

Self Control and Liquidity: How to Design a Commitment Contract

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September 20, 2011

Abstract: If individuals have self-control problems that lead them to spend money when they had previously planned to save it, they may take up financial commitment devices that restrict their future ability to access their funds. We experimentally investigate how the demand for commitment contracts is affected by contract design features. In our experiments, each subject is endowed with a sum of money and asked to divide that money between a liquid account, which permits unrestricted withdrawals at any time over the course of the months-long experiment, and one or more commitment accounts, which impose withdrawal penalties or restrictions. The design features of the liquid account are the same for all subjects, but the design features of the commitment account(s) are randomized across subjects. When the interest rates on the two types of accounts are the same, we find that allocations to a commitment account are higher when the account is less liquid. The commitment account that disallows early withdrawals altogether attracts the largest allocations. However, this relationship no longer holds when the commitment account interest rate is greater than the liquid account interest rate.

This research was made possible by generous grants from the National Institute on Aging (grants P01AG005842 and R01AG021650), the Russell Sage Foundation and the Sloan Foundation (joint grant 98-10-11), and the Social Security Administration (grant 9920100031). We have benefited from the comments of seminar audiences at Georgia Tech, Princeton, UC Berkeley, Wharton, and the NBER Summer Institute. The findings and conclusions expressed are solely those of the authors and do not represent the views of the National Institute on Aging, the Russell Sage Foundation, the Sloan Foundation, the Social Security Administration, any agency of the Federal Government, or the NBER.

Illiquid forms of wealth constitute an important component of households' assets. In the 2007 Survey of Consumer Finances, mean assets among U.S. households were \$655,000; the value of primary residences represented 32% of total assets; and the value of retirement accounts such as 401(k) plans represented 12% of total assets.¹ There are many benefits to holding wealth in illiquid forms, including the convenient services that some illiquid assets provide (such as housing) and certain tax advantages (such as the deductibility of home mortgage interest payments and retirement plan contributions). At the same time, it is by definition difficult or costly to tap these stores of wealth in order to fund current consumption or purchases of other assets – selling a house or obtaining a home equity loan involves significant transaction costs, and early withdrawals from many retirement accounts incur tax penalties. We focus on a silver lining of this illiquidity: if people have self-control problems, illiquid forms of wealth may serve as commitment devices that help them avoid the temptation to spend money when they had previously planned to save it. In this paper, we ask how the demand for such commitment devices is affected by their design features, especially their degree of illiquidity.

Previous research indicates that people indeed suffer from self-control problems – that is, they intend to make choices that carefully weigh both short-run and long-run costs and benefits, but in the decision-making moment they place disproportionate weight on immediate costs and benefits. For example, DellaVigna and Malmendier (2006) find that individuals' gym membership contract choices suggest that their planned frequency of gym attendance at the time of contract signing exceeds their actual frequency of gym attendance. When signing these contracts, it seems that individuals plan to attend the gym regularly in order to capture the long-term benefits of exercise. However, when it comes time to attend the gym, the short-term inconveniences and discomforts of gym attendance tend to outweigh any long-term benefits.²

If individuals are sophisticated in the sense that they correctly anticipate their future self-

¹ Sources: Bucks et al. (2009) and authors' calculations.

² For further evidence on self-control problems, see Read and van Leeuwen (1998), Wertenbroch (1998), Read, Loewenstein, and Kalyanaraman (1999), Angeletos et al. (2001), O'Connor et al. (2002), McClure et al. (2004), DellaVigna and Paserman (2005), Oster and Scott Morton (2005), Shapiro (2005), Laibson, Repetto, and Tobacman (2007), McClure et al. (2007), Milkman, Rogers, and Bazerman (2009, 2010), Reuben, Sapienza, and Zingales (2009), and Meier and Sprenger (2010). From a theoretical perspective, self-control problems can be derived from declining intertemporal discount rates (Strotz, 1955; Loewenstein and Prelec, 1992; Laibson, 1997), planner-doer models (Thaler and Shefrin, 1981; Fudenberg and Levine, 2006), visceral factors and cue-conditioned impulsivity (Loewenstein, 1996; Bernheim and Rangel, 2004), the internal conflict between "should" and "want" urges (Bazerman, Tenbrunsel, and Wade-Benzoni, 1998; Milkman, Rogers, and Bazerman, 2008), and temptation preferences (Gul and Pesendorfer, 2001).

control problems (O'Donoghue and Rabin, 1999), they may be willing to take up commitment devices. Today, they may agree to forego payments or other rewards if they fail in the future to execute their current long-run plans. By agreeing to such a system, they create incentives for themselves to follow through on their intended course of action. The demand for commitment devices has been documented in the domains of completing homework assignments for university courses (Ariely and Wertenbroch, 2002), quitting cigarette smoking (Gine, Karlan, and Zinman, 2010), avoiding repeated temptations in a laboratory environment (Houser et al., 2010), and achieving workplace goals (Kaur, Kremer, and Mullainathan, 2010). This paper is most closely related to the work of Ashraf, Karlan, and Yin (2006), who offered a financial commitment device to Philippine households in the form of a savings account that restricted withdrawals. In this context, self-control problems may manifest themselves as account withdrawals that fund immediately gratifying current consumption at the expense of long-term financial goals, and the commitment account allowed individuals to prevent such impulsive withdrawals. The commitment account was taken up by 28% of households and increased savings among households that were offered the account relative to a randomized control group.

We build on the findings of Ashraf, Karlan, and Yin (2006) by offering commitment accounts to U.S. households in a pair of internet-based experiments. Our key contribution is that we vary the characteristics of the commitment accounts, particularly their degree of illiquidity, to investigate which contract design features are attractive to consumers.

In our two experiments, subjects are endowed with an initial sum of money (\$50, \$100, or \$500) and asked to allocate the money between a liquid account, which does not limit withdrawals, and one or more commitment accounts, which impose penalties on early withdrawals, restrict early withdrawals, or disallow early withdrawals altogether. Early withdrawals are defined as withdrawals that are requested prior to a commitment date chosen by the subject. All subjects have access to the same liquid account, but the characteristics of the commitment account(s) vary across subjects. Any balances, including accumulated interest, remaining in the accounts at the end of the months-long experiments are disbursed to subjects automatically.

Several findings emerge from the experiments. First, when subjects have access to a commitment account with the same interest rate as the liquid account, nearly half of the money given to subjects is allocated to the commitment account. Even when the interest rate on a

commitment account is less than that on the liquid account, the commitment account receives one-quarter of the money. When commitment dates are set, they are non-trivial – that is, they are typically several months later than the earliest possible commitment dates.

Second, the amount of money allocated to a commitment account is increasing in the interest rate on the commitment account.

Third, when a commitment account and the liquid account have the same interest rate, the fraction of dollars allocated to the commitment account is increasing in the degree of account illiquidity. The commitment account with a 10% early withdrawal penalty receives less money than the commitment account with a 20% early withdrawal penalty, which in turn receives less money than the commitment account that prohibits early withdrawals entirely. The no early withdrawal account attracts larger allocations than the 10% penalty account both when comparing across subjects who are offered one account or the other and when comparing within subjects who are offered both accounts simultaneously. The relationship between commitment account allocations and account illiquidity suggests that subjects' willingness to take up commitment devices is not an artifact of experimental demand effects.

Finally, when a commitment account has a higher interest rate than the liquid account, the relationship between commitment account allocations and account illiquidity no longer holds. Allocations are approximately equal for different degrees of illiquidity.

These results are consistent with several possible models of commitment, and we focus on two of them. First, we analyze a model in which agents have self-control problems in the form of quasi-hyperbolic time discount functions and are heterogeneous in their sophistication or naïveté when it comes to anticipating their time-inconsistent preferences (Laibson, 1997; O'Donoghue and Rabin, 1999). Sophisticated agents value commitment and are therefore willing to allocate money to a commitment account when it offers the same interest rate as the liquid account or a lower interest rate than the liquid account. Thus, sophistication about self-control problems can explain the first set of results. Both sophisticated and naïve agents choose to allocate a (weakly) larger fraction of their money to a commitment account as its interest rate increases, providing an explanation for the second set of results. Regarding the third and fourth sets of results, sophisticated agents' allocations to a commitment account are largest when it prohibits early withdrawals. Naïve agents' commitment account allocations are smallest when the account prohibits early withdrawals, but naïve agents do not value commitment for its own

sake and therefore do not allocate any money to a commitment account until its interest rate exceeds that of the liquid account. Therefore, when a commitment account has the same interest rate as the liquid account, sophisticated agents determine the relationship between commitment account allocations and the degree of illiquidity. However, when a commitment account has a higher interest rate than the liquid account, sophisticated and naïve agents jointly determine the relationship between commitment account allocations and the degree of illiquidity, and their reactions to changes in the degree of illiquidity can offset each other.

A second possible explanation for our experimental results is that subjects may be engaging in reason-based choice processes (Shafir, Simonson, and Tversky, 1993). When a commitment account has the same interest rate as the liquid account, subjects must construct reasons for their allocation decision based on the accounts' differences in liquidity. Subjects favor the liquid account if withdrawal flexibility is their primary motivation, and they favor a commitment account if elimination of temptation is their primary motivation. A commitment account that has a greater degree of illiquidity is more effective at eliminating temptation, so commitment account allocations increase in the degree of illiquidity. However, if a commitment account has a different interest rate than the liquid account, the difference in interest rates can serve as a subject's reason for an allocation decision. When a commitment account has a higher interest rate than the liquid account, subjects focus on the interest rate difference and do not base their decision on the commitment account's degree of illiquidity, eliminating the relationship between commitment account allocations and the degree of illiquidity.

Our experimental findings shed light on the nature of the demand for commitment. Under some circumstances, complete illiquidity has advantages over penalty-based commitment devices. This insight has potential implications for the design of the institutional environment within which households make important financial decisions. For example, participants in many 401(k) plans have the ability to access their plan balances through a withdrawal that incurs a 10% tax penalty or through a penalty-free loan. Our results suggest that there may be situations in which individuals actually prefer stricter rules governing the availability of balances.

The paper proceeds as follows. Section I describes the design and the results of our first experiment, and Section II describes the design and the results of our second experiment. Section III discusses potential explanations for our findings. Section IV concludes.

I. First Experiment

A. Design

(i) Subject recruitment

We recruited subjects in early 2010 from the RAND American Life Panel (ALP), a panel of respondents of age 18 years or older who are selected to be broadly representative of the U.S. adult population. ALP respondents participate in approximately two half-hour surveys per month over the internet, and respondents who do not have their own internet access are provided with a device that enables them to access the internet through their televisions.

RAND sent an email to 750 panel members inviting them to participate in a year-long experiment on financial decision-making that would provide at least \$40 in compensation. The email contained a link to the ALP website, where the experiment was conducted. Panel members are accustomed to receiving emails of this nature from RAND, and they are comfortable clicking on survey links embedded in these emails. When accessing the ALP website, panel members log in with a username and password, enabling researchers to link an individual's responses across surveys.

After panel members clicked on the survey link and logged into the ALP website, they were taken to an informed consent page that gave a brief description of what would happen in the study: study participants would be given money to divide between two accounts, would have the ability to withdraw money from the accounts over the course of a year, and would receive weekly emails reminding them of their account balances. Out of the 750 panel members invited to take part, 495 consented to participate and completed the study.³

Data on the demographic characteristics of the 495 subjects, which were collected by RAND in other surveys, are summarized in Table 1. For the sake of comparison, Table 1 also summarizes the demographic characteristics of the 550 subjects in the second experiment, who were recruited in a similar fashion (see Section II). In both experiments, 43% of the subjects are male, and their ages are distributed fairly evenly across ten-year age categories. Nearly two-thirds have at least some college education. Less than 10% of subjects have annual household income below \$15,000, while 17% of subjects have annual household income of at least \$100,000. Two-thirds are married, and more than 60% are currently working. Approximately

³ Of the remaining 255 panel members, 170 did not respond to the invitation, 36 responded to the invitation but did not complete the consent process, 40 responded to the invitation but declined to consent to participation, and 9 consented to participate but did not start the experiment.

80% of subjects are White/Caucasian; approximately 10% are Black/African American; and the others are American Indian, Alaskan Native, Asian, Pacific Islander, or of unknown race. Finally, the median subject has one other household member. In fact, 41 subjects in the first experiment are in the same household as at least one other subject in the first experiment.⁴ In the second experiment, 23 subjects are in the same household as a subject in the first experiment.⁵ No subject in the second experiment is a subject in the first experiment, and no two subjects in the second experiment are from the same household.

