Denial of Death and Economic Behavior*

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Abstract

We model denial of death and its effect on economic behavior. Attempts to reduce death anxiety and the possibility of denial of mortality-relevant information interact with intertemporal choices and may lead to time-inconsistent behavior and other "behavioral" phenomena. In the model, repression of signals of mortality leads to underconsumption for unsophisticated individuals, but forward-sophisticated individuals may over-consume in anticipation of future denial and may seek ways to commit to act according to one's mortality prospects as currently perceived. We show that the mere possibility of engaging in this kind of denial leads to time-inconsistent but efficient behavior. Refusal to face up to the reality of death may help explain a wide range of empirical phenomena, including the underutilization of tax-advanced inter vivos gifts and inadequate purchase of life insurance.

KEYWORDS: time consistency, behavioral economics

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Death. William James called it the "worm at the core of all our usual springs of delight." Life must end for all living beings, but only humans may grasp its existential meaning. Many, though, recoil. "One cannot look directly at either the sun or death," said La Rochefoucauld. Winston Churchill claimed that "any man who says he is not afraid of death is a liar."

The implications of turning away (or denying) death have been taken seriously by some psychologists, sociologists, and philosophers. In his influential book *Denial of Death*, Ernest Becker (1973) argued that people do many things — such as having children and passing wealth to next generation — to achieve a kind of symbolic immortality. In the standard work on the psychology of death, Kastenbaum (2000) summarized the state of psychological research about attitudes toward death by saying that "there are divergent theories and somewhat discordant findings, but general agreement that most of us prefer to minimize even our cognitive encounters with death."

In contrast, economics has generally treated death in a perfunctory manner, assuming that people make decisions to maximize expected utility over their lifetime given rationally-formed assumptions about their longevity, perhaps also receiving utility from the prospect of bequests left to descendants or charities. Although recently economics has begun to address aspects of behavior that systematically diverge from the standard construction of rationality (cf. Mullainathan and Thaler 2000, Rabin 1998), the field dubbed behavioral economics has not yet addressed James' "worm at the core." Yet arguably death is the essential aspect of human nature that humans, or at least some humans, do not confront rationally. Indeed, the sociologist/philosopher Zygmunt Bauman asserts that "death blatantly defies the power of reason: reason's power is to be a guide to good choice, but death is not a matter of choice" (Bauman, 1992). The new social science of "non-rational" behavior has not yet directly addressed the fundamental aspect of humanity that defies rationality. In so doing it may be overlooking explanations for patterns of lifetime consumption and intergenerational behavior.

In this paper we propose a model of humans who are "rational" but who fear death. Our approach is motivated by a significant literature in psychology and sociology that has its origin in the work of Rank (1941) and Becker (1973). Becker (1973) asserts that "the fear of death must be present behind all our normal functioning, in order for the organism to be armed toward self-preservation. But the fear of death cannot be present constantly in one's mental functioning, else the organism could not function." Fearfulness in the presence of a danger is a natural phenomenon that can be easily explained on evolutionary grounds: fear forces an individual to fully concentrate on its source and, therefore, facilitates survival. Fear arises when and if an immediate danger is perceived and leaves no room for manipulating it. If generalized death anxiety is a consequence of an evolutionary-grounded fear coupled with a fully rational understanding that one is mortal and therefore constantly endangered, cognitive strategies that lead to ignoring non-preventable risks can play an important role.

We argue that anxiety associated with thinking about death may in some circumstances lead people to repress, or deny, news about their mortality. We use the terms "denial" and "repression" to refer to selective ignoring of information, regardless of whether it takes the form of actual forgetting, selective attention or conscious effort to keep certain thoughts away. What is essential is that some previously received information is not assimilated. Such a broad notion of repression has been considered in an economic context by Benabou and Tirole (2001).

While the possibility of active repression is taken seriously by psychologists, there is limited understanding of its biological mechanisms. A recent study by Anderson et al. (2004) showed that subjects asked to forget a piece of information were indeed able to suppress it and, using a functional Magnetic Resonance Imaging technique, identified the neural systems involved in this process. These researchers concluded that their work confirms the existence of "an active process by which people can prevent awareness of an unwanted past experience." We note, though, the classic experiment by Wegner, Schneider, Carter, and White (1987) that offers conflicting evidence: when given five minutes to state their thoughts—but told not to think of a white bear—most people could suppress the "white bear" thought only for a brief period, suggesting that thought suppression can have the effect of inducing the very thought it is directed against.

There is evidence that in some situations people choose not to receive information that is crucial to their longevity. Lyter et al. (1987) report that many patients are reluctant to learn their HIV status, and commonly cite as a reason the anticipation of severe psychological distress if the result is positive. Wong, Reker, and Gesser (1994) report that for five statements having to do with death avoidance (e.g., "I always try not to think of death.") on a 7-point Likert scale where three corresponds to "mildly disagree," the mean response was 2.89, with a standard deviation of 1.36. The self-professed fear of death was slightly higher. For seven statements having to do with fear of death (e.g., "I have an intense fear of death."), the mean response was 3.02, with a standard deviation of 1.30. Thus, on average, people neither constantly think of death nor intensely fear it. These answers are merely suggestive, however, because this pattern of response may, but might not be, the result of successful repression of disturbing thoughts about one's mortality.

Our objective is to model the impact of the fear of death on the most basic economic decisions: consumption and saving. Our departure point is the realization that attitudes toward death should determine how individuals discount the future. We model this by assuming that perceived mortality risk plays both the role of determining death anxiety (which reduces utility) as well as the standard role of being a component of the discount rate. Thus, there is a trade-off involved in manipulating the perceived mortality risk through denial: denial will alleviate future anxiety, but it will also bias time preference in the future. In contrast, the standard modeling assumption of using mortality rates for discounting only amounts to assuming that individuals fully acknowledge the prospect of death; this is a special case of our model for which fear is non-existent. When fear is present, however, individuals will pursue strategies intended to reduce it, and these strategies will have consequences for how they think about the future.

In the model, individuals receive a signal about their mortality, make their consumption decision under full information, and repress the signal over time if they (consciously or unconsciously) choose. As a result, their future decisions may rely on a skewed information set but, if repression is successful, future fear will be reduced. The cost of allaying the fear of death in this model is therefore an otherwise inefficient intertemporal pattern of consumption: an unrealistically optimistic assessment of one's longevity will induce people to consume too little, and leave too much wealth upon their death. But this is not the end of the story. People who are forward-sophisticated (the term we use to describe people aware of the consequences of their denial on future behavior) will anticipate the possibility that later they will repress bad news about their longevity, and adjust consumption to minimize the cost of leaving too much wealth unconsumed.

