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Can Intertemporal Choice Experiments Elicit Time Preferences for Consumption? Yes

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by

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ABSTRACT.

The most popular experimental method for eliciting time preferences involves subjects making choices over smaller, sooner amounts of money and larger, later amounts of money. Under some theoretically possible configurations of preferences and procedures, the discount rates inferred from these choices could lead to misleading inferences about time preferences for consumption. Using a direct empirical test, we show that those configurations of preferences are empirically implausible.

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A long series of intertemporal choice experiments have asked subjects to make decisions over time-dated amounts of money. From these observed choices inferences about discount rates have been drawn. Strictly speaking, these are discount rates over stocks of money. So the inferences are about money discount rates: see Frederick, Lowenstein and Prelec [2002] for a review, and Coller and Williams [1999] and Harrison, Lau and Williams [2002] for detailed examples. To economists, it is more natural to think of discount rates defined over utility, and then one has to attend to the possibility of diminishing marginal utility in order to make correct inferences about utility discount rates: see Andersen, Harrison, Lau and Rutström [2008]. But once one thinks of utility discount rates, it becomes more natural, for many economists, to think in terms of the utility of consumption flows, rather than stocks of money. In that case, Cubitt and Read [2007] correctly show that, even if one assumes linear utility functions for simplicity of exposition, discount rates over money do not necessarily elicit discount rates over consumption.

There are several immediate rhetorical responses to this conclusion, none of which are convincing to all. After reviewing these, we propose a direct, constructive test of the question, and then provide evidence.

The first rhetorical response is to note that economists tend to think of utility functions the way geese think of their parents: they imprint on their first vision. If the first utility function you saw had consumption as the argument, that is what you view as "the" utility function; if it had wealth, money, or just a solitary x, then that is "the" utility function. The reality is that utility functions are just a convenient mathematical receptacle for whatever we want them to be about, and one can find serious economics done with any of these arguments. But this does not justify ignoring the implications for consumption as an argument, it just puts those arguments in perspective as one of several in which economists are interested.

The second rhetorical response is to recognize that one can make structural assumptions about the link between time-dated money and consumption flows, and hence "translate" inferences about the former into inferences about the latter. This is what Andersen, Harrison, Lau and Rutström [2008] did, with a "dual-self" model of decision-making following Fudenberg and Levine [2006]. But this approach does not *test* the proposition in question. Instead it makes assumptions, whether or not they are *a priori* plausible, that are hard to easily test, and that allow one to infer discount rates over consumption flows if true.

The third rhetorical response is to ask if the "worst case" preferences that generate differences between money discount rates and consumption discount rates are plausible. As illustrated below, this worst case requires that the elasticity of substitution between consumption flows in two periods be sufficiently low. Assumptions about this elasticity allow one to bound the possible difference between the two discount rates, and those bounds can become very tight for plausible elasticities. But this type of argument cannot be complete: economists love theoretical exceptions that cannot be directly ruled out *a priori*.

Our approach is to ask if this "worst case" behavior is indeed observed, when one modifies the basic experimental design to allow it to show itself. A simple modification of the canonical experimental task, channeling a constructive suggestion by Cubitt and Read [2007] themself, shows that one "almost never" observes the preferences that generate the problems they pose. Of course, this conclusion, while comforting, is only for the sample of subjects from one population. But it shifts the burden of proof to those who would claim that intertemporal choice experiments defined over time-dated money cannot elicit time preferences for consumption.

1. Theory

We briefly restate the useful theoretical construction of Cubitt and Read [2007], to see the problem and our resolution. Let the pre-task endowment be e1 in period 1 and e2 in period 2. Option S offers the income stream (e1+*s*, e2) and option L offers the income stream (e1, e2+*l*). When will these income streams be the consumption streams? Call SC the consumption stream from S, and LC the consumption stream from L.

Consider the interesting case in which the subject faces imperfect capital markets, and hence faces the opportunity set in the lab marked by the bold lines in Figure 1, from Cubitt and Read [2007; Figure 2]. In their notation, borrowing and lending rates, r_b and r_l respectively, bound the lending rates available in the experimental lab, r_e. Points SC and LC can be immediately realized if the subject picks S or L and consumes that income stream. But, critically, S and L also support the consumption points in the line joining SC and E, and then E and LC, since the agent can (imperfectly) convert period 1 income into period 2 consumption (hence the segment from SC to E), and *vice versa* (hence the segment from LC to E).

