Awareness of Low Self-Control: Theory and Evidence from a Homeless Shelter

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Abstract:
Self-reported survey measures of self-control continue to appeal to practitioners for ease of implementation, necessitating further investigation of how well they predict outcomes. Here we argue that survey responses may not always be measuring self-control: it may instead be measuring awareness of self-control, especially when administered in populations with relatively low self-control. This paper focuses on the Ameriks et al. (2007) survey, which utilizes the deviation between self-reported ideal and predicted behavior, namely Expected Deviation (ED), to capture self-control problems. Previous empirical evidence, derived from highly successful populations, has shown that larger ED is correlated with worse outcomes. However, our theoretical model predicts that in settings where awareness can play a large role (e.g. when self-control is low and commitment devices are available), larger ED will be correlated with better outcomes. Our empirical evidence from the homeless population shows that ED is indeed positively correlated to the amount saved in shelter lockboxes, a commitment savings device. Furthermore, we find that the correlation is stronger for those experiencing more self-control problems: shelter residents with past addiction problems.

Keywords: Self-control; consumer behavior; surveys; commitment devices; awareness; sophistication

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1. Introduction

A large number of studies in economics and psychology have suggested that self-control is an important determinant of real-life outcomes. Higher measures of self-control have been found to be correlated with better personal finances (e.g. less credit card debt, Meier and Sprenger, 2010), less substance abuse, higher educational attainment, and less criminal offenses (e.g. Tangney et al., 2004; Moffitt et al., 2011). Though incentivized measures of self-control are preferred by economists due to explicit incentives for subjects to truthfully reveal preferences, survey methods remain more appealing for large scale use due to their low cost and ease of implementation (Falk et al., 2016). However, truthfulness aside, the informativeness of some survey measures may be arguable since it requires subjects to first be aware of their self-control problem. To address this issue, in this paper we attempt to elucidate theoretically and empirically the role of awareness in a self-control survey and how this affects the predictive validity of survey responses on actual behavior.

The survey measure on which we will focus is Expected Deviation (ED), which is introduced by Ameriks et al. (2007). This method presents survey respondents with a specific scenario and asks respondents with stating their ideal and predicted actions therein. The difference between the ideal and predicted behavior is then used as a measure of the self-control problem. ED is unique in that it directly asks respondents to formulate what all self-control measures are attempting to capture: the temptation to deviate from one’s ideal course of action. This will indeed reflect the variation in self-control across the population if respondents are similar in their awareness of their self-control problem. So far empirical evidence on the ED survey, collected from financially and academically successful populations (Ameriks et al., 2007; Wong, 2008), have shown a negative correlation with outcomes. This supports the idea that ED captures the variation of self-control in the population. However, this may not always be true. In this paper we allow for the possibility that the population also varies in awareness. We theoretically show that when awareness drives the variation in ED, ED will be positively correlated with outcome when commitment devices are available. In addition, the positive correlation will be stronger for those facing a larger self-control problem. We then empirically show that among the homeless population, ED responses are positively correlated with the amount saved in shelter lockboxes, and that this positive correlation is more significant for those facing larger self-control problems (e.g. individuals with addiction problems).

To model survey responses as well as savings with and without commitment devices, our theoretical section (Section 2) utilizes the standard quasi-hyperbolic discounting model (Phelps and Pollak, 1968; Laibson, 1997). This widely used model of self-control conceptualizes an individual as a collection of different selves that are strategically interacting; commitment is modeled as allowing the earlier selves to use strategies to make the deviations from the earlier selves' optimal plan costly or infeasible (Carillo and Dewatripont, 2008). We rewrite O'Donoghue and Rabin’s (2001) representation of partial awareness to isolate awareness (\( \alpha \)) from self-control (\( \beta \)). After exploring how \( \alpha \) and \( \beta \) drive survey responses, we use a simple three-period model to illustrate an environment with withdrawal-side commitment devices (Ashraf et al., 2003). These devices, such as the 529 college savings account or the lockbox at a homeless shelter, restrict withdrawal but require deposits to be made in the first place. Since subjects have to first invest costly effort into activating the commitment device, partial naiveté leads to suboptimal investment of effort and, subsequently, suboptimal savings. This echoes the insight from O'Donoghue and Rabin (2003) that “...if

\[\text{Quasi-hyperbolic discounting is one of the most frequently used models of self-control; it is analytically tractable and is especially suitable to study awareness. Other well-known models of self-control include Thaler and Shefrin’s (1981) planner-doer model, Fudenberg and Levine’s (2006) dual-self model, Gul and Pesendorfer’s (2004) temptation model, and Benhabib and Bisin’s (2003) internal commitment model.}\]
people are naïve, then they won’t fully recognize the commitment value of certain savings instruments” (p.233).

In Section 3 we provide a contribution to empirical evidence of predictive validity of self-control surveys by administering the ED survey to an understudied population: the homeless in America. Our subject pool provides an important complement to the existing population where the ED survey has been administered: the top 15% income bracket in the US (Ameriks et al., 2007) and students at a highly selective university (Wong, 2008). Given the many correlations between self-control and life outcomes, it is likely that these high-status populations have relatively higher self-control than our population, leaving less room for awareness to make a difference. Awareness is likely to matter much more among our population, a sizeable portion of which has characteristics linked to low self-control (e.g. 36.8% stated that they are homeless due to addiction, another third reported dropping out of high school). The shelter environment provides a rare opportunity to see not only how the homeless population responds to a commitment device, but also differences within subpopulations as a function of challenges in self-control.

We find that, among the homeless, larger ED predicts larger savings in the commitment savings account offered at the shelter; in addition, our tests for heterogeneity consistently suggest that the correlation is stronger for those experiencing more self-control problems. To understand what is driving the correlation between ED and actual savings, we decompose ED into ideal and predicted savings and analyze them separately. We find that neither has any predictive power in itself; it is only when the two are included together that we see an effect, suggesting that ED is indeed driven by awareness of the deviation from the ideal. Together with previous findings from Ameriks et al. (2007) and Wong (2008) that larger ED is correlated with lower investment among highly successful populations, this evidence suggests that the ED measure of self-control correlates with outcomes in a theoretically consistent manner after accounting for awareness.

Our findings suggest that we can use ED as a measure of self-control for subject pools that are expected to have high self-control, since awareness has only a limited role to play in this population. However, trying to measure self-control with ED (or other self-assessments) might result in omitted variable bias for populations with low self-control. Among these subjects, the variance in ED might be better explained by variation in self-awareness.

### 2. Theory

This section provides an intuition for how awareness ($\alpha$), together with self-control ($\beta$), drives the association between ED survey responses and savings. We do so in several steps. In Section 2.1, we review the $\beta$-$\delta$ model (O’Donoghue and Rabin, 2001) and introduce $\alpha$ in the context of responses to the ED survey. In Section 2.2, we explore the role of $\alpha$ and $\beta$ on savings in the presence of withdrawal-side

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2 In Ameriks et al. (2007), respondents have a median net-worth of $500k (in 1998 USD), placing the sample in the top 15% US income bracket (Kennickell, 2009). The homeless population, on the other hand, may be in the bottom 95%, with the national rate of homelessness being 20 people per 10,000 (Sermons and Witte, 2011). Erdem and Can (2013) finds a much higher prevalence of present bias among the low-income.

3 In fact the self-control parameter estimated in Linardi and Tanaka (2013) for this population is 0.6, while the average self-control parameter estimated in a review by Frederick et al. (2002) is 0.8.

4 Addiction has been widely related to higher discount rates; this is the case for both alcohol (Bjork et al., 2004) and illicit drugs (Petry, 2003).

5 O’Donoghue and Rabin (2001) show that procrastination worsens when the stakes of the decision is higher. For example, O’Donoghue and Rabin (1999c) show that procrastination in saving for retirement increases with principal. Consistent with their findings, we find that ED-saving correlations are higher for those experiencing positive income shocks (thus having more principal from which to save from) or are randomly offered additional incentives to save.
commitment device (Ashraf et al., 2003). Section 2.3 links these two subsections by connecting the ED survey responses to saving behavior. All proofs can be found in the Theoretical Appendix.

2.1 The $\beta$-$\delta$ model and the ED survey

The $\beta$-$\delta$ model, or the quasi-hyperbolic discounting model, has been one of the most widely used models since its introduction in Phelps and Pollak (1968) and Laibson (1997). In this model, a decision maker receiving a stream of utility from period $t=0$ on and discounts them by $\{1, \beta\delta, \beta\delta^2, \ldots\}$. The exponential discount factor, $\delta$, captures the trade-off between any two consecutive periods. The focus of this paper, $\beta$, captures the preference for immediate gratification. If $\beta < 1$, the trade-off between two consecutive periods in the future remains a function of only $\delta$; however, the trade-off between the current period and future periods is affected by $\beta$. This results in the decision maker not following through the optimal plan for period $t$ once she arrives at that period, allowing $\beta$ to model time inconsistency and to capture self-control problems.