Although we do not suggest that repression is a fully conscious phenomenon, it is nevertheless reasonable to expect that some people may be aware of their tendency to forget selectively. That does not change the fact that some information may be truly forgotten. Benabou and Tirole (2001) introduce an assumption of "meta-cognition" to allow that, when decisions are made, people consider the possibility that information has been repressed in the past. We refer to this assumption as "*partial* backward sophistication."[1]

This model of the denial of death derives, rather than assumes, several of the so-called behavioral phenomena that have been drawn on to justify rethinking of conventional economic models. In our model, time-inconsistent behavior is a consequence of fear and denial for everyone with at least a moderate degree of

[1] *Fully* backward sophisticated may additionally look back upon their life and try to infer from their past consumption patterns whether relevant information has been suppressed, so that inconsistency of beliefs with all available information cannot persist. In anticipation of that, fearful people may try to arrange their behavior so as to conceal having received bad news. The idea of full backward sophistication is that repression by an aware individual may be successful only if it is accompanied by a logically consistent picture of the world. Apparent contradictions (e.g., there is no reason to worry even though I drank too much yesterday, but I only drink when there is a reason to worry) may reveal self-deception of an unpleasant event, even though the event itself is otherwise forgotten and should not be present. Many real-life decisions may serve as clues about one's state of mind when the decision was made.

backward sophistication. Backward-sophistication does not preclude the possibility that repression is unconscious; it requires only some awareness of a *tendency* to repress. Even though individuals are fully rational in a standard economic sense, they may discard some informative signals. Although not everyone denies information about their own mortality, even people who do not repress end up with distorted behavior because a person who does not repress at all cannot distinguish herself *ex post* from someone who successfully repressed. This implies that the equilibrium distribution of death anxiety may not be characterized by a general overoptimism. On average, people perceive their mortality risk accurately, but under repression are closer to the mean than they should be.

Our model of death anxiety and the possible repression of information about mortality implies that people who are unaware of their denial will underconsume, acting as if their expected lifetime is longer than is accurate. Sophisticated individuals may, however, overconsume early in life in anticipation of future denial and may seek ways to commit themselves to act according to the mortality prospects as they currently appear. Repressing small reminders of mortality is always beneficial in this setting, but whether stronger signals should be repressed depends on balancing the utility gain from repressing anxiety and the utility cost of making inappropriate intertemporal decisions. Finally, the behavior of those individuals who recognize the possibility of past denial may be affected even if they do not end up repressing negative mortality signals.

This is not the first model that generates time inconsistency from more fundamental assumptions. For example, Caplin and Leahy (2001) demonstrate that time inconsistency may arise as the result of the (dis)utility flow from anticipation prior to the resolution of uncertainty. In their model, time inconsistency may arise because, *ex ante*, people may make decisions about the future motivated in part by the desire either to reduce anxiety or to facilitate savoring; *ex post* such choices need not be preferred. In our model, there is no present anxiety that can be manipulated. Instead, the individual is attempting to reduce *future* fear. Furthermore, in our model, time inconsistency hinges on the ability to suppress information, a feature that is not present in the Caplin and Leahy (2001) framework. Without an ability to repress, fear of death would have no effect on economic decisions in this model. Kőszegi (2003) uses a framework motivated by Caplin and Leahy (2001) to analyze the patient-physician relationship, and shows that patients might be reluctant to gather information (as a result of visiting a doctor) that could indicate bad outcomes. His focus is on the decision whether to pursue the acquisition of information, and his two-period framework does not give rise to time inconsistency. In contrast, our objective is to analyze the implications that fear and repression have for discounting future utility and for critical decisions such as consumption and saving. Finally, Brunnermeier and Parker (2005) develop a model where individuals can directly choose their beliefs to influence current felicity, which may depend on the perceived level of expected future utility, while imposing conditions on the evolution and consistency of beliefs. Two features of our framework distinguish our approach. First, individuals derive disutility directly from their beliefs. Second, while in our model beliefs also have to be consistent over time (by following Bayes rule), they cannot be arbitrarily selected. Instead, pieces of information can be effectively (consciously or unconsciously) ignored and therefore entail consequences for *future* beliefs.

We believe that further elaboration of the implications of death anxiety and the denial of death may help to explain other empirical phenomena that hinge on the rational contemplation of the world after one's demise, such as procrastination in estate planning, the apparent underutilization of tax-advantaged inter vivos gifts to heirs and the inadequate provision of life insurance, but these questions must await future research. We begin next to develop the formal model of death anxiety, denial of death and their implications for economic behavior.

1. Model - Preliminaries

We consider an individual who may live as long as three periods $i = 0,1,2$. She is characterized by an unknown frailty parameter f that can take either of two values f_L and f_H, $f_L < f_H$, with corresponding unconditional probabilities π and $1-\pi$. An individual with frailty of f faces a hazard rate of dying by the end of period i given by $h_i(f)$. Everybody dies by the end of period 2 so that, trivially, $h_2(f) = 1$ for all values of f. Higher frailty corresponds to higher mortality risk, in that $h_i(f_H) \geq h_i(f_L)$ for $i = 0,1$. Individuals hold beliefs about the frailty parameter that are summarized by $q = P(f = f_L)$.

Instantaneous utility in period i is given by $u(C_i) - F_i$, where C_i is consumption and F_i is an index of the fear of death. We assume that $u(\cdot)$ is increasing and concave. Fear of death depends on the subjective probability of death occurring before the next period. If that probability is equal to m, the fear of death index is $F(m)$, where F is an increasing function.

We denote by b_i^j the belief, or subjective probability, as of period i that one will survive until period j conditional on being alive at time $j-1$ (with $b_i^i = 1$). For example, b_0^2 is a belief held at time 0 that one will live to see period 2 if one is alive at time 1. The value of b_i^j depends directly on the frailty belief q in a manner we make explicit later. Given beliefs, the individual maximizes in period

i the additively separable expected utility[2]

$$\sum_{j=i}^{2}\left(\prod_{k=i}^{j} b_i^k\right)\mathrm{E}[u(C_j)-F_j]. \tag{1}$$

Mortality risk is accounted for explicitly in this objective function through its dependence on subjective mortality. The only non-standard element is the presence of fear. The current level of fear cannot be manipulated and is given by $F_i = F(1-b_i^{i+1})$. However, future fear F_j, $j > i$, can be divorced from the currently perceived future hazard rate $1-b_i^{j+1}$ by actions that bias future perceptions of the subjective mortality risk. Because mortality risk plays the dual role of determining fear as well as being a component of the discount rate, there is a trade-off involved in manipulating the perceived mortality risk through denial: denial will bias time preference in the future. By itself, this suggests that time inconsistency may arise as an outcome of the model. We will explore this possibility in what follows.