(ii) Randomization

After consenting to take part in the experiment, subjects were randomly assigned to one of seven treatment conditions. In all conditions, subjects allocated their experimental endowment between a liquid account and a commitment account. The features of the liquid account were constant across the seven conditions – balances in the liquid account earned a 22% interest rate compounded daily, and withdrawals from the liquid account were allowed at any time starting one week from a subject’s initial participation in the experiment. The features of the commitment account were the only variables that differed across treatment conditions. There were three possible interest rates for the commitment account: 21%, 22%, and 23%. There were also three possible degrees of illiquidity associated with the commitment account. Early withdrawals, defined as withdrawals requested prior to a commitment date specified by the subject at the outset of the experiment, were subject to a 10% penalty, subject to a 20% penalty, or disallowed altogether.⁶ Instead of having a full factorial design involving nine conditions, the experiment omitted conditions offering a commitment account with a 21% interest rate and a 20% early withdrawal penalty or no possibility of early withdrawals.

The experimental design is summarized in Table 2, which also gives the number of subjects in each treatment condition.

Two design decisions deserve further comment. First, the interest rates on the liquid account and the commitment accounts are quite high. They were chosen to be higher than typical credit card interest rates so that most subjects would not find it advantageous to allocate money to the liquid account in order to withdraw the money immediately and use it to pay down

⁴ Our results remain unchanged if these 41 subjects are dropped from the sample.

⁵ Our results remain unchanged if these 23 subjects are dropped from the sample.

⁶ As in the case of the liquid account, no version of the commitment account permitted withdrawals during the first week of the experiment. A 10% penalty implied that an early withdrawal of W dollars reduced the subject’s account balance by $(1.1 \times W)$ dollars. The 20% penalty was defined analogously.

credit card debt. Second, the design omits two treatment conditions offering a commitment account with a 21% interest rate. We anticipated that commitment accounts with a 21% interest rate would not attract large allocations, so we did not want to devote much of our sample to those conditions. At the same time, we hoped to compare commitment account allocations when the commitment account interest rate was lower than, equal to, and higher than the liquid account interest rate. Therefore, we included one condition offering a commitment account with a 21% interest rate, providing sufficient statistical power to permit direct comparisons while holding the degree of illiquidity fixed.

(iii) Initial allocation

Subjects in the experiment were not expressly informed of the overall experimental design, but they were given all information that was pertinent to their treatment condition. Following the informed consent page, subjects clicked through a series of screens describing the details of their participation. They would receive \$50, \$100, or \$500, with the outcome determined by a random number drawn as part of a national lottery. Their immediate task was to make three allocation decisions: for each possible monetary endowment, they would divide the money between two accounts, a liquid account and a commitment account. They would receive weekly emails displaying their account balances and providing a link to the webpage where withdrawals could be requested, but they could log in at any time to view their account balances and request account withdrawals. Transfers between the two accounts would be impossible after the initial allocation, and withdrawal requests would result in a check being mailed to the subject within three business days.

The experimental website then described the details of the two accounts. Throughout the experiment, the liquid account was labeled the “Freedom Account,” and the commitment account was labeled the “Goal Account.” These labels were meant to help subjects both remember the rules associated with the accounts and understand the purposes for which the accounts were designed.

The description of the liquid account emphasized that it permitted flexibility and mentioned that partial withdrawals were possible, with interest accruing at a 22% rate on the balances in the account at any given point in time. Figure 1 shows an image of the screen explaining the liquid account.

The description of the commitment account emphasized that it could help subjects reach their savings goals. Subjects using the commitment account would have to select a commitment date (labeled the “goal date”), and this date might be associated with a gift purchase, a vacation, another special event, or no particular purpose. Withdrawals before the commitment date were restricted in the manner prescribed by the treatment condition. Partial withdrawals were possible, and the balances in the account at any given point in time would earn the interest rate for that condition. Figure 2 shows an example of a screen explaining a commitment account.

After learning about the details of the two accounts, subjects learned about the details of the randomization procedure that would assign them \$50, \$100, or \$500. The randomization procedure was based on Powerball, a national lottery with jackpots of many millions of dollars. Twice a week, six integers between 1 and 39, inclusive, are randomly drawn without replacement, and one of these numbers is designated as “the Powerball.” All numbers have an equal likelihood of being the Powerball. Subjects were informed that they would choose four numbers. If the next drawing’s Powerball was the first or second number chosen, the subject would receive \$500. If the next drawing’s Powerball was the third or fourth number chosen, the subject would receive \$100. In all other cases, the subject would receive \$50. The money would then be allocated between the two accounts according to the subject’s stated wishes for the given monetary amount.

Subjects were then asked to make their three allocation decisions. All subjects completed the \$50 allocation decision first, followed by the \$100 decision second and the \$500 decision third. When subjects allocated any money to the commitment account, they were required to choose a commitment date no later than one year from the current date, and they were invited to type in the goal associated with the commitment account. A screen shot for an example allocation page is shown in Figure 3.

Finally, subjects chose their four Powerball numbers. After the following Powerball drawing, they received emails indicating the dollar amount they were assigned and reminding them of the allocation of that amount. All 495 subjects made their initial allocation decisions between February 1, 2010, and February 11, 2010.

(iv) Withdrawals

During the year after the initial allocation decision, subjects received weekly emails indicating their current account balances and offering a link to the experimental website where

withdrawals could be requested. For the text of a sample e-mail, see Figure 4. Subjects could also log into the website at any time during the year to access the same information. Figure 5 shows an image of this summary page. When a subject requested a withdrawal, a message asked the subject to confirm the withdrawal amount and the amount by which the account balance would be reduced. If the withdrawal was confirmed, a check for the withdrawal amount was mailed to the subject within three business days.

If subjects withdrew all money from their accounts before a year had elapsed, they were asked to complete an exit questionnaire asking whether any parts of the study were confusing and whether they would have changed any of their decisions in the experiment with the benefit of hindsight. If subjects still had money in their accounts a year after their initial allocation decisions, the account balances were automatically disbursed to them, and they were asked to complete the same exit questionnaire.

B. Results

We first examine the initial allocation decisions of subjects. We treat each of a subject's three allocation decisions as a separate observation, and for each observation we calculate the fraction of the endowment directed to a commitment account. We perform statistical inference using standard errors clustered at the subject level.⁷ Panel A of Table 3 shows the mean fraction allocated to a commitment account by treatment condition. Our four main results are immediately apparent.

First, about half of initial balances are allocated to a commitment account when it has the same interest rate as the liquid account (22%), and about one-quarter of initial balances are allocated to a commitment account when it has a lower interest rate than the liquid account. Thus, it seems that subjects place some value on commitment.

Second, the fraction allocated to a commitment account increases as the commitment account interest rate increases. Comparing across conditions with a 10% early withdrawal penalty, the commitment account with a 21% interest rate attracts a mean allocation of 28%; the commitment account with a 22% interest rate attracts a mean allocation of 39%; and the commitment account with a 23% interest rate attracts a mean allocation of 58%. The differences across these three conditions are statistically significant at the 5% level. The mean allocation to

⁷ Commitment account allocations generally increase as the initial endowment amount increases, but our results are otherwise qualitatively similar if we separately examine all \$50 allocation decisions, all \$100 allocation decisions, or all \$500 allocation decisions.

the commitment account with a 20% early withdrawal penalty and a 22% interest rate is also statistically significantly less than the mean allocation to the commitment account with a 20% early withdrawal penalty and a 23% interest rate. However, the means are approximately the same for the two commitment accounts that prohibit early withdrawals.

Third, when the interest rate on a commitment account is equal to the interest rate on the liquid account, the fraction allocated to the commitment account increases in the account's degree of illiquidity. Increasing the illiquidity from a 10% early withdrawal penalty to a 20% early withdrawal penalty to a prohibition on early withdrawals increases the mean fraction allocated to the commitment account from 39% to 45% to 56%. The first and second means are not statistically significantly different from each other, but the first and third as well as the second and third are. This result gives us some confidence that the value subjects place on commitment is not purely an artifact of experimental demand effects. Such demand effects could explain our result only if they intensify as the commitment account becomes more illiquid. While possible, this pattern of experimental demand is not necessarily one that would be predicted *ex ante*.

Fourth, when the interest rate on a commitment account is higher than the interest rate on the liquid account, the relationship between commitment account allocations and the degree of illiquidity disappears. Commitment accounts with a 23% interest rate attracted mean allocations of approximately 60% in the 10% penalty, 20% penalty, and no early withdrawal cases.⁸

Panel B of Table 3 is similar to Panel A, except it contains regression-adjusted mean allocations to the commitment account by treatment condition. We perform an ordinary least-squares regression of the fraction allocated to a commitment account on treatment group indicator variables and the demographic variables summarized in Table 1. For each demographic variable, we construct indicator variables for the categories listed in Table 1.⁹ We demean these indicator variables, drop one category for each demographic variable, and omit a constant term from the regression so that the coefficients on the treatment group indicators, displayed in Panel B of Table 3, are maximally comparable to the corresponding entries in Panel

⁸ A formal test of this interaction effect is provided in Appendix A.

⁹ We combine some categories. For education, the no high school diploma and high school graduate categories are combined, and the associate's degree and bachelor's degree categories are combined. For marital status, job status, and race, all categories other than the majority category are combined.

A of Table 3. As expected in a randomized experiment, controlling for demographic characteristics does not change our results.

To give a sense of the distribution of the fraction of balances allocated to a commitment account, Figure 6 displays cumulative distribution functions by treatment condition. The results are in accord with the results from Table 3. When two conditions have mean fractional allocations that are statistically significantly different, the corresponding distributions display the empirical analog of a first-order stochastic dominance relationship. In particular, differences in the fraction of subjects who allocate all money to the liquid account and differences in the fraction of subjects who allocate all money to the commitment account align with the differences in mean fractional allocations.

When subjects allocate money to a commitment account, they are required to specify a commitment date, which is the date before which early withdrawal restrictions apply. Therefore, a comprehensive measure of a subject's chosen extent of commitment must take into account both the amount of money devoted to a commitment account and the amount of time before the commitment date arrives. For each of a subject's three allocation decisions, we calculate the dollar-weighted days to commitment date, which is the fraction of balances allocated to the commitment account multiplied by the number of days between the date of the allocation decision and the commitment date. Panel A of Table 4 displays the unadjusted mean dollar-weighted days to commitment date by treatment condition, while Panel B of Table 4 displays the regression-adjusted mean using a regression specification analogous to the specification for Panel B of Table 3. Differences across conditions here are similar to the differences in mean fractional commitment account allocations but are slightly weaker statistically. Comparing conditions offering commitment accounts with a 10% penalty on early withdrawals, the mean dollar-weighted days to commitment date increases from 64 to 82 to 130 as the interest rate increases from 21% to 22% to 23%. Comparing conditions offering commitment accounts with a 22% interest rate, the mean dollar-weighted days to commitment date increases from 82 to 101 to 132 as the degree of illiquidity increases from a 10% early withdrawal penalty to a 20% early withdrawal penalty to a prohibition on early withdrawals. However, among conditions offering commitment accounts with a 23% interest rate, the means of dollar-weighted days to commitment date are statistically indistinguishable.

Finally, Figure 7 displays withdrawal patterns for the seven treatment conditions. For each subject and for each day during the year-long experiment, we calculate the sum of the liquid account and commitment account balances that the subject would have had if no withdrawals had been requested. This hypothetical total balance takes as given the subject's initial allocation between the liquid account and the commitment account, which can have different interest rates, and it uses the allocation decision that applies to the ex post realization of the endowment amount (\$50, \$100, or \$500). We then calculate the ratio of the subject's actual balance to the hypothetical total balance, and we use this ratio as our measure of withdrawal activity. For each treatment condition, we plot the mean of our measure against the number of days since the initial allocation decision. Withdrawals take place slightly earlier in the experiment when the interest rate on the commitment account is lower. Withdrawals patterns do not seem to systematically vary according to the commitment account's degree of illiquidity. Of course, it is important to note that differences in withdrawal patterns across treatment conditions are somewhat difficult to interpret. For instance, when comparing a condition offering a 22% interest rate commitment account to a condition offering a 23% interest rate commitment account, it is unclear whether any differences in withdrawals are the direct result of the difference in interest rates or are the result of differences in commitment account allocations and commitment dates, which are themselves influenced by the difference in interest rates. The breakdown of withdrawals into liquid account withdrawals and commitment account withdrawals further complicates matters. We examine withdrawals more closely in our second experiment.

II. Second Experiment

A. Design

(i) Subject recruitment

The recruitment procedure for the second experiment was very similar to that for the first experiment. In early 2011, RAND emailed 737 ALP members inviting them to participate. When panel members logged into the ALP website, they were informed that the experiment involved allocating \$100 among different accounts. The study would end on September 1, 2011, at which point subjects would receive checks for any balances remaining in the accounts, but withdrawals could be requested before the end of the study, with withdrawal checks mailed

within three business days of the withdrawal request. As in the first experiment, subjects would receive weekly emails stating their account balances.

