TIME PREFERENCE AND ADDICTIVE CONSUMPTION: EXPERIMENTAL AND THEORETICAL APPROACHES

A Dissertation

by

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ABSTRACT

This dissertation studies the relationship between time preference and addictive consumption. I first provide the theoretical background and the simulation results of an intertemporal choices model; then discuss the experimental approach to study the relationship between time preference and addictive consumption in the lab setting. From there I draw conclusions of the relationship between time preference and addictive consumption. The main contribution of the dissertation is to add new empirical evidence to the literature of addictive consumption and time preference.

In the first chapter, I give an overview of this topic and address the importance of the issue, and then I provide an extensive literature review in this area.

In the second chapter, I illustrate my baseline model, simulate a life cycle intertemporal choices problem and illustrate optimal consumption paths under different circumstances.

In the third chapter, I use an incentivized consumption game to simulate addictive behavior in the lab setting and correlate the subjects' behaviors with their time preference by using various measures in the experiment.

In the last chapter, I conclude this dissertation and address some problems for future research.

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CHAPTER I

INTRODUCTION AND LITERATURE REVIEW

1.1 Introduction

In 2013, a congressional proposal has been raised to legalize marijuana while at the same time imposing a 60 percent excise tax on junk food, candy, and soda. This proposal drives public attention on a long-standing policy debate over government's role on the regulation of the consumption of addictive goods. The category of addictive goods has been expanded in past decades. It not only includes traditional addictive goods such as cigarette, alcoholic drink, illegal drugs, but also the goods that were not traditionally viewed as addictive goods, such as video games, junk food, online gambling and porn. The consumption of these goods has not only brought disutility to the consumer itself, but also brought negative externality to the whole society. For instance, according to MADD, the nation's largest nonprofit working to protect families from drunk driving and underage drinking, every 53 minutes on average, someone is killed in a drunk driving crash (9,878 people in total in 2011).[1] Therefore, it provides room for the government to step in and regulate the consumption of addictive goods.

Given the importance of government regulation on addictive consumption, there is huge debate among policymakers over the ways to regulate it. One possible way is through taxation, or the so-called sin tax. In US, the consumption of cigarette and alcohol has been taxed at both the federal and state levels. According to Alcohol and Tobacco Tax and Trade Bureau of the United States Department of the Treasury, roughly 21 billion were collected in 2011 in excise taxes rightfully due to the federal government. On the other hand, the government also uses other methods to regulate the consumption of addictive goods. For instance, marijuana has been viewed illegal in 32 out of 50 states in US. Some

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[1] http://www.madd.org/drunk-driving

states have restricted the sale of certain type of alcoholic drinks during certain hours and in certain places. For instance, according to the Texas Alcoholic Beverage Commission, a wine only package store that holds beer license may not sell wine containing more than 17 percent alcohol by volume on Sunday or after 10pm on any day.[2]

Finally, the consumption of some addictive goods is not restricted, but whether or not to regulate them are constantly under policy debate. For instance, the so-called fat tax, a tax on junk food has been introduced by Denmark in 2011 and is also under debate in US under the hope that such tax could help fight the obesity problem in US.[3]

Despite the huge social impact of taxation on addictive goods and the various public policies toward the consumption of those goods, economists have provided mixed results on both theoretical and empirical evidence over this topic. A growing literature of models of addictive behavior are developed in recent years to help explain those contradictory results (Becker & Murphy, 1988; Bernheim & Rangel, 2004; O'Donoghue & Rabin, 1999b). Yet no consensus has been reached in even the basic assumptions of modeling addictive consumption. Therefore the first step towards reaching a consensus is to understand and model the cause of addictive consumption, thus the aim of this dissertation.

1.2 Literature review

1.2.1 Economic theory of time discounting and addictive behavior

Time discounting is one key determinant in solving intertemporal choice problems. Economists have been using the discounted utility model (DU) to model time discounting since Samuelson (1937). It assumes that consumers discount future consumption at a constant discount rate. Despite its popularity, the discounted utility model has also been

[2] http://www.tabc.state.tx.us/faq/general.asphours
[3] http://en.wikipedia.org/wiki/Fattax

criticized. One prominent issue is the time inconsistency problem. Empirical research on both humans and a variety of organisms has shown that temporal discount functions are not exponential. Ainslie (1975) develops a model called “hyperbolic discounting” to explain the anomalies in discounted utility. The problem of the hyperbolic discounting model is that its mathematics is complicated. Laibson later developed the model of quasi-hyperbolic discounting. It captures the essence of hyperbolic discounting, yet in a way that is much easier to track mathematically.

Besides time discounting, other important mechanisms also impact intertemporal decision-making. Berns, Laibson, and Loewenstein (2007) point out that there are three other mechanisms playing important roles in intertemporal choice problems: anticipation, the physiological arousal associated with anticipation of the outcome; self-control, the willpower to restrain from short-run temptations and representation, differences in context or in the way that a decision is “framed” or cognitively construed. These three mechanisms have drawn the attention of economists. The interactions among different mechanisms are also worth studying.

Among all intertemporal problems, the phenomenon of under-saving has been studied most extensively by economists. The other side of the under-saving problem is the problem of over-consumption. One extreme case and also a possible cause of over-consumption is addictive consumption.

The best-known economic model of addictive consumption is by Becker and Murphy (1988). In their model, they assume addictive consumption is chosen by rational forward-looking agents who fully recognize the future damage of their current addictive behavior. Their model, also very controversial, captures some important factors of addiction. The assumptions imposed are: 1) past consumption lowers the present utility from the same consumption level, or the tolerance effect; 2) the reinforcement effect, i.e., an increase in past consumption increases present and future consumption. In their model, they adopt exponential discounting, so the addiction is only caused by the above feature of the good itself.

Another group of addiction models assume the decision maker (DM) has time inconsistent preference. For example, O'Donoghue and Rabin (1999b) study the relationship between addiction and self-control. By imposing hyperbolic discounting on a simple binary addiction consumption model, they are able to show that individuals tend to over consume addictive products. Over time, even a person with mild self-control problem can hurt himself severely. Gruber and Koszegi (2000) incorporate hyperbolic discounting into the model of rational addiction. They find that imposing the assumption of hyperbolic discounting change the policy implications would change dramatically because of the "internalities" imposed by addicts on themselves.

Braun and Vanini (2003) go one step further by assuming time preference is endogenous for addictive consumption. They distinguish habitual and addictive consumption by assuming an addict's time preference depends on the consumption history, whereas a non-addict's time preference rate is just an exogenously fixed constant. Therefore, once a DM becomes addicted, he or she will develop a stronger impatience or become more present-oriented.

Bernheim and Rangel (2004) develop a model of addiction that is based on a cue-triggered decision processes. In their model, addicts have two modes, a "hot" mode and a "cold" mode. Each period, the addict has a stochastic probability of entering the hot mode. He will always use the substance in the hot mode. In the cold mode, he evaluates the benefits and costs of any possibility of current and future outcomes and has a discounting rate for future payoffs. Therefore, the DM's time preference is a combination of the exponential discounting in the cold mode and the myopic case in the hot mode.

Fudenberg and Levine (2006) adopt a dual-self approach to study a DM's impulsiveness control problem. In their model, they assume a long-run self who has a constant time discounting factor each period and a short-run self who only considers his utility in the current period. The so-called dual-self model has been used in a lot of economic problems and addictive consumption is one of them.

1.2.2 Experimental evidence about addictive consumption

There are few experiments conducted to study addiction, mostly due to the fact that it is very hard to mimic addictive behaviors in the laboratory setting. One of a few economic experiments to study addiction is done by Fehr and Zych (1998). They test rational addiction theory in the lab by adopting an induced preference approaching, i.e., they impose a payoff function that mimics the utility function as of Becker and Murphy (1988) on the subjects and make subjects fully aware of their own utility function. The utility function also determines the payoff of the subjects in the lab, therefore providing incentives for subjects to maximize their utility. Subjects' behaviors deviate significantly from the prediction of the rational addiction theory in the lab.

Richards and Hamilton (2012) study the relationship between obesity and hyperbolic discounting. They conduct an experiment to test whether the discount rate for individuals who engage in harmful addictive behaviors differ from those who do not. Their results show that the discount rates are quasi-hyperbolic in shape and addictive behaviors such as obesity and drinking are positively linked to the discount rate. The difference between their paper and ours is they use survey data as a measure of addictive behavior versus we us an incentivized experiment to capture individuals' addictive behaviors.

1.2.3 Experimental evidence about time discounting

The literature on estimating time discounting, on the other hand, is much larger. Coller and Williams (1999) is among the first experiment to estimate time preference. They designed an experiment in which one person is randomly chosen from the subject pool to receive a large amount of payment (over $500). The subject has to choose between payment in one month or in 3 months. The experiment also has several treatments; for instance, provide interest rate information to subjects.

Andreoni and Sprenger (2012a) argue that the experiment-induced time inconsistent behaviors could be due to the unmeasured risk of the future. They conduct a time preference experiment in which the risk of future payment is tightly controlled and find there is no time inconsistency.

Andreoni and Sprenger (2012b) argue that the standard elicitation techniques for measuring time preference is biased because they use linear preference instead of concave ones. Therefore, they propose the Convex Time Budget (CTB) method, along with a structural estimation method, to measure time preference and estimate the parameters of a utility function. Their results show that the annual discount rates are substantially lower than those obtained in the previous literature.

Wölbert and Riedl (2013) also conducted a time preference experiment but they did not find any present bias in the experiment. In addition, they used the Barratt Impulsiveness Scale to measure impulsiveness and found discount rates elicited in a monetary intertemporal choice task are highly correlated for three different intertemporal choice sets, and they observed good test-retest correlations for discount rates over an interval of 5–10 weeks.

Arya, Eckel, and Wichman (2013) studies the relationship between credit scores and preferences such as impulsivity, time preference, risk attitude, and trustworthiness. They find that credit scores are positively related to time preference (i.e., more patient subjects have better credit score) and negatively related to impulsivity. In their paper, they also adopt a time preference measure that is a variation on the “multiple price list” approach of Coller and Williams (1999). We use a variation on their measure too.

In addition to economists, some psychologists also address similar issue from their perspective. Shah, Mullainathan, and Shafir (2012) use several experiments to show that over-consumption is related to how people allocate their attention. In experiment 1, subjects play “Wheel of Fortune” and they are randomly selected into rich group, which has 280 guesses and poor group, which has 84 guesses. Later they are given a test to measure cognitive fatigue. It turns out the poor are more fatigued despite spending less time on guesses. Although it does not directly related to my topic, it does provide some insight into the reason consumers may over-consume addictive goods.