1.1 News

We assume that at time 0 individuals observe with probability α a signal indicating their frailty. The signal is bad news: individuals with high frailty f_H observe it with probability s_H that is higher than the probability of observing it when frailty is low, s_L. The kind of signal we have in mind might be subtle such as, for example, perceived discomfort that may, but need not, indicate illness. Our framework is also consistent with the possibility that one of the frailty beliefs is unrealistically optimistic (in the extreme, a belief in immortality) and the other one corresponds to more realistic expectations.[3] In that case, many real-life events may act as signals by simply reminding (or informing) people that they are mortal.

Individuals update their beliefs regarding their frailty type using Bayes' rule. The signal is used to update beliefs at time 0. If still remembered at time 1, it is analogously used to construct beliefs then. If, however, it is not remembered in period 1, the individual (depending on her level of sophistication[4]) may take

[2] We assume no discounting other than via the survival probability. Introducing exponential discounting would not change major conclusions, but it would complicate notation.

[3] A pattern like that would be consistent with the developmental process of constructing and understanding the concept of death in childhood (Kastenbaum, 2000).

[4] Sophistication refers here to the updating process and is different than sophisticated behavior with time-inconsistent preferences (O'Donoghue and Rabin, 1998). Benabou and Tirole (2002) use the term "meta-cognition" in a related sense. Because we deal with both kinds of issues later in the paper, we will later refer to sophistication in the time-inconsistency context as "forward sophistication" and to sophistication related to the Bayesian updating as "backward

Period 0	Frailty belief π $\Rightarrow$ Signal $\Rightarrow$ Beliefs q_0, $b_0^1 = b_0(q_0)$, $b_0^2 = b_1(q_1^*(q_0))$ $\Rightarrow$ Choose C_0 & denial
Interim	Denial takes place, belief based on retained information is q_0^*
Period 1	Mortality resolved $\Rightarrow$ Update beliefs to $q_1 = q_1^*(q_0^*)$, $b_1^2 = b_1(q_1)$ $\Rightarrow$ Choose C_1
Period 2	Mortality resolved $\Rightarrow$ Choose C_2.

Table 1: Sequence of Events

into account the likelihood that the signal was repressed while updating beliefs.
At time i, the present fear F_i is no longer a choice variable. Manipulation of information (if any) is intended to affect future fear, that is F_j, $j > i$. With three periods of life, only the fear level in period 1 can be affected (at time 0): fear in period 0 is predetermined, and fear in period 2 must be $F(1)$. Given that by assumption fear does not interact with consumption in the utility function, F_0 and F_2 do not play any role in individual behavior and we suppress these terms throughout the paper.

We assume that the individual updates beliefs throughout the whole lifespan. The sequence of actions and evolution of beliefs is depicted in Table 1. Before the signal can be observed, the prior belief of low frailty f_L is equal to its population frequency π. We denote the belief in period 0 that incorporates the signal by q_0. Our assumption of Bayesian updating and the information structure imply that q_0 can take two values, as follows

$$q_0 = \begin{cases} \pi, & \text{if no signal was received,} \\ \dfrac{\pi s_L}{\pi s_L + (1-\pi)s_H}, & \text{if a signal was received.} \end{cases} \tag{2}$$

We denote the value of q_0 when the signal was (not) received by q_0^S (q_0^N). Note that $q_0^S < q_0^N$ because $s_H/s_L > 1$. Receiving the signal increases the likelihood that one is of high frailty. In the same manner, we also introduce beliefs formulated in period 1 and denote them by q_1.

Frailty beliefs translate in a natural manner into subjective survival rates. To facilitate the discussion, we introduce a function $b_i(q)$ that maps frailty risk q into a subjective one-period survival rate conditional on being alive at time i. Equivalently, $b_i(q)$ is one minus the subjective mortality hazard rate at time i. The value of $b_i(q)$ is defined as

sophistication."

$$b_i(q) = q[1 - h_i(f_L)] + (1 - q)[1 - h_i(f_H)]. \tag{3}$$

Clearly, $b'_i(q) = h_i(f_H) - h_i(f_L) > 0$: a higher likelihood of low frailty increases subjective survival rates. From this formula, $b_0^1 = b_0(q_0)$ and $b_1^2 = b_1(q_1)$. Note, though, that $b_0^2 \neq b_1(q_0)$. This is because surviving one period provides new information about frailty, so that the survival rate between the first and second period should reflect the updated frailty belief. Having survived until period 1, beliefs should be revised according to[5]

$$q_1^*(q) = \frac{1 - h_0(f_L)}{b_0(q)} q. \tag{4}$$

The function $q_1^*(q)$ represents updating of the prior q to incorporate the fact of survival. If no information is forgotten in period 1, then $q_1 = q_1^*(q_0)$. In general, however, due to repression q_0 need not be known in period 1 and the appropriate prior has to be constructed using available and possibly incomplete knowledge. That prior is denoted by q_0^* (with $q_0^* = q_0$ if no information is repressed), so that generally $q_1 = q_1^*(q_0^*)$. This is not a concern in period 0 when no information is yet forgotten, so that

$$b_0^2 = b_1(q_1^*(q_0)) = b_1\left(\frac{1 - h_0(f_L)}{b_0^1} q_0\right). \tag{5}$$

The final piece of the individual's problem is the budget constraint. We denote by Y the total initial wealth and, to simplify notation, set the interest rate to zero. All income is received in the first period and we assume away annuity and insurance markets as well as bequest motives. Consequently, the intertemporal constraint is

$$C_0 + C_1 + C_2 \leq Y, \tag{6}$$

which must hold in every state of the world (with just C_2 or both C_1 and C_2 equal to zero in the case of death before the last period).