After receiving this information, panel members could consent to participate in the experiment. Out of the 737 invited ALP members, 550 gave their informed consent and completed the study.¹⁰ Their demographic characteristics, summarized in Table 1, are similar to those of the participants in the first experiment. There is no overlap between the subjects in the first experiment and the subjects in the second experiment. Furthermore, no subject in the second experiment is in the same household as another subject in the second experiment, but 23 subjects in the second experiment are in the same household as a subject in the first experiment.

(ii) Randomization

Subjects were randomized into four treatment conditions. In all conditions, subjects had access to a liquid account that was similar to the liquid account in the first experiment. The liquid account had a 22% interest rate and allowed penalty-free withdrawals. In contrast to the first experiment, the second experiment permitted withdrawals immediately instead of allowing withdrawals only if one week had elapsed since the initial allocation decision. The commitment accounts varied across conditions but earned a 22% interest rate in all cases. Two treatment conditions mimicked conditions in the first experiment: subjects had access to one commitment account, and withdrawals from the commitment account prior to the commitment date chosen by the subject incurred a 10% penalty or were prohibited altogether. The third treatment condition offered subjects two commitment accounts, one with a 10% penalty on early withdrawals and the other with no possibility of early withdrawals. Subjects in this condition could allocate money to the two commitment accounts simultaneously, and each commitment account could be assigned its own distinct commitment date. Finally, the fourth treatment condition offered a commitment account with a “safety valve” – early withdrawals from this account were not allowed unless a subject indicated that the funds were needed for a financial emergency. Financial emergencies would not be verified, but subjects were asked to indicate honestly whether or not they were experiencing a financial emergency.

After subjects indicated their desired allocations, they were randomly assigned to receive \$100 divided according to their wishes or \$100 allocated entirely to the liquid account. At the

¹⁰ Of the remaining 187 panel members, 107 did not respond to the invitation, 26 responded to the invitation but did not complete the consent process, 46 responded to the invitation but declined to consent to participation, and 8 consented to participate but did not start the experiment.

time they indicated their allocation preferences, they knew there was a 50% probability that their choices would be implemented and a 50% probability that the experimenters would choose their allocations, but they did not know what allocations the experimenters would choose.

Table 5 indicates the number of subjects assigned to each treatment condition broken out into the number who received allocations according to their wishes and the number who received all of their funds in the liquid account. We did not stratify by treatment condition when randomly assigning subjects to receive their chosen allocations or the 100% liquid account allocation, so the distribution of subjects within a treatment condition appears somewhat imbalanced. However, the overall imbalance is negligible.

The second experiment allows us to investigate some questions that follow naturally from the first experiment. First, given subjects' apparent preference for commitment accounts with a greater degree of illiquidity, it is puzzling that such commitment products are rarely observed in the market. It is possible that highly illiquid commitment accounts are attractive when placed in contrast to a completely liquid account but unattractive when a less illiquid commitment account is added to the choice set, since the latter comparison makes the highly illiquid account seem like an extreme option (Simonson, 1989). Furthermore, the complexity of choosing from a set including multiple commitment accounts may make individuals favor the simple liquid account (Redelmeier and Shafir, 1995). The treatment condition that offers subjects the liquid account, the 10% penalty commitment account, and the no early withdrawal commitment account simultaneously helps us address these possibilities.

Second, it is interesting to ask whether it is possible to design a commitment account that is even more attractive to subjects than the commitment account that prohibits early withdrawals. The advantage of an account with no possibility of early withdrawals is that it provides subjects with a strong form of commitment, but the drawback of the account is that it does not permit subjects to access their funds even when a financial emergency arises. The treatment condition that offers subjects a "safety valve" commitment account may provide a superior combination of commitment and flexibility. Instead of imposing a monetary penalty on early withdrawals or disallowing early withdrawals altogether, the "safety valve" commitment account requires subjects to certify that they are experiencing a financial emergency if they wish to make an early withdrawal. Because we make no attempt to verify whether or not a financial emergency has actually occurred, the "safety valve" commitment account only imposes the psychic cost of lying

on subjects if they wish to make an early withdrawal when they are not experiencing a financial emergency. There is probably no psychic cost associated with an early withdrawal during a true financial emergency, so the “safety valve” commitment account may be able to create a state-contingent cost of early withdrawals that does not discourage withdrawals in financial emergencies but does discourage withdrawals in other cases.

Finally, the second experiment allows us to connect desired commitment account allocations with a proxy for self-control problems that is based on choice data. Approximately half of the subjects indicated their desired allocations but received all of their money in the liquid account. The withdrawal decisions of these subjects can serve as a noisy measure of the subjects’ self-control problems because the decisions are free from the influence of any penalties or restrictions imposed by a commitment account. Correlations between withdrawal patterns and desired commitment account allocations provide some indication of whether the desire for commitment is indeed linked to self-control problems.

(iii) Initial allocation

After subjects gave their informed consent and were randomly assigned to treatment conditions, they were informed of the details relevant to their respective conditions. They would be given \$100 and would allocate the money to a liquid account (again labeled the “Freedom Account”) and one or more commitment accounts (again labeled “Goal Accounts”). The experimental website would display balances and allow withdrawal requests at any time, and weekly emails would also display balances and provide a link to the withdrawal webpage. Deposits into and transfers between the accounts would not be allowed, and withdrawal checks would be mailed within three business days of the withdrawal request.

The description of the liquid account, the description of the 10% penalty commitment account, and the description of the no early withdrawal commitment account were the same as the descriptions used in the first experiment except for appropriate adjustments to relevant dates. When the 10% penalty commitment account and the no early withdrawal commitment account were offered simultaneously, they were labeled “Goal Account A” and “Goal Account B,” respectively, and were explained concurrently instead of consecutively (see Figure 8). Subjects learned that the two commitment accounts could be assigned distinct commitment dates (again labeled “goal dates”). In the case of the “safety valve” commitment account, subjects were informed that early withdrawals were possible only when a financial emergency occurred.

Subjects would be the sole judges of whether or not an emergency was actually occurring (see Figure 9).

Subjects were then told that they would receive their chosen allocation with 50% probability and would receive an allocation selected by the experimenters with 50% probability. They did not know that the allocation selected by the experimenters would place all of the money in the liquid account. A computer rather than a public randomizing device was used for this randomization procedure.

Finally, subjects made their allocation decisions. When appropriate, they selected one or more goal dates and were given the option to describe the goals associated with the commitment accounts. After making these decisions, subjects were informed whether they were randomly assigned to receive their chosen allocation or the 100% liquid account allocation.

Subjects completed this initial phase of the experiment between February 14, 2011, and March 2, 2011. The experiment ended for all subjects on September 1, 2011.

(iv) Withdrawals

As in the first experiment, subjects in the second experiment could see their balances and request withdrawals by logging into the ALP website at any time. They also received weekly emails displaying current balances and a link to the experimental website.

All subjects who requested withdrawals were asked to confirm their requests. In addition, subjects who wished to make early withdrawals from the “safety valve” commitment account were shown the following text:

We are relying on you to be *honest* in judging whether you have a financial emergency. If you are sure you want to make a withdrawal, please type the sentence below, then click “Next.”
Otherwise, click “Cancel my withdrawal.”

The sentence that these subjects were asked to type was, “I attest that I have a financial emergency.” However, the website accepted any entered text.

Similar to the first experiment, the second experiment gave an exit questionnaire to subjects who withdrew all of their money before September 1, 2011. Subjects who had remaining balances on September 1, 2011, automatically received checks for their balances and received emails with links to the same exit questionnaire. The exit questionnaire gave subjects the opportunity to identify confusing aspects of the experiment. However, in contrast to the first

experiment, subjects in the second experiment were not asked to explain anything that they would have done differently in retrospect. Also, whenever subjects in the second experiment made any withdrawals (including partial withdrawals) before September 1, 2011, they were given the option to provide their reasons.

B. Results

Panel A of Table 6 gives mean fractional allocations to a commitment account by treatment condition. For the condition offering both the 10% penalty commitment account and the no early withdrawal commitment account, we report the mean of total fractional allocations to either commitment account as well as mean allocations to each of the commitment accounts separately. Standard errors are robust to heteroskedasticity.

The results replicate and extend some of the main findings from the first experiment. Commitment account allocations represent a meaningful fraction of endowments and are similar in magnitude to allocations in the first experiment. When subjects are offered the liquid account and the 10% penalty commitment account only, the mean commitment account allocation is 46% of the endowment, roughly similar to the 39% mean allocation observed in the first experiment. When subjects are offered the liquid account and the no early withdrawal commitment account only, the mean commitment account allocation is 54%, approximately the same as the 56% mean allocation in the first experiment and statistically significantly different at the 5% level from the 46% mean allocation among subjects in the 10% penalty commitment account only condition.

The commitment account that disallows early withdrawals is desirable even when it is offered in the same choice set as the commitment account that imposes a 10% penalty on early withdrawals. The no early withdrawal commitment account attracts a mean allocation of 34%, while the 10% penalty commitment account attracts only a mean allocation of 16%, a difference that is highly statistically significant in a paired t-test. Thus, it does not seem that the direct comparison of the no early withdrawal commitment account with the 10% penalty commitment account makes the no early withdrawal commitment account an extreme, unattractive option. Interestingly, making two commitment accounts available simultaneously does not lead to higher mean overall allocations to commitment accounts when compared to making only the no early withdrawal commitment account available. In the condition offering two commitment accounts, total commitment account allocations have a mean of 50%, which is smaller than but not statistically significantly different from the mean allocation of 54% in the condition offering only

the no early withdrawal commitment account. It is possible that the availability of two commitment accounts makes the allocation decision more complex and therefore leads subjects to view the simple and distinct liquid account as slightly more desirable (Redelmeier and Shafir, 1995).

The “safety valve” commitment account receives a mean allocation of 45%, approximately the same as the 10% penalty commitment account and statistically significantly less than the no early withdrawal commitment account. It may be that the psychic cost of lying about a financial emergency in order to make a withdrawal is sufficiently low that the “safety valve” commitment account does not serve as an effective commitment device, but there are many other potential explanations for this result.

Panel B of Table 6 is analogous to Panel B of Table 3. We perform an ordinary least-squares regression of the fraction allocated to a commitment account on treatment condition indicator variables and demeaned indicator variables for the demographic categories in Table 1, omitting a constant term.¹¹ Panel B of Table 6 reports the coefficient estimates on the treatment condition indicator variables, along with the associated heteroskedasticity-robust standard errors. The results are similar to the results in Panel A of Table 6. Note that we do not perform a regression-adjusted comparison of 10% penalty commitment account allocations and no early withdrawal commitment account allocations among subjects who were offered both commitment accounts, since the within-subject comparison already controls for demographic characteristics.

We also report the distribution of commitment account allocations. Figure 10.A displays cumulative distribution functions by treatment condition for the fraction allocated to a commitment account. For the condition offering two commitment accounts, we display the distribution of total allocations to either account. As in the first experiment, commitment account allocations in the treatment condition offering only the no early withdrawal commitment account have the empirical analog of a first-order stochastic dominance relationship with allocations in the condition offering only the 10% penalty commitment account. Comparisons to the condition offering two commitment accounts and the condition offering the “safety valve” commitment account are less clear, although the condition offering only the no early withdrawal commitment account generally exhibits higher commitment account allocations. Figure 10.B

¹¹ Again, we merge some categories. The category groupings here are the same as the groupings used in Panel B of Table 3.

focuses on the condition offering two commitment accounts and separately displays the cumulative distribution functions for the fraction allocated to each commitment account. Subjects exhibit a clear preference for the commitment account that disallows early withdrawals. Only 25% of subjects allocate no money to this commitment account, while 44% of subjects allocate no money to the 10% penalty commitment account. Furthermore, 8% of subjects allocate all of their money to the no early withdrawal commitment account, while only one subject allocates all of his money to the 10% penalty commitment account.

We also calculate each subject's chosen dollar-weighted days to commitment date. For the three treatment conditions offering only one commitment account, we simply multiply the fraction of balances allocated to the commitment account by the number of days separating the subject's allocation decision from the subject's chosen commitment date. In the case of the condition offering two commitment accounts, we multiply the fractional allocation by the number of days until the commitment date for each of the commitment accounts, and we add these two products together. Note that these calculations use subjects' desired allocations, even though approximately half of the subjects were randomly assigned to receive all of the money in the liquid account. Panel A of Table 7 gives the unadjusted means of the dollar-weighted days to commitment date for the four treatment conditions, and Panel B of Table 7 gives the regression-adjusted means. The results are in line with the differences in fractional commitment account allocations across treatment groups. The condition offering only the no early withdrawal commitment account has a mean dollar-weighted days to commitment date of 75 days, which is slightly higher than the mean of 71 days in the condition offering two commitment accounts. The condition offering only the 10% penalty commitment account and the condition offering the "safety valve" commitment account have lower means of 64 days and 62 days, respectively, although the differences relative to the condition offering only the no early withdrawal commitment account are not statistically significant or marginally statistically significant. The magnitudes are difficult to compare to the magnitudes from the first experiment, since the first experiment took place over the course of a full year instead of slightly more than half a year.