O’Donoghue and Rabin (2003) observe that “people are aware that they will have self-control problems, but underestimate their magnitude” (p.220). They capture an individual’s perception of her self-control problem by the parameter $\alpha$, where $0 \leq \alpha = \alpha' \leq 1$. For an individual with a present bias, $\alpha' = 1$ indicates complete unawareness (naïveté), $\alpha' = \beta$ denotes complete awareness (sophistication), and $\beta < \alpha < 1$ denotes partial awareness (underestimation of self-control problems). Since we are interested in investigating the effect of awareness ($\alpha$) separately from the effect of self-control ($\beta$), we rewrite their formulation into Eq (1):

$$\beta' = 1 - \alpha(1 - \beta) \text{ with } 0 \leq \alpha \leq 1$$

(1)

With this formulation, complete naïveté is represented with $\alpha = 0$ while complete sophistication is captured by $\alpha = 1$. It is also apparent from the equation that since $\beta'$ is bounded below by $\beta$, the role of awareness decreases as self-control increases. This does not mean, however, that $\alpha$ and $\beta$ are exclusive: a person of $\beta = 0.9$ can be completely naïve ($\alpha = 0$) and think that her $\beta$ is 1 or completely sophisticated ($\alpha = 1$) and correctly know that her $\beta$ is 0.9. What this means is that $\alpha$ makes a much smaller difference for this $\beta = 0.9$ person than it does for someone with $\beta = 0.1$, for whom $\alpha'$ could vary from 0.1 to 1.

Now suppose an individual characterized with parameter $(\alpha, \beta, \delta)$ is thinking about her future savings, $s$. At Period 0, a person with income $I$ will have the opportunity to set aside $s \geq 0$ for consumption at Period $t$. Her Period 0 self ideally will save $s^*$, defined in Eq.2. Taking the first order condition shows that $s^*$ is independent of $\alpha, \beta$ since it needs only to satisfy $u'(I - s) = \delta u'(s)$. However, she anticipates that unlike her current period self, her Period $t$ self will additionally discount her utility for Period $t$ consumption by $1 - \alpha(1 - \beta)$. As a result, her predicted saving is $s^p \leq s^*$ (Eq. 3). The Expected Deviation (ED) measure (Ameriks et al., 2007) utilizes the difference between self-reported ideal and predicted behavior, which in this setting is the difference between $s^*$ and $s^p$ (Eq. 4).

$$s^* = \text{argmax} \beta\delta^t [u(I - s) + \delta u(s)]$$

(2)

$$s^p = \text{argmax} u(I - s) + (1 - \alpha(1 - \beta))\delta u(s)$$

(3)

$$\text{Expected Deviation (ED)} = s^* - s^p$$

(4)

Unfortunately once she arrives at Period $t$, her utility will actually be discounted by $\beta$ instead of $1 - \alpha(1 - \beta)$. Therefore $s^p$ may still be an overestimation of temptation saving, $s^t$, which we define as the amount she will actually save without a commitment device.
\[ s^t = \text{argmax } u(I - s) + \beta \delta u(s) \]  \hspace{1cm} (5)

In order to see the relationships between these variables clearly, we explicitly solve for the maximization problems for \( u(x) = \ln(x) \) and use them to numerically simulate how ED and \( s^t \) change as a function of \( \alpha \) and \( \beta \). To keep the focus on \( \alpha \) and \( \beta \), we will assume without loss of generality that \( \delta = 1 \). Substituting and solving Equations (2)-(5) we arrive at following the closed-form expressions:

\[ ED = s^* - s^p = l \frac{\alpha(1 - \beta)}{4 - 2\alpha(1 - \beta)} \]  \hspace{1cm} (6)
\[ s^t = l \frac{\beta}{1 + \beta} \]  \hspace{1cm} (7)

Figures 1a and 1b, respectively, illustrate level curves of ED (Eq.6) and \( s^t \) (Eq.7) in \( \alpha \) and \( \beta \) for \( I=100 \). The horizontal axis is increasing in \( \alpha \) (awareness of self-control problems) while the vertical axis is increasing in \( \beta \) (self-control). As we move along the horizontal (\( \alpha \)) axis in Figure 1a, ED gradually changes from black (\$0-10) to white (\$40-50), indicating that ED is increasing in \( \alpha \). On the other hand the regions darken as we move along the vertical (\( \beta \)) axis, indicating that ED is decreasing in \( \beta \). This is quite intuitive: between two people with similar self-control problems, the one who is more aware of hers will predict a larger difference between \( s^p \) and \( s^* \). Similarly, between two people with similar awareness of themselves, the one who actually has less self-control problems will report a smaller difference between \( s^p \) and \( s^* \). Note also that the gradation in colors spans a much wider range in the lower region of the figure than in the upper region: the smaller \( \beta \) is, the more ED increases in \( \alpha \). This indicates that the lower the self-control of the survey population, the more likely it is that the variation in self-control survey responses is due to differences in awareness.

Lemma 1 formalizes the relationship between ED, \( \alpha \), and \( \beta \). A consumer who is time consistent (\( \beta = 1 \)) or is completely naive (\( \alpha = 0 \)) will believe that she can reach her ideal savings and hence will report an ED of 0 (Lemma 1.1). For everyone else, a decrease in self-control will result, ceteris paribus, in a larger ED (Lemma 1.2.1). Similarly, an increase in awareness (while holding self-control constant) will also result in a larger ED (Lemma 1.2.2). However, the marginal effect of awareness on ED decreases with self-control (Lemma 1.2.3). This can be seen in Eq.3: as \( \beta \) approaches 1, the influence of \( \alpha \) on \( s^p \) approaches 0. This suggests that the variation in ED in a high self-control population is likely to be driven by \( \beta \), while the variation in ED in a population where self-control is relatively low is likely to be driven by \( \alpha \).

\textbf{Lemma 1. Expected Deviation depends on both self-control and awareness. Specifically,}
\textit{1.1 if} \( \alpha = 0 \) or \( \beta = 1 \), \( ED = 0 \)
\textit{1.2 if} \( \alpha > 0 \) and \( \beta < 1 \),
\textit{1.2.1} \( \frac{\partial ED}{\partial \beta} < 0 \)
\textit{1.2.2} \( \frac{\partial ED}{\partial \alpha} > 0 \)
\textit{1.2.3} \( \frac{\partial}{\partial \beta} \left( \frac{\partial ED}{\partial \alpha} \right) \leq 0 \)

\textbf{Proof. See} Theoretical Appendix A.

\(^{\dagger}\) See Theoretical Appendix B for the details of calculations.
Note that though the proof for Lemma 1 is written for general CARA utility functions (Theoretical Appendix A),\(^7\) it is also holds true for the non-CARA function we used for the closed form solutions and simulations, \(u(x) = \ln(x)\) (Theoretical Appendix B). This suggests that Lemma 1 may hold true for a more general class of functions beyond CARA utility; this is, however, not the focus of this paper.

We now move on to Figure 1b, which depicts the level curves of savings when commitment devices are not available. Unlike the ED curves, here we see straight horizontal lines, indicating that awareness (\(\alpha\)) does not affect savings without commitment devices. The only change in color happens along the \(\beta\) axis, indicating that only self-control matters. It is thus unlikely for there to be any correlation between ED and savings if the variation in ED is driven by \(\alpha\). However, if the variation in ED is driven by \(\beta\), there will be a negative correlation between ED and savings since savings are increasing in \(\beta\) while ED is decreasing in \(\beta\).

### 2.2 Savings with a commitment device

In their review of commitment devices, Ashraf et al. (2003) distinguish between two types of financial products. Deposit-side commitments, such as automatic withdrawals, explicitly commit individuals to deposit funds in their savings accounts. Withdrawal-side commitment, on the other hand, prevent individuals from withdrawing funds until a certain date or goal is reached, but do not explicitly commit individuals to deposit funds in the first place. This latter type is not only widely offered by formal banking institutions (for example, the Cloverdell 529 education account, the SEED commitment savings account, as in Ashraf et al. (2006b), but also informally among those without access to banks. Some examples of are physical lockboxes (Shipton, 1992) or moneyguards (Rutherford, 2000), where individuals entrust their savings to another person to restrict access to themselves, used in developing countries or among the very poor.

What is the role of \(\alpha\) and \(\beta\) on savings with withdrawal-side commitment? With these accounts, an individual’s upfront efforts to “activate” the device (e.g. ensure that deposits are made in the first place) determine the extent to which the device helps one achieve his or her goal. These efforts can be wide-ranging and non-financial; they may include scheduling frequent trips to make deposits, setting up secondary commitment devices to temporarily safeguard the cash at hand in between deposits, or avoiding social events where one may be tempted to spend money.\(^8\) Since these investments of effort are costly (in terms of convenience, time, or social capital), an individual will only do what is necessary given her perceived need for external restriction. Here awareness is likely to matter. We illustrate this intuition in a simple three-period model representing: the commitment period \((t=0)\), where an individual invests costly effort into the commitment device; the saving period \((t=1)\), where total savings is determined under the constraint of the commitment device; and the consumption stage \((t=2)\), where \(t=1\) savings is consumed.\(^9\)

In \(t=0\), an individual decides how much costly effort \(e \in [0,1]\) to invest into a withdrawal-side commitment device. For example, suppose a person can set up appointments with a strict and dull coworker to walk her to the lockbox and ensure that whatever was earned that day is deposited. An \(e=0.5\) would mean setting these appointments for half of her work days next month, therefore leaving her with

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\(^7\) In the theoretical section we make several simplifying assumptions. First, we treat \(\delta\) as a constant as is standard in this literature. Second, we assume constant absolute risk aversion (CARA). Lastly, we assume that \(\beta\) and \(\alpha\) are independent of each other.