There are also experiments conducted to test the relationship between subjects’ behaviors in intertemporal choice games and time preference. Augenblick, Niederle, and Sprenger (2013) study individual time preference for a real effort task. In their experiment, they introduce a longitudinal design asking subjects to allocate and subsequently reallocate units of effort through time. They find limited evidence of present bias in choices over monetary payments and substantial present bias in choices over effort. Moreover, at price zero roughly 60% of subjects prefer commitment to flexibility. And individuals who demand commitment are significantly more present-biased in effort than those who do not.

Brown, Chua, and Camerer (2009) conduct an experiment in which thirsty subjects are allowed to either receive a beverage immediately or with a delay. Those who receive the beverage immediately over-consume more compared to those who receive it with a delay, which is consistent with quasi-hyperbolic discounting models. The above experiments, although not directly related to addictive behavior, show the importance of present bias in intertemporal decision making.

1.2.4 Indication on taxation problems from current literature

The most influential model of addictive behavior is the "rational addiction" theory developed by Becker and Murphy (1988). The basic assumption of their model is that consumers are rational forward-looking agents so that they fully recognized the future damage of their current addictive consumption, yet still willing to consume the addictive goods. For example, a smoker who chooses to smoke one more cigarette is fully aware of the future health cost as well as increased addiction to smoking caused by smoking one more cigarette. However, according to the model of rational addiction, by making the choice of smoking one more cigarette, the smoker believes the benefit of smoking is greater than the cost of it. Given this assumption, an optimal taxation on addictive goods for government need to take consideration of negative externalities of such consumption, but not negative welfare effect for the addict himself or herself, as that individual is already pursuing his or her maximum discounted utility. Therefore, it suggests a fairly low optimal tax rate for addictive goods that has a low external cost, for example, cigarettes and a high tax rate for goods that has a high external cost, for example, alcoholic drinks.

The model of rational addiction has been supported by some empirical evidence. For instance, according to this model, anticipation of future increases in price also reduce current consumption of additive goods. Gruber and Koszegi (2000) show some empirical evidence that future tax raise does decrease current consumption of cigarette. But it has also raised some controversial empirical results. Auld and Grootendorst (2004) show, however, that it is somewhat problematic to use aggregate data to study the empirical evidence of the rational addiction model. Yet more controversial results come from evidence found in economic laboratory. One big objection is that more and more laboratory results show that individual preferences are time inconsistent. For example, when subjects in the laboratory are asked whether to choose a dollar today or three dollars tomorrow, a large portion of subjects take the offer today. On the other hand, when asked whether to take a dollar in one year or three dollars in one year and a day, most subjects would take three dollars instead Thaler (1991). It contradicts with the basic assumption in rational addiction model, that individual preferences are time consistent. Based on the growing evidence on time inconsistent preference, Ainslie (1991) developed the model of hyperbolic discounting. He argues that the discount rate for shorter time period is higher than the discount rate for longer time period for most people. Therefore there exists a conflict between one's preference today and the preferences in the future.

The model of hyperbolic discounting was later developed to study the self-control problem with in an individual relative to time-consistent preferences, a person makes choices that he or she might regret in the future (Laibson, 1997; O'Donoghue & Rabin, 2002). The welfare implication of the time-inconsistent model of addiction is also quite different from that of rational-choice model. Unlike the rational-choice model, a person with self-control problems would hurt herself by consuming too much addictive goods. In other words, consumption of addictive goods not only causes negative externality, but also negative internality to the addict herself.

Time-inconsistent model of addiction also has different implication over optimal taxation problem compared to rational addiction model. Of all, the optimal tax rate should be higher as negative internality has been taken. Gruber and Koszegi (2000) estimate the optimal tax rate of cigarette should be at least one dollar higher in their model compared to the rational addition model. They also provide empirical evidence to support their argument that government policy should take consideration of the smokers' internality that they posed on themselves.

Bernheim and Rangel (2004) propose a different kind of addiction model. Their model is based on the premises that consumption of addictive goods is often triggered by some cues. Their model suggests an optimal tax rule is different for different addictive substance. Interestingly, they point out for substances that are highly addicted, a subsidy instead of taxation is optimal. Such goods include cocaine and heroin. On the other hand, for substance that are inexpensive and used regularly, but become addictive when the cue trigger effect is established, it is optimal to tax; for instance, coffee, cigarettes and alcohol.

In Chapter II, we adopt the model of rational addiction developed by Becker and Murphy (1988). The simple theoretical framework has proven to be useful in explaining a lot of phenomena related to additive consumption. We use this framework to conduct a simulation of negative and positive addiction consumption paths. It also serves as a useful theoretical background for the experiments we conducted in Chapter III.

CHAPTER II

INTERTEMPORAL CHOICES MODEL OF ADDICTIVE COMSUMPTION: THEORY AND SIMULATION

To better understand the intertemporal choice associated with addictive consumption, this paper presents a model of addictive consumption and provides simulation results of the model of rational addiction. We divide addictive consumption into two categories: negative addiction and positive addiction. For negative addiction, examples include consumption of alcohol, tobacco and so on. On the positive side one might imagine beginning an exercise regime, which is unpleasant to begin with, but then becomes pleasurably addictive and has long term benefits.

The important features of the utility function of addiction are the same between negative addiction and positive addiction: past consumption lowers the present utility from the same consumption level, or the tolerance effect; and increases the marginal utility of future consumption, or the reinforcement effects. These two distinct features separate the utility function of addictive goods from the utility function of normal non-addictive goods.

The marginal utility of current consumption, however, is different between positive addiction and negative addiction. For the case of negative addiction, the marginal utility of current consumption is always positive. Therefore, one enjoys the current consumption of addictive goods. For the case of positive addiction, the marginal utility of current consumption is first negative, then positive. One might imagine beginning an exercise regime, which is unpleasant to begin with, but then becomes pleasurably addictive and has long term benefits.

One can also think of addiction as a special case of the rich set of habit formation utility functions. As with a habit formation utility function, current utility depends on past consumption. However, a habit formation utility function does not necessarily satisfy the tolerance effect. This distinction in the utility functions of positive addiction is important in defining the consumption path of addictive consumption and separates itself from the general habit formation consumption path.

In this chapter, I apply the model of rational addiction to study a life-cycle intertemporal choice problem. I first present the model, and then give simulation results of the model.

2.1 The baseline model

Following Becker and Murphy (1988), the utility of an individual at period t, u_t, is a function of his current consumption c_t and the stock of previous consumption S_t:

$u_t = u(c_t, S_t)$ (2.1)

S_t denotes the level of addiction and can be written as:

$S_t = (1 - \delta)\, S_{t-1} + c_{t-1}$, (2.2)

Where δ denotes the rate of depreciation. Therefore, his lifetime utility would be given by,

$U_T = \sum_{t=1}^{T}(1+\sigma)^{T-t+1}\, u(c_t, S_t)$, (2.3)

Where σ denotes his rate of time preference and T is his lifetime.

Assume A_t is the DM's wealth at the beginning of period t, the interest rate is r, the price of the consumption good is p_c and the income per period is given by w. Each period, the individual has to make the decision of how much to spend on consumption goods c_t and how much to save to the next period so that he can increase his wealth at the beginning of the next period A_{t+1}. The intertemporal budget constraint is thus given by,

$p_c c_t + \frac{A_{t+1}}{1+r} - A_t \leq w,\ t = 1, \dots . T$. (2.4)

So a rational individual chooses a consumption sequence $(c_1, c_2, \dots c_T)$ to maximize U_T subject to (2.2) and (2.4) and $c_t \geq 0$ and $A_{T+1} \geq 0$.

The above utility function has the following important features,

$\frac{\partial u_t}{\partial S_t} \equiv u_s < 0$ (2.5)

$\partial^2 u_t / \partial c_t \partial S_t \equiv u_{cs} > 0$ (2.6)

The first equation shows past consumption lowers the present utility from the same consumption level, or the tolerance effect. The second equation shows past consumption increases the marginal utility of future consumption, or the reinforcement effect. These two distinct features distinguish the utility function of addictive goods from the utility function of normal non-addictive goods.

To simplify the problem, we adopt the quadratic form of the utility function:

$\mathrm{u}(\mathrm{c_t}, \mathrm{S_t}) = \mathrm{a_0} + \mathrm{a_c c_t} + \frac{\mathrm{a_{cc}}}{2}\mathrm{c_t}^2 + \mathrm{a_S S_t} + \frac{\mathrm{a_{ss}}}{2}\mathrm{S_t}^2 + \mathrm{a_{cs} c_t S_t}$ (2.7)

Therefore we have,

$u_s = a_S + a_{ss}S_t + a_{cs}c_t$ (2.8)

$u_c = a_c + a_{cc}c_t + a_{cs}S_t$ (2.9)

$u_{cs} = a_{cs}$ (2.10)

Since the reinforcement effect requires $u_{cs} > 0$, as long as $a_{cs} > 0$, the utility function satisfies the reinforcement effect. The tolerance effect requires $u_s < 0$. Therefore, it depends on the value of the parameters as well as current consumption and addiction level.

As for the case of positive addiction, everything else remains the same except for equation 2.5. Here we assume,

$\frac{\partial u_t}{\partial S_t} \equiv u_s > 0$ (2.11)

2.2 Simulation results of optimal paths of addiction

To start, we first provide a benchmark for the optimal consumption of normal goods. The parameters of the utility function are set as follows: $a_0 = 0, a_c = 0.6, a_{cc} = 0, a_S = 0, a_{SS} = 0$ and $a_{cS} = 6 * 10^{-5}$. The parameters are set in the way that the utility function is concave as $u_{cc} = a_{cc} = 0$. The other parameters are set as follows: *T=30, δ=0.1,* *r=σ=0.03, w=10,* p_c*=1,* A_1*=0 and* S_1*=0*. Figure 1 shows the optimal consumption path for normal goods. The reason that the consumption path is flat is because there is no impact of prior consumption on the marginal utility of current consumption and the interest rate is set equal to the discount rate. Therefore, there is no incentive for consumers to change their consumption level over time.