1.2. Perfect recall

Note that, without fear of death, repressing information is not optimal and behavior is time-consistent. We next introduce a fear of death but without the possibility of denial, which we refer to as perfect recall. We proceed by backward induction. The individual problem in period 2 is trivially to maximize $u(C_2)$, so

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[5] To see the derivation of equation (4), note that the subjective probability of survival is $b_0(q)$, while the subjective probability of survival and being low-frailty is $q(1 - h_0(f_L))$. Hence, the formula follows by Bayes' rule.

that all the remaining resources are spent on consumption.
In period 1, the individual updates frailty beliefs using two available pieces of information: the fact that she survived until period 1, and information pertaining to the period 0 signal. Having perfect recall, $q_1 = q_1^*(q_0)$ as in expression 4 (with q_0 being the first-period frailty belief that already incorporates news as defined in expression 2). In period 1, the consumer attempts to maximize $u(C_1) - F(1-b_1^2) + b_1^2 u(C_2)$. The fear of death is no longer uncertain then, so that $F(1-b_1^2)$ is taken as given. As a result, the problem is completely standard and the optimal consumption choice is to pick consumption according to a variant of the Euler equation given by

$$u'(C_1) = b_1^2 u'(C_2)). \tag{7}$$

The decision in period 0 can be analyzed analogously, with individuals having beliefs $q_0 = q_0^S$ or $q_0 = q_0^N$ depending on the signal. When evaluated in period 0, consumption in periods 1 and 2 are weighted using the discount factors of b_0^1 and $b_0^2 b_0^1$, respectively, so that the relative discount rate is b_0^2. Crucially, $b_1^2 = b_0^2$ because $q_1 = q_1^*(q_0)$, so that in period-0 and period-1 the individual uses the same discount rate to compare first- and second-period consumption: behavior is perfectly time-consistent.[6]

2. Denial of Death among Backward-Naïve Individuals

We now allow that individuals may want to repress bad information. In particular, following Benabou and Tirole (2002), we assume that the individual may select the rate of recall $1-\mu$. Thus if news is received, the individual may be able to forget this information with the probability of μ.[7]

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[6] Halevy (2001) shows that this is a more general result in the presence of mortality risk.

[7] Building on the model developed in Carrillo and Mariotti (2000), Benabou and Tirole (2002) show that ignoring information may be beneficial if a person is time-inconsistent (in their framework: if the person is a hyperbolic discounter) to begin with. Our argument is different: a person may decide to ignore information to alleviate fear and thereby ends up being time-inconsistent. In this case considerations that Benabou and Tirole (2002) analyzed can come into play: given time inconsistency generated by denial, the individual may additionally manipulate information to increase self-confidence. Contrary to Benabou and Tirole (2002), we do not introduce a cost of forgetting. Allowing for the utility cost of forgetting is a straightforward extension of the problem that would not affect our conclusions in an important manner. In particular, except for the simplest case considered in what follows (the case of individuals who are both backward- and forward-naive), we obtain an interior optimum for .

We again proceed by backward induction. In period 2, the problem is trivial: with no bequest motive, in the last period of life one should consume everything that is left. In period 1, the individual must formulate subjective beliefs regarding her frailty. There are again two sources of information: the fact that one is still alive and information pertaining to news received in period 0. We will assume throughout that information stemming from survival is fully incorporated into individual beliefs.

As for the information regarding the signal, we will consider both "backward-sophisticated" and "backward-naive" behavior. A backward-naive individual trusts her memory: if the signal is not recalled she believes that it was not received. In the same circumstances, a backward-sophisticated individual engages in introspective behavior, incorporating into the updating process the possibility that the bad news was received but was repressed. (To avoid confusion, we denote as a "forward-naïve" individual someone who assumes that future selves will share her preferences, while a "forward-sophisticated" individual recognizes that there may be a conflict between today's and tomorrow's objectives.) We begin by considering the backward-naïve case.

A backward-naive individual trusts her state of knowledge in period 1. If she does not remember observing the signal, she presumes it was not received; if she remembers observing it she presumes it was received. Without acknowledging the possibility of repression, Bayesian updating implies that q_1 is given by $q_1^N \equiv q_1^*(q_0^N)$ when no signal is recalled and $q_1^S \equiv q_1^*(q_0^S)$ when one is remembered. This amounts to completely discarding a repressed signal.

The initial problem is now more complex, because the individual must also decide whether to repress bad news. Repressing bad news will increase future subjective survival rates, which reduces future fear of death, but also leads to sub-optimal future choices (i.e., too much saving), because the choices do not reflect the full information available.

There are two scenarios to consider at time 0. People who did not receive the signal have no decision to make regarding the rate of recall. In this case, in the next period the individual will presume that the signal was not received and proceed as in the perfect recall case.[8]

Individuals who have received the signal have to decide whether to repress it. For all those who repress it, their behavior is time-inconsistent. When repression is successful (and thus reduces fear), the objectives of period-1 and period-0 selves diverge: given the level of first-period fear, the period-1 self maximizes $u(C_1)+b_1(q_1^N)u(C_2)$, rather than $u(C_1)+b_1(q_1^S)u(C_2)$, as preferred by

[8] Note that even if it was possible to fabricate signals, people who did not receive a bad signal about their frailty do not have an incentive to do so, because it would both increase their future fear and lead to sub-optimal consumption choices.

the period-0 self.

In this model, time inconsistency is the result of a *choice* that, while reducing fear, results in a sub-optimal consumption profile.[9] Although the possibility of time inconsistency follows in a straightforward manner from the assumed form of preferences, our modification of standard preferences is grounded in two important aspects of human behavior: people fear death and have an ability to repress. Both of these are required for behavior to be time-inconsistent. Fear of death alone does not lead to time-inconsistent behavior but without a fear of death, an individual (with additively separable preferences and exponential discounting) has no incentive to forget anything. Consequently, contrary to most of the prior literature on time-inconsistent behavior, time inconsistency here is a *consequence* of human psychology, rather than an assumption.

We now turn to the implications of whether people are forward-naïve or sophisticated. In order to characterize the repression strategy, we introduce the solution function for the optimization problem of the period-1 self as $C(q,z) \equiv (C_1(q,z), C_2(q,z))$, where q is the first-period frailty belief, and z is the available income. $C(\cdot)$ is defined as follows:

$$C(q,z) = \underset{C_1, C_2 \in R}{\operatorname{argmax}} \{u(C_1) + b_1(q)u(C_2) \mid C_1 + C_2 = z\}, \tag{8}$$

Note that, due to the way fear enters the utility function, this solution does not depend on the level of fear. We also define the quasi-value functions $V(q,b,z)$ and $V^F(q,b,z)$ as

$$V(q,b,z) = u(C_1(q,z)) + bu(C_2(q,z)), \tag{9}$$

$$V^F(q,b,z) = V(q,b,z) - F(1 - b_1(q)). \tag{10}$$

The function $V(\cdot)$ represents the value given some alternative subjective survival belief b, so that it allows one to evaluate welfare generated by the period-1 self's choices from a different perspective. Total continuation utility that depends on both $V(\cdot)$ and the fear of death is represented by V^F.