Now simply add some carefully drawn, but legitimate, indifference curves, as in Figure 2, from Cubitt and Read [2007; Figure 3], and one can see the potential inferential problem. This picture shows a situation in which S provides greater utility than L, but the agent prefers LC to SC. The agent prefers LC to SC if these were the only consumption streams available from these lab choices over L and S. But the agent would really like to get to A, and that requires a choice of S (to get to SC) and some use of the (imperfect) capital market.

Binary choices between S and L run into this issue. The point has logical validity for some interesting cases and some popular conceptions of what utility is defined over, as noted earlier. Inspection of Figure 2 shows how different assumptions about preferences could affect the severity of the issue. The "problem" arises if utility functions are sufficiently kinked. If the elasticity of substitution between sooner and later consumption is low enough, there is a problem; but if it is high enough there will be no problem, and individuals will jump directly from S to L without lusting after some intermediate, mixed allocation like A. How can "low enough" and "high enough" be tested?

Cubitt and Read [2007] propose some complicated income-indifference methods, which have been popular in the Fill-In-the-Blank (FIB) literature, in order to judge how serious this problem is.[1] But if one *offers subjects the choice of forming a portfolio in the lab between the sooner and later options*, then in effect one is allowing them to pick a consumption point in Figure 1 along the dotted span connecting LC and SC. For each time-dated pair of monetary payments, the subject can decide what fraction of each to receive. If the pair is \$100 now or \$150 in 1 year, and the subject picks the fraction ¼, then this choice would entail the subject receiving \$100 × ¼ = \$25 now and \$150 × ¾ = \$112.50 in 1 year. Obviously, the binary choice method widely used in the discounting literature is a special case when the subject picks a fraction of 0 or 1.

As noted, this portfolio approach allows the individual to pick a consumption point in Figure 1 along the dotted span connecting LC and SC. This span dominates the span LC-E-SC. So if someone declines the opportunity to be in the dotted span joining LC and SC when it is costlessly offered, and clings to the LC or SC options, then this theoretical concern vanishes.

The portfolio method was actually proposed briefly, but clearly, by Cubitt and Read [2007;

[1] We firmly reject the behavioral reliability of FIB methods, which have been widely and casually adopted across the experimental spectrum. We appreciate that they are theoretically attractive in the sense of providing more information *if* behaviorally reliable. It is always more informative to know the certainty equivalent of a lottery instead of a binary choice, or the present value of a time-dated money stock instead of a binary choice, *if one can rely on those elicited values behaviorally*. We reject that premise. The argument on this issue is not germane here.

p.384]. It was subsequently implemented by Andreoni and Sprenger [2010], with some other extensions.[2] Our interface, shown in Figure 3, follows the clean design of Andreoni and Sprenger [2010].

One might argue that the portfolio method runs into problems because of "Fisherian separation." This is where the agent has access to perfect capital markets, so a choice of S or L reveals nothing about what consumption tradeoffs are. But the portfolio method only gives the agent access to a perfect capital market *inside* the lab, and only with respect to the allocation between SC and LC. If the agent does not take advantage of the intermediate income stream made available in the lab then they are presumed to face the imperfect capital market outside the lab.

2. Data

Sixty subjects were recruited to participate in experiments at Georgia State University in March 2011. The general recruitment message did not mention the show-up fee or any specific range of possible earnings, and subjects were recruited from large classes across campus. Instructions for the discounting task are presented in an appendix. Every subject received a copy of the instructions, printed in color, and the instructions were read out word-for-word by the same experimenter. Every subject also completed a demographic survey covering standard characteristics, as well as a survey of alcohol use and gambling behavior. All subjects were paid in cash at the end of

[2] The formal procedure employed by Andreoni and Sprenger [2010] extended the method proposed here by giving the subject 100 tokens to allocation between the sooner and later time period, and then varying the exchange rate between tokens and money for sooner or later amounts. In our case the exchange rate is the same for sooner and later amounts. The reason for their procedural extension is to avoid having to conduct a separate experimental task to elicit the (instantaneous) utility function of the subject, as proposed by Andersen, Harrison, Lau and Rutström [2008]. For present purposes this correction for diminishing marginal utility is not important.

each session, as well as by check for any time-delayed payment choices.[3] Every subject also completed a salient task involving choices between lotteries, prior to the discounting task.