Figure 1 Optimal consumption path for normal goods

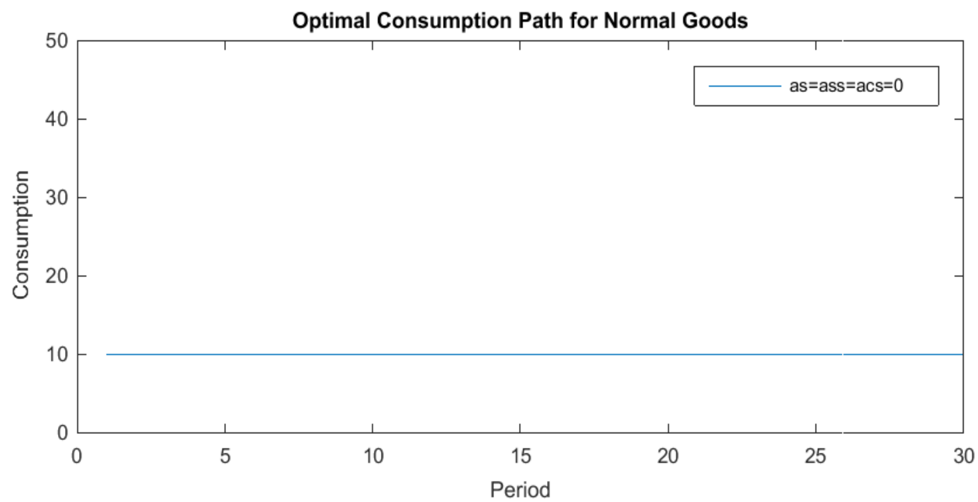
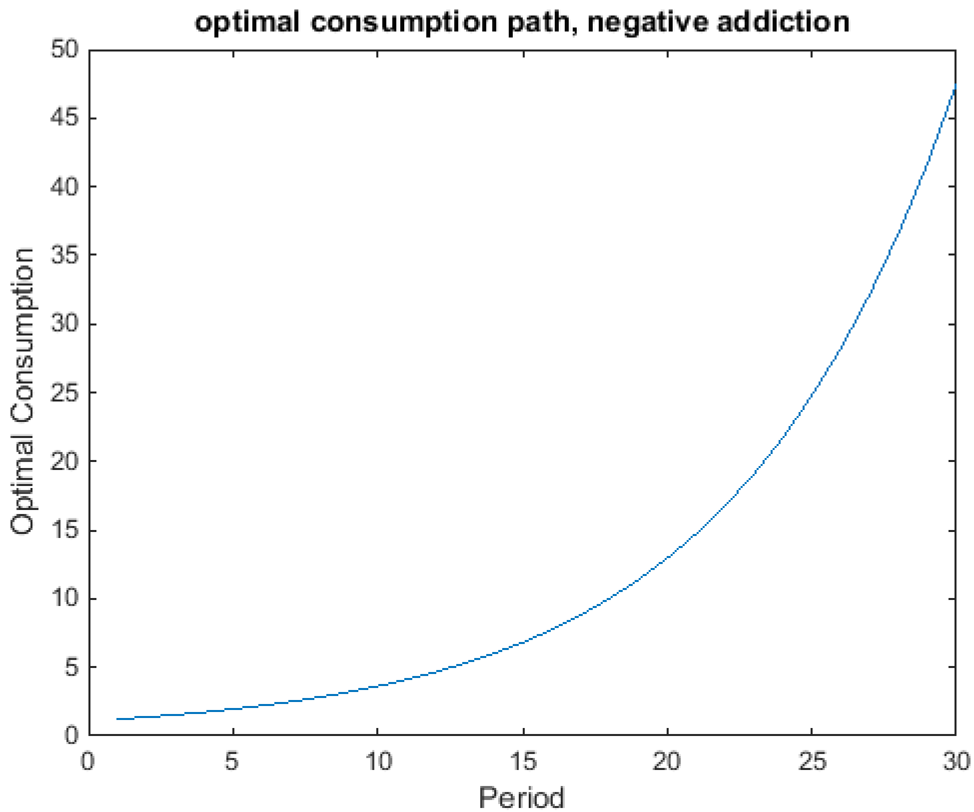


Figure 2 gives an optimal consumption path for negative addiction. The parameters of the utility function are set as follows: $a_0 = 0, a_c = 0.6, a_{cc} = -0.01, a_S = -0.06, a_{SS} = -6 * 10^{-6}$ and $a_{cS} = 6 * 10^{-5}$. The parameters are set in the way that the utility function is strictly concave as $u_{cc} = a_{cc} < 0$ and the assumptions of rational addiction model are met. The other parameters are set as follows: *T=30, δ=0.1, r=σ=0.03, w=10,* p_c*=1,* A_1*=0 and* S_1*=0.*

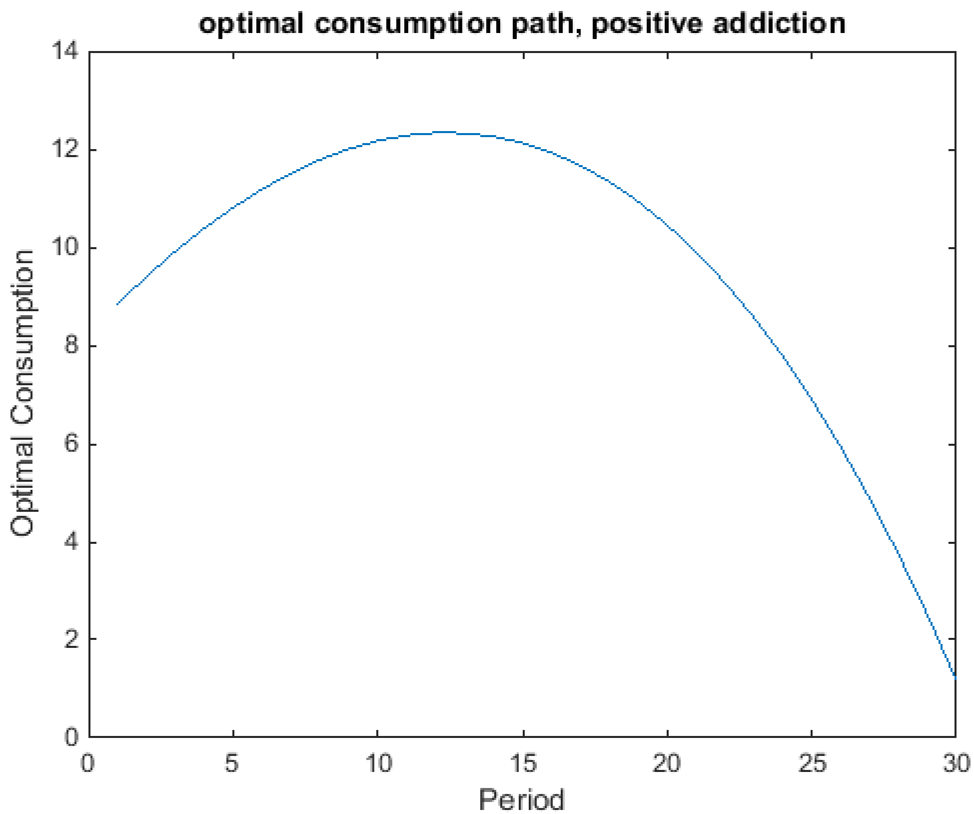
Figure 2 Optimal consumption path for negative addiction



One can tell from Figure 2 that the optimal consumption path for negative addiction is gradually increasing in a 30-period life-cycle. The marginal utility of current consumption is positive, but decreases with an increase in past consumption.

Now we give an example of positive addiction in Figure 3. In this case, the parameters of the utility function are set as follows: $a_0 = 0, a_c = -0.06, a_{cc} = -0.01, a_S = -0.06, a_{SS} = -6 * 10^{-6}$ and $a_{cS} = 6 * 10^{-4}$. Compared with the case of negative addiction, now a_c is negative instead of positive. This is because in the positive addiction case, marginal utility of consumption is first negative, then becomes positive. The parameters are set to ensure the feature of positive addiction, i.e., $u_s > 0$ as well as the concavity of the utility function given by $u_{cc} = a_{cc} < 0$. The other parameters are set the same as the negative addiction case: *T=30, δ=0.1, r=σ=0.03, w=10,* p_c*=1,* A_1*=0 and* S_1*=0.*

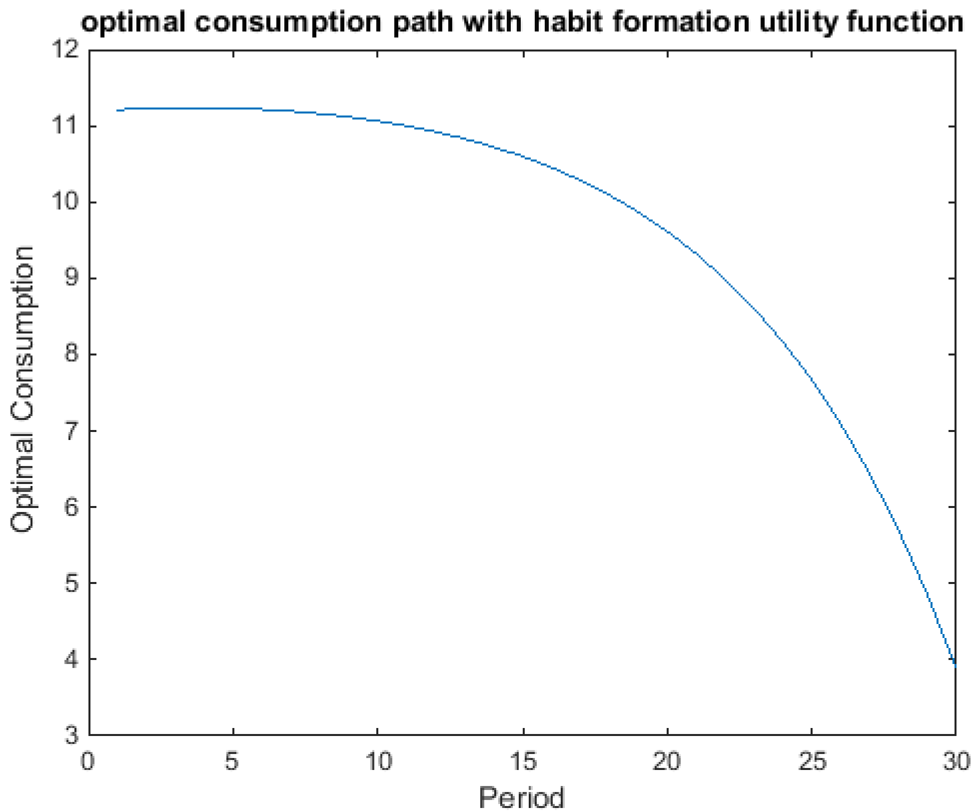
Figure 3 Optimal consumption path for positive addiction



The optimal path of positive addiction starts from a level significantly higher than zero, increases first and then declines after it has reached the maximum point. The marginal utility of current consumption is negative first, and gradually increases to a positive level. This suggests that to get into an optimal path of positive addiction, one has to start with a higher level of consumption in order for the marginal utility level to be positive.