\(^8\) Bryan, Karlan, and Nelson (2010) define soft commitment devices as those which do not have real economic penalties but have psychological consequences. Some of these upfront efforts to activate the commitment device can be considered as soft commitments.

\(^9\) Note that this simple model is designed more for intuition than as a realistic representation of the complex and dynamic process of savings with withdrawal-side commitments.
only half as much temptation to spend the day’s earnings. We therefore model e as constraining t=1 savings to the weighted average between savings with no constraints and ideal savings ($s^*$). Since a person believes at $t=0$ that at $t=1$ she would save $s^P$ without a commitment device (Eq.3), she believes that if she puts forth effort $e$, her $t=1$ savings $s^1$ will be bounded from below by $s^P(1-e) + s^*e$ (Eq.8). Her optimal upfront effort $e^*$ can therefore be derived by solving for $s^1$ as a function of $e$, plugging it into Eq. (9), and solving for $e$ given a per unit effort cost of $c > 0$. We assume that the individual will invest no effort if she is indifferent between using the commitment device or not.

\[s^1_0 = \arg\max_{s \geq s^P(1-e)+s^*e} u(l-s) + (1-\alpha(1-\beta))\delta u(s) \quad (8)\]

\[e^* = \arg\max_{0 \leq e \leq 1} \beta \delta[u(l-s^0) + \delta u(s^0)] - ce \quad (9)\]

At $t=1$, the individual makes her actual savings decision, $s^1$, given the constraint $e^*$ that she has set up for herself in the previous period. Note that $s^1$ (Eq.10) differs from $s^0$ (Eq.8) in two ways. First, the consumption period is discounted by $\beta$ instead of $1-\alpha(1-\beta)$. Second, the constraint in this problem is a function of $s^e$ (Eq.4), instead of $s^P$ (Eq.3), since she is actually only able to save $s^e$ without the commitment device. Hence $e^*$, which was the optimal choice given her beliefs at $t=0$, may not be optimal according to her preferences at $t=1$. This underinvestment in $e^*$ will be worse the lower $\alpha$ is.

\[s^1 = \arg\max_{s \geq s^e(1-e^*)+s^*e^*} u(l-s) + \beta \delta u(s) \quad (10)\]

We can derive several theoretical results. First, Lemma 2 states that the constraint in Eq. (8) will always bind. Second, Lemma 3 shows that if the cost of effort is positive but small enough, the investment of effort will depend on awareness of self-control. For this range of costs, naïveté will lead to a suboptimal investment of effort in the commitment stage, which will then lead to suboptimal savings in the saving stage (Lemma 4).

Lemma 2. At the commitment period, an individual expects to save $s^0_1 = s^P(1-e) + s^*e$ if she invests $e \in [0,1]$ into the commitment device.

**Proof.** See Theoretical Appendix A.

Lemma 3: Optimal effort invested into the commitment device, $e^*$, depends on self-control ($\beta$), awareness ($\alpha$), and the unit cost of effort ($c$). Specifically:

3.1. If $\alpha = 0$ or $\beta = 1$, then $e^* = 0$.

3.2. If $\alpha > 0$ and $\beta < 1$, there exists an upper bound for the unit cost of commitment effort, $c^* > 0$, such that

3.2.1. $e^* = 0$ for $c > c^*$

3.2.2. $e^* = 1$ for $c = 0$.

3.2.3. $\frac{\partial e^*}{\partial \alpha} > 0$ for $0 < c < c^*$

**Proof.** See Theoretical Appendix A.

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Some withdrawal-side commitments can be imperfect: for example, some account allows deposits to be withdrawn after paying a penalty. This “restrictiveness” can be explicitly included in the model as $r \in [0,1]$, where $r < 1$ represents the probability of getting out of the commitment and Eqs. (8) and (10) would be constrained by $r e$ instead of $e$.

The individual will put in no effort if the device is very costly or unavailable, and will put in maximum effort if the device is costless.
Lemma 3 formalizes the relationship between $e^*$, $\alpha$, and $\beta$. A consumer who is time consistent ($\beta = 1$) or is completely naive ($\alpha=0$) will not use the commitment device since she believes that she can reach her ideal savings without help (Lemma 3.1). Partial naives will not put in any effort if the cost of restriction is too high (Lemma 3.2.1), but will put in maximum effort if the cost is negligible, thus ensuring that $s^*$ is achieved (Lemma 3.2.2). However, if the cost of effort is non-negligible but is not too high, the use of the device will increase in awareness.

**Lemma 4** The actual commitment saving, $s_1^* = s^t (1 - e^*) + s^* e^*$, depends on awareness ($\alpha$) and self-control ($\beta$). Specifically:

4.1. If $\alpha=0$ or $c \gg e^*$, then $s_1^* = s^t$.
4.2. If $\beta = 1$ or $c=0$, $s_1^* = s^*$.
4.3. If $\alpha > 0$ and $\beta < 1$ and $\theta < e^*$, then $\frac{\partial s_1^*}{\partial \alpha} > 0$.

*Proof.* See Theoretical Appendix A.

Lemma 4 follows Lemma 3 naturally. The complete naives ($\alpha=0$) and the time-consistent ($\beta = 1$) will not use the commitment device; therefore the former will save $s^t$ while the latter will save $s^*$. Devices that are too costly will not be used; hence savings will remain at $s^t$ (Lemma 4.1). Devices of negligible cost will be used to the maximum, bringing savings to $s^*$ (Lemma 4.2). For commitment devices with cost between these two, savings will increase with awareness (Lemma 4.3).

To see more clearly the relationship between actual savings, effort, $\alpha$, and $\beta$, we continue with the example of $u(x) = \ln(x)$ and $\delta = 1$ to explicitly solve for the solution of the maximization problems in Eqs. (8), (9), and (10). The solutions are below, and the derivation can be found in Theoretical Appendix B. Eq. (11) is the unbounded optimal effort $e^c$; it is strictly increasing in $\alpha$. Eq. (12) is the optimal effort $e^*$ $\in [0,1]$ invested into the commitment device. Eq. (13) is the resultant actual savings with commitment.

\[
e^c = \frac{1 + \frac{\beta}{c} - \sqrt{1 + \left(\frac{\beta}{c}\right)^2 + 4 \frac{1 - \alpha(1 - \beta)}{\alpha^2(1 - \beta)^2}}}{1 - \alpha(1 - \beta)}
\]

\[
e^* = \begin{cases} 
0, & \text{if } 2c \geq \frac{\alpha^2(1 - \beta)^2}{1 - \alpha(1 - \beta)} \\
1, & \text{if } c = 0 \\
e^c, & \text{otherwise}
\end{cases}
\]

\[
s_1^* = I \left(\frac{\beta(1-e^c)}{1+\beta} + \frac{e^*}{2}\right)
\]

The level curves of $e^*$ (Eq.12) for $I=$100 for $c=0.05$ is illustrated in Figure 2a; as before, $\alpha$ is plotted in the x-axis while $\beta$ is plotted in the y-axis and lighter regions denote larger amounts. Regions of $e^*$ go from dark to light as one moves along $\alpha$, indicating that effort is increasing in awareness (Lemma 3.2.3); this makes sense since the marginal benefit of investing effort into the commitment device is a function of ED, which is increasing in $\alpha$. However, comparing Figure 2a to Figure 1a reveals that ED and $e^*$ do not increase in $\alpha$ at the same rate. One of the reasons is that the marginal cost of $e^*$ is driven by $c$, a variable external to the individual. Since one will only start to use the commitment device when $\alpha$ is high enough such that the perceived marginal benefit is higher than the marginal cost, there is a wide range of $\alpha$ lower than this threshold awareness level for which ED is increasing in $\alpha$ but $e^*$ is not. In other words, one may

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The cost of restriction is infinite ($c=\infty$) in settings without a commitment device.
report a non-zero ED but not think it is worthwhile to pay the cost of the commitment device to overcome it.

Moving along the y (β) axis, we see that e* goes from dark to light to dark again indicating that e* is non-monotonic in β. When β is low, self-control problems make it hard to invest effort at the current period to ensure that the commitment device will provide sufficient restriction on future behavior even when one is highly aware of the need to do so. The lower right region in Figure 2a corresponds to this area: here an increase in β rapidly increases e* by lowering the relative cost of effort. After a certain point, however, any further increase in β actually lowers e* since the benefit of commitment is lower for high self-control individuals.

Figure 2a and 2b here

Figure 2b illustrates level curves of the actual savings, $s^1_1$ (Eq.13). The first thing to notice is at low α (left side of graph) the curves are identical to those in Figure 1b, which depicts savings when commitment devices are not available. In this region the individual is not adequately aware of the true extent of her self-control problem and hence is not investing effort into the commitment device. However, the marginal benefit is eventually larger than the marginal cost as awareness passes a certain threshold, and savings start to increase in α (Lemma 4.2.3). Note also that while the color in the top half changes only slightly as we move across the x-axis, the colors in the bottom half change dramatically from very dark to very light. This indicates that α makes a much bigger difference on $s^1_1$ for low β than for high β.