The discounting tasks used principals of \$10, \$30 and \$60, and horizons of 1, 2, 3, 4, 5 and 6 weeks. Each subject made 72 choices: for each principal and each horizon, they were offered 4 choices with nominal discount rates selected at random between 5% and 200%.[4] There was no front end delay on the sooner option, so the choice was between money now and money later, following most of the discounting literature.

Figure 4 displays the data, which "speaks for itself." The overwhelming majority of choices were at the endpoints of 0 and 100% portfolio allocation. Table 1 shows the data, rounded to the nearest 5 percentage points allocated to the later amount. The detailed data are just as clear: of the 4,320 total choices, 2,942 were at exactly 0% allocated to the later amount, 12 were at 1%, 9 were at 2%, 9 were at 3%, 6 were at 5%, 8 were at 95%, 1 was at 96% and 552 were at exactly 100%. So 81% of the choices were at the extremes. No statistical analysis of these data seems needed.

3. Conclusion

Yes, intertemporal choice experiments do elicit time preferences for consumption, at least for the sampled population.

[3] Subjects were told that any future payments would be sent to them by check, mailed two days prior to the date identified in the task. They were also told that if they preferred to arrange to collect it on campus they could do so. All dates for future payments were week-days and none were holidays.

[4] For each principal-horizon combination, 4 nominal discount rates were randomly chosen with equal probability from a set of 14 candidate rates consisting of 5%, 10%, 15%, 20%, 25%, 30%, 40%, 50%, 75%, 100%, 125%, 150%, 175%, and 200%.

Figure 1: The Budget Sets Resulting from S and L when r_e is Strictly Intermediate (Figure 2 of Cubitt and Read [2007])

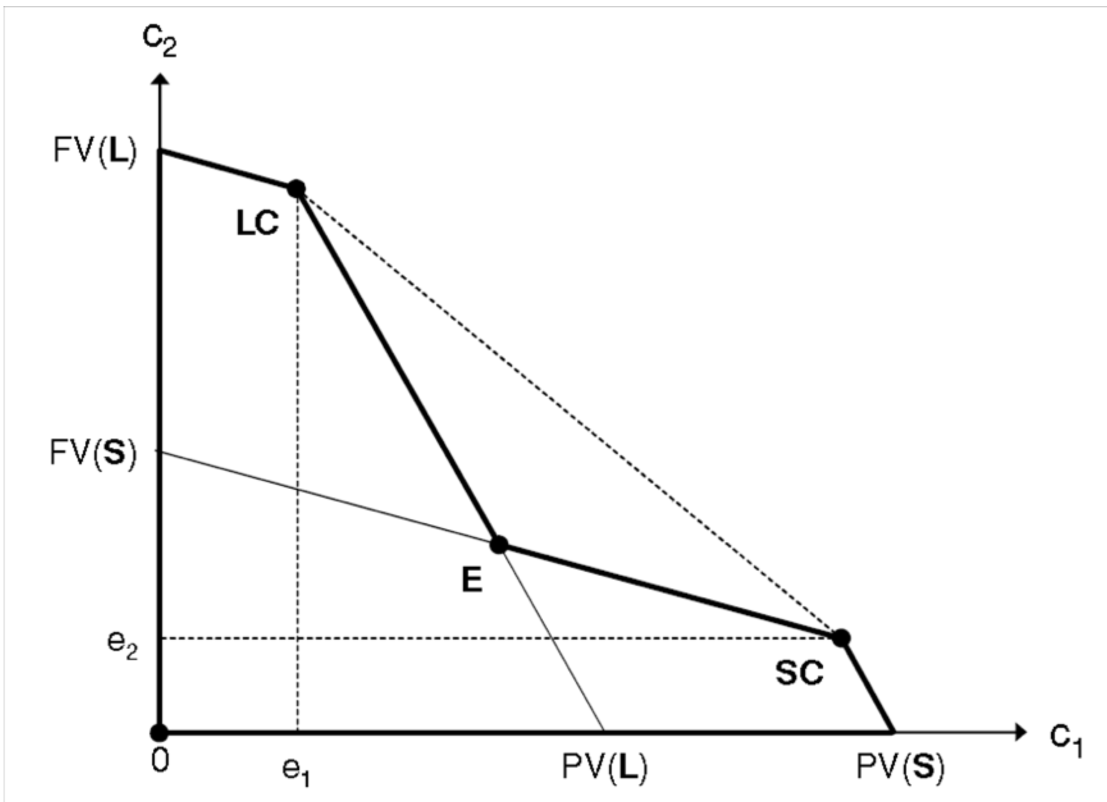


Figure 2: Time Preferences Such That S is Chosen Over L Although LC is Preferred to SC (Figure 3 of Cubitt and Read [2007])