Now we compare the case of positive addiction with habit formation in Figure 4. The parameters of the utility function are set as follows: $a_0 = 0, a_c = 0.6, a_{cc} = -0.01, a_S = 0.01, a_{SS} = -6 * 10^{-6}$ *and* $a_{cS} = 6 * 10^{-5}$. The other parameters are set as follows: *T=30, δ=0.1, r=σ=0.03, w=10, p_c=1, A_1=0 and S_1=0.* Compared to the previous case, the major change in the parameter setting is that a_S is positive instead of negative. As a result, the marginal utility of addiction level is positive. In this case, the reinforcement effect still exists, but the tolerance effect does not. In other words, past consumption no longer lowers the present utility from the same consumption level. Because of the absence of the tolerance effect, the optimal consumption path is declining all the way in a 30-period life as shown in Figure 4.

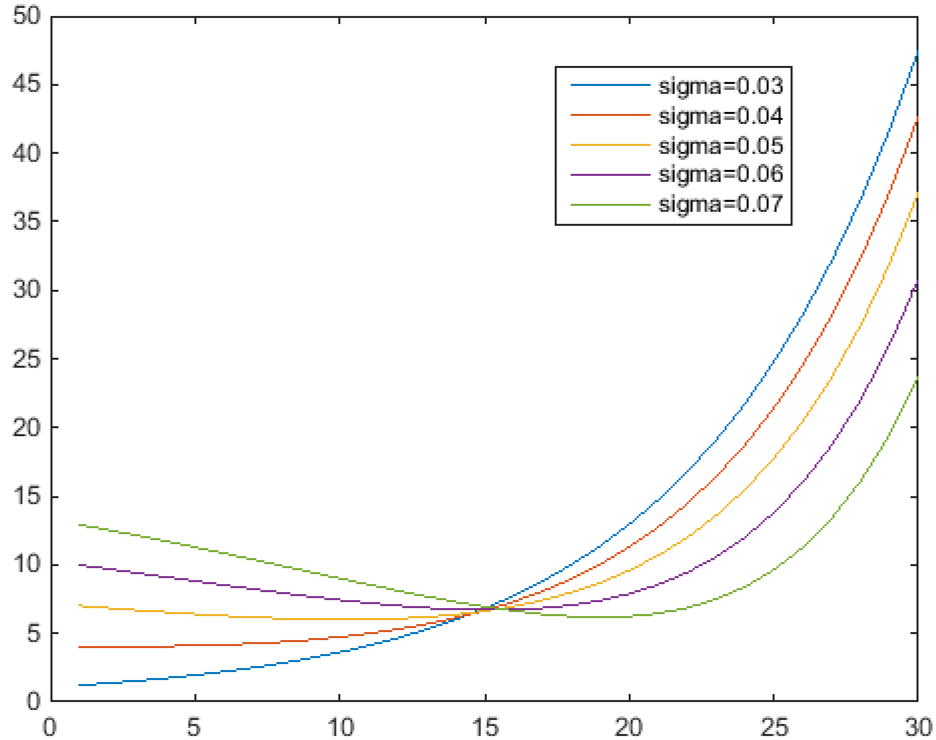
Figure 4 Optimal consumption path for habit formation



2.3 Simulation results of variations of negative addiction

To further explore the variation of different parameters, we look at changes in the optimal consumption path with changes in the discount rate σ. Figure 5 shows that the lower the discount rate, the more tilted consumption is towards the end. It says a higher discount rate increases current consumption relative to later consumption.

Figure 5 Change in optimal path with the discount rate



Next, we look at the change in the consumption path with respect to the depreciation rate of the addiction level S. Not surprisingly, the higher the depreciation rate, the greater past consumption would decrease future utility, therefore the less consumers will consume at the end of the life cycle. Figure 6 shows that a higher depreciation rate raises current consumption and flatten the consumption path, lowering consumption at the end of life.

Figure 6 Change in optimal path with the depreciation rate

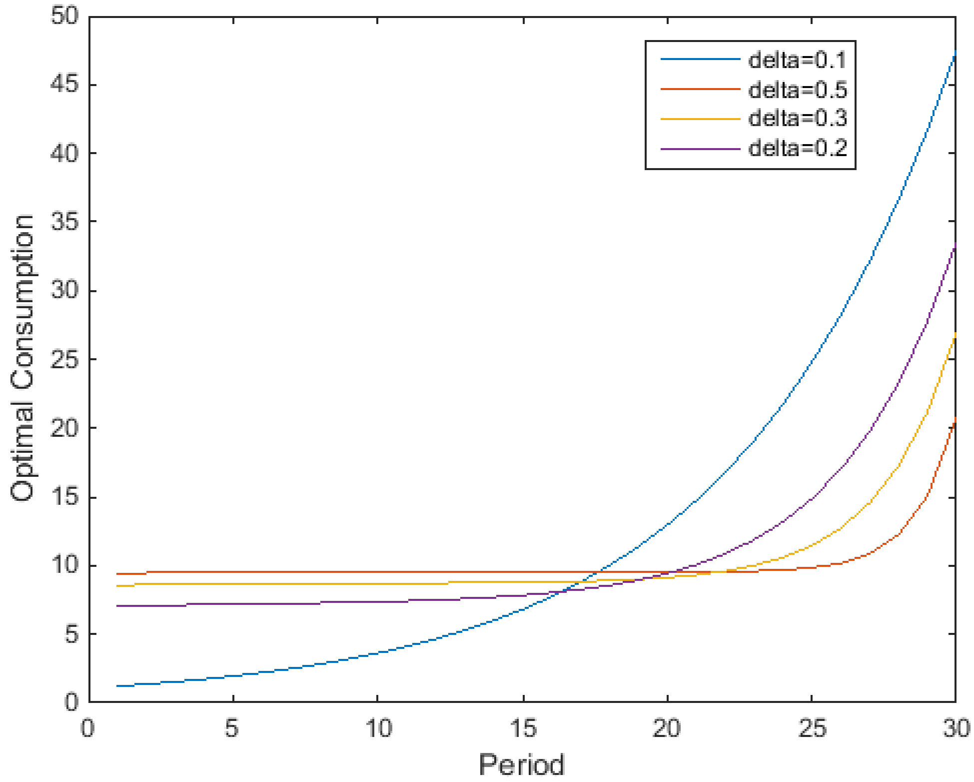


Figure 7 below illustrates the change in optimal consumption with a change in price. It turns out the optimal consumption path is not sensitive at all to the change in price, at least compared with other parameters. When the price is higher, consumers consume slightly less at the beginning, and more at the end.

Figure 7 Change in the optimal path with price

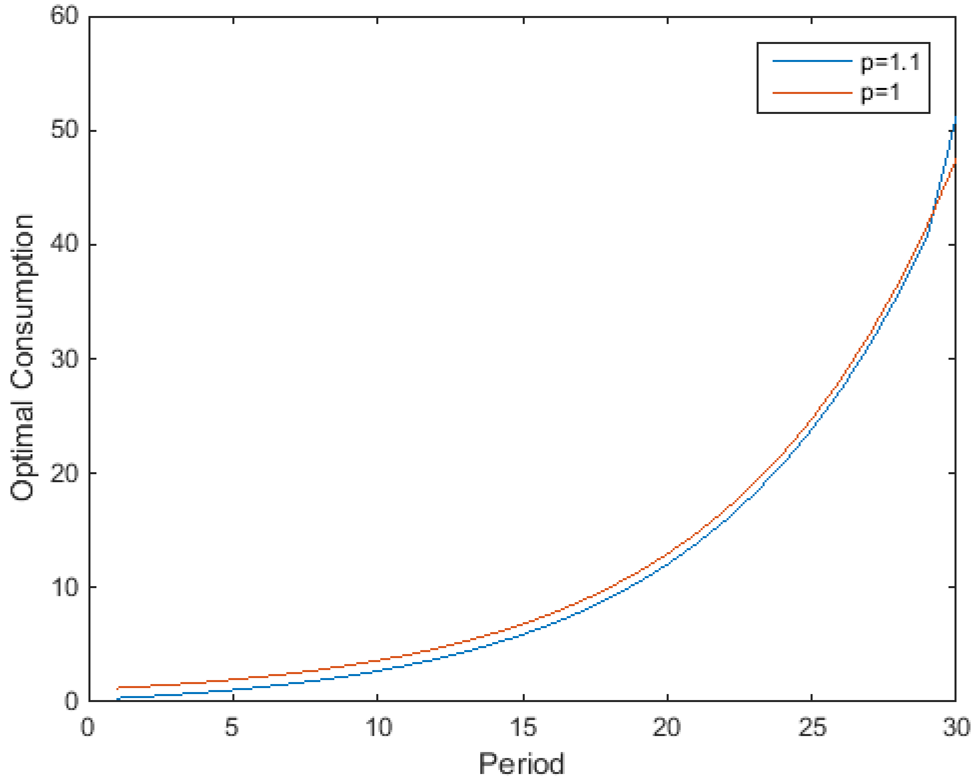
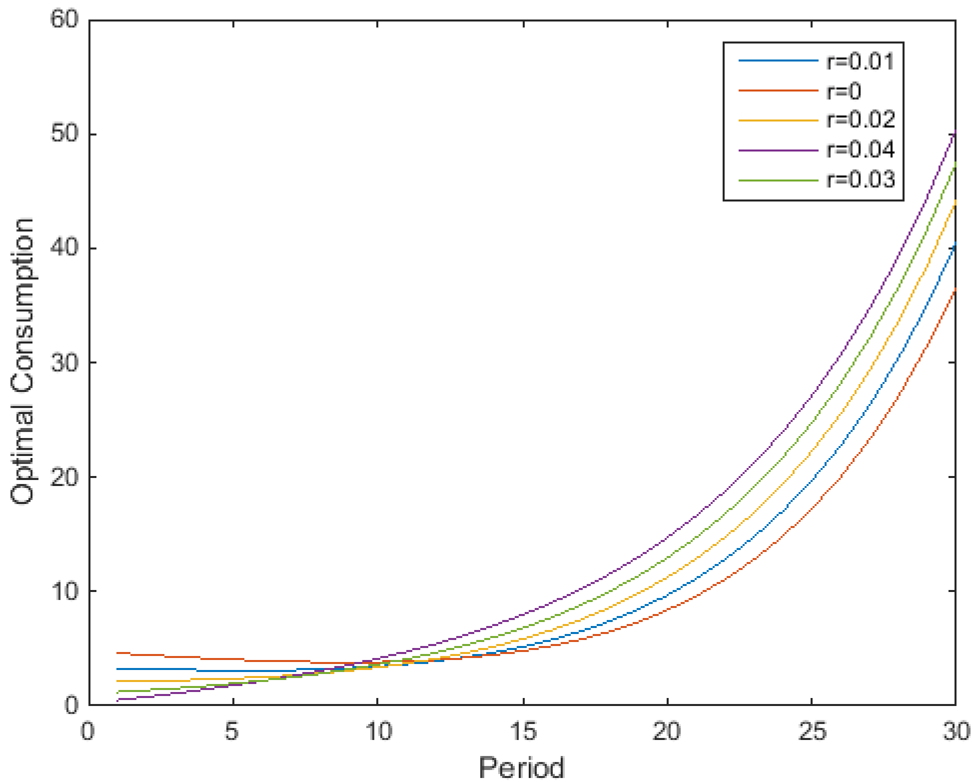


Figure 8 gives the optimal paths with changes in the interest rate r. From the graph, the change in optimal path is relatedly more sensitive to the change in r than the change in price. The higher the interest rate, the more consumers consume at the end and less at the beginning.