The relationship between $s^1_1$ and β is more complicated. As we have seen in Figure 2a, increases in β cause two opposing forces in e* by decreasing the cost of effort and decreasing the benefit of using commitment devices. However, because β has an additional large positive effect on $s^1_1$ through $s^t$ (Eq.10), the positive effect of β on $s^1_1$ generally dominates its negative effect. This can be seen in the graph: with the exception of a narrow region in the center of the graph, the areas get consistently lighter as we move up the y-axis, indicating that savings increase in β for most parameters of α and β.

2.3 Connecting the ED survey with savings

Below we list all the testable implications from our discussion in Section 2.1 and 2.2 about the relationship between ED and actual savings. For brevity, Population β will refer to a population where difference in self-control across individuals is larger than the differences in awareness. Conversely, Population α refers to populations where the difference in awareness dominates the differences in self-control.

Testable implications:
1. There is no correlation between ED and actual outcome $s^1_1$ for time-consistent populations or completely naïve populations. This is because ED is 0 for both populations (Lemma 1.1).
2. ED and $s^1_1$ is also uncorrelated for all other types of populations if the cost of commitment devices is zero, since everyone will be able to achieve their ideal saving $s^*$ regardless of α and β (Lemma 4.2).
3. When commitment devices are unavailable or too costly to activate, $s^1_1 = s^t$, and hence:

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13 The nonmonotonicity of e* in β is another reason ED and e* (and subsequently, $s^1_1$) do not increase at the same rate.
14 In Figures 1 and 2 we can think about Population α as horizontal shape (spanning across the x (awareness) axis) and Population β as a vertical shape (spanning across the y (self-control) axis).
ED and $s_1^1$ are negatively correlated for Population $\beta$. This is because ED is decreasing in the source of variation in the population $\beta$ (Lemma 1.2.1), while $s^t$ is increasing in it.

ii. ED and $s_1^1$ are uncorrelated for Population $\alpha$. This is because $s^t$ is uncorrelated to $\alpha$, the source of variation in the population.

4. When commitment devices have non-negligible but low enough costs:
   i. ED and $s_1^1$ are positively correlated for Population $\alpha$. This is because both ED and $s_1^1$ is increasing in $\alpha$ (Lemma 1.2.1 and Lemma 4.3), the source of variation in the population.
   ii. The positive correlation between ED and $s_1^1$ will be stronger for low self-control population (Lemma 1.2.3) since awareness has the potential of making a much bigger difference with this population.
   iii. ED and $s_1^1$ are, for the most part, negatively correlated for Population $\beta$. This is because ED is decreasing in $\beta$ (Lemma 1.2.1), the source of variation in the population, while $s_1^1$ is generally increasing in $\beta$.

These hypotheses organize some of the current empirical results on ED. Ameriks et al. (2007) studies high net worth TIAA CREF mutual fund owners. This subject pool is within the top 15% income bracket in the US; more than one-third of their sample has a PhD, the vast majority has significant nonretirement assets, and the median level of debt is zero. They find a negative correlation between ED and liquid assets, which is consistent with Implication 3i. They do not however, find a correlation between ED and retirement assets. Ameriks et al. (2007) does not specify which retirement savings plan they include, however, if these retirement savings take the form of automatic withdrawal that is relatively costless to participate in, this findings fit Implication 2. Wong (2008) ran the ED survey with students of the National University of Singapore, which is one of the top universities of Asia. While we cannot comment on their financial success in the absence of income data, we can say that his subjects are from the highest end of academic success. Wong (2008) finds a negative correlation between ED and academic achievement without commitment, which is again in line with Result 3.1.

Previous research showing a positive correlation between financial and academic success and self-control suggests that these two populations are likely to be from the upper range of self-control (Tangney et al., 2004; Moffitt et al., 2011). To complement these empirical results we need to look at those who did not do well economically or academically. Self-control is expected to be low in a population from the lower end of academic and financial success, making it possible to observe the effect of awareness on ED when commitment devices are offered. For this reason, we study the ED self-control measure in a homeless shelter that offers a commitment savings account.

3 Empirical Evidence

3.1 Setting

We conducted our study at a large transitional homeless shelter in Arizona between 2009 and 2010. The shelter covers almost all of its residents’ living expenses (such as room and board, bus passes, limited toiletries, and clothing) and also provides supportive services to help them regain the ability to sustain permanent housing. In exchange, shelter residents agree to complete programs to advance through various “levels” at the shelter. When they provide proof of employment, individuals are promoted to Level III, the highest level at the shelter before transitioning to permanent housing. Upon entering Level III, residents are required to report their financial standing, including their income, expenditure, and savings, to

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15 Social security and defined-benefit pension plans can also be considered costless to join.
their case managers biweekly. Individuals are also expected to participate in a commitment savings program. Since there are no banks in the vicinity of the shelter and most residents do not have a bank account, the shelter provides an option to save their newly earned income by directly depositing cash to a shelter-managed lockbox service. This is a withdrawal-side commitment device: money that has entered the lockbox cannot be withdrawn until the individual exits the shelter. Residents appear to be aware that it does not directly help them to save their earnings, but helps to protect the saved amounts from temptation spending. It is also common in the shelter to hear of people leveraging social support (Ashraf et al., 2006a; Gugerty, 2007) to use the lockbox more.

While in theory demotion from Level III is possible, in practice there is no consistent punishment for those who do not submit financial reports, do not earn any income, or do not save anything. Case management has found in the past that those who do not submit reports are likely not to have earned any income and have not deposited anything in the lockbox. The shelter therefore began encouraging reports of zero or very low income to be submitted anyway in 2009; by 2010, the frequency of report submission had improved. Meanwhile, missing reports were treated as $0 income and $0 savings by the shelter. Linardi and Tanaka (2015) find that the average income expectations for the shelter residents during 2009-2010 is about $995 (SE: $87.27) per month, but only half of the supposedly employed residents earn any income at all. Among them, average earned income is half of their expectations ($490) and the correlation between expectation and earnings is 0.42 (pval=0.037).

All Level III shelter residents in Summer 2009, Winter 2010, and Summer 2010 were sent an invitation to participate in the study. Participation involved completing a survey questionnaire through an in-person interview and permission to access their financial behavior at the shelter for the duration of the study. More than 90% of the residents (N = 110) agreed to participate. Eleven subjects could not provide subsequent proof of having been formally admitted to Level III and another four did not complete the ideal/predicted questionnaire, resulting in 95 survey respondents. The survey included questions about ideal/predicted savings, demographics, and the subject’s experience with homelessness. Adopting the survey question from Ameriks et al. (2007) for this setting, we asked participants to state the ideal amount they would like to save and to predict the amount that they would actually save over the next four weeks. The exact statements of the questions were: “How much would you ideally like to save in the next 4 weeks?” and “How much do you think you will actually save in the next 4 weeks?” We construct our main dependent variable, Expected Deviation (ED), by subtracting predicted savings from ideal savings for each individual. After the survey, we tracked participants’ actual savings for the first four weeks through their financial reports.

The general disadvantage of survey measures is that respondents may interpret the measure in ways not intended by the researcher. For our survey question, this disadvantage can appear in three ways. First, while subjects’ responses to the second question (“How much do you think will you actually save?”) is reflective of their current financial standing, the first question (“How much would you ideally like to save?”) may have cued subjects to imagine savings in an “ideal world” with an “ideal income” unbounded by reality.

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16 Reports must be accompanied by evidence such as paystubs and ATM or lockbox receipts.
17 Residents are often employed in unstable, lower-quality jobs in construction, retail, or seasonal events. The reason for not earning income might be because they lost their job soon after starting, are temporary workers and have not been assigned any hours, or had taken commission-only sales jobs and have not been able to earn commission.
18 This survey was conducted at the very beginning and very end of the survey period with an N=50. There is no correlation between earning no income and income expectation (p=-0.11, pval=0.41). Losing one’s job, not getting any hours, or having worked but not having earned anything appear to be random shocks.
19 A $5 fast food gift certificate was given for survey completion.
20 Neither the computer system nor the shelter management was able to indicate when these subjects were promoted to Level III.
21 Survey questions are provided in the Appendix.
However, we think this is highly unlikely given the very high correlation between ideal and predicted savings ($\rho = 0.92, pval = 0.00$). Second, ideal savings might be a reflection of ambition or aspirations that then drives the correlation between ED and savings. Third, subjects might respond to ideal and predicted savings questions without recognizing possible future shocks to their future outcome. However, income mispredictions would not cause a correlation between ED and the actual savings since the mispredicted income would increase both ideal and predicted savings compared to the actual income but would not alone create a positive ED. In Table 3 we will investigate this closer by decomposing ED to its separate elements of ideal and predicted savings.

During the period of the study, the shelter participated in a randomized control trial on savings competition. A random sample of resident was offered an additional bonus for saving: every month, the resident that saves the largest portion of their income wins $100 in cash (Linardi and Tanaka, 2013). Though the incentive is common knowledge, subjects do not know whether it will apply to them since the survey was conducted before the randomization and subjects are unaware of the probability of being in the incentivized group. Nevertheless, the possibility of receiving additional incentives to use the commitment device may elevate both subjects’ ideal and predicted savings and further dampen their differences. All but 25 of our subjects (26%) are in the incentive group. We therefore take the difference between shelter residents’ ideal and predicted savings as a lower bound of subject’s perception of their self-control problem. We will revisit the incentive and non-incentive groups when we investigate heterogeneity in Table 4.