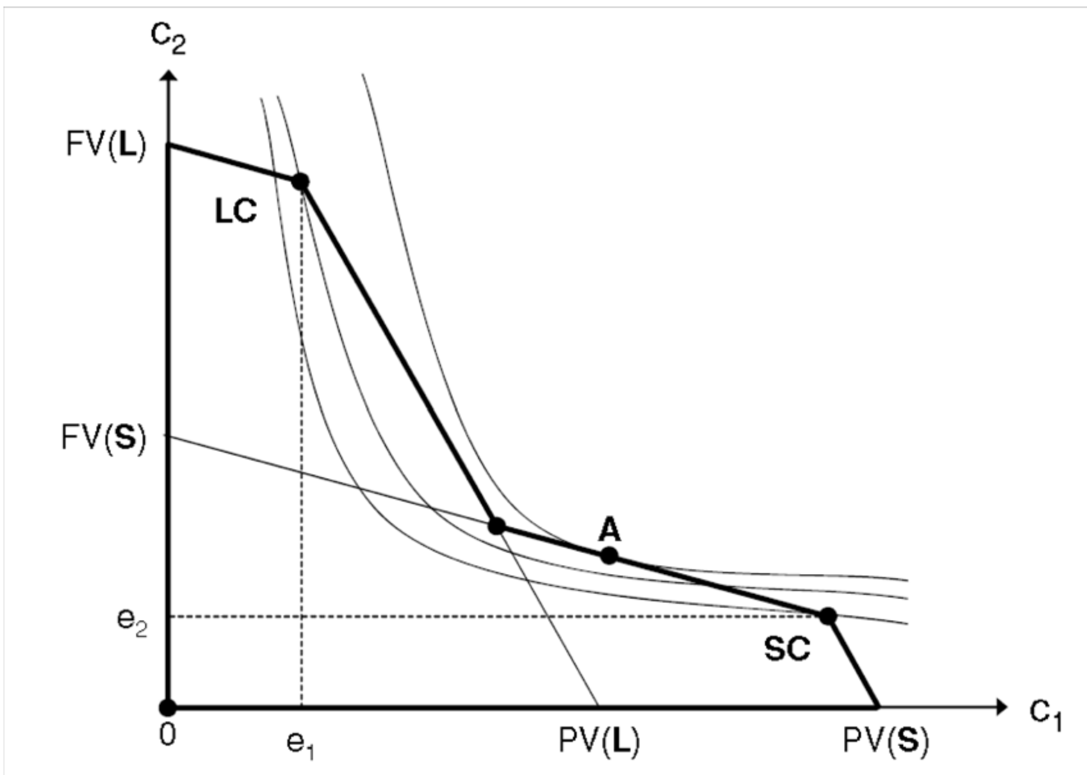
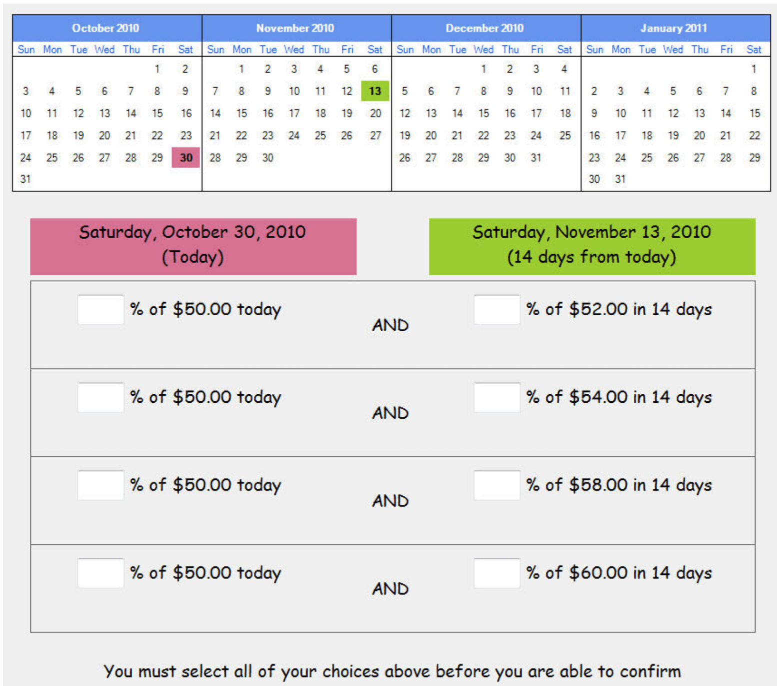