Figure 8 Change in optimal path with the interest rate



2.4 Conclusion

In this paper, we provide simulation results of an intertemporal choice model. It is shown that to achieve an optimal consumption path for goods that are negatively addicting, consumers start with relatively small amount of consumption at first, and gradually increase their consumption level towards the end. To achieve an optimal consumption path for goods or activities that are positively addicting, consumers start with a relatively high initial consumption level, gradually increase their consumption, and declines once it has reached the maximum level. We also show that the optimal path is sensitive to the discount rate, the depreciation rate of the addiction level, but less sensitive to the price of the good.

The results of simulations provide the background for our experiment, which will be illustrated in the next chapter.

CHAPTER III

ADDICTIVE CONSUMPTION AND TIME PREFERENCE: AN EXPERIMENTAL APPROACH

In this chapter, we discuss an experiment designed to study the relationship between addictive consumption and time preference.

3.1 Introduction

Individuals sometimes engage in short-term behavior that has long-term consequences. These are the so-called intertemporal choice problems in economics. An important example on the negative side is the consumption of "addictive" substances such as alcohol or tobacco. Addictive consumption has significant social welfare impacts. It does not only have financial consequences, but also can have severe health consequences. On the other hand, the underlying mechanisms for addictive behaviors are complicated. They range from some complex neurochemical mechanisms to various personality traits as well as social and economic influences. This paper attempts to decompose the addiction problem by providing the link between addictive behavior and time discounting.

It has been well documented in the psychology literature that addictive consumption is positively related to impulsiveness. In the economics literature, however, there has not been a consensus on how addictive consumption is related to time preference. In particular, there are two elements in time preference, present bias and time discounting, which are likely to affect the consumption of negative addictive substances. Time discounting is characterized as the discounting factor over payoffs in the future. Present bias, on the other hand, is characterized as an overweighting of current payoffs relative to future payoffs.

Specifically, economists consider “present-biased” preferences to work as follows. Suppose someone would prefer \$100 today to \$120 in one month, but if the decision period is moved into the future, would prefer $120 in two months over $100 in one month. That is, a person requires a larger compensation to wait for a larger payoff when the sooner payoff is “now”.

Time discounting, on the other hand, works as follows. Suppose someone would prefer $100 today to $120 in one month; her time discounting rate would be the same as someone who would prefer $120 in two months over $100 in one month.

Therefore, the above two factors, although similar, capture different aspects of an individual’s intertemporal preferences. It is unclear, though, which one plays the key role in addictive consumption and how they interact with each other. Although impulsiveness has been identified as one of the major causes of addictive consumption by psychologists and present bias is correlated with impulsiveness, the relationship between present bias and addictive consumption remain unclear. On the other hand, although time discounting has been related to addictive consumption through modeling by economists, there has not yet any experimental evidence on the relationship between addictive consumption and time discounting. Our study attempts to examine and distinguish the roles of those two factors play in decisions involving the consumption of negative addictive substances.

It is our assumption that someone with high present-biased preference and low time discount will be more likely to engage in negative addictive behavior, and someone with low present-bias --whose preferences for $100 v. $120 a month apart are consistent --will be less likely to engage in negative addictive consumption. It is unclear though what would someone with low present-bias and high time discount and someone with high present-bias and high time discount behave when it comes to addictive behavior. Table One summarizes our analysis above.

Table 1 The relationship between time discounting and addictive behaviors

	High present-bias	Low present-bias
High time-discounting	High negative addiction, low positive addiction	Unclear
Low time-discounting	Unclear	Low negative addiction, high positive addiction

Theorists have adopted two different approaches to model addictive consumption. One is to model the addictive behaviors as a consequence of time inconsistent preference (Gruber & Koszegi, 2000; Richards & Hamilton, 2012). The other, following the classic model of Becker and Murphy (1988), assumes addicts have time consistent behaviors, but defines other characterizes to capture the features of addictive behaviors (Bernheim & Rangel, 2004; Fudenberg & Levine, 2006; Laibson, 2001). Therefore, our paper also attempts to answer the question: do addictive behaviors involve time inconsistent preferences?

To sum up, we raise the following two questions in this paper.

1. Do addicts behave in a time consistent way?
2. How do present-bias and time discounting affect addictive behaviors?

As for the experimental setting, addictive behavior is approximated using an incentivized game, where a subject selects a "consumption" path (in this case for small amounts of money) over a number of periods in a lab experiment. The game is calibrated so that there is a "best"(i.e., highest-earning) consumption path. We anticipate that those with present-biased preferences and/or high time discounting will be more likely to deviate from the best consumption path in the game by consuming too much too soon. Someone who does not exhibit this behavior will be more likely to enter into a consumption path involving positive addiction (Note that no "addictive substances" are in any way involved in this study).

We then use a different incentivized experimental task to assess time preference. This task involves real tradeoffs between smaller amounts of money at a sooner date, and larger amounts of money at a later date. There have been many different versions of time preference elicitation methods. Our paper adopts a time preference measure developed by Arya et al. (2013). The details of the experiment setting will be explained in the experimental design session.

Present-bias, on the other hand, does not have a standardized measurement in economic literature. Although it has been argued that impulsiveness and impatience are the major drivers for present-bias (Rachlin & Raineri, 1992), there has been little empirical evidence due to the difficulty of testing it either in the lab or using real-world data. In this paper, we use an impulsiveness survey as a proxy for individuals' present-bias. Although it is not the perfect measurement for present-bias, we believe it captures the essence of present-bias by and large.

It is also worth noting that there is a large number of psychology studies showing addictive behaviors are linked with the underlying personality trait impulsiveness. It is, however, less studied in the psychology literature how impulsiveness is linked with time preference and present-biased preference. Our study provides further evidence by connecting the underlying personality trait in psychology with economists' approach to the same problem.

Our paper adopts the experiment of Fehr and Zych (1998). The difference between their experiment and ours is they are only looking at subjects' behaviors in the addiction game, while ours is testing the relationship between time preference and individual's behaviors in the lab.

3.2 Experimental design

The experiment includes two tasks. The first task is the addiction of Fehr and Zych (1998). In each period, the subjects are asked to choose how much to spend in each period of a 30-period game. Their earnings in this experiment will be a function of their consumption in each period.

In the second task, they are asked to make six choices between a smaller and sooner payment and a larger and later payment. The aim of the second task is to test their time preference. There have been many different versions of time preference elicitation methods. Our paper adopts the Eckel time preference measure used in Arya et al. (2013).

Eckel time preference measure consists of six choices. Each choice asks the subject to choose between a smaller payment at an earlier time and a larger payment at a later time. In our experiment, the earlier payment is fixed at 100 ECUs, where all ECUs will be paid in cash at an exchange rate of 1 ECU=0.1 dollar. The later payments are 101 ECUs, 105 ECUs, 110 ECUs, 125 ECUs, 150 ECUs and 200 ECUs. The subject can choose either to be paid tomorrow or one month from tomorrow for the later payment.

Finally, we will also ask subjects to answer a survey. The survey consists of three parts: the first part is a demographic survey including questions about students' financial status; the second part is a survey about addictive behaviors such as smoking and drinking; the third part is the Barratt Impulsiveness Scale survey. The Barratt Impulsiveness Scale is the most widely used questionnaire for the assessment of impulsiveness in psychology literature for 50 years (For review see Stanford et al. (2009)). The questionnaire contains 30 questions asking things related to individual's impulsiveness. Subjects will need to choose among the four scales: Never/Rarely, Occasionally, and Often, Always /Almost Always. A sample question would be "I plan for job security". The screenshot of the survey questions are included in the appendix.

The payment scheme is as follows: at the end of the experiment, all subjects will be paid for task one and two subjects in each session are randomly selected to be paid for task two. The payoff they receive is equal to the show-up fee plus the payoff calculated based on their choices in the experiment. If they are chosen to be paid for task two, a check will be mailed to them at the address they provide to the experimenter at the date the subjects select.

Experimental sessions were conducted at the Economics Research Lab in the Department of Economics. Subjects are recruited from the ERL subject database. Participation is open to all students enrolled in the subject pool, except that prior participants are excluded from further sessions. Subjects participate on computers with privacy partitions. There are 4 sessions in total and each lasts from 30 minutes to 1 hour. The average earning per subject is 13 dollars. Below we provide some screenshots in the experiment.