### 3.2 Summary Statistics and Analysis

Table 1 provides summary statistics of the survey responses of the 95 subjects. The average age is around 42 years, 16% of respondents are female and 38% are black. The median subject has been homeless for about seven months and has been employed for less than three weeks at the time of the survey. 44% of our subjects are homeless for the first time in their lives. Even though the average participant has a high school education, there are more than five times as many high school dropouts in this sample (37%) than there are nationally (7%).

Addiction and incarceration were mentioned as the reason for homelessness by 37% and 20% of residents, respectively.

Table 1 here

The average amount that subjects would ideally save in the four weeks following the survey is $776 (SE: $71) and the average amount they predict they will save is $660 (SE: $73). These quantities are well within the $1k income expectation (Linardi and Tanaka, 2013) and highly correlated ($\rho = 0.92, pval = 0.00$). Subtracting the two amounts, we arrive at an average Expected Deviation (ED) of $115.66. Appendix Table 1 Columns 1 and 2 explore these survey responses further. Stated ideal and predicted savings are higher for people who are homeless for the first time and are lower for female and black residents. However, most of these demographic-driven differences are netted out in ED (Column 3). Apart from a slight decrease in ED

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22 In their analysis, Linardi and Tanaka (2013) checked closely for unintended effects of the competition, including manipulation of financial reporting and discouragement of those in the baseline group. They found that competition induced a temporary increase in savings rate without affecting behavior in any other dimension. They also found no evidence of strategic behavior such as underreporting income to inflate savings rate or deferring savings from one month to another. There were also no positive or negative spillovers: competition did not change the likelihood of submitting a financial report or earning an income. Their findings, combined with the fact that competition is widely used in other environments as a commitment device, motivated us to proceed under the assumption that the subjects in the baseline and competition groups are different only in that the competition group is provided with stronger incentives to use the commitment device.


24 These responses are respectively about 78% and 67% of the average income expectation of shelter residents in 2009-2010.
for older individuals, neither demographics, reasons for homelessness, nor institutional and timing factors are significant predictors of ED. All of this suggests that ED is netting out demographic or situational factors that affect income and capturing something more specific to the individual.

We observe the financial behavior of these subjects in the four weeks following the survey through their verified financial reports. We see in Appendix Table 1 Column 4 that the frequency of reporting was low in Summer 2009, but improved significantly in 2010 after the shelter made an effort to encourage those with $0 income to make reports anyway. This, however, does not result in any difference across seasons in income earned or savings (Columns 5 and 6) due to the low (or zero) amounts reported.

Averaging across our entire sample, 72 of the 95 homeless individuals (76%) submitted financial reports. 28 residents reported zero income; the other 44 residents reported a positive income averaging $473.37 and savings averaging $301.65 (a 64% savings rate). If we use the shelter convention and code the missing income and savings as $0, we arrive at an average income of $219.25 and average savings of $139.71 for the entire sample. In Appendix Table 1 Column 5 we see that older residents and individuals that are homeless for the first time earn more while black residents earn less. In Column 6, we see that subjects save about 57 cents out of every dollar earned, and consistent with Linardi and Tanaka (2013), subjects who are not offered additional savings incentives saved less. Beyond that, very little other individual or institutional factors predict savings.

We now explore the correlation between ED and actual outcomes using ordinary least squares (OLS) and the Heckman selection model. The institutional details of the shelter give us several dependent variables: whether individuals made a financial report, the income reported, and the reported savings. Commitment devices were offered for savings alone; therefore, awareness of self-control problems can only improve savings and not income or submission of financial reports. Since the variation in ED in this population is likely to be driven more by differences in awareness rather than differences in self-control, we expect ED to be positively correlated with savings but not income or reports.

Table 2 here

Table 2 Columns 1-4 explore all three dependent variables in the entire sample using OLS, treating the shelter’s coding of missing reports as 0. In all columns we include a dummy variable for those not offered extra incentives to use the commitment savings account, seasonal effects dummies to control for time varying unobservables, and robust standard error. Full tables are in Appendix Table 2. In Columns 1 and 2, we see that a respondent’s ED does not affect his likelihood of submitting reports or his income, two outcomes for which there are no commitment devices. However, ED has a positive effect on the amount saved in the commitment savings account: an extra $100 in ED translates to about $7.20 in extra savings (Column 3). The significance drops to 0.11 when we add demographic controls and variables capturing experience with homelessness (Column 4), but an F test reveals that these additional control variables have very little explanatory power (F(9, 79)=1.13 Prob > F =0.3541) and are hence dropped from future regressions.

In Table 2 Columns 5-6, we investigate if those who did not submit reports are systematically different from those who submitted reports in a way that would bias our estimate of ED. We exploit the differential rate of reporting in Summer 2009 for the selection equation. As we have seen in Appendix Table 1, individuals in Summer 2009 are less likely to submit reports, but are similar in survey responses, earnings and savings as individuals from other cohorts. Column 5 shows that the effect of ED on savings is actually larger when estimated with the Heckman selection model, suggesting that $100 in ED translates to about $9.82 in extra savings beyond the 56 cents saved per $1 earned. We will revisit this estimate for

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25 Appendix Figure 1 plots the residual of the regression in Table 2 Column 3 when ED is not included against ED.
various subgroups in Table 4. Column 6 shows that ED is insignificant in the selection equation, again confirming that for this population, ED is uncorrelated with outcome variables with no commitment component. The test statistic for the regression ($\rho$) is -0.273, but the chi-squared test on $\rho$ indicates that the error term in the first and second stages are uncorrelated.

In Table 3 we investigate the role of ideal savings and predicted savings in the correlation between ED and actual savings. We replace ED in the Heckman selection model earlier with Ideal Savings in Columns 1-2, Predicted Savings in Columns 3-4, and both variables in Columns 5-6. Columns 2, 4, and 6 show that neither of the survey response variables predict submission of financial reports. Column 1 shows that Ideal Savings on its own does not have a significant effect in predicting Actual Savings; we would expect this to be true if Ideal Savings has captured other factors such as higher aspiration and the ED savings correlation was driven by higher aspiration. Similarly, Predicted Savings (Column 3) also do not predict Actual Savings. It is only when the two are included (Column 5) that we see an effect. This suggests that the correlation of ED and higher Actual Savings is driven by the unique deviation of predicted from ideal, in other words, awareness or self-control.

3.3 Heterogeneity

There are reasons to believe that if ED was working through awareness, the effect of ED on savings would be different for certain subpopulations. The theory in Section 2 suggests that we should see a larger correlation between ED and savings among those with lower $\beta$. In addition, O'Donoghue and Rabin (2001) show that the external environment can also exacerbate one's self-control problems: increasing the stakes of a decision can lead to more procrastination for the partially naïve. In this section we explore these potential sources of heterogeneity by looking at two individual characteristics as proxies for low self-control (addiction and dropping out of high school) and two factors that raise the stakes for savings (income and additional incentives to save). In Appendix Table 3, we interacted these four variables with ED in the baseline Heckman selection model (Table 3 Column 5). Table 4 below summarizes the regression results by displaying the linear combinations of ED and its interaction with each of these four variables.

Table 4 Panels A and B explore the impact of ED on two individual characteristics that may be related to self-control: whether one had past issues with substance addiction or had dropped out of high school. Addiction has long been used in the literature as a classic proxy for low self-control (O'Donoghue and Rabin, 1999d; Gul and Pesendorfer, 2007). Though some psychology studies have found correlation between self-control and likelihood of dropping out of high school (Moffitt et al., 2011; Tangney et al., 2004), this variable is not as widely used to proxy self-control as addiction. Panel A shows that a $100 difference in ED translates to $11.30 (p=0.02) in savings for shelter residents who are homeless due to substance addiction and $4.16 (p=0.65) for those who are not. Even though the difference between the two is not statistically significant, the increase in savings is only significant for those who were addicted. Table 4 Panel B shows that the same pattern can be seen with high school dropouts ($11.49, p<0.10$) as for non-dropouts ($9.39, p>0.10$) though the difference between the two is very slight. This confirms that the effect of awareness in an environment with a commitment device is larger among those who may have a larger self-control problem.

Table 4 here

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26 We thank an anonymous referee for suggesting the ideas contained in this section.
O'Donoghue and Rabin (2001) show that for the partially naïve, procrastination increases in the importance of the action. For our paper, this implies that in the presence of commitment devices, higher awareness will make a larger difference for those facing a high stakes decision, since they are the ones most tempted by present bias. O'Donoghue and Rabin (1999c) show that larger principals are correlated with a higher likelihood in procrastinating in saving for retirement. Our first investigation follows their study in using income as a proxy for the stakes of saving. Table 4 Panel C shows that ED indeed has a larger impact of increasing savings for those with a higher income. While shelter residents in general save at a rate of 53%, an extra $100 in ED translates to another of 4% for people earning $300 and 13.6% for people earning $500. This means that someone who reports an ED of $0 will save $159.74 if she earns $300 and $266.2 if she earns $500, while someone who reports an ED of $100 will save an additional $12 if she earns $300 and $68 if she earns $500.