Data on withdrawals are not yet available for the second experiment because the experiment ends on September 1, 2011.

III. Explanations

We present two models of commitment account usage that can produce our main experimental results. The first model features agents with time-inconsistent preferences and heterogeneity in either their intertemporal discount functions or their beliefs about their intertemporal discount functions. The second explanation relies on the psychological theory of reason-based choice. We do not propose these models as the only possible explanations for our findings – we simply view the models as useful frameworks for synthesizing the experimental results. However, it is likely that other explanations will share many elements in common with the two we propose.

A. Time-Inconsistent Preferences

Consider a model of intertemporal choice with three periods. At time $t = 0$, the agent divides an endowment between a liquid account and a commitment account. In our simple setup, the agent will in fact choose to allocate the entire endowment to the liquid account or the entire endowment to the commitment account. At time $t = 1$, the agent can make a withdrawal from the chosen account and use the proceeds for consumption. At time $t = 2$, the agent withdraws any remaining balances and uses those proceeds for consumption. In the context of our experiments, $t = 0$ is the initial allocation decision; $t = 1$ is an interim consumption opportunity, which can be thought of as close in time to $t = 0$; and $t = 2$ is the end of the experiment.

The agent has a quasi-hyperbolic intertemporal discount function of the form $(1, \beta\delta, \beta\delta^2, \dots)$, where $0 < \beta < 1$ and $0 < \delta \leq 1$ (Laibson, 1997). The objective function in each period is:

$$\begin{aligned} t = 0: & \quad \beta\delta u_1 + \beta\delta^2 u_2 \\ t = 1: & \quad u_1 + \beta\delta u_2 \\ t = 2: & \quad u_2 \end{aligned}$$

where u_t is the period t utility flow to the agent. The key feature of this function is that it generates a higher discount rate in the short run than in the long run, leading agents to be relatively patient when contemplating future tradeoffs (e.g., the agent at $t = 0$ contemplating tradeoffs between $t = 1$ and $t = 2$) and relatively impatient when contemplating immediate tradeoffs (e.g., the agent at $t = 1$ contemplating tradeoffs between $t = 1$ and $t = 2$). In a finite-horizon model, the parameter δ is not important conceptually, so for simplicity we set $\delta = 1$.

At $t = 0$, the agent has an endowment of one and chooses to place it in the liquid account or the commitment account. Between $t = 1$ and $t = 2$, balances in the liquid account grow at the

interest rate r_l , and balances in the commitment account grow at the interest rate r_c . Balances do not earn interest between $t = 0$ and $t = 1$. A withdrawal w_l from the liquid account at $t = 1$ reduces the liquid account balance by w_l . A withdrawal w_c from the commitment account at $t = 1$ reduces the commitment account balance by $(1 + p)w_c$, where $p > 0$ represents the early withdrawal penalty. At $t = 1$, neither negative balances nor additional deposits are possible. If the agent chooses the liquid account, withdrawals are restricted to $0 \leq w_l \leq 1$ and $w_c = 0$. If the agent chooses the commitment account, withdrawals are restricted to $w_l = 0$ and $0 \leq w_c \leq \frac{1}{1+p}$.

Withdrawals at $t = 1$ fund consumption $c_1 = w_l + w_c$. With probability $(1 - q)$, consumption c_1 delivers a utility flow of $u_1 = bc_1$. With probability q , consumption c_1 delivers a utility flow of $u_1 = gc_1$. This uncertainty is resolved after the agent chooses the liquid account or the commitment account but before the agent chooses $t = 1$ consumption. Balances remaining in an account at $t = 2$ are withdrawn without penalty to fund consumption c_2 . If the agent chooses the liquid account, we have $c_2 = (1 + r_l)(1 - w_l)$. If the agent chooses the commitment account, we have $c_2 = (1 + r_c)(1 - (1 + p)w_c)$. Consumption c_2 delivers a utility flow of $u_2 = c_2$.

Throughout our analysis, we assume

$$\begin{aligned} \beta(1 + r_l) &< b < (1 + r_l) < g \text{ and} \\ (1 - q)b + qg &< (1 + r_l). \end{aligned}$$

The first series of inequalities ensures that the model captures the interesting features of self-control problems. Having $b < (1 + r_l)$ implies that the agent, from the $t = 0$ perspective, prefers not to withdraw money from the liquid account when $u_1 = bc_1$. However, $\beta(1 + r_l) < b$ implies that from the $t = 1$ perspective, the agent prefers to withdraw money from the liquid account when $u_1 = bc_1$. This is the essence of time-inconsistent preferences, and b represents the marginal utility of $t = 1$ consumption when that consumption is “bad” from the $t = 0$ perspective. The inequality $(1 + r_l) < g$ captures the fact that there are states of the world, such as financial emergencies, in which $t = 1$ consumption is “good” from the $t = 0$ perspective. This feature sets up the fundamental tradeoff in the model: the commitment account may help the agent avoid “bad” $t = 1$ consumption, but it discourages “good” $t = 1$ consumption. Finally, the assumption that $(1 - q)b + qg < (1 + r_l)$ implies that $t = 1$ consumption is “bad” in an average sense. This assumption qualitatively accords with the design of our experiments, which feature a high liquid account interest rate of 22%.

Our experimental treatment conditions set the commitment account interest rate equal to or approximately equal to the liquid account interest rate. Therefore, to map the model onto our experiment, we fix the liquid account interest rate r_l and study cases where the commitment account interest rate r_c is in a neighborhood of r_l (i.e., cases where $r_l - \varepsilon < r_c < r_l + \varepsilon$ for ε positive but small). In our experiment, the commitment account early withdrawal penalty varies widely: early withdrawals in some conditions incur a 10% penalty, while early withdrawals in other conditions are disallowed (the equivalent of an infinitely large penalty). We therefore consider the full range of penalties p in our model.

We consider two types of agents: sophisticates and naifs (O'Donoghue and Rabin, 1999). Sophisticated agents correctly predict the nature of their future intertemporal discount functions. In the context of our model, a sophisticate understands at $t = 0$ that the $t = 1$ objective function is $u_1 + \beta\delta u_2$. Naïve agents, on the other hand, incorrectly predict that their future intertemporal discount functions will be consistent with their present ones. In the model, a naif falsely believes at $t = 0$ that the $t = 1$ objective function is $u_1 + \delta u_2$. Because we focus on the model's implications for commitment account allocations at $t = 0$, the second type of agent can equivalently be characterized as a time-consistent agent with $\beta = 1$. The two equivalent interpretations of the second type are conceptually distinct but difficult to disentangle in our setting, so we do not attempt to distinguish between them. For simplicity, the remainder of our discussion refers to the second type of agent as a naïve agent.

If the population contains both types of agents, the model can deliver comparative statics in line with our experimental results. We first analyze the case of the sophisticated agent.

PROPOSITION 1:

- (a) If $\beta(1+p)(1+r_c) < b$, the sophisticated agent chooses the liquid account.
- (b) If $b \leq \beta(1+p)(1+r_c) < g$, the sophisticated agent chooses the liquid account when $(1-q)(1+r_c) + q\frac{g}{1+p} < (1-q)b + qg$ and chooses the commitment account when $(1-q)(1+r_c) + q\frac{g}{1+p} \geq (1-q)b + qg$.
- (c) If $\beta(1+p)(1+r_c) \geq g$, the sophisticated agent chooses the commitment account.

PROOF: See Appendix.

Intuitively, if $\beta(1+p)(1+r_c) < b$, the sophisticated agent realizes that the commitment account is not a sufficiently strong commitment device to deter $t = 1$ consumption when $u_1 = bc_1$, so the agent chooses the liquid account in order to avoid early withdrawal penalties. If $\beta(1 +$

$p)(1 + r_c) \geq g$, the commitment account leads the agent not to make early withdrawals in either state of the world. Because early withdrawals are in expectation undesirable from the $t = 0$ perspective, the agent chooses the commitment account in that case. If $b \leq \beta(1 + p)(1 + r_c) < g$, the agent makes an early withdrawal when $u_l = gc_l$ and does not make an early withdrawal when $u_l = bc_l$. The agent then faces a tradeoff: from the $t = 0$ perspective, the commitment account is undesirable because it leads to a penalty when $u_l = gc_l$ but desirable because it deters $t = 1$ consumption when $u_l = bc_l$.

Comparative statics for the case of the sophisticated agent follow immediately from Proposition 1. As r_c increases, the left-hand side of $\beta(1 + p)(1 + r_c) < b$, the left-hand side of $(1 - q)(1 + r_c) + q\frac{g}{1+p} \geq (1 - q)b + qg$, and the left-hand side of $\beta(1 + p)(1 + r_c) \geq g$ all increase, and these changes tend to make the agent choose the commitment account. When p is small (specifically, when $\beta(1 + p)(1 + r_c) < b$), the agent chooses the liquid account. When p is large (specifically, when $\beta(1 + p)(1 + r_c) \geq g$), the agent chooses the commitment account. In the intermediate range, it is possible that the agent switches from the commitment account to the liquid account as p increases, but this non-monotonicity disappears if $(1 - q)b + qg < (1 - q)(1 + r_c) + q\beta(1 + r_c)$, a condition that will hold if q is sufficiently small.¹² Thus, for a range of parameter values, the sophisticated agent tends to choose the commitment account as p increases.

We now consider the naïve agent. Recall that we analyze cases in which r_c is in a small neighborhood of r_l .

PROPOSITION 2:

- (a) If $r_c \leq r_l$, the naïve agent chooses the liquid account.
- (b) If $r_c > r_l$, the naïve agent chooses the commitment account when $(1 + p)(1 + r_c) < g$ and $(1 - q)(1 + r_c) + q\frac{g}{1+p} > (1 - q)(1 + r_l) + qg$, and the agent chooses the liquid account when $(1 + p)(1 + r_c) \geq g$ or $(1 - q)(1 + r_c) + q\frac{g}{1+p} \leq (1 - q)(1 + r_l) + qg$.

PROOF: See Appendix.

Because naïveté implies an inability to anticipate the inconsistency between the $t = 0$ objective function and the $t = 1$ objective function, the naïve agent does not value the commitment account as a tool for influencing the $t = 1$ withdrawal decision. The commitment

¹² The non-monotonicity also disappears if $(1 - q)b + qg > (1 - q)(1 + r_c) + q\beta(1 + r_c)\frac{g}{b}$, but this condition is less intuitive.

account is only valued insofar as it offers a higher interest rate than the liquid account. Thus, the naïve agent does not allocate any money to the commitment account when $r_c \leq r_l$. When r_c is slightly larger than r_l , the agent weighs the benefit of the commitment account's higher interest rate against the cost of the early withdrawal penalty imposed by the commitment account.

Again, comparative statics follow from the proposition. When p is small, increasing r_c from being equal to r_l to being slightly greater than r_l leads the naïve agent to switch from the liquid account to the commitment account. However, when p is large, the agent uses the liquid account both when r_c is equal to r_l and when r_c is slightly larger than r_l . If $r_c \leq r_l$, the naïve agent's decision to use the liquid account does not change as p changes. On the other hand, an increase in p leads to an increase in the left-hand side of $(1 + p)(1 + r_c) < g$ and a decrease in the left-hand side of $(1 - q)(1 + r_c) + q\frac{g}{1+p} > (1 - q)(1 + r_l) + qg$. If $r_c > r_l$, both of these changes tend to make the agent choose the liquid account.

This model can generate several patterns that are observed in our experiments if the population contains both sophisticated and naïve agents. First, sophisticated agents may choose to allocate money to the commitment account even when its interest rate is lower than that of the liquid account, as is the case in the treatment condition with a 21% commitment account interest rate.

Second, when the two interest rates are similar, sophisticated agents and naïve agents both exhibit a stronger tendency to choose the commitment account when its interest rate increases to be slightly higher than the liquid account interest rate. Consistent with this feature of the model, we find in the first experiment that commitment account allocations are increasing in the account's interest rate.