Figure 9 Screenshot of the addiction game: decision screen

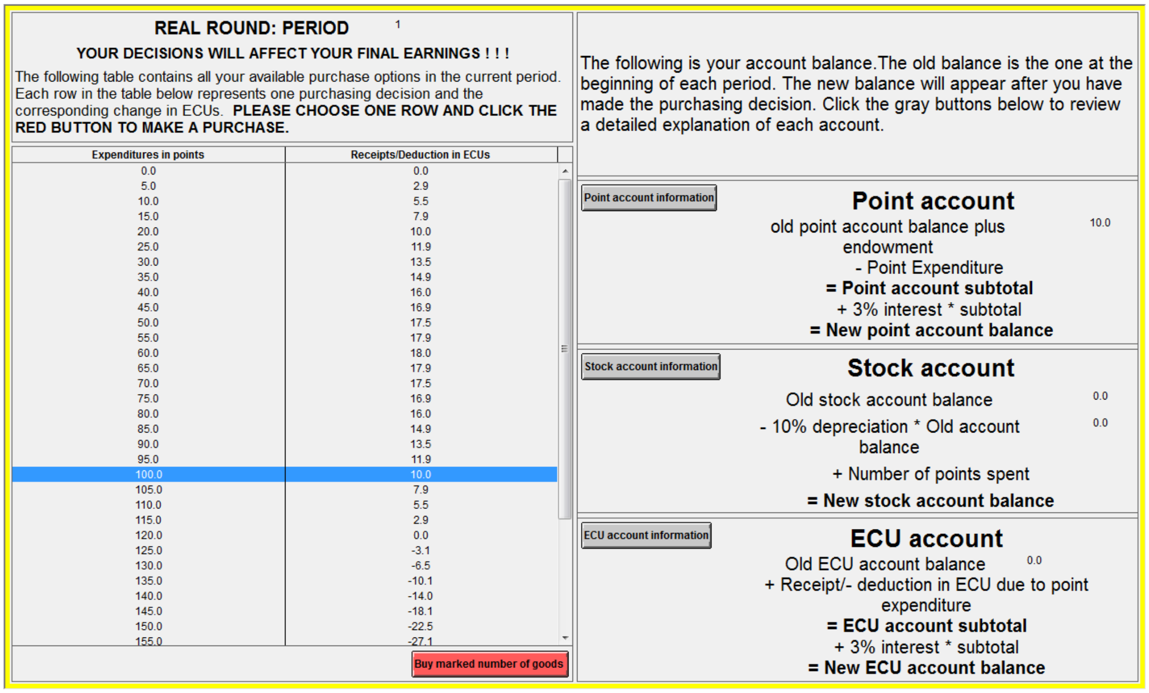
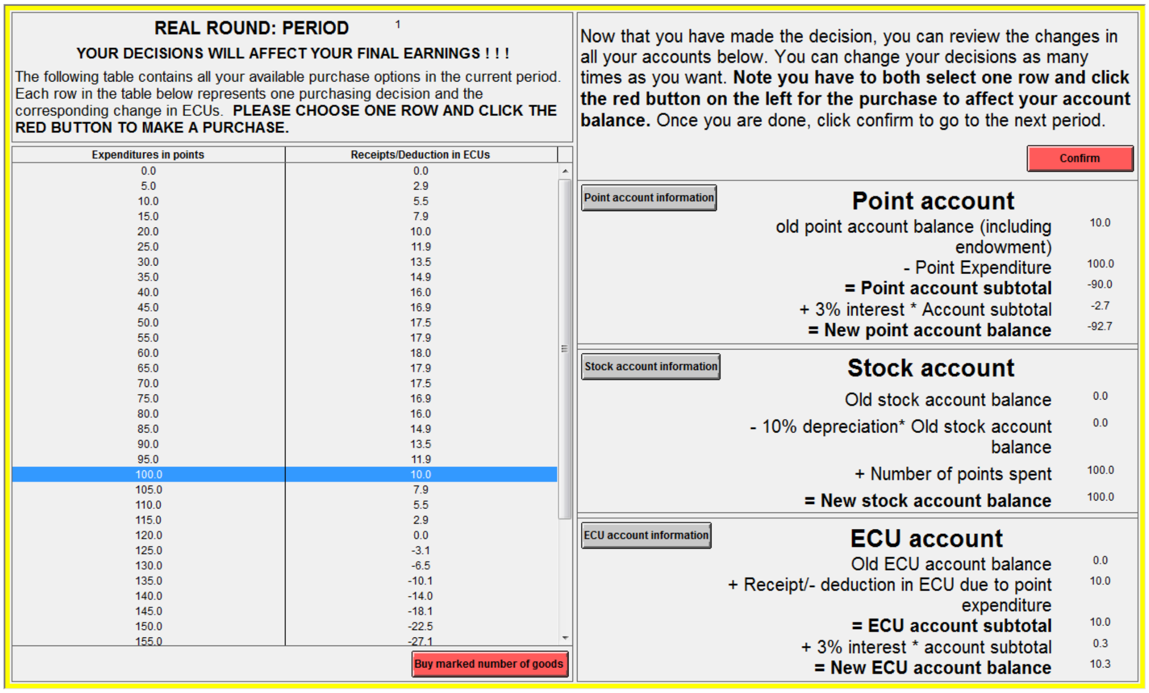


Figure 9 shows the screenshot of the addiction game. This screenshot shows all the components of the subject's decision making. The subject's budget consists 10 points (top right), which can be spent to purchase consumption (left). Consumption earns ECS, which are translated to dollar earnings at the end. Total consumption so far determines "stock"; the higher the stock, the more "addicted" is the subject. The subject makes his or her purchasing decision by selecting one row in the table on the left and clicking the red button on the bottom of the left screen. Once they make their decisions, the account information on the right will change accordingly and show their account balance after the purchasing decisions are made as shown in Figure 10. The subject can then click confirm if they are satisfied with the change in their accounts or they can change their decisions by selecting a different row on the left of the screen.

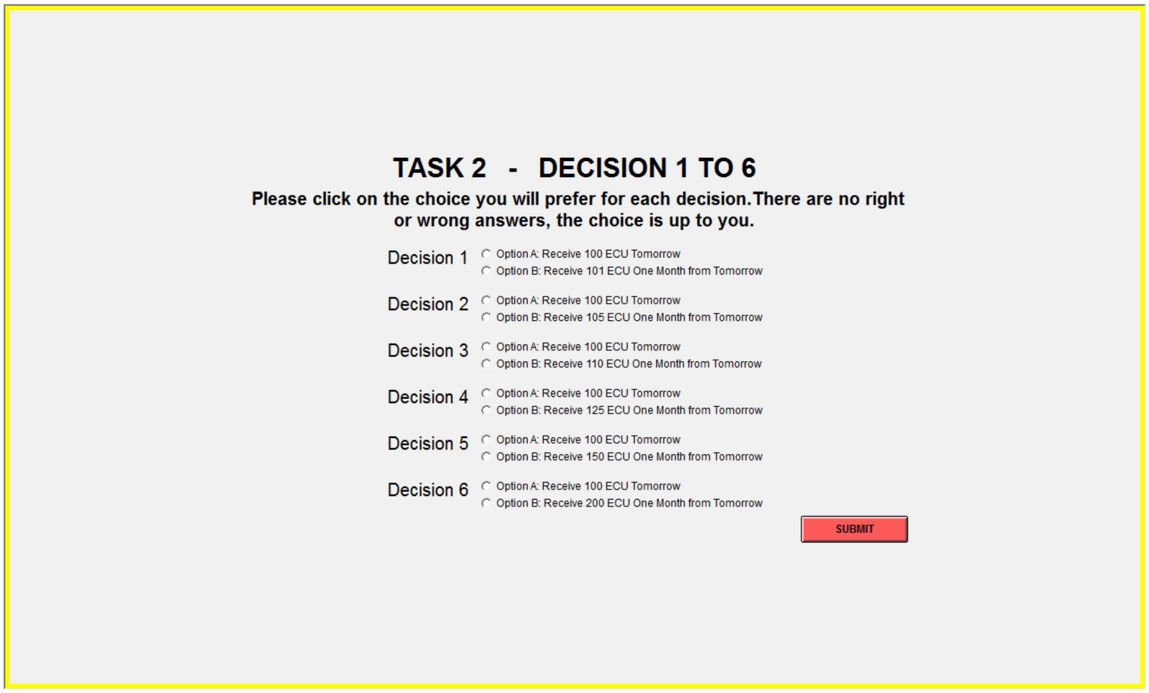
Figure 10 Screenshot of the addiction game: confirmation screen



Expenditures in points	Receipts/Deduction in ECUs
0.0	0.0
5.0	2.9
10.0	5.5
15.0	7.9
20.0	10.0
25.0	11.9
30.0	13.5
35.0	14.9
40.0	16.0
45.0	16.9
50.0	17.5
55.0	17.9
60.0	18.0
65.0	17.9
70.0	17.5
75.0	16.9
80.0	16.0
85.0	14.9
90.0	13.5
95.0	11.9
100.0	10.0
105.0	7.9
110.0	5.5
115.0	2.9
120.0	0.0
125.0	-3.1
130.0	-6.5
135.0	-10.1
140.0	-14.0
145.0	-18.1
150.0	-22.5
155.0	-27.1

The addiction game includes a practice round which subjects can end at any time at their own discretion and a real round in which they have to finish a 30-period new game. After the subjects complete the addiction game, they are directed to the second task. Figure 11 provides a screenshot of the second task.

Figure 11 Screenshot of the time preference task



In the second task, subjects are asked to make choices for Decisions 1 to 6. Each decision involves a choice between a sooner and smaller payment (100) and a larger and later payment. In each session, two subjects are chosen to be paid for task 2, and they will receive mail with a check inside at the date they choose (tomorrow or one month from tomorrow).

3.3 Key variables and hypothesis

There are a few key variables that we measure in the experiment. We want to use these variables to explain subjects' intertemporal choices in the addiction game.

TotalUtility is measured as the total amount subjects earn at the end of a 30-period addiction game. TotalUtility measures subjects' intertemporal choices in the addiction game. The highest earnings will be achieved by those who most closely match the optimal time path.

Patience is measured as the number of times the subject chooses a larger, later payment in the time preference task, i.e., the number of patient choices. Someone with a high discount rate will have few patient choices. Therefore, the more patient a subject is, the higher his or her Patience is.

Addiction is constructed using the sum of scores individuals we get from the addiction questionnaire. This provides a measure of their addictive behavior, especially drinking and smoking, as these are the most common addictive behaviors among college students. Specifically, there are in total seven questions asking individuals' addictive behaviors. For example, how often do you have a drink containing alcohol? Subjects choose from never, less than monthly, two to four times a month, two to four times a week to four or more times a week. The more frequent they drink, the higher they score in this question. If they choose "never", their score for this question is 0. If they choose "four or more times a week", their score for this question is 4. The Addiction variable is obtained by adding each subject's scores for each question measuring their addictive behaviors. The larger the Addiction variable is, the more addictive consumption the subjects engage in their everyday life according to their survey answers.

There are six first-order factors measured by the Barratt Impulsiveness Scale: Self-Control, Attention, Cognitive Instability, Motor, Perseverance and Cognitive Complexity. Each subscale is constructed by adding items contributing to each subscale in the survey. We construct them in a way that the higher each subscale is, the more impulsive the person is in that category, and create six corresponding variables for each subscale. There are NoSelfControl, InAttention, CognitiveInstability, Motor, NoPerseverance, CognitiveSimplicity.