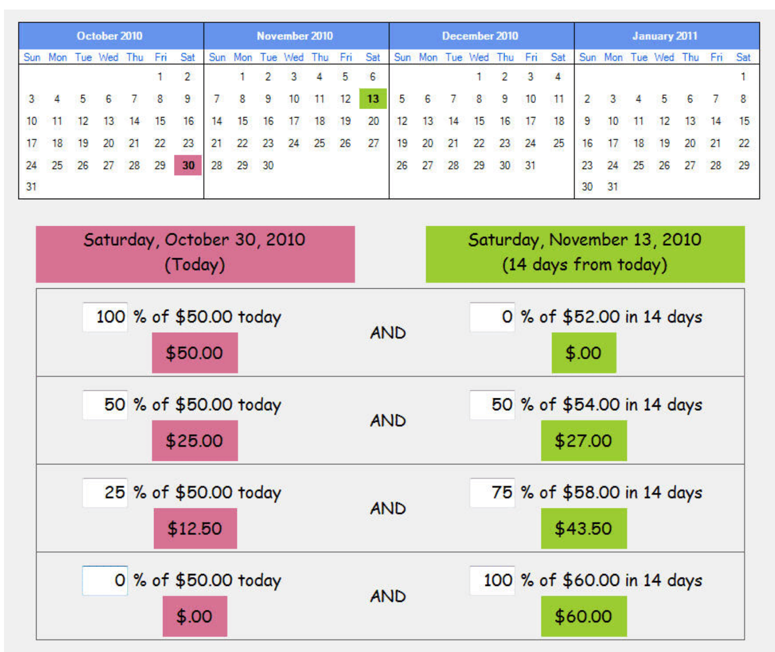