Third, when the commitment account and the liquid account have the same interest rate, sophisticated agents are the only agents to allocate money to the commitment account, and their allocations generally increase as the penalty increases. Both the first experiment and the second experiment produced this pattern, and subjects in the second experiment who were offered both the 10% penalty commitment account and the no early withdrawal (infinitely large penalty) commitment account often preferred the no early withdrawal account. Furthermore, the fact that the second experiment's "safety valve" treatment condition led to commitment account allocations approximately equal to those in the 10% penalty condition can be explained in this

framework if the psychic cost of lying about a financial emergency is roughly equivalent to the cost of a 10% monetary penalty.

Fourth, when the commitment account has a slightly higher interest rate than the liquid account and the penalty is low, sophisticated agents' commitment account allocations generally increase as the penalty increases, while naïve agents' allocations decrease as the penalty increases. The average response in the population to penalty increases is ambiguous in sign. In line with this feature of the model, commitment account allocations in the first experiment were approximately the same across different penalty levels when the commitment account had a 23% interest rate.

B. Reason-Based Choice

The psychology of reason-based choice can provide another explanation for our experimental findings. An agent engaged in reason-based choice processes makes decisions by developing a narrative that justifies the selection of one option over its alternatives (Shafir, Simonson, and Tversky, 1993). Our experimental procedure provides subjects with a narrative that explains allocations to the liquid account as well as a narrative that explains allocations to the commitment account: the liquid account (labeled the "Freedom Account") provides flexible access to money, while the commitment account (labeled the "Goal Account") helps subjects achieve their financial goals by limiting their ability to make early withdrawals.

Since subjects have a coherent reason for choosing the commitment account that is unrelated to its interest rate, some subjects may allocate money to the commitment account even when its interest rate is lower than that of the liquid account, as is the case in the treatment condition with a 21% commitment account interest rate. Of course, interest rate differences can also serve as a powerful narrative for choosing one account over the other, so it is natural to expect commitment account allocations to increase in the commitment account interest rate, as we observe in the first experiment.

When the liquid account and the commitment account have the same interest rate, the justification for allocating money to the commitment account is its ability to help subjects achieve their goals. The commitment account becomes more helpful in this regard as its degree of illiquidity increases, leading subjects to increase commitment account allocations. However, when the commitment account has a higher interest rate than the liquid account, the interest rate difference can serve as the primary motivation for allocating money to the commitment account,

so subjects may be less responsive to the commitment account's degree of illiquidity. Our experiments provide evidence for both of these patterns.

The logic of reason-based choice provides a rich set of possibilities when subjects are offered both the 10% penalty commitment account and the no early withdrawal commitment account. If the 10% penalty account is perceived as dominated by the no early withdrawal account but not dominated by the liquid account, the “attraction effect” implies that the no early withdrawal account will look even more appealing and will receive even higher allocations than when only the liquid account and the no early withdrawal account are offered (Huber, Payne, and Puto, 1982). Alternatively, if the 10% penalty account is perceived as a “compromise” between the flexibility offered by the liquid account and the commitment offered by the no early withdrawal account, allocations to the 10% penalty account may be higher than in the case where only the liquid account and the 10% penalty account are available (Simonson, 1989). It is also possible that subjects perceive the 10% penalty account and the no early withdrawal account as options that are difficult to differentiate, making the distinct liquid account more attractive (Redelmeier and Shafir, 1995).¹³ This last possibility seems most in line with the experimental results. Total commitment account allocations are slightly lower when subjects are offered both the 10% penalty account and the no early withdrawal account than when subjects are offered only the no early withdrawal account, although the difference is not statistically significant. Among subjects who are offered both commitment accounts, there is a strong preference for the no early withdrawal account, perhaps because of the previously explained reason that the no early withdrawal account is associated with a more compelling narrative of achieving financial goals.

In the reason-based choice framework, there are also several possible interpretations of the “safety valve” commitment account, which received allocations of approximately the same magnitude as commitment account allocations among subjects who were offered the liquid account and the 10% penalty account. Like the 10% penalty account, the “safety valve” account may be perceived as not offering sufficiently rigid commitment when it comes to helping subjects achieve their financial goals. It is also possible that the narrative justifying the use of the “safety valve” account involves an elevated likelihood of financial emergencies. Subjects

¹³ Relatedly, subjects may experience “choice overload,” a sense of being overwhelmed with the set of options that leads individuals to select a status quo option like the liquid account (Iyengar and Lepper, 2000).

may not find this narrative compelling because they do not view themselves as highly susceptible to such emergencies.

IV. Conclusion

This paper studies the circumstances under which individuals value illiquid forms of wealth as commitment devices that help them avoid spending money that they had planned to save. We experimentally examine the features of commitment accounts that make them attractive by offering subjects the ability to allocate an endowment between a liquid account and one or more commitment accounts, which place restrictions on early withdrawals. We find that subjects allocate meaningful fractions of their endowments to commitment accounts. This is true even when the commitment account offers a lower interest rate than the liquid account, and it holds more strongly as the commitment account interest rate increases. When the commitment account and the liquid account have the same interest rate, commitment account allocations are increasing in the account's degree of illiquidity, but the pattern disappears when the commitment account has a higher interest rate than the liquid account. These results are consistent both with a model featuring sophisticated and naïve time-inconsistent agents and with explanations grounded in the psychology of reason-based choice.

Our findings have interesting implications for the design of the institutional environment in which households make financial decisions. For example, time-deposit financial products such as certificates of deposit generally impose early withdrawal penalties equal to the amount of interest earned over the previous few months. Our results suggest that there may be a role for deposit products with larger penalties on early withdrawals. For another example, many defined contribution retirement savings plans impose some degree of illiquidity on individuals' account balances – in the case of 401(k) plans, withdrawals before the age of 59½ generate a 10% tax penalty.¹⁴ One study found that 46% of workers who have 401(k) accounts and who leave their jobs receive their 401(k) balances as lump-sum withdrawals (Hewitt Associates, 2009), and retirement savings plan managers worry that this “leakage” can reduce retirement wealth (Steyer, 2011). Accounts with a greater degree of illiquidity would directly limit “leakage.” At the same time, our experimental results suggest that such accounts could be more attractive to individuals.

¹⁴ Often, it is also possible to access 401(k) account balances by taking a loan or (in more extreme circumstances) by taking a hardship withdrawal.

Future research should test whether the results from our experiments generalize to field settings such as the market for time-deposit products and the domain of retirement savings plans.

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Table 1. Subject Characteristics

This table summarizes subjects' demographic characteristics in the first experiment ($n = 495$) and the second experiment ($n = 550$).

	First	Second		First	Second
Percent male	43%	43%	Marital status		
			Married	68%	66%
Age			Separated/divorced	11%	14%
≤ 25	8%	8%	Widowed	5%	5%
26-35	17%	19%	Never married	16%	15%
36-45	21%	18%	Job status (has overlap)		
46-55	22%	22%	Working now	63%	60%
55-65	16%	15%	Unemployed	8%	9%
≥ 66	16%	17%	Temporary layoff	1%	1%
Education			Disabled	4%	6%
No high school diploma	3%	5%	Retired	19%	19%
High school graduate	32%	29%	Homemaker	10%	11%
Some college	20%	23%	Race		
Associate's degree	7%	12%	White/Caucasian	80%	81%
Bachelor's degree	24%	19%	Black/African American	8%	10%
Graduate degree	13%	12%	American Indian or Alaskan Native	1%	1%
Annual household income			Asian or Pacific Islander	4%	2%
< \$15,000	6%	9%	Size of household		
\$15,000 - \$34,999	19%	20%	0	48%	40%
\$35,000 - \$49,999	16%	16%	1	19%	20%
\$50,000 - \$74,999	27%	22%	2	15%	21%
\$75,000 - \$99,999	15%	16%	≥ 3	15%	19%
≥ \$100,000	17%	17%			

Table 2. Sample Size in Each Treatment Condition: Experiment 1

This table reports the number of subjects who were assigned to each treatment condition in Experiment 1 (2/01/2010-2/13/2011).

Withdrawal restrictions on commitment account prior to commitment date	Commitment account interest rate		
	21%	22%	23%
10% early withdrawal penalty	72	66	78
20% early withdrawal penalty	0	79	68
No early withdrawals	0	64	68

Table 3. Fraction of Endowment Allocated to Commitment Account: Experiment 1

For each treatment condition, this table reports the mean fraction of endowment allocated to a commitment account. There are three observations for every subject, one observation for each possible endowment amount. Standard errors clustered at the subject level are in parentheses. The table also gives t-statistics from tests of the equality of means as indicated. Panel A reports unadjusted means, and Panel B reports regression-adjusted means (see text).

Panel A: Unadjusted means					
Withdrawal restrictions on commitment account prior to commitment date	Commitment interest rate			Test of equality of means	
	21%	22%	23%	21% vs. 22%	22% vs. 23%
10% early withdrawal penalty	0.276 (0.028)	0.389 (0.034)	0.582 (0.034)	-2.576	-4.014
20% early withdrawal penalty	--	0.448 (0.034)	0.611 (0.034)	--	-3.418
No early withdrawals	--	0.560 (0.041)	0.599 (0.036)	--	-0.727
Test of equality of means					
10% penalty vs. 20% penalty	--	-1.231	-0.615		
10% penalty vs. no early w/d	--	-3.207	-0.360		
20% penalty vs. no early w/d	--	-2.123	0.242		
Panel B: Regression-adjusted means					
Withdrawal restrictions on commitment account prior to commitment date	Commitment interest rate			Test of equality of coeff.	
	21%	22%	23%	21% vs. 22%	22% vs. 23%
10% early withdrawal penalty	0.274 (0.028)	0.388 (0.034)	0.575 (0.032)	-2.54	-3.93
20% early withdrawal penalty	--	0.441 (0.033)	0.620 (0.035)	--	-3.73
No early withdrawals	--	0.570 (0.040)	0.600 (0.035)	--	-0.57
Test of equality of coefficients					
10% penalty vs. 20% penalty	--	-1.11	-0.94		
10% penalty vs. no early w/d	--	-3.44	-0.54		
20% penalty vs. no early w/d	--	-2.48	0.39		

Table 4. Dollar-Weighted Days to Commitment Date: Experiment 1

For each treatment condition, this table reports the mean dollar-weighted days to commitment date. Dollar-weighted days to commitment date is defined as the fraction of endowment allocated to a commitment account multiplied by the number of days separating the allocation decision and the commitment date. There are three observations for every subject, one observation for each possible endowment amount. Standard errors clustered at the subject level are in parentheses. The table also gives t-statistics from tests of the equality of means as indicated. Panel A reports unadjusted means, and Panel B reports regression-adjusted means (see text).

Panel A: Unadjusted means					
Withdrawal restrictions on commitment account prior to commitment date	Commitment interest rate			Test of equality of means	
	21%	22%	23%	21% vs. 22%	22% vs. 23%
10% early withdrawal penalty	64.3 (7.3)	81.8 (9.1)	129.6 (10.6)	-1.498	-3.433
20% early withdrawal penalty	--	100.5 (10.9)	127.0 (12.3)	--	-1.616
No early withdrawals	--	131.8 (13.9)	117.9 (11.2)	--	0.781
Test of equality of means					
10% penalty vs. 20% penalty	--	-1.323	0.161		
10% penalty vs. no early w/d	--	-3.012	0.763		
20% penalty vs. no early w/d	--	-1.777	0.549		
Panel B: Regression-adjusted means					
Withdrawal restrictions on commitment account prior to commitment date	Commitment interest rate			Test of equality of coeff.	
	21%	22%	23%	21% vs. 22%	22% vs. 23%
10% early withdrawal penalty	65.6 (7.6)	79.9 (8.9)	125.8 (10.3)	-1.23	-3.34
20% early withdrawal penalty	--	98.7 (10.7)	128.0 (12.0)	--	-1.82
No early withdrawals	--	134.8 (13.7)	120.8 (11.2)	--	0.79
Test of equality of coefficients					
10% penalty vs. 20% penalty	--	-1.36	-0.14		
10% penalty vs. no early w/d	--	-3.31	0.33		
20% penalty vs. no early w/d	--	-2.07	0.44		

Table 5. Sample Size in Each Treatment Condition: Experiment 2

This table reports the number of subjects who were assigned to each treatment condition in Experiment 2 (2/14/2011-9/01/2011). All accounts in Experiment 2 had a 22% interest rate.

Withdrawal restrictions on commitment account prior to commitment date	Endowment allocated	
	According to subject's choice	All in liquid account
Safety valve (withdrawals only in financial emergencies)	85	65
10% early withdrawal penalty	54	46
No early withdrawals	60	90
Two commitment accounts: 10% early withdrawal penalty and no early withdrawals	70	80

Table 6. Fraction of Endowment Allocated to Commitment Account: Experiment 2

For each treatment condition, this table reports the mean fraction of endowment allocated to a commitment account. For the condition offering two commitment accounts, mean fractional allocations are also reported for each individual commitment account. Standard errors robust to heteroskedasticity are in parentheses. The table also gives t-statistics from tests of the equality of means as indicated. Panel A reports unadjusted means, and Panel B reports regression-adjusted means (see text). All accounts in Experiment 2 had a 22% interest rate.