Finally, there are a few demographic variables such as age, gender, whether the subject is a graduate student, whether the subject is Asian, and the amount of loans he is taking out in student loans.

The follows are our two main hypothesis:

Hypothesis 1*: TotalUtility is negatively correlated with Addiction and the impulsiveness subscales; positively correlated with Time Preference.*

Since TotalUtility is a summary measure of subjects' behaviors in the addiction game, and higher TotalUtility indicates better performance in the addiction game, or the less they become addictive in the game. Therefore, we anticipate TotalUtility to be negatively correlated with Addiction variable, which measures subjects' addictive behaviors in their everyday life. On the other hand, the more addictive behavior a subject engages in, the more impulsive and the less patient the person should be, so TotalUtility should be negatively correlated with impulsiveness scales and positively correlated with Time Preference.

Hypothesis 2*: Patience is negatively correlated with Addiction.*

The more patient a subject is, the less addictive behaviors he or she engages in. Therefore, Patience should be negatively correlated with Addiction.

3.4 Results

Fifty one students from Texas A&M University participated in the experiment. Forty-three percent are graduate students in fields other than economics, and the others are undergraduate students. Forty percent are female students. The average age is 23. We first discuss each key variable in the experiment. Table 2 contains descriptive statistics and Figure 12 to Figure 14 show histograms of the key variables in the study.

Table 2 Summary statistics

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
TotalUtility	51	80.06	15.77	35.52	105.9
Patience	51	2.706	1.487	0	6
NoSelfControl	51	11.49	3.009	6	20
Age	51	22.59	2.325	19	29
Male	51	0.608	0.493	0	1
Grad	51	0.431	0.500	0	1
Asian	51	0.529	0.504	0	1
Addiction	51	13.08	5.295	8	41

Next we look at the histogram of TotalUtility in Figure 12.

Figure 12 Histogram of TotalUtility

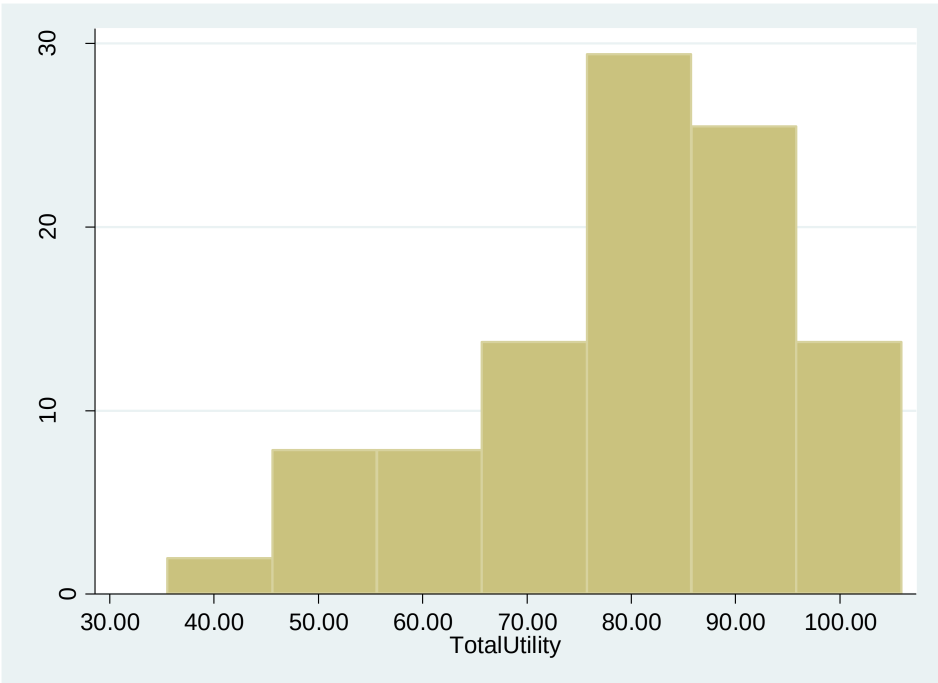
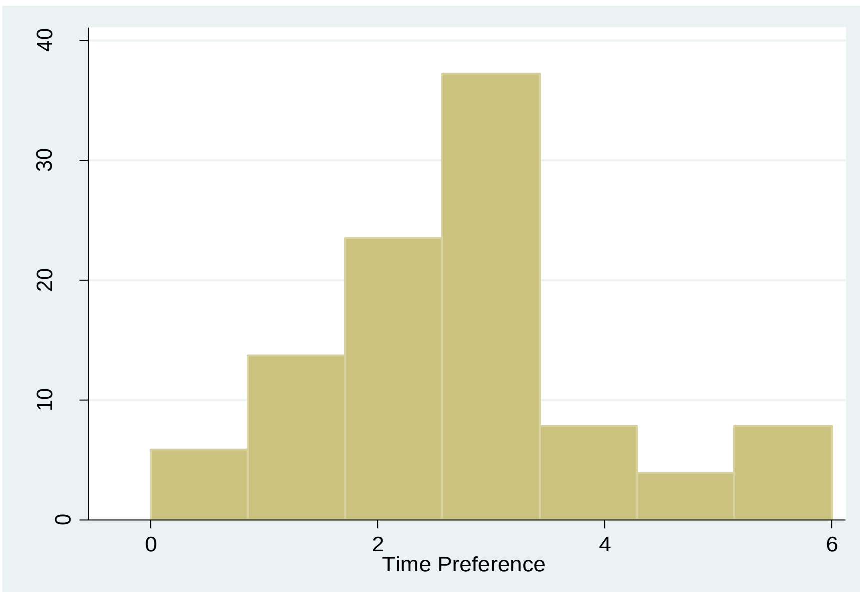


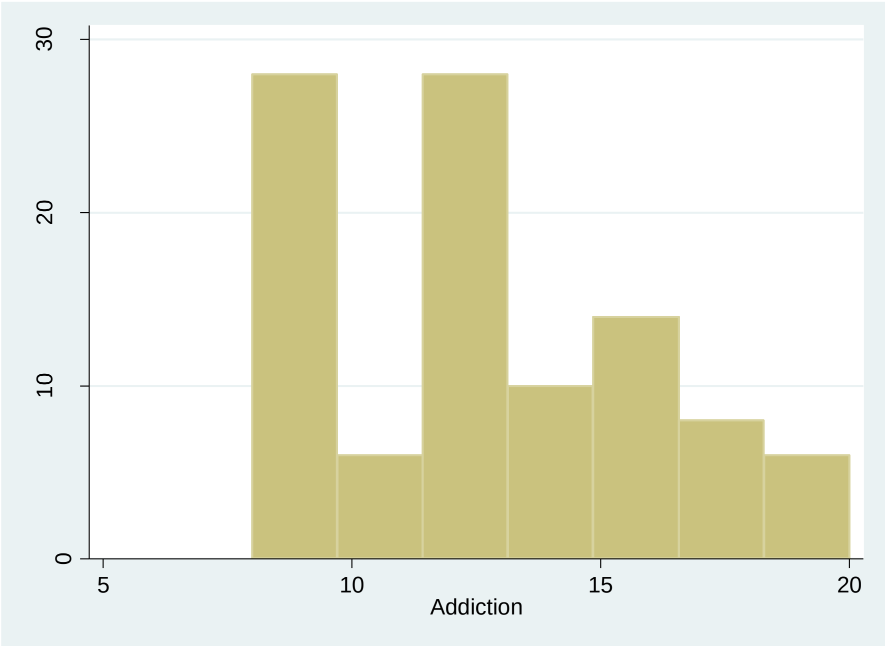
Figure 12 shows a histogram of subjects' performance in the addiction game, revealing a distribution of a mean of 80, and a range of 35.5 to 105.9 (see Table 2). The standard deviation is 15.77. The maximum total utility one can achieve is 117.7. About 12% of subjects achieve close to maximum earning. Performance is highly variable, with close to 20% of subjects earns less than half of possible earnings.

Figure 13 Histogram of time preference task



A histogram shows the distribution of subjects' time preference, which is measured by the number of patient (later, larger) choices in the time preference task. The distribution shows a range from 0 to 6 with a mean of 3.9. We are interested in the correlation between time preference and total utility as well as the correlation between time preference and the addiction variable from the survey data.

Figure 14 Histogram of addiction level



A histogram of the survey measure of addiction level is shown on Figure 14. It is computed as a weighted sum of all the survey questions related to addictive consumption. The higher the addiction variable, the more addictive goods the subject consumes.

Figure 15 Histogram of Barratt Impulsiveness Subscales

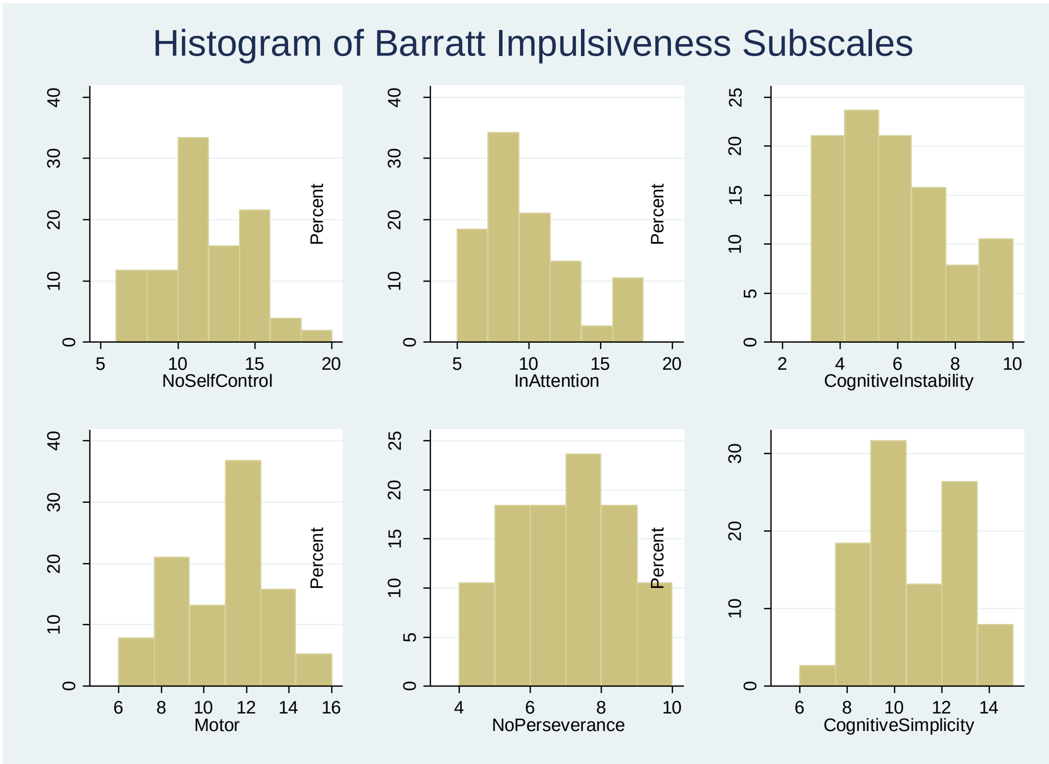


Figure 15 shows a combination of histograms of the six subscales we get from the Barratt Impulsiveness Survey.