In Panel D we investigate whether the correlation between ED and savings is higher for those who are randomly selected for the opportunity to win $100 in the shelter savings competition, thereby facing higher stakes in their saving decisions. Indeed we see that while $100 in ED translates to an additional $3.89 (p=0.71) in savings for a shelter resident who was not offered additional incentives to save, it translates to an additional $11.30 (p=0.02) for residents facing higher stakes savings. Taken together, Table 4 strongly suggests that ED is indeed measuring awareness: the more likely it is that an individual is facing self-control problems in saving, the larger the correlation between ED and commitment savings.

4. Discussion and Conclusion

It is important to separate the effects of self-control and awareness. Frederick et al. (2003) note that "If people are sufficiently sophisticated about their own self-control problems, providing commitment devices may be beneficial. If people are naive, however, policies might be better aimed at either educating people about loss of control (making them more sophisticated), or providing incentives for people to use commitment devices, even if they don't recognize the need for them" (p.35).

This paper theoretically and empirically tests how awareness drives the connection between a self-reported survey measure and actual outcomes. This is important because, while many psychological studies empirically explore the relationship between measures of self-control elicited through unincenitized surveys and life outcomes (see Duckworth and Kern (2011) for a meta-analysis), only a small number of studies assess the behavioral validity of survey measures in economics. We fill this gap by focusing on a survey measure composed by the deviation between self-reported ideal and predicted behavior, namely Expected Deviation (ED) from Ameriks et al. (2007).

Our theoretical section makes three contributions. Our first contribution is to formally capture the interaction of awareness and self-control on responses to a self-control survey. Second, we analytically show that unawareness results in suboptimal investment into withdrawal-side commitment devices, which then leads to suboptimal outcomes. While models of commitment demand with quasi-hyperbolic consumers usually assume full sophistication (Basu, 2011; Carrillo and Dewatripont, 2008; Bond and Sigurdsson, 2013), we model the effect of partial awareness. The model closest to ours is Laibson (2015), who numerically computes a partially naive agent’s decision to commit her future selves to a binding deadline to complete a task (e.g. fill in the paperwork to join a 401(k) automatic withdrawal plan). However, Laibson’s model best describes deposit-side commitment devices, not withdrawal side commitment devices, such as

\[\text{For example, Vischer et al. (2013) relate self-assessment of impatience to actual behavior in an experiment involving inter-temporal trade-offs.}\]

\[\text{This relates to the point made in Ariely and Wertenbroch (2002) and O'Donoghue and Rabin (2003) that even when commitment devices are available, partial naives may not be using them optimally.}\]
the lockbox in the shelter. Last, we use awareness and availability of costly commitment devices to show the predictive value of these survey responses on actual outcomes.

Unlike prior studies with a focus on high self-control groups, this study tests the validity of the ED measure using a sample of homeless people characterized by low self-control. Our findings suggest that we can use ED as a measure of self-control for subject pools that are expected to have high self-control, since awareness has only a limited role to play in this population. However, trying to measure self-control with ED (or other self-reports) might result in omitted variable bias for populations with low self-control. Among these subjects, the variance in ED might be better explained by variation in awareness of self-control. However, our model suggests that once we account for awareness, the empirical evidence on the ED measure of self-control does indeed correlate with outcomes in a theoretically consistent manner.

REFERENCES


Figure 1a. Expected deviation (ED)
Figure 1b. Savings without commitment (s')
Figure 2a. Effort invested into commitment device ($e^*$)
Figure 2b. Savings with commitment ($s^1$)
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Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1, +p<0.11
See full table in Appendix Table 2
Table 3: The role of Ideal and Predicted savings in ED (Heckman)

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Table 4: Heterogeneous effects of ED

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<td>Additional saving per $100 if income is $300</td>
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Theoretical Appendix A

For conciseness, we simplify the maximization problems for ideal, expected, and temptation savings in the main text respectively as:

\[ s^* = \arg \max u(I - s) + \delta u(s) \]  
\[ s^p = \arg \max u(I - s) + (1 - \alpha(1 - \beta)) \delta u(s) \]  
\[ s^t = \arg \max u(I - s) + \beta \delta u(s) \]

We write them concisely,

\[ \max u(I - s) + Au(s) \]

by defining,

\[ A^* = \delta \]  
\[ A^p = (1 - \alpha(1 - \beta)) \delta \]  
\[ A^t = \beta \delta \]

We write the FOCs from (4):

\[ u'(I - s) = Au'(s) \]

Take the derivative of FOC (8) w.r.t \( \beta \) and \( \alpha \) separately and solve for the partials,

\[ \frac{\partial s}{\partial \beta} = -\frac{\partial A}{\partial \beta} u'(s) \]
\[ \frac{\partial s}{\partial \alpha} = -\frac{\partial A}{\partial \alpha} u'(s) \]

We write (9) and (10) for a CARA utility function (\( u''(x) = -\gamma u'(x) \)) and by using (8),

\[ ^1 \text{We drop } \beta \delta \text{ without loss of generality in the ideal savings problem since it does not affect the trade-off between future periods.} \]
Proof of Lemma 1. We define ED as:

\[ ED = s^* - s^p \]  \hspace{1cm} (13)

If \( \alpha = 0 \) or \( \beta = 1 \), then \( A^* = A^p \), therefore \( s^* = s^p \) and \( ED = 0 \) proving Lemma 1.1.

Plugging (5) into (11) and (12),

\[ \frac{\partial s^*}{\partial \beta} = 0 \]  \hspace{1cm} (14)
\[ \frac{\partial s^*}{\partial \alpha} = 0. \]  \hspace{1cm} (15)

In order to see how \( ED \) changes with \( \beta \) and \( \alpha \), we also need to find the partial derivative of \( s^p \) w.r.t \( \beta \) and \( \alpha \). We will solve this under CARA. The following numbered list proves Lemma 1.2.1, 1.2.2, and 1.2.3 respectively.

2. Plugging (6) into (11) gives \( \frac{\partial s^p}{\partial \beta} > 0 \) for \( \alpha > 0 \). When we plug this together with (14) into (13), we find \( \frac{\partial ED}{\partial \beta} < 0 \) for \( \alpha > 0 \).

3. Plugging (6) into (12) gives \( \frac{\partial s^p}{\partial \alpha} < 0 \) for \( \beta < 1 \). When we plug this together with (15) into (13), we find \( \frac{\partial ED}{\partial \alpha} > 0 \) for \( \beta < 1 \).

4. Take the second partial of (12) w.r.t \( \beta \),

\[ \frac{\partial}{\partial \beta} \left( \frac{\partial s}{\partial \alpha} \right) = \frac{1}{2\gamma A^2} \left( \frac{\partial^2 A}{\partial \beta \partial \alpha} A - \frac{\partial A}{\partial \alpha} \frac{\partial A}{\partial \beta} \right) \]

When we plug (6) and (5) into the previous equation separately, we obtain

\[ \frac{\partial^2 s^p}{\partial \beta \partial \alpha} = \frac{1}{2\gamma(1 - \alpha + \alpha \beta)^2} > 0 \]
\[ \frac{\partial^2 s^*}{\partial \beta \partial \alpha} = 0. \]
The partial derivative of (13) w.r.t. $\alpha$ and $\beta$ gives $\frac{\partial}{\partial \beta} \left( \frac{\partial \mathcal{ED}}{\partial \alpha} \right) = \frac{\partial^2 s^*}{\partial \beta \partial \alpha} - \frac{\partial^2 s^p}{\partial \beta \partial \alpha}$. When we plug the previous two expressions into this one, we obtain $\frac{\partial}{\partial \beta} \left( \frac{\partial \mathcal{ED}}{\partial \alpha} \right) < 0$ if $\alpha > 0$ and $\beta < 1$, proving Lemma 1.2.3.

**Proof of Lemma 2.** Recall the t-1-self’s problem according to t-0-self

$$\max_{s \geq s^p(1-e)+s^*e} u(I-s) + (1-\alpha(1-\beta))\delta u(s)$$

Note that the solution of this utility maximization problem without the constraint would be $s^p$ from (2). Since $s^* \geq s^p$, the constraint will always be binding giving $s_1^0 = s^p(1-e) + s^*e$. ■

**Proof of Lemma 3.** The individual will solve the following problem to find the optimal effort

$$\max_{0 \leq e \leq 1} \beta \delta \left[ u(I - s_1^0) + \delta u(s_1^0) \right] - ec$$

where $s_1^0 = s^p(1-e) + s^*e$.

Note that $s^p = s^*$ if the individual does not have a self-control problem ($\beta = 1$) or if he is not aware of it ($\alpha = 0$). As a result, the individual’s belief about his future savings, $s_1^0$, will be $s^*$ which is independent of $e$. We assume that the individual does not spend any effort if he is indifferent between spending and not. Consequently, $e^* = 0$ if $\beta = 1$ or $\alpha = 0$, proving Lemma 3.1.