Panel A: Unadjusted means		
Withdrawal restrictions on commitment account prior to commitment date		Test of equality of means, vs. no early withdrawals
Safety valve (withdrawals only in financial emergencies)	0.453 (0.027)	-2.379
10% early withdrawal penalty	0.458 (0.029)	-2.131
No early withdrawals	0.537 (0.023)	
Two commitment accounts: 10% early withdrawal penalty and no early withdrawals	0.501 (0.027)	-1.016
10% early withdrawal penalty	0.162 (0.014)	-6.105
No early withdrawals	0.339 (0.024)	
Panel B: Regression-adjusted means		
Withdrawal restrictions on commitment account prior to commitment date		Test of equality of coeff., vs. no early withdrawals
Safety valve (withdrawals only in financial emergencies)	0.473 (0.026)	-1.75
10% early withdrawal penalty	0.445 (0.030)	-2.37
No early withdrawals	0.534 (0.023)	
Two commitment accounts: 10% early withdrawal penalty and no early withdrawals	0.493 (0.027)	-1.16

Table 7. Dollar-Weighted Days to Commitment Date: Experiment 2

For each treatment condition, this table reports the mean dollar-weighted days to commitment date. When one commitment account is offered, dollar-weighted days to commitment date is defined as the fraction of endowment allocated to a commitment account multiplied by the number of days separating the allocation decision and the commitment date. When two commitment accounts are offered, dollar-weighted days to commitment date is obtained by calculating this product for each account and taking the sum. Standard errors robust to heteroskedasticity are in parentheses. The table also gives t-statistics from tests of the equality of means as indicated. Panel A reports unadjusted means, and Panel B reports regression-adjusted means (see text). All accounts in Experiment 2 had a 22% interest rate.

Panel A: Unadjusted means		
Withdrawal restrictions on commitment account prior to commitment date		Test of equality of means, vs. no early withdrawals
Safety valve (withdrawals only in financial emergencies)	62.0 (4.6)	-2.007
10% early withdrawal penalty	64.4 (5.5)	-1.493
No early withdrawals	74.8 (4.4)	
Two commitment accounts: 10% early withdrawal penalty and no early withdrawals	71.3 (4.8)	-0.543

Panel B: Regression-adjusted means		
Withdrawal restrictions on commitment account prior to commitment date		Test of equality of coeff., vs. no early withdrawals
Safety valve (withdrawals only in financial emergencies)	64.0 (4.7)	-1.64
10% early withdrawal penalty	63.1 (5.5)	-1.65
No early withdrawals	74.7 (4.3)	
Two commitment accounts: 10% early withdrawal penalty and no early withdrawals	70.3 (4.8)	-0.68

Figure 1. Description of the Liquid Account

The **Freedom Account** is designed to let you access your money whenever you want. You can withdraw money from this account any time over the next year, starting one week from today.

Money in the Freedom Account will grow at an interest rate of 22% per year until you withdraw it. When you withdraw money from the Freedom Account, you don't have to withdraw all of it. Whatever you leave in the account will continue to earn 22% interest until the end of the experiment, one year from today.



Figure 2. Description of the 22% Interest Rate, 10% Early Withdrawal Penalty Commitment Account

The **Goal Account** is designed to help you save. You can withdraw money from this account without penalty any time after a goal date that you pick. Setting a goal for yourself and picking the right goal date can help you avoid the temptation to spend your money too soon.

Money in the Goal Account will grow at an interest rate of 22% per year, both before and after the goal date, until you withdraw it. When you withdraw money from the Goal Account, you don't have to withdraw all of it. Whatever you leave in the account will continue to earn 22% interest until the end of the experiment, one year from today.

As explained earlier, if you withdraw money from the Goal Account before your goal date, you will incur a penalty equal to 10% of the amount you withdraw.

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To use the Goal Account, you will need to pick a goal date. You might want to pick a date based on something you want to save money for, like a birthday gift, holiday presents, vacation, or any other special purchase that you plan to make. You can also use the Goal Account as a way to help you save, even if you don't have a special purchase in mind.

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Figure 3. Example Allocation Page

Suppose you receive \$50. How would you like to divide it between the two accounts?

Freedom Account	Goal Account
<ul style="list-style-type: none">• No goal date• Withdraw money any time you want to, starting one week from today• 22% interest per year	<ul style="list-style-type: none">• You pick the goal date, no earlier than one week from today• If you choose to withdraw money before the goal date you will incur a penalty of 10%• 22% interest per year
\$ <input type="text"/> .00	\$ <input type="text"/> .00

Remember, if you receive \$50, it will be divided between the accounts based on this decision.

If you have decided to put some money into the Goal Account, please choose a goal date below.

Would you like to share your goal with us (eg: birthday gift, holiday presents, vacation, general saving)? If yes, enter it here:

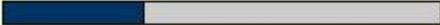




Figure 4. Sample Weekly Email to Subject

Dear Subject,

This is a breakdown of your current balances:

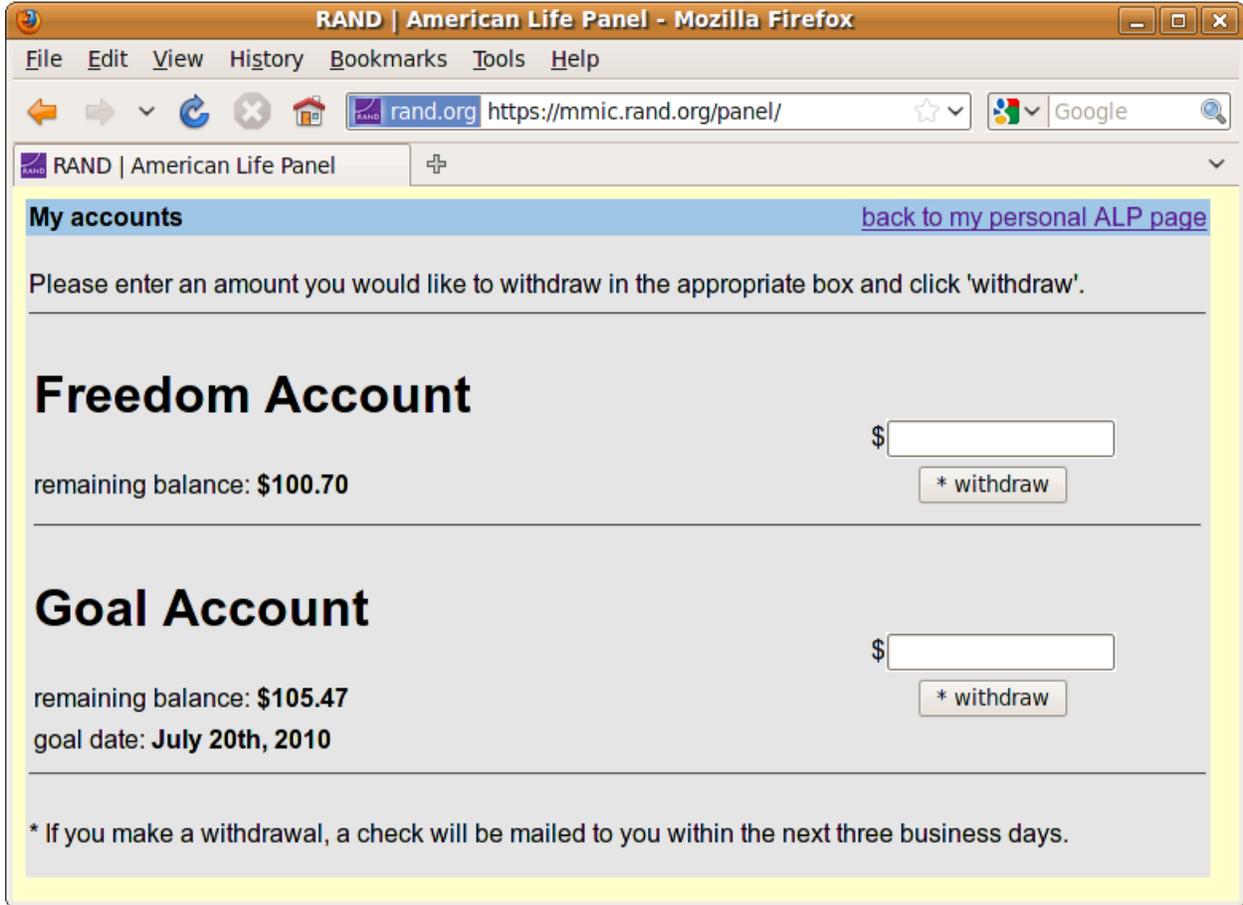
Freedom Account: \$24.25
Goal Account: \$53.18
Goal Date: July 20th, 2010

If you wish to withdraw any money from your accounts, please go to your panel pages and click on the "Savings Game" button: <https://mmic.rand.org/panel>

If you have any questions about this game or your accounts, please feel free to contact us at webhelp@rand.org or [866.591.2909](tel:866.591.2909)

