full precommitment? Although this is beyond the scope of this paper, there might be reasons why the former is easier to administer.

  - Any employer can run lock-in accounts with advance contributions. Multiple employers do not cause difficulties as long as each one of them runs a plan.

  - Credit ceilings are more difficult to implement. But laws limiting the ability to issue instant credit and to raise credit ceilings without the individuals prior approval and without a waiting period could go a long way.

  - By contrast, the full precommitment institution requires a centralized agency to keep track of all saving accounts and credit card transactions.

- It is important to emphasize that our analysis has ignored two important issues:

  1) Black markets. During the faulty mode, individuals might be willing to pay a premium to loan sharks who are willing to circumvent the law and provide instant credit.

  2) Families and relatives might provide alternative sources for small loans.

  Although we acknowledge that these two forces are likely to reduce the ability of the precommitment institutions to stop binges, we do not believe that they will cause them to fail completely. Since both sources of credit are very imperfect substitutes to standard credit markets, they should only be able to finance a small fraction of the binges.

- A more important concern is the role of uncertainty and unforeseen contingencies:

  -If there is uncertainty about future expenditures, individuals need to keep some assets unlocked. Since these assets could be used during binges, the first best is no longer possible.

  - Importantly, since the use of these precommitment devices are voluntary, the individuals would use them only if they are welfare improving.

  - Furthermore, as long as periods are small, good insurance coverage is available, and the uninsurable risks small, the amount of unlocked assets needed is small.

- Note that sophistication plays a crucial role in our results. Individuals use lock-in accounts only because they anticipate future binges. If individuals are naive, these institutions provide no protection. By contrast, mandatory savings can help even if the DMs are naive.

- The following difference between mandatory and voluntary precommitments is worth emphasizing:

  - Since the DMs do not need to use them, voluntary saving precommitments are always (weakly) welfare improving. Furthermore, they do not require that the government have information about the optimal saving path, which is likely to be different across individuals.

  - By contrast, mandatory savings require the government to have more information, and can decrease welfare if they require too high a level of savings

- To conclude, note once more that the introduction of precommitment institutions can increase welfare while decreasing savings. This occurs in any economy in which the possibility of future mistakes lead to increased savings in the absence of precommitment institutions.

8 Consumption Precommitments

- To be completed

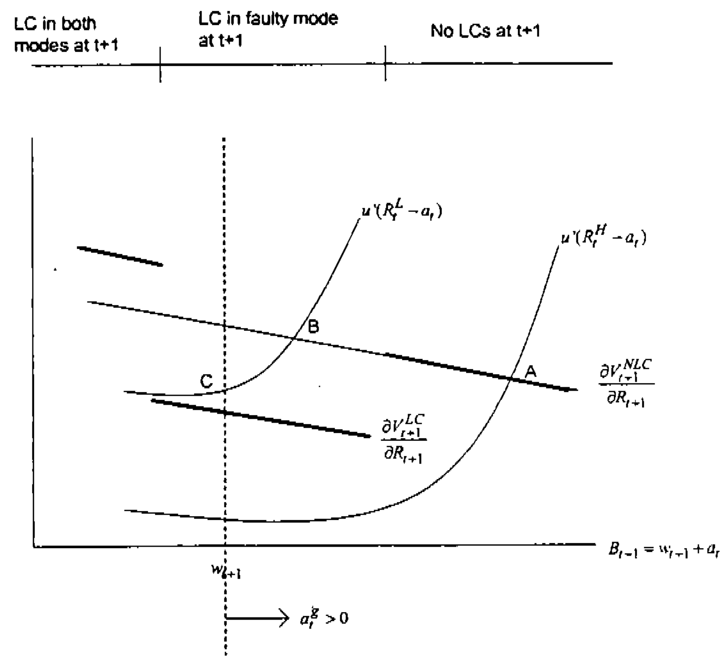

Figure 1: Choice of intended savings in period t with and without LCs

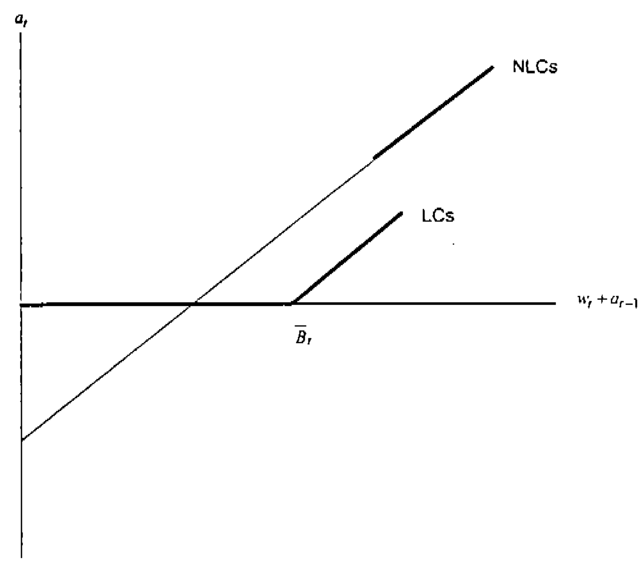

Figure 2: Period t savings as a function of resorces with and without LCs.