Figure 3: Our Portfolio Choice Interface





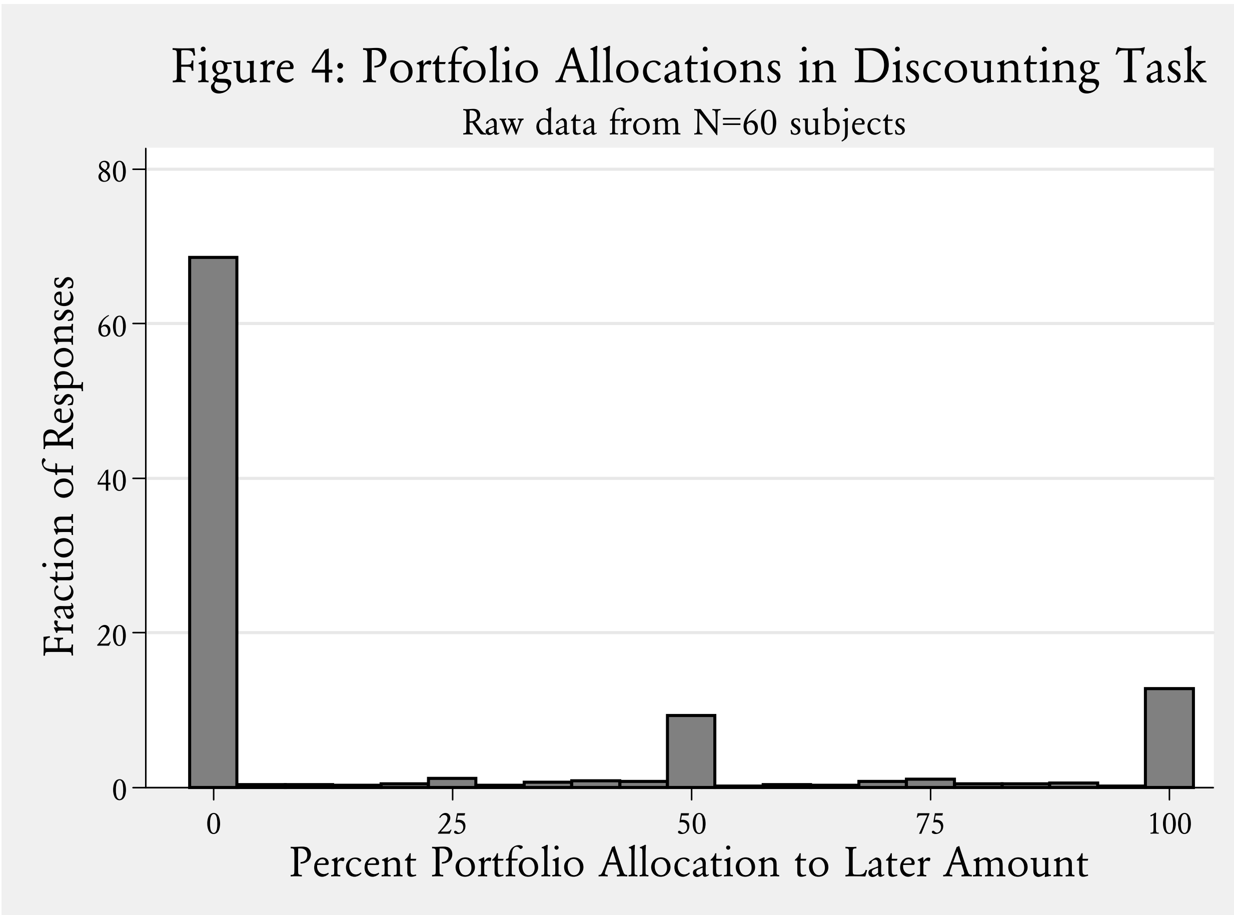


Figure 4: Portfolio Allocations in Discounting Task
Raw data from N=60 subjects
Fraction of Responses
80
60
40
20
0
0
25
50
75
100
Percent Portfolio Allocation to Later Amount

Table 1: Tabulation of Portfolio Choices

Observed allocations rounded to the nearest 5 percentage points

Percent Allocation to Later Amount	Frequency	Fraction
0	2,963	68.6%
5	15	0.3%
10	16	0.4%
15	13	0.3%
20	18	0.4%
25	51	1.2%
30	11	0.2%
35	28	0.7%
40	37	0.9%
45	34	0.8%
50	401	9.3%
55	7	0.2%
60	14	0.3%
65	10	0.2%
70	31	0.7%
75	47	1.1%
80	18	0.4%
85	19	0.4%
90	26	0.6%
95	9	0.2%
100	552	12.3%
All	**4,320**	**100%**