The Lagrangian

$$L = \beta \delta \left( u(I - (s^p(1-e) + s^*e)) + \delta u(s^p(1-e) + s^*e) - ec + \lambda_1 e - \lambda_2 (e - 1) \right)$$

FOCs:
\[
\beta \delta (s^* - s^p) \left( -u'(I - (s^p + (s^* - s^p)e^*)) + \delta u'(s^p + (s^* - s^p)e^*) \right) = 0
\]
\[
\begin{align*}
\lambda_1 e^* &= 0 \\
\lambda_2(e^* - 1) &= 0 \\
\lambda_1, \lambda_2 &\geq 0 \\
e^* - 1 &\leq 0 \\
-e^* &\leq 0
\end{align*}
\]

where \( e^* \) is the optimal effort level, which depends on \( \delta, \beta, \alpha, \) and \( c \).

1. If \( e^* = 0 \), then \( \lambda_1 \geq 0 \) and \( \lambda_2 = 0 \), and

\[
\beta \delta (s^* - s^p) (-u'(I - s^p) + \delta u'(s^p)) - c + \lambda_1 = 0.
\]

which holds if \( c \geq c^H \) defined as \( \beta \delta (s^* - s^p) (-u'(I - s^p) + \delta u'(s^p)) \).

Since \( s^p < s^* \) and the utility function is concave, it can be shown that \( c^H > 0 \), proving Lemma 3.2.1.

2. If \( e^* = 1 \), then \( \lambda_1 = 0 \) and \( \lambda_2 \geq 0 \), and

\[
\beta \delta (s^* - s^p) (-u'(I - s^*) + \delta u'(s^*)) - c - \lambda_2 = 0
\]

which holds if \( c = 0 \).

This is because \( \beta \delta (s^* - s^p) (-u'(I - s^*) + \delta u'(s^*)) = 0 \) from (1), requiring \( c = 0 \) to satisfy the equality above together with \( \lambda_2 \geq 0 \). This proves Lemma 3.2.2.

3. If \( 0 < e^* < 1 \), then \( \lambda_1 = 0 \) and \( \lambda_2 = 0 \), and

\[
\beta \delta (s^* - s^p) (-u'(I - (s^p + (s^* - s^p)e^*)) + \delta u'(s^p + (s^* - s^p)e^*)) - c = 0
\]

We know that \( B = \beta \delta (s^* - s^p) (-u'(I - s^p) + \delta u'(s^p)) \) if \( e^* = 0 \) and \( B = 0 \) if \( e^* = 1 \) from the derivations above. Moreover, \( \frac{\partial B}{\partial e^*} < 0 \) since \( u \)
is concave. Therefore, there exists an interior solution for the optimal effort problem if $0 < c < c^H$. We want to see how the optimal effort $e^*$ changes with $\alpha$ when there is an interior solution. Therefore, we take the derivative of the first FOC w.r.t $\alpha$

\[
\begin{aligned}
\beta \delta \left( -\frac{\partial s^p}{\partial \alpha} \right) (-u'(I - (s^p + (s^* - s^p)e^*)) + \delta u'(s^p + (s^* - s^p)e^*)) + \\
+ \left[ \beta \delta (s^* - s^p) \begin{pmatrix} u''(I - (s^p(1 - e^*) + s^*e^*)) + \\
\left( \frac{\partial s^p}{\partial \alpha}(1 - e^*) + s^p \left( -\frac{\partial e^*}{\partial \alpha} + s^* \frac{\partial e^*}{\partial \alpha} \right) \right) \end{pmatrix} \right] = 0
\end{aligned}
\]

First, we want to find the sign of $\frac{\partial e^*}{\partial \alpha}$. We know from the proof of Lemma 1 that $\left(-\frac{\partial s^p}{\partial \alpha}\right) > 0$. We also infer that

\[
(-u'(I - (s^p + (s^* - s^p)e^*)) + \delta u'(s^p + (s^* - s^p)e^*)) > 0
\]

if $e^* < 1$, making the expression "C" positive. In order to satisfy the equality above, the expression "D" should be negative. It is easy to see that $\beta \delta (s^* - s^p) > 0$ for a partially aware person. Moreover, $(u''(I - (s^p(1 - e^*) + s^*e^*)) + \delta u''(s^p(1 - e^*) + s^*e^*)) < 0$ since $u$ is increasing and concave. As a result, for the expression "D" to be negative, $(\frac{\partial s^p}{\partial \alpha}(1 - e^*) + s^p \left( -\frac{\partial e^*}{\partial \alpha} + s^* \frac{\partial e^*}{\partial \alpha} \right))$ should be positive. In detail,

\[
\frac{\partial s^p}{\partial \alpha}(1 - e^*) + (s^* - s^p)^2 \frac{\partial e^*}{\partial \alpha} > 0
\]

requires $\frac{\partial e^*}{\partial \alpha} > 0$ completing the proof of Lemma 3.2.3.

**Proof of Lemma 4.**  T-1-self’s actual problem is

\[
\max_{s \geq s^i(1 - e^*) + s^*e^*} u(I - s) + \beta \delta u(s)
\]

where $e^*$ is the optimal commitment effort chosen by commitment period self. Note that the solution of this utility maximization problem without the
constraint would be \( s^* \) as shown in (3). Since \( s^* > s^t \), the constraint will always be binding giving the solution of this constraint utility maximization as \( s^1 = s^t(1 - e^*) + s^*e^* \).

If the consumer is unaware (\( \alpha = 0 \)) or if the cost of commitment is too high (\( c > c^H \)), Lemma 3.1 and Lemma 3.2.1 show that the individual will not spend any commitment effort, resulting in \( s^1 = s^t \) and proving Lemma 4.1.

If the individual does not have a self-control problem (\( \beta = 1 \)) or if the commitment is not costly (\( c = 0 \)), Lemma 3.2.2 shows that the individual will either spend no effort or spend the highest effort respectively, resulting in \( s^1 = s^* \) and proving Lemma 4.2.

For all other cases (\( \alpha > 0 \) and \( \beta < 1 \), and \( 0 < c < c^H \)), we can take the derivative of \( s^1 \) with respect to \( \alpha \),

\[
\frac{\partial s^1}{\partial \alpha} = (s^* - s^t) \frac{\partial e^*}{\partial \alpha} > 0
\]

since \( \frac{\partial e^*}{\partial \alpha} > 0 \) from Lemma 3.2.3, proving the Lemma 4.3. ■
Theoretical Appendix B

Recall the equations giving us the ideal, expected and the temptation savings from our general model

\[ s^* = \arg \max u(I - s) + \delta u(s) \]
\[ s^p = \arg \max u(I - s) + (1 - \alpha(1 - \beta)) \delta u(s) \]
\[ s^t = \arg \max u(I - s) + \beta \delta u(s) \]

We write them concisely,

\[ \max u(I - s) + Au(s) \]  

by defining,

\[ A^* = \delta \]  
\[ A^p = (1 - \alpha(1 - \beta)) \delta \]  
\[ A^t = \beta \delta \]

We write the FOCs from (1):

\[ u'(I - s) = Au'(s) \]  

Without loss of generality we will assume \( \delta = 1 \) to simplify the calculations. We solve for \( s^*, s^p, \) and \( s^t \) for a simple utility function \( \ln(x) \) from (2), (3), (4), and (5)

\[ s^* = \frac{I}{2} \]  
\[ s^p = \frac{I \beta'}{1 + \beta'} \]  
\[ s^t = \frac{I \beta}{1 + \beta} \]

where \( \beta' = 1 - \alpha(1 - \beta) \).

Let us explicitly write how ED changes with \( \alpha \)

\[ ED = s^* - s^p = \frac{I}{2} - \frac{I \beta'}{1 + \beta'} = I - \frac{\alpha(1 - \beta)}{2(2 - \alpha(1 - \beta))} \]  
\[ \frac{\partial ED}{\partial \alpha} = I - \frac{1 - \beta}{(2 - \alpha(1 - \beta))^2} > 0 \]

Moreover,
\[
\frac{\partial^2 ED}{\partial \beta \partial \alpha} = \frac{(-1)(2 - \alpha(1 - \beta))^2 - (1 - \beta)2(1 - \alpha(1 - \beta))\alpha}{(2 - \alpha(1 - \beta))^4} \\
= \frac{-4 - \alpha(1 - \beta)(2 - \alpha(1 - \beta))}{(2 - \alpha(1 - \beta))^4} < 0 \quad (11)
\]

The commitment-period-self’s belief about how much to save in the following period is

\[
s_i^0(e) = s^p + (s^* - s^P)e \quad (12)
\]

where \( e \in [0, 1] \) is the effort that the commitment-period-self chooses.

Consequently, commitment-period-self’s problem can be written as

\[
\max_{0 \leq e \leq 1} \beta \left[u(I - s_i^0(e)) + u(s_i^0(e))\right] - ec
\]

where \( c \in [0, \infty) \) is unit cost of effort.