2.1. Backward- and Forward-Naive Individuals

A forward-naive individual appreciates the benefits of reduced fear but does not recognize the implications of repression for her future behavior.[10] Therefore,

[9]This idea is conceptually similar to the cognitive dissonance approach of Akerlof and Dickens (1982). There are several key differences, though. They assume that people can directly choose their beliefs, they do not consider a game-theoretic framework, and they consider contexts that are different than the fear of death.

[10] She also know that, if < 1, repression may not be successful.

regardless of the outcome of repression, she expects to receive utility from consumption given by $V(q_1^S, b_1(q_1^S), z)$. At period 0, her objective function is

$$u(C_0) + b_0(q_0^S)\left[V(q_1^S, b_1(q_1^S), z) - (1-\mu)F_1^S - \mu F_1^N\right]. \qquad (11)$$

The marginal impact of a change in μ is thus equal to $F_1^S - F_1^N$, which is unambiguously positive: repression is beneficial because it reduces fear from the high level of F_1^S to the low level of F_1^N. The individual will feel better off with a lower level of fear and thus full repression ($\mu = 1$) is optimal. A fearful forward-naive individual always denies death, and so sets $\mu = 1$.

Period-0 consumption is identical to what it would be without the ability to deny death. However, because all bad news is fully repressed, first-period consumption will be smaller than in the full-information case, $C_1(q_1^N, z) < C_1(q_1^S, z)$.[11] The time-1 self will perceive lower mortality risk and thus consume *less than otherwise* in order to save for later periods of life that are, over-optimistically, perceived to be following. He is more likely to die without having consumed his wealth which, in the absence of any bequest motive, is a waste of resources.

2.2. Backward-Naive but Forward-Sophisticated Individuals

A forward-sophisticated individual realizes that the cost of denial is a future consumption pattern that may not be what she would prefer *a priori*. The period-0 self's objective is to select C_0 and μ to maximize

$$u(C_0) + b_0(q_0^S)\left[(1-\mu)V^F(q_1^S, b_1(q_1^S), z) + \mu V^F(q_1^N, b_1(q_1^S), z)\right], \qquad (12)$$

where recall that $z = Y - C_0$, is the income available in period 1. With probability $1-\mu$, the individual will assimilate the bad news and make choices according to the "right" objective function but with a high level of fear. With probability μ, the individual will repress the news successfully and will make choices with the "wrong" frailty belief q_1^N and a corresponding lower level of anxiety.

The utility impact of a marginal change in the level of repression is given by

$$\begin{aligned} W(q_1^N, q_1^S, z) &\equiv V^F(q_1^N, b_1(q_1^S), z) - V^F(q_1^S, b_1(q_1^S), z) \\ &= \left(F_1^S - F_1^N\right) - \left(V(q_1^S, b_1(q_1^S), z) - V(q_1^N, b_1(q_1^S), z)\right). \end{aligned} \qquad (13)$$

This formula does not depend on μ, so that the individual will decide to either repress fully or not to repress at all. The decision depends on which of the following two factors dominates: the reduction in fear $F_1^S - F_1^N$, or the loss of

[11] The inequality is a straightforward consequence of the concavity of $u(\cdot)$ in consumption.

utility due to the bias in the discount rate used in the future, $\left(V(q_1^S, b_1(q_1^S), z) - V(q_1^N, b_1(q_1^S), z)\right)$.

Note, though, that a small degree of time inconsistency has only a second-order effect on welfare, while a reduction in fear has a first-order effect.[12] So, in the case where s_H/s_L is sufficiently close to 1, so that q_1^S is arbitrarily close to q_1^N, such as weak indicator of frailty will always be fully repressed ($\mu = 1$). As a result, behavior becomes (slightly) time-inconsistent.[13]

As the informativeness of the signal increases ($s_H/s_L \to \infty$), there is a loss of utility from suboptimal choices and a gain from the reduced fear of death. Which of the effects dominates depends on the specification of utility and fear of death. Note that changes in the functional form of $F(\cdot)$ do not affect consumption choices. Therefore, depending on one's innate fearfulness, the benefits of reduced fear may be smaller or greater than the utility loss from suboptimal future consumption and saving decisions.

There is no monotone relationship between optimal repression and the informativeness of signals. One interesting specification of F would allow for fear to increase without bounds as mortality risk increases, so that $\lim_{m \to 1} F(m) = \infty$. In this case, signals that point to almost certain death by the end of first period[14] will result in complete repression. Consequently, it may be that both non-informative and very informative signals will end up being repressed, while moderate signals end up being accepted.

Intuitively, information will be repressed when the marginal gain in welfare from reduction in fear is large relative to the marginal loss of welfare from a distorted pattern of lifetime consumption. This must the case if the disutility from fear is large (for example when we increase fear holding constant the utility from consumption), but it is also the case when the loss of welfare from consumption is negligible (for example, in the neighborhood of optimal consumption choices absent any fear.)

Because in the presence of denial future consumption decisions are suboptimal, it might seem that a forward-sophisticated denier should increase present consumption and reduce the resources devoted to misallocated subsequent

[12] This is intuitive: the period-1 self will proceed with a slightly biased rate of time preference and will therefore pick only a slightly different consumption plan than the period-0 self would. Because we start at the period-0 self's optimum, such consumption changes do not have a first-order impact on welfare. Fear, on the other hand, affects welfare directly.

[13] A proof is offered in the appendix.

[14] The signal must be both informative, i.e., have a large value of s_H/s_L and be such that high frailty indicates a hazard rate close to one: $h_1(f_H) \approx 1$.

consumption. This is not necessarily so, however. Recall that O'Donoghue and Rabin (1998) have shown that a (forward) sophisticated individual facing a time-inconsistency problem may decide to perform a task earlier than would be optimal with commitment, because she realizes that otherwise she would procrastinate too long. Such a possibility is present in this setting as well, even though time inconsistency arises as a choice and decisions are continuous rather than being binary.

The direction of the effect of repression on period-0 consumption and saving depends on preferences. The key to determining the effect of repression on C_0 lies in understanding its effect on the marginal utility of wealth carried over to period one. Holding C_0 constant, the level of utility in the future must unambiguously fall, but the same does not necessarily obtain for marginal utility: it is possible that the marginal utility in the future will be lower under repression than without it, but it is also possible that it will be higher. Depending on the direction of this effect, consumption should be postponed or accelerated. An example presented in the appendix shows that with an isoelastic utility function where $u(c) = \frac{c^{1-\xi}}{1-\xi}$ it depends on whether $\xi > 1$. If it is, period-0 consumption moves upward. The ambiguity is due to the fact that a suboptimal allocation of future consumption has two offsetting effects on the attractiveness of present consumption: the fact that saving will be put to suboptimal use makes present consumption more attractive, but the knowledge that future utility will be lower due to suboptimal consumption makes saving more needed, and thus makes present consumption less attractive. In the isoelastic utility case, whether $\xi > 1$ determines which of these effects dominates.