Thanks!
www.rand.org/alp

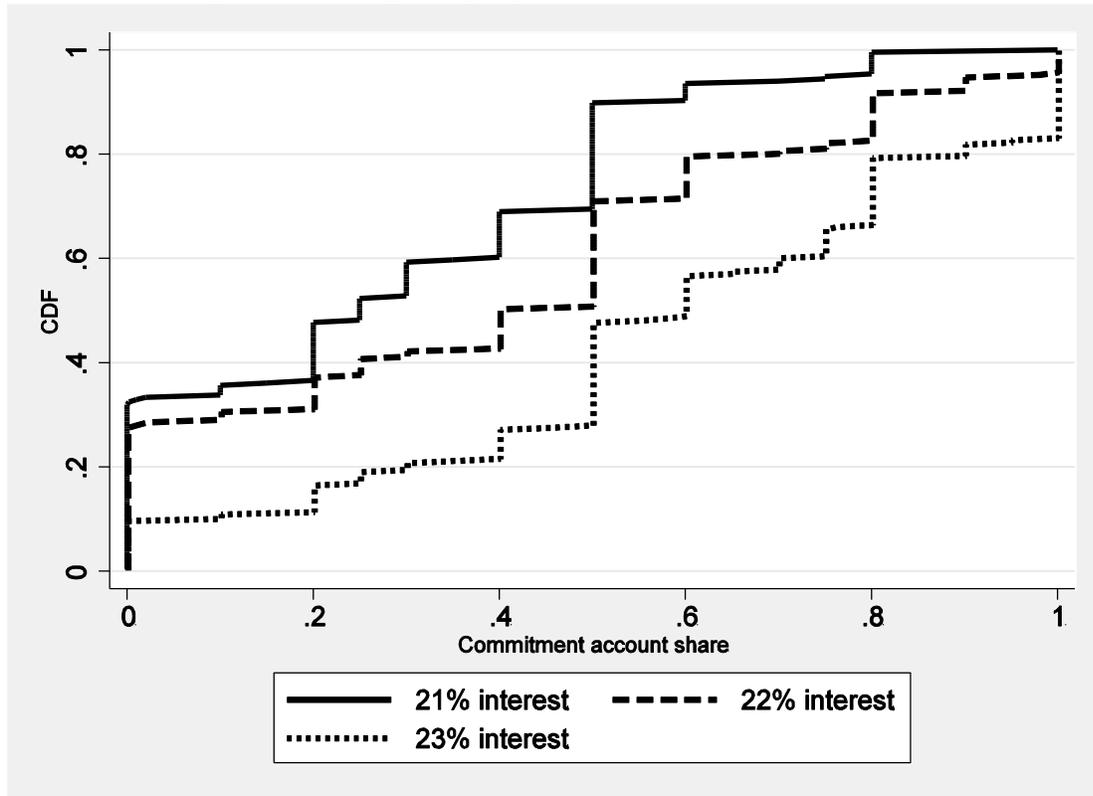
Figure 5. Withdrawal Interface



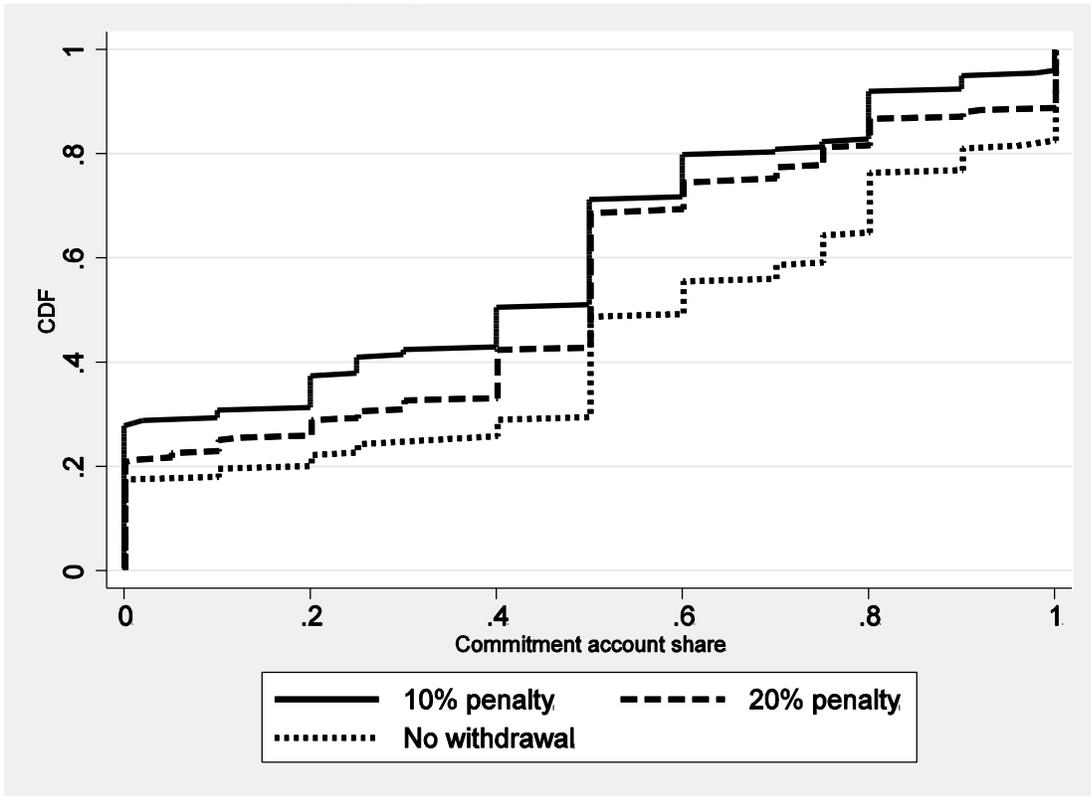
**Figure 6. Distributions of Fraction of Endowment Allocated to Commitment Account:
Experiment 1**

These figures show cumulative distribution functions, by treatment condition, of fraction of endowment allocated to a commitment account. There are three observations for every subject, one observation for each possible endowment amount.

A. 10% early withdrawal penalty, by interest rate



B. 22% interest rate, by early withdrawal restriction



C. 23% interest rate, by early withdrawal restriction

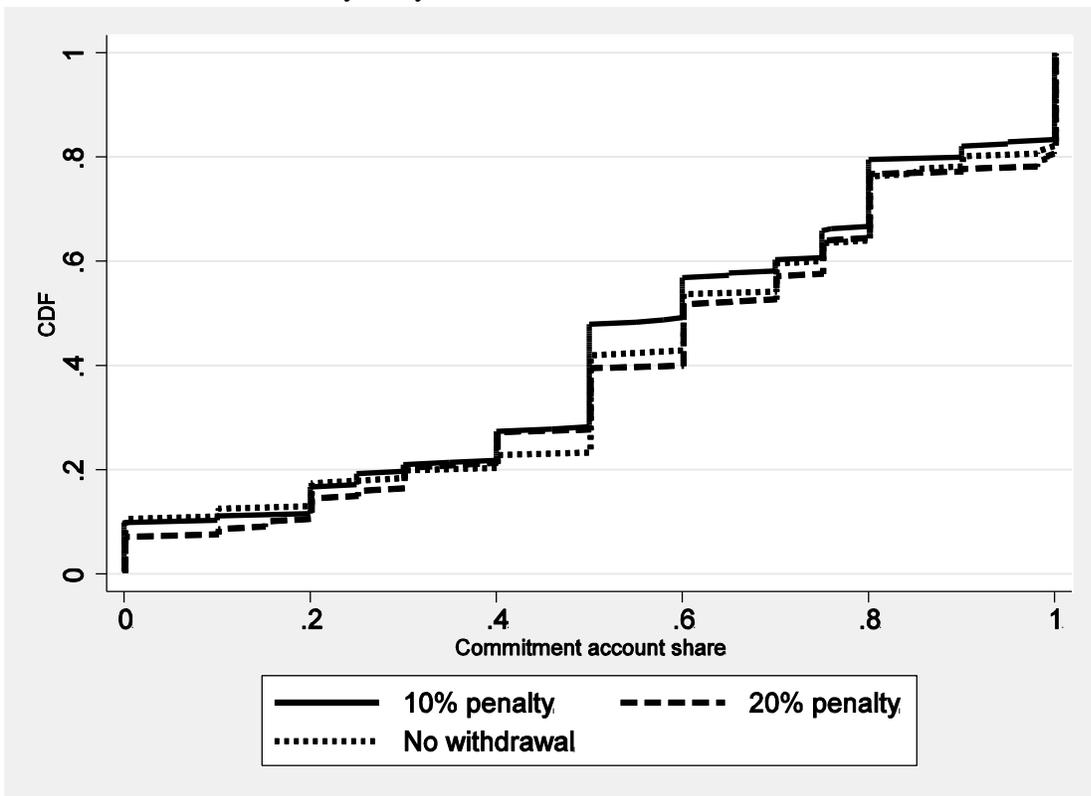


Figure 7. Withdrawal Patterns: Experiment 1

For each treatment condition, these figures show withdrawal patterns over the course of the experiment. For each subject and for each day, we calculate the sum of the liquid account and commitment account balances that the subject would have had if no withdrawals had been requested. This hypothetical total balance takes as given the subject's initial allocation between the liquid account and the commitment account, and it uses the allocation decision that applies to the ex post realization of the endowment amount (\$50, \$100, or \$500). We then calculate the ratio of the subject's actual balance to the hypothetical total balance, and we plot the mean of this ratio against the number of days since the initial allocation decision.

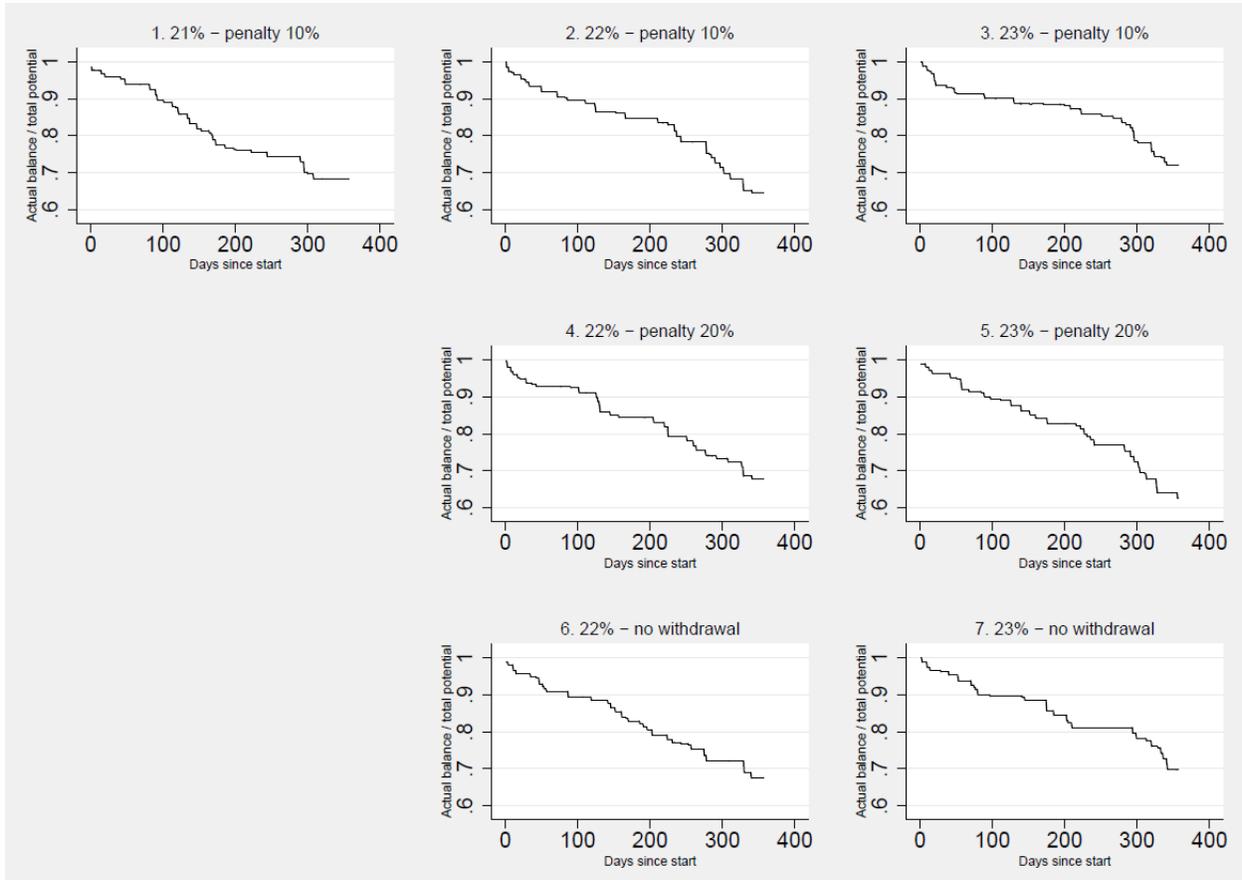


Figure 8. Description of Two Commitment Accounts Offered Simultaneously

The **Goal Accounts** are designed to help you save. You can withdraw money from these accounts any time **on or after** goal dates that you pick. Setting goals for yourself and picking the right goal dates can help you avoid the temptation to spend your money too soon.

There are two types of Goal Accounts:

- Goal Account A (10% Penalty) allows you to withdraw your money **before** its goal date, but you will be charged a 10% penalty on early withdrawals. For example, if you withdraw \$10 before your goal date, your account balance will be reduced by \$11.
- Goal Account B (No Withdrawal) does **not** allow withdrawals **before** its goal date.

If you choose to use both Goal Accounts, you can pick a different goal date for each Goal Account, or you can pick the same goal date.

Money in both Goal Accounts will grow at an interest rate of 22% per year, both before and after the goal date, until you withdraw it. When you withdraw money from a Goal Account, you don't have to withdraw all of it. Whatever you leave in the accounts will continue to earn 22% interest until the end of the experiment on September 1, 2011.

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Figure 9. Description of the Safety Valve Commitment Account

The **Goal Account** is designed to help you save. You can withdraw money from this account any time **on or after** a goal date that you pick. Setting a goal for yourself and picking the right goal date can help you avoid the temptation to spend your money too soon.

You cannot withdraw from this account **before** the goal date, except in the case of a financial emergency. If you have a financial emergency, you can make an early withdrawal. We are relying on you to be honest in judging whether you have a financial emergency.

Money in the Goal Account will grow at an interest rate of 22% per year, both before and after the goal date, until you withdraw it. When you withdraw money from the Goal Account, you don't have to withdraw all of it. Whatever you leave in the account will continue to earn 22% interest until the end of the experiment on September 1, 2011.