For an interior solution, \( 0 < e^* < 1 \), the FOC is

\[
\beta \frac{\partial s_i^0(e)}{\partial e} \left(-u'(I - s_i^0(e^*)) + u'(s_i^0(e^*))\right) - c = 0 \quad (13)
\]

We will solve for \( e^* \) using the utility function of \( u(x) = \ln x \)

\[
\beta \frac{\partial s_i^0(e)}{\partial e} \left(-\frac{1}{I - s_i^0(e^*)} + \frac{1}{s_i^0(e^*)}\right) - c = 0
\]

\[
\frac{I - 2s_i^0(e^*)}{s_i^0(e^*)(I - s_i^0(e^*))} = \frac{c}{\beta \frac{\partial s_i^0(e)}{\partial e}}
\]

\[
\frac{I - 2(s^p + (s^* - s^P)e^*)}{(s^p + (s^* - s^P)e^*)(I - (s^p + (s^* - s^P)e^*))} = \frac{c}{\beta (s^* - s^P)}
\]

Substitute (6), (7), and (8) into this equation

\[
\frac{I - 2 \left( \frac{I \beta'}{1 + \beta'} + \left( \frac{1}{2} - \frac{I \beta'}{1 + \beta'} \right) e^* \right)}{\left( \frac{I \beta'}{1 + \beta'} + \left( \frac{1}{2} - \frac{I \beta'}{1 + \beta'} \right) e^* \right) \left( I - \left( \frac{I \beta'}{1 + \beta'} + \left( \frac{1}{2} - \frac{I \beta'}{1 + \beta'} \right) e^* \right) \right)} = \frac{c}{\beta \left( \frac{1}{2} - \frac{13 \beta'}{1 + \beta'} \right)}
\]

Simplify to obtain

\[^1\text{See the proof of Lemma 3 in the Theoretical Appendix A for the complete set of FOCs.}\]
\[ 1 - 2 \left( \frac{\beta' + 1 - \beta'}{2(1+\beta')} e^* \right) \left( 1 - \frac{\beta' + 1 - \beta'}{2(1+\beta')} e^* \right) = c \]
\[ \frac{\beta'}{2(1+\beta')} \frac{2(1-\beta')^2(1-e)}{2(1-\beta')^2 e^*} = \frac{c}{\beta} \]
\[ \left( e^* - \left( 1 + \frac{\beta}{e} \right) \right)^2 = 1 + \left( \frac{\beta}{e} \right)^2 + \frac{4\beta'}{(1-\beta')^2} \]

As a result,
\[ e^* = 1 + \frac{\beta}{e} - \left( 1 + \left( \frac{\beta}{e} \right)^2 + \frac{4\beta'}{(1-\beta')^2} \right)^{1/2} \tag{14} \]

when there is an interior solution, \( 0 < e^* < 1 \).

We can find how the interior solution changes with \( \alpha \) by taking the derivative of the above expression w.r.t. \( \alpha \)
\[ \frac{\partial e^*}{\partial \alpha} = 2 \left( 1 + \left( \frac{\beta}{e} \right)^2 + \frac{4\beta'}{(1-\beta')^2} \right)^{-1/2} \frac{2 - \alpha(1 - \beta)}{\alpha^3(1 - \beta)^2} > 0 \tag{15} \]

The actual savings and how it changes with \( \alpha \) are
\[ s^1 = s^t + (s^* - s^t)e^* \tag{16} \]
\[ \frac{\partial s^1}{\partial \alpha} = (s^* - s^t) \frac{\partial e^*}{\partial \alpha} > 0 \tag{17} \]

Explicitly,
\[ \frac{\partial s^1}{\partial \alpha} = (s^* - s^t) \frac{\partial e^*}{\partial \alpha} = \frac{I}{1 + \beta} \left( 1 + \left( \frac{\beta}{e} \right)^2 + \frac{4\beta'}{(1-\beta')^2} \right)^{-1/2} \frac{2 - \alpha(1 - \beta)}{\alpha^3(1 - \beta)^2} + 2 - \alpha(1 - \beta) \]
\[ \frac{\partial s^1}{\partial \alpha} = I \left( 1 + \left( \frac{\beta}{e} \right)^2 + \frac{4\beta'}{(1-\beta')^2} \right)^{-1/2} \frac{1 - \beta}{(1 + \beta)} \frac{2 - \alpha(1 - \beta)}{\alpha^3(1 - \beta)^2} \]
\[ \frac{\partial s^1}{\partial \alpha} = I \left( 1 + \left( \frac{\beta}{e} \right)^2 + \frac{4\beta'}{(1-\beta')^2} \right)^{-1/2} \frac{1}{(1 + \beta)} \frac{2 - \alpha(1 - \beta)}{\alpha^3(1 - \beta)} \]
\[ \frac{\partial s^1}{\partial \alpha} = I \left( 1 + \left( \frac{\beta}{e} \right)^2 + \frac{4\beta'}{(1-\beta')^2} \right)^{-1/2} + 2 - \alpha(1 - \beta) \frac{2 - \alpha(1 - \beta)}{\alpha^3(1 - \beta^2)} > 0 \tag{18} \]
## Empirical Appendix

### Appendix Table 1

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<th>Variables</th>
<th>(1) Ideal saving ($100)</th>
<th>(2) Predicted saving ($100)</th>
<th>(3) ED ($100)</th>
<th>(4) Submit Report</th>
<th>(5) Income</th>
<th>(6) Saving</th>
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Appendix Figure 1: Variation in savings unexplained by non-ED control variables

Appendix Table 3 (Interactions with factors that may worsen self-control problem)

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Standard errors in parentheses. Lincoms in Table 4 in the manuscript. 
*** p<0.01, ** p<0.05, * p<0.1
Appendix: Survey Questions

1) Age: _________ years old

2) When did you arrive in CASS?: _______ weeks ago

3) Are you planning to stay at CASS for the next 2 months?
   Yes / No / I don’t know

4) Gender: Male / Female (circle one)

5) Ethnicity: (circle one)
   White/Caucasian
   Black/African American
   Hispanic
   Asian or Pacific Islander
   Native American or Alaskan Native
   Other (Specify)

6) Marital Status: single / married / separated / divorced (circle one)

7) Have children: Yes/ No (circle one)
   8) If yes, how many children? _______

9) How many years did you go to school? _________ years

10) What is the Highest Level of Education You Completed? (circle one)
    No formal education
    6th grade or less
    9th grade or less
    High school degree or GED
    Some College
    Tech/Vocational/Associates
    College Degree
    Post Graduate Education

11) Were you under foster care when you were a child? Yes / No (circle one)

12a) Total Income: $___________ per month  12b) Wage $______ per hour

13a) Total Length of Homelessness: _____ years _____ months
13b) Is this the first time you became homeless? Yes / No

13c) How many times have you become homeless for the last 2 years? ___ times

14) Do you receive government assistance? If yes, what types of assistance do you receive? How much government assistance do you receive per month?

   a) General Relief. Yes / No (circle one) b) If Yes, $________ per month
   c) Food Stamps. Yes / No (circle one) d) If Yes, $________ per month
   e) SSI or SSDI. Yes / No (circle one) f) If Yes, $________ per month
   g) Medical benefits. Yes / No (circle one) h) If Yes, $________ per month
   i) Veteran’s Benefits Yes / No (circle one) j) If Yes, $________ per month
   k) Other (specify) Yes / No (circle one) l) If Yes, $________ per month

15) To what extent have each of these factors contributed to your current homelessness? (1-5 scale, 1=least important, 5=most important)

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<td>h) Incarceration</td>
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<td>i) Divorce or other family problems</td>
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<td>j) Domestic Violence</td>
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<td>k) Lack of affordable health care</td>
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<td>l) Lack of affordable housing</td>
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<td>m) Natural disaster (fire, flood)</td>
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<td>n) Mortgage foreclosures</td>
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<td>o) Relationship (girl friend / boy friend / roommate)</td>
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<td>p) Other (Specify)</td>
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16) Are you interested in buying a property in the future? Yes / No (circle one)

17) Are you interested in getting further education? Yes / No (circle one)

18) Are you interested in starting your own business? Yes / No (circle one)

19) In addition to getting a home, what are your primary goals upon leaving this shelter? (This should be open ended. Interviewer to note down all the stated goals).

20) Which of the following will help you achieve your goals?
a. Increasing Saving Yes / No
b. Further education / taking classes Yes / No
c. Improving relationship with your family Yes / No
d. Quitting alcohol / drug Yes / No

21) How much would you ideally like to save in the next 4 weeks? $________

22) Why would you like to save that amount of money?

23) Do you have a savings account? Yes / No (circle one)

24) Do you have a checking account? Yes / No (circle one)

25) List up to 5 people who you rely on in hard times (see examples below)

   Family, Homeless friend, Non homeless friends, Church, Social Workers, Nobody

   a) 
   b) 
   c) 
   d) 
   e) 

26) Do you smoke? Yes / No (circle one)

27) Have you ever tried to quit smoking? Yes / No (circle one)

28) Have you succeeded in quitting smoking? Yes / No (circle one)

29) Do you want to quit smoking? Yes / No (circle one)

30) Do you drink? Yes / No (circle one)

31) Have you ever tried to quit drinking? Yes / No (circle one)

32) Have you succeeded in quitting drinking? Yes / No (circle one)

33) Do you want to stop drinking? Yes / No (circle one)

34) Are you saving for retirement? Yes / No (circle one)

35) How much do you think you will actually save in the next 4 weeks? $________

36) Since you arrive at CASS, have you had any financial emergencies? Yes / No

37) From 1-10, 1 being the worst thing that has ever happened to you and 10 being the best,
a. How would you rate your life before homelessness? ______

b. How would you rate your experience of homelessness before coming to CASS? ______

c. How would you rate your life at CASS? ______

38) If you have been in other shelters before, how is CASS the same/different from those other shelters? ______