Even if C_0 is not affected by repression, the lifetime pattern of consumption is still affected by the presence of denial: consumption decisions in period 1 will be made relying on the "wrong" mortality rate. The forward-sophisticated individual knows that tomorrow she may make bad choices. This realization induces time inconsistency, but of a type that is conceptually different than instant gratification: this is a fully rational choice that would be affirmed by any of the selves if they had the same information. Note also that there is an unambiguous welfare measure that selves at different points in time would agree on: the utility that relies on full information for discounting. In this respect, by providing an unambiguous welfare metric while allowing for time inconsistency, this is an alternative to the framework of Gul and Pesendorfer (2001, 2002).

A forward-sophisticated person could in principle deal with time inconsistency using various commitment devices. What is interesting here is that an appropriate commitment device would force the individual to consume in period 1 rather than save. Knowing that the period-1 self will be committed to consume would reduce the period-0 self's concern that her saving will be used inefficiently. The period-0 self could then consume appropriately. At the same time, the availability of such devices would make repression less costly by reducing future inefficiency without affecting the utility benefit of the lower level of fear.

3. Denial of Death among Partially Backward-Sophisticated Individuals

A backward-naive model is inconsistent with some stylized observations. For example individuals do appear to, on average, predict their mortality accurately (Hurd and McGarry 1995, 2002; Smith et al. 2001). For this reason, it is worthwhile to consider an extension of this model that is consistent with this evidence. In particular, we now consider the possibility that people are what we call partially backward-sophisticated. (In what follows, we will concentrate on individuals who are also forward-sophisticated.) In addition, although we allow the individual to be sophisticated enough to recognize the possibility of past denial, we do not allow her to be so sophisticated as to learn about the possibility of past denial by examining past *consumption* decisions. In period 1, C_0 is not in the information set of the individual or, alternatively, the information related to the initial income Y is not in the information set.

For an individual who is partially backward-sophisticated and forward sophisticated, when the signal is remembered it is clear that it was received, so that the likelihood of being of low frailty before mortality risk is resolved is q_0^S. If it is not remembered, however, the person recognizes that there is a chance that it was in fact received, but repressed. Recall that the likelihood of receiving the signal is α. If the repression rate is , the likelihood that the signal was received and repressed is then $\alpha\mu$. Therefore, after the signal is forgotten, but before it is known whether the individual survived until period 1, the chance of being low frailty conditional on observing no signal is given by[15] $q_0^*(\mu) = \frac{(1-\alpha)q_0^N + \alpha\mu q_0^S}{(1-\alpha)+\alpha\mu}$. On top of that, the individual uses expression (4) to incorporate information due to survival. Consequently, individuals who remember the signal hold the first-period belief of $q_1^S = q_1^*(q_0^S)$, while individuals who do not remember it hold a belief of

[15]The unconditional probability of not remembering a signal is given by $(1-\alpha)+\alpha\mu$: the signal either was not received or was repressed. In the first case, the likelihood of being low frailty is q_0^N. In the second case, it is q_0^S.

$$q_1^K(\mu) = q_1^*\left(\frac{(1-\alpha)q_0^N + \alpha\mu q_0^S}{(1-\alpha)+\alpha\mu}\right). \tag{14}$$

It is trivial to show that unless $\mu = 0$ we have $q_1^K < q_1^N$: a partially backward-sophisticated individual who does not remember the signal doubts herself, and thus is less confident of being a low-frailty type than a backward-naive individual would be. Clearly, $q_1^{K'}(\mu) < 0$: the higher is the degree of repression, the less confidence is placed on not remembering bad news and the lower is the subjective survival rate when the news is not recalled.

The decision of the period-0 individual who received bad news differs from the decision faced by a forward-naive individual as set out in (12) due to the fact that the belief $q_1^K(\mu)$ is held instead of q_1^N: if the signal is not recalled, it is no longer automatically assumed that it was not received. Thus the maximand becomes

$$u(C_0) + b_0(q_0^S)\left[(1-\mu)V^F(q_1^S, b_1(q_1^S), z) + \mu V^F(q_1^K(\mu), b_1(q_1^S), z)\right]. \tag{15}$$

The problem of the period-0 individual who did *not* receive bad news is also different than for a backward-naive individual, whose consumption decision is completely unaffected by fear and repression considerations.

The partially backward-sophisticated individual who received no signal does not repress, but also knows that she is not able to transfer this knowledge to the period-1 self. When period 1 arrives, she will suspect she might be of high frailty. This problem is caused by the repression strategy of the bad-news type, , that must be taken as given. We assume that in equilibrium the period-1 self knows the actual rate of repression , but does not know whether repression did in fact occur or not. Consequently, the period-1 self will proceed with a belief of $q_1^k(\mu)$ instead of the "right" one, q_1^s, where $q_1^k(\mu) > q_1^s$, and will strive to maximize

$$u(C_0) + b_0(q_0^N)V^F(q_1^K(\mu), b_1(q_1^N), z). \tag{16}$$

Note that for a partially backward-sophisticated individual who would repress bad news, behavior is time-inconsistent even for individuals who did not receive the signal. The healthy, low-frailty person suspects himself on being a high-frailty denier of death, and over-consumes.[16]

To see this, we define a perfect Bayesian equilibrium of this game with partial

[16] Interestingly, in this case the direction of the bias in the discount rate is the same as considered in the hyperbolic discounting and related literature: the individual without bad news appears impatient. Consequently, the results from a hyperbolic model apply *conditional* on the degree of time inconsistency. This degree is not under the control of the individual who did not receive a signal, but rather follows from the behavior of the other type and the uncertainty concerning which type one is.

backward sophistication as consisting of (1) assignments of C_0, C_1, C_2 to both types conditional on the realization of repression, (2) a denial strategy μ, and (3) beliefs q_1, for which: (4) q_1 is formulated using Bayes' rule given the repression outcome and μ, (5) consumption choices C_1 and C_2 are optimal given q_1, i.e., $C_i = C_i(q_1, Y - C_0)$, $i = 1,2$, and (6) C_0 of the no-news type is optimal given μ (i.e., it maximizes (16)), while μ and C_0 of the bad-news type maximize (15).