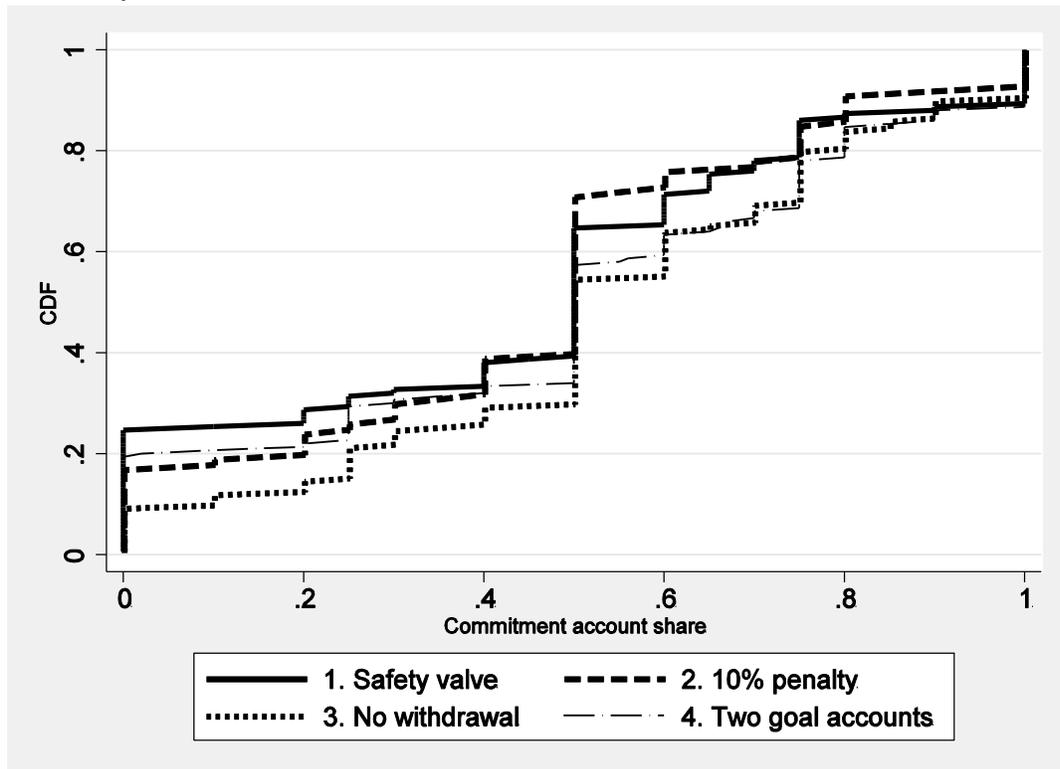
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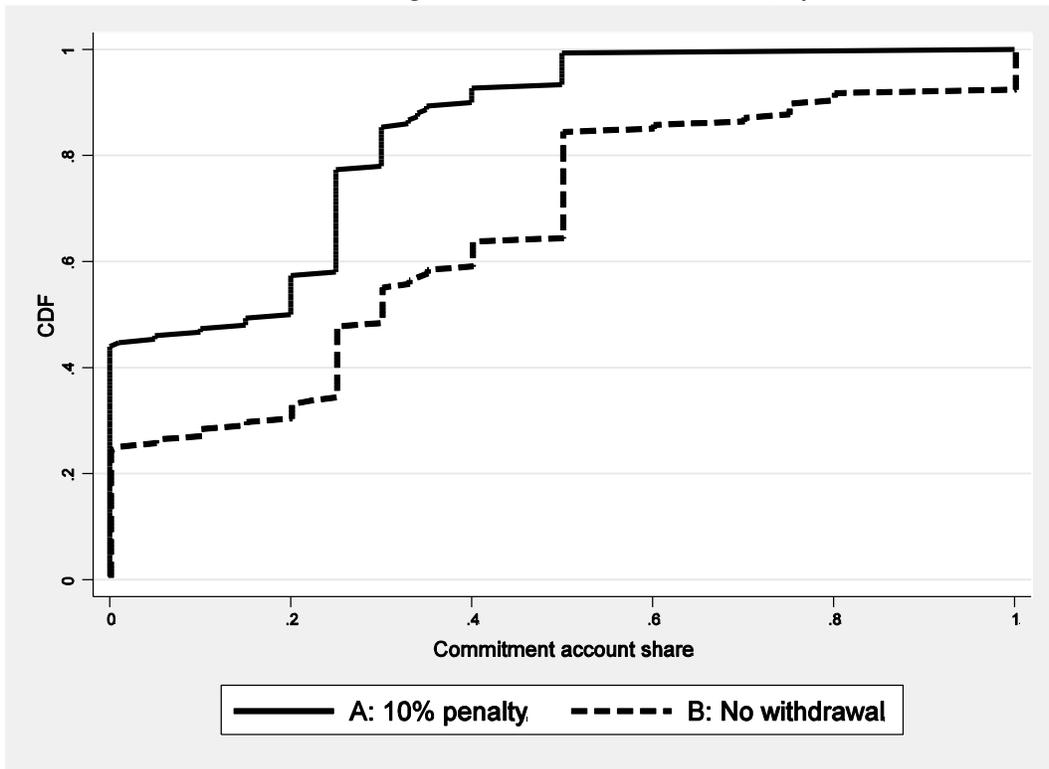
**Figure 10. Distributions of Fraction of Endowment Allocated to Commitment Account:
Experiment 2**

These figures show cumulative distribution functions of fraction of endowment allocated to a commitment account.

A. By treatment condition



B. Within condition offering two commitment accounts, by commitment account type



Appendix A. Regression Analysis of Fraction of Endowment Allocated to Commitment Account and Dollar-Weighted Days to Commitment Date: Experiment 1

This table reports coefficients and t-statistics from ordinary least-squares regressions where the outcome variable is fraction of endowment allocated to a commitment account or dollar-weighted days to commitment date. Dollar-weighted days to commitment date is defined as the fraction of endowment allocated to a commitment account multiplied by the number of days separating the allocation decision and the commitment date. There are three observations for every subject, one observation for each possible endowment amount. Standard errors are clustered at the subject level. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

	Fraction of endowment allocated to commitment				Dollar-weighted days to commitment date			
	Coeff.	t	Coeff.	t	Coeff.	t	Coeff.	t
20% penalty	0.059	(1.233)	0.053	(1.108)	18.708	(1.325)	18.788	(1.360)
No withdrawal	0.171**	(3.213)	0.182***	(3.442)	50.017**	(3.018)	54.858***	(3.312)
21% interest	-0.113*	(-2.580)	-0.114*	(-2.539)	-17.415	(-1.501)	-14.276	(-1.231)
23% interest	0.193***	(4.021)	0.187***	(3.931)	47.815***	(3.438)	45.886***	(3.340)
23% X 20%	-0.029	(-0.435)	-0.008	(-0.120)	-21.317	(-0.992)	-16.600	(-0.785)
23% X no w/d	-0.154*	(-2.125)	-0.156*	(-2.200)	-61.743**	(-2.734)	-59.862**	(-2.685)
\$100			0.013	(1.665)			4.597*	(2.543)
\$500			0.044***	(4.119)			18.670***	(6.289)
Male			0.008	(0.283)			-3.558	(-0.420)
Age 26-35			-0.136*	(-2.400)			-17.471	(-1.022)
Age 36-45			-0.075	(-1.352)			-5.097	(-0.291)
Age 46-55			-0.116*	(-2.022)			-6.640	(-0.353)
Age 56-65			-0.155*	(-2.452)			-4.634	(-0.229)
Age > 65			-0.131*	(-2.138)			-18.947	(-0.920)
Some college			-0.010	(-0.268)			-7.878	(-0.640)
Assoc or BA			-0.067	(-1.898)			-18.274	(-1.621)
Higher degree			-0.069	(-1.445)			-12.562	(-0.835)
Inc 15-35k			0.098	(1.794)			60.215***	(3.733)
Inc 35-50k			0.118*	(2.030)			48.562**	(2.823)
Inc 50-75k			0.107	(1.882)			55.365**	(3.268)
Inc 75-100k			0.125	(1.964)			43.453*	(2.201)
Inc > 100k			0.075	(1.090)			42.392*	(2.012)
Married			0.027	(0.905)			10.853	(1.159)
Working now			-0.003	(-0.091)			1.047	(0.102)
White			-0.047	(-1.427)			-6.695	(-0.675)
0 hhold mem			0.068	(1.685)			24.915*	(2.086)
1 hhold mem			0.052	(1.239)			9.896	(0.806)
2 hhold mem			-0.018	(-0.371)			-1.944	(-0.140)
Constant	0.389***	(11.371)	0.390***	(5.199)	81.761***	(9.012)	27.645	(1.202)
Observations		1485		1485		1485		1485

Appendix B. Proofs

PROPOSITION 1:

- (a) If $\beta(1+p)(1+r_c) < b$, the sophisticated agent chooses the liquid account.
- (b) If $b \leq \beta(1+p)(1+r_c) < g$, the sophisticated agent chooses the liquid account when $(1-q)(1+r_c) + q\frac{g}{1+p} < (1-q)b + qg$ and chooses the commitment account when $(1-q)(1+r_c) + q\frac{g}{1+p} \geq (1-q)b + qg$.
- (c) If $\beta(1+p)(1+r_c) \geq g$, the sophisticated agent chooses the commitment account.

PROOF: The sophisticated agent correctly anticipates that choosing the liquid account will lead to full withdrawals from the account in both states of the world. Therefore, choosing the liquid account generates expected utility from the $t = 0$ perspective of $\beta(1-q)b + \beta qg$.

- (a) When $\beta(1+p)(1+r_c) < b$, the agent anticipates that choosing the commitment account will lead to full withdrawals in both states of the world. These withdrawals incur penalties, so expected utility from the $t = 0$ perspective is $\beta(1-q)\frac{b}{1+p} + \beta q\frac{g}{1+p}$, which is strictly less than $\beta(1-q)b + \beta qg$.
- (b) If $b \leq \beta(1+p)(1+r_c) < g$, the agent anticipates that choosing the commitment account will lead to a withdrawal when $u_l = gc_l$ and will not lead to a withdrawal when $u_l = bc_l$. Expected utility from the $t = 0$ perspective is $\beta(1-q)(1+r_c) + \beta q\frac{g}{1+p}$, and the agent chooses the commitment account or the liquid account by comparing expected utility with $\beta(1-q)b + \beta qg$.
- (c) When $\beta(1+p)(1+r_c) \geq g$, the agent anticipates that choosing the commitment account will not lead to withdrawals in either state of the world. Expected utility from the $t = 0$ perspective is $\beta(1-q)(1+r_c) + \beta q(1+r_c) = \beta(1+r_c)$, which is strictly greater than $\beta(1-q)b + \beta qg$ because of the assumption that $(1-q)b + qg < (1+r_l)$ and the fact that r_c is in a small neighborhood of r_l .

PROPOSITION 2:

- (a) If $r_c \leq r_l$, the naïve agent chooses the liquid account.
- (b) If $r_c > r_l$, the naïve agent chooses the commitment account when $(1+p)(1+r_c) < g$ and $(1-q)(1+r_c) + q\frac{g}{1+p} > (1-q)(1+r_l) + qg$, and the agent chooses the liquid account when $(1+p)(1+r_c) \geq g$ or $(1-q)(1+r_c) + q\frac{g}{1+p} \leq (1-q)(1+r_l) + qg$.

PROOF: The naïve agent incorrectly believes at $t = 0$ that choosing the liquid account will lead to a withdrawal when $u_l = gc_l$ and will not lead to a withdrawal when $u_l = bc_l$. Thus, choosing the liquid account generates expected utility from the $t = 0$ perspective of $\beta(1-q)(1+r_l) + \beta qg$.

- (a) Assume that $r_c \leq r_l$.

When $(1+p)(1+r_c) < b$, the agent believes at $t = 0$ that choosing the commitment account will lead to withdrawals in both states of the world. These withdrawals incur penalties, so expected utility from the $t = 0$ perspective is $\beta(1-q)\frac{b}{1+p} + \beta q\frac{g}{1+p}$, which is strictly less than $\beta(1-q)(1+r_l) + \beta qg$.

If $b \leq (1+p)(1+r_c) < g$, the agent believes at $t = 0$ that choosing the commitment account will lead to a withdrawal when $u_l = gc_l$ and will not lead to a withdrawal when $u_l = bc_l$. Expected utility from the $t = 0$ perspective is $\beta(1-q)(1+r_c) + \beta q\frac{g}{1+p}$, which is strictly less than $\beta(1-q)(1+r_l) + \beta qg$.

When $(1 + p)(1 + r_c) \geq g$, the agent believes at $t = 0$ that choosing the commitment account will not lead to withdrawals in either state of the world. Expected utility from the $t = 0$ perspective is $\beta(1 - q)(1 + r_c) + \beta q(1 + r_c) = \beta(1 + r_c)$, which is strictly less than $\beta(1 - q)(1 + r_l) + \beta qg$.

Therefore, the agent chooses the liquid account.

- (b) Assume that $r_c > r_l$. Note that $b < (1 + p)(1 + r_c)$, so the agent believes at $t = 0$ that choosing the commitment account will not lead to a withdrawal when $u_l = bc_l$.

When $(1 + p)(1 + r_c) < g$, the agent believes at $t = 0$ that choosing the commitment account will lead to a withdrawal when $u_l = gc_l$. Expected utility from the $t = 0$ perspective is $\beta(1 - q)(1 + r_c) + \beta q \frac{g}{1+p}$, and the agent chooses the commitment account

or the liquid account by comparing expected utility with $\beta(1 - q)(1 + r_l) + \beta qg$.

When $(1 + p)(1 + r_c) \geq g$, the agent believes at $t = 0$ that choosing the commitment account will not lead to a withdrawal when $u_l = gc_l$. Expected utility from the $t = 0$ perspective is $\beta(1 - q)(1 + r_c) + \beta q(1 + r_c) = \beta(1 + r_c)$, which is strictly less than $\beta(1 - q)(1 + r_l) + \beta qg$ because r_c is in a small neighborhood of r_l .