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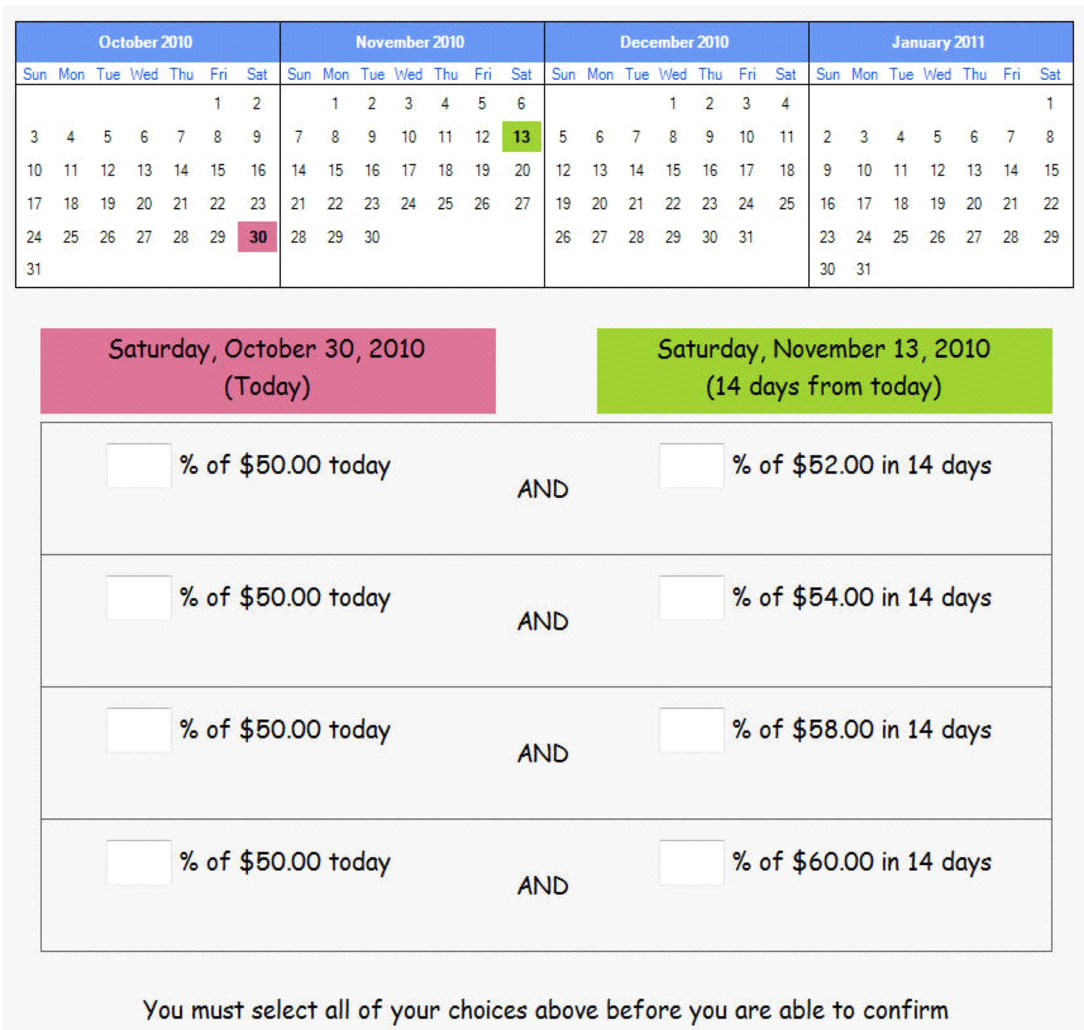
Appendix: Instructions

Sooner versus Later Payments

In this task you will make a number of choices between receiving an amount of money on a "sooner" date or a different amount of money on a "later" date. The sooner date will always be today, while the later date will vary between 1 and 6 weeks from today. An example of decision screen is shown below. You will make all decisions on a computer.



This screen shows four decisions. Each decision is presented on a different row. All decisions have the same format. Let's look at the first decision in the example above (the one on the first decision row). The sooner payment is $50 today and the later payment is $52 in two weeks from today. You choose an allocation of each payment by entering percentages in each box. You can choose any allocation you want: for example, 100% now and 0% later, 75% now and 25% later, 33% now and 67% later, or 0% now and 100% later. As you type in percentages, the screen will display the dollar amount associated with each percentage.

The percent allocation you indicate will be paid to you on the date indicated. Thus, if you pick 50% of the $50 today you would receive $25 = 0.50 × $50 today, and you would receive $26 = 0.50 × $52 in 14 days. If needed, we will round to the nearest penny.

We will present you with 18 of these decision screens, with each screen having 4 allocations for you to make. You must make all 4 allocations on the decision screen before moving to the next decision screen. While on a single decision screen, the only difference between decisions is that the dollar amounts of the future payment will change. However, different decision screens will have different dollar amounts and future payment dates. So, you should make sure to pay attention to both the changing dollar amounts and changing dates as you make your decisions.

You will be paid for one of these decisions. We will select one of your 18 decision sheets by rolling a 20-sied die until a number between 1 and 18 comes up, and then rolling a 4-sided die to pick one decision on that screen. When you make your choices you will not know which decision is selected for payment. You should therefore treat each decision as if it might actually count for payment.

You will receive the money on the date stated in your preferred option. If you receive some money today, then it is paid out at the end of the experiment as cash. If you receive some money to be paid in the future, then a check will be mailed to you two days before the specified date, and dated for payment on the specified date. If you receive some money to be paid in the future you will receive a written confirmation from Professor Harrison which guarantees that the money is to be paid to you on that date. If you prefer to pick the check up on the specified date we can make arrangements for that instead of mailing it to you.

The money you receive from these choices is in addition to the show-up fee and any earnings from other tasks in this session.