The marginal welfare effect of a change in μ for an individual who receives bad news is given by

$$W(q_1^K(\mu), q_1^S, z) + b_0(q_0^S)\mu \cdot q_1^{K'}(\mu) \cdot V_1(q_1^K(\mu), b_1(q_1^S), z). \quad (17)$$

The $W(\cdot)$ term represents the considerations that were also faced by a backward-naive, though forward-sophisticated, individual. Repression reduces fear but leads to suboptimal consumption choices. The second term is new: repressing leads to suboptimal consumption choices even if repression is not successful. The first-order condition implies that at an interior optimum, expression (17) is equal to zero.[17]

It can be shown that a partially backward-sophisticated individual who receives bad news selects at least partial repression ($\mu > 0$) whenever a backward-naive but forward-sophisticated individual represses fully.[18] Then, behavior of all types is time-inconsistent.

With a small degree of repression, the loss of utility due to self-doubting when news is forgotten is negligible because it happens with very low probability. Therefore, the decision to engage in denial is warranted if the reduction in fear dominates the cost of sub-optimal consumption, as in equation (13). In particular, the previous discussion of denial of weak indicators of mortality applies here as well with a qualification that such indicators will certainly be repressed with $\mu > 0$, but denial needn't be complete.

Even full repression may be optimal in this context. This is because $q_1^K(1) < q_1^S$: even though the individual realizes *ex post* that he always forgets bad news, there is still the possibility that no news was received. As in the backward-naïve case, there are no general results regarding the direction of the bias in period-0 consumption for the forward-sophisticated, partially backward-sophisticated case.[19]

Backward naïveté implies that even though a tendency to repress is

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[17] Corner solutions are also possible. When no repression is optimal this expression is negative at $\mu = 0$, and it is positive at $\mu = 1$ when full denial is optimal.

[18] A proof is offered in the appendix.

[19] Examples using an isoelastic and constant absolute risk aversion utility function are available from the author.

recognized, its implications are ignored ex post. Introducing partial backward sophistication eliminates this model feature by requiring that past repression strategy be accounted for when constructing future beliefs. This has the consequence of introducing diminishing payoffs to extensive repression: the more common is repression, the less effective it will be in reducing fear because it undermines confidence in one's own future memory. It also has the consequence of affecting the decisions of good-news types who do not repress at all: they will doubt their state of knowledge in the future.

4. Conclusions

Fear and even a form of paralysis in the face of death is a common theme among psychologists, sociologists, and philosophers. The model described in this paper incorporates into an economic model of lifetime consumption the intuitively attractive idea that some people act, ceteris paribus, to reduce this fear. We model death anxiety as dependent on subjective mortality expectations, and allow anxiety to be manipulated by repressing information that would lead to a higher level of fear in the future. Such repression is, however, costly: suppressing information makes future intertemporal decisions suboptimal. As a result, repression induces time-inconsistency. The consequences of this mechanism depend on the individuals' fearfulness, to be sure, but also on their degree of sophistication, both looking forward (recognizing the time inconsistency problem) and looking backward (recognizing the tendency to repress).

A forward-naive individual does not consider the possibility of future denial, and will under-consume upon receiving (and repressing) bad news. A forward-sophisticated individual who is aware of the possibility of self-deception may (but need not) over-consume in anticipation of future denial, and may seek ways to commit himself to act according to the mortality pattern that he perceives now, knowing that in the future he may be over-confident about his mortality prospects. We demonstrate that repressing minor reminders of mortality is always beneficial: it results in a first-order reduction in fear, but only a second-order utility loss from regular consumption. Stronger signals may be repressed or not, depending on the utility cost of fearfulness and the cost of making inappropriate intertemporal allocation decisions. This result highlights that to some extent the ability to repress can be helpful rather than harmful, and suggests a justification of "behavioral" phenomena from an evolutionary standpoint: while economically "rational" behavior is feasible, it may not be the optimal strategy in the presence of conflicting objectives that give rise to fear.

Perhaps most surprisingly, time inconsistency is not limited to those individuals who repress. For backward-sophisticated individuals, repression is successful only to the extent that it is not distinguishable from not having received bad news at all. As a result, the behavior of individuals who are aware of the phenomenon of repression is affected by the possibility of repression, regardless of whether they actually repressed or not. In this case, the possibility that one successfully represses information is enough to result in behavioral bias. The model of fear and repression provides a fabric for a profound psychological trait even within a fully "rational" economic framework. In a sense, the model is an economic interpretation (and a vindication) of the ideas of Rank (1941) and Becker (1973), who postulate that the fear of death is a key to understanding the human psyche.

As a possible extension, we note that this theory should be able to match any age-profile of denial without making the specification of how fear affects utilty explicitly age-dependent. This is because as the horizon becomes shorter, the utility cost of the misallocation of lifetime consumption becomes smaller, but higher baseline mortality rates shift individuals to a different segment of the anxiety function. Because it is the local properties of the fear function that matter for engaging in denial, by appropriately choosing the shape of the fear function one could make the likelihood of denial grow or fall with age. This suggests that age variation can be useful in pinning down the shape of the fear function.

Ultimately, the contribution of thinking through the implications of denial of death will rest on whether it can explain behavior that other models cannot. This will not be an easy task, in part because of the problematic nature of interpreting measures of what people may be denying to themselves. Indeed, the early psychology literature concerning death attitudes that addresses the causes, correlates, and consequences of death anxiety took seriously the idea that most people, most of the time, live in denial of their true attitude toward death, and tried to delve below the level of conscious report using such diverse procedures as imagery tasks, galvanic skin response, and word association tasks. This approach waned by the mid-1970's, and most death anxiety measures since then have been based on conscious reports in the form of written scales or questionnaires.

Although there is intriguing evidence that induced shocks to mortality salience have immediate attitudinal consequences (e.g. Greenberg et al. (1990) and Solomon et al. (2000)), no research has investigated the cross-sectional relationship between self-confessed death anxiety and behavior, nor would the theoretical implications be clear (as indicated by our model), in part because denial of death might otherwise affect immediate attitudes and behavior. The same caveat applies to the findings in economics that elderly people do not systematically overestimate their longevity, and that individuals' subjective assessments of their chances of living to a ripe old age co-vary with known risk factors in an appropriate way.

The refusal to face up to one's mortality seems consistent with the substantial evidence demonstrating the inadequacy of life insurance (Bernheim et al*.,* 2003). In addition, it is consistent with the observation that, among people wealthy enough to have a taxable estate, intergenerational transfers are postponed for too long (Poterba 2001, Kopczuk and Slemrod 2003). The level of inter vivos giving is much lower than would be implied by simple models of dynastic utility maximization, and the intergenerational transfers in the estates of the first dying spouse of a married couple are too small in view of the significant tax advantages they afford. Although both the tax law and the financial vehicles constructed to contravene the tax law are complicated (and so the incentives are difficult to precisely identify), it appears that many people forgo a significant amount of tax saving by postponing passing along their wealth to the next generation.[20]

This behavior is broadly consistent with an unwillingness to face up to one's mortality. It is, to be sure, also broadly consistent with an aversion to financial planning and with simple myopia. There is, though, reason to be hopeful that careful empirical research could distinguish between these alternative explanations and the implications of the denial of death. Clearly, the immediate objective of any further theoretical and empirical research in this area is to document the particular identifying implications of fear and denial of death, such as the behavioral response to events that increase the salience of mortality.

This paper discusses a first attempt to model the psychological and behavioral implications of mortality. One can imagine other approaches. Becker (1973) argued that people attempt to gain symbolic immortality through their children — we survive and live through them — and through wealth accumulated and passed on to the next generation. A model with immortality in the utility function and with wealth and children as substitutable means for "producing" immortality could imply that, ceteris paribus, estates would be higher for childless people, producing data patterns that are routinely taken by economists to be evidence for a bequest motive.

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[20] Fennell (2003) discusses how the effect and evaluation of the estate tax depends on how people cognitively process the prospect of death.

Appendix

Section 2.2:
Time inconsistency for backward-naïve but forward-sophisticated individuals

Lemma: Fear considerations alone determine whether an individual decides to repress when repression has a sufficiently small effect on future beliefs: $\frac{\partial}{\partial q}\left\{W(q,q_1^S,z)\right\}(q_1^S)=F'b'_1(q_1^S)>0$ and $\frac{\partial}{\partial q}\left\{W(q_1^N,q,z)\right\}(q_1^N)=-F'b'_1(q_1^N)<0$.

Proof. Note that $\frac{\partial}{\partial q}\left\{W(q,q_1^S,z)\right\}=V_1(q,b_1(q_1^S),z)+F'b'_1(q)$. Also, $V(q,b_1(q_1^S),z)=V(q,b_1(q),z)+[b_1(q_1^S)-b_1(q)]u(C_2(q,z))$. Because $V(q,b_1(q),z)$ is the value function of the period-1 self with a frailty belief of q, the envelope theorem applies to it. Thus, $V_1(q,b_1(q_1^S),z)=b'_1(q)u(C_2)-b'_1(q)u(C_2)+[b_1(q_1^S)-b_1(q)]\frac{\partial}{\partial q}u(C_2(q,z))$, where C_2 is evaluated at (q,z). Substituting $q=q_1^S$ makes this term equal to zero and yields the first part of the lemma. To show the second part, note that $\frac{\partial}{\partial q}\left\{W(q_1^N,q,z)\right\}(q_1^N)=b'_1(q)\left[V_2(q_1^N,b_1(q),z)-V_2(q,b_1(q),z)\right]-V_1(q,b_1(q),z)-F'b'_1(q_1^S)$. The first term is zero when evaluated at $q=q_1^N$. The second term was considered in the first part with q_1^N replacing q_1^S, and was shown to be equal to zero. □

Proposition: Weak indicators of frailty are fully repressed, causing behavior to be time-inconsistent

Proof. Define $q_1^S(\frac{s_H}{s_L})$, which satisfies $q_1^N=q_1^S(1)$ and $q_1^{S'}<0$. The welfare impact of an increase in $\frac{s_H}{s_L}$ is given by $\left\{\partial/\partial\frac{s_H}{s_L}\right\}\left\{W(q_1^N,q_1^S(\frac{s_H}{s_L}),z)\right\}=q_1^{S'}(\frac{s_H}{s_L})W_2$, which is positive when evaluated at $\frac{s_H}{s_L}=1$, by the previous lemma. Noting that $W(q_1^N,q_1^N,z)=0$ for any z, this implies that repression increases welfare for $\frac{s_H}{s_L}$ close enough to 1. □

Section 2.2: the impact of denial on consumption is ambiguous.

Example Consider an isoelastic utility function $u(C)=\frac{C^{1-\xi}}{1-\xi}$ where $\xi>0$. In the presence of certain denial ($\mu=1$), period-0 consumption is biased upward (downward) if $\xi<1$ ($\xi>1$). In the special case of $u(C)=\ln(C)$ ($\xi=1$), C_0 is unaffected by the ability to repress.

Proof. Fix the value of z. Denote $b_1(q_1^N)=\tau$. It is straightforward to show that

$C_2 = z\left(1+\tau^{-\frac{1}{\xi}}\right)^{-1}$ and $C_1 = \tau^{-\frac{1}{\xi}} C_2$. The marginal utility of z is

$$V_z(q_1^N, b_1(q_1^S), z) = u'(C_1)\left(1 - \frac{\tau - b_1(q_1^S)}{\tau}\frac{\partial C_2}{\partial z}\right) = \tau z^{-\xi}\left(1+\tau^{-\frac{1}{\xi}}\right)^{\xi}\left[1 - \frac{\tau - b_1(q_1^S)}{\tau}\left(1+\tau^{-\frac{1}{\xi}}\right)^{-1}\right]$$

This whole expression is positive and depends on z only through the contribution of the $z^{-\xi}$ terms. Therefore, the marginal utility is decreasing in z (V is concave in z). It can be shown by direct differentiation that V_z is decreasing (increasing) with τ when $(b_1(q_1^S) - \tau)(1-\xi) < 0$ (> 0). Because $\tau = b_1(q_1^N) > b_1(q_1^S)$, when $\xi > 1$ ($\xi < 1$), the marginal utility of z under repression is uniformly greater (smaller) than without it.

The optimal choice of C_0 is subject to the linear budget constraint $C_0 + z = y$. Without repression, it is characterized by $u'(C_0) = b_0(q_0^S)V_z(q_1^S, b_1(q_1^S), z)$, while with repression it is characterized by $u'(C_0) = b_0(q_0^S)V_z(q_1^N, b_1(q_1^S), z)$. The impact of repression on V_z established above (given the concavity of $u(\cdot)$ and the concavity of V_z in z) implies that C_0 falls as the result of repression when $\xi > 1$ and increases if $\xi < 1$. □

Section 3: Partially-backward sophisticated individuals

Proposition: A partially backward-sophisticated individual selects at least partial repression whenever a backward naïve but forward-sophisticated individual represses fully.

Proof. When $\mu = 0$, the second-term in equation (17) is zero and $q_1^K(\mu) = q_1^N$. Therefore, the individual will select $\mu > 0$ if $W(q_1^N, q_1^S, z) > 0$ and will select $\mu = 0$ otherwise. This is the same criterion as the one used by a backward-naive but forward-sophisticated individual. □

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