Table 3 and 4 shows pairwise correlations between total utility and time preference. This allows us to test our hypothesis.

Table 3 Pair-wise correlations including impulsiveness subscales[4]

	TotalU~y	TimePr~e	Addict~n	SelfCo~l	Attent~n	Cog~lity	Motor
TotalUtility	1.0000						
TimePrefer~e	0.0097	1.0000					
	0.9463						
Addiction	-0.2560	-0.3577	1.0000				
	0.0698	0.0100					
SelfControl	-0.3528	-0.0565	0.0101	1.0000			
	0.0111	0.6936	0.9440				
Attention	-0.3133	0.0118	0.2155	0.6400	1.0000		
	0.0554	0.9439	0.1939	0.0000			
CognitiveS~y	-0.1830	-0.2808	0.2785	0.1803	0.3416	1.0000	
	0.2715	0.0876	0.0905	0.2788	0.0358		
Motor	-0.0090	-0.2460	0.1849	0.1246	0.0148	0.3036	1.0000
	0.9573	0.1365	0.2663	0.4562	0.9296	0.0639	
Perseverance	-0.1215	-0.0871	-0.0929	0.1296	-0.1186	0.0890	0.4926
	0.4676	0.6030	0.5789	0.4381	0.4782	0.5951	0.0017
CognitiveC~y	-0.3015	-0.1926	-0.0158	0.4203	0.1045	0.0305	0.4447
	0.0658	0.2465	0.9251	0.0086	0.5326	0.8559	0.0052

	Persev~e	Cog~xity
Perseverance	1.0000	
CognitiveC~y	0.4095	1.0000
	0.0107	

[4] Numbers on the second line of each row indicate the p-values.

Table 4 Pair-wise correlations including demographic variables

	TotalU~y	TimePr~e	Addict~n	age	Male	Female	Grad
TotalUtility	1.0000						
TimePrefer~e	0.0097	1.0000					
	0.9463						
Addiction	-0.2560	-0.3577	1.0000				
	0.0698	0.0100					
age	-0.2227	0.2708	-0.0379	1.0000			
	0.1163	0.0546	0.7916				
Male	0.1117	0.2487	0.0273	0.2750	1.0000		
	0.4350	0.0785	0.8490	0.0508			
Female	-0.1117	-0.2487	-0.0273	-0.2750	-1.0000	1.0000	
	0.4350	0.0785	0.8490	0.0508	0.0000		
Grad	-0.1096	0.2546	-0.1867	0.6544	0.2131	-0.2131	1.0000
	0.4438	0.0714	0.1895	0.0000	0.1333	0.1333	
Asian	0.0553	0.2919	-0.2257	0.3774	0.2887	-0.2887	0.7419
	0.6997	0.0377	0.1113	0.0063	0.0399	0.0399	0.0000

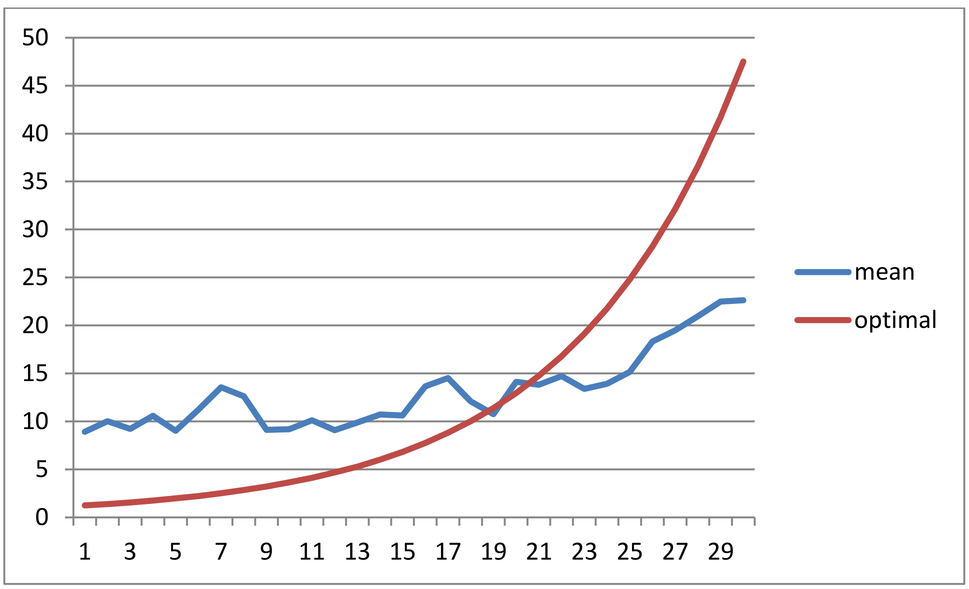
	Asian
Asian	1.0000

As we can see from the above tables, time preference is not significantly related to total utility, indicating that the patience level is not directly related to the overall performance in the addiction game. However, time preference is significantly negatively related to the addiction variable from the survey data ($p<=.01$). It indicates that there may be some latent variables that connect time preference and total utility. Addiction level has a marginally significant negative relation with total utility ($p<=.10$), suggesting at least to some extent, the behaviors in the addiction game is mimicking the consumption of addictive goods in the real world.

Other demographic variables include age, gender, dummy variables for graduate student and Asian, the amount of student loans and part-time working hours. None of them are significantly related to TotalUtility. Among the six subscales, self-control is positively correlated with total utility.

To have a closer look at results for task 1, we compare the optimal path with the actual consumption on average in the following figure.

Figure 16 Average of actual paths for all main rounds and optimal path



From Figure 16, one can tell that actual path deviates from the optimal path significantly. The optimal consumption is gradually increasing. Most subjects overconsume at the beginning periods and under consume towards the end.

3.5 Regression analysis

Our next step is to find out to what degree subjects' behaviors in the addiction game are determined by the key variables defined in the experiment. To this end, we use a linear regression model to study subjects' behaviors in the addiction game. The dependent variable is total utility; the independent variables are time preference, self-control, age, dummies for gender, graduate students, and Asian students. As shown in the table below, addiction is negatively related to total utility, No self-control is negatively related to total utility.

Table 5 Total utility determinants, OLS regression

	TotalUtility	TotalUtility
Patience	-0.109	0.307
	(0.08)	(0.21)
NoSelfControl	-1.852	-2.185
	(2.61)*	(3.11)**
Age		-2.609
		(2.06)*
Female		-4.307
		(0.96)
Grad		-1.693
		(0.22)
Asian		4.451
		(0.69)
_cons	101.630	163.318
	(10.75)**	(5.37)**
R2	0.12	0.26
N	51	51

* p<0.05; ** p<0.01

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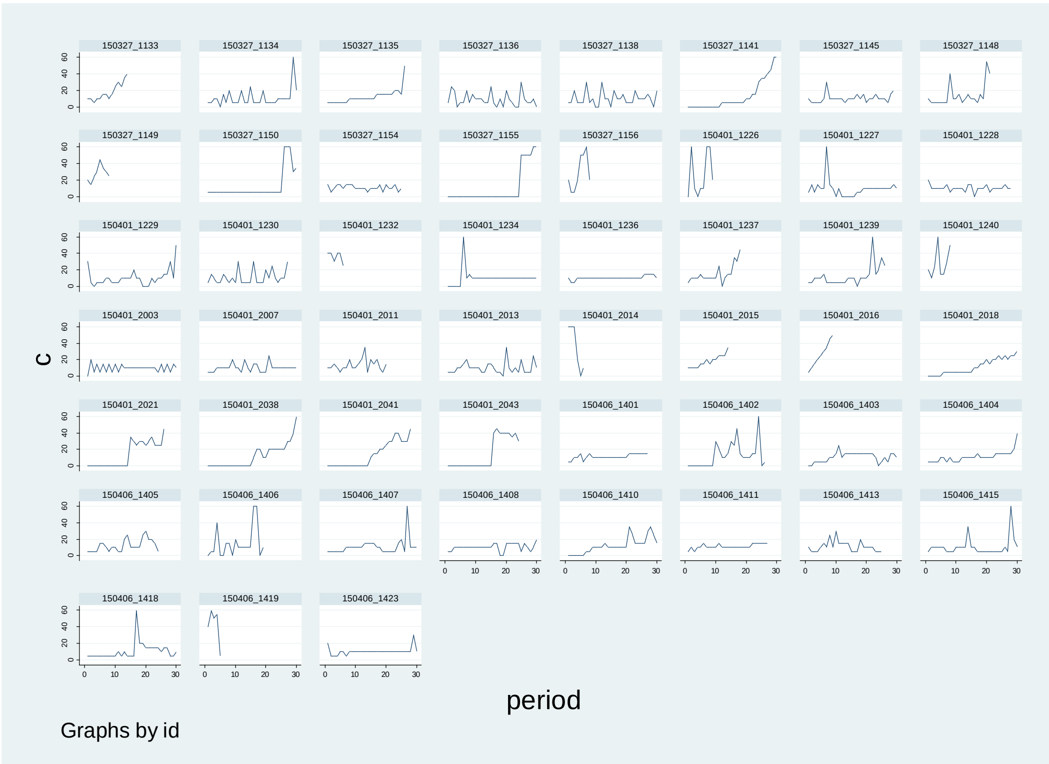
When we add the demographic variables, the results are still robust although R-square becomes larger. None of the democratic variables are significantly correlated with total utility.

Next, we take a look at the consumption path for each individual subjects in Figure 17.

Figure 17 Individual consumption path in addiction game



The above graph shows that there are significant individual differences in the consumption path. Therefore, we divide the subjects into different groups to further exploit their behaviors. First, we drop those observations that end the addiction game before period 15. It leaves us with 41 observations. A regression on these 41 observations give us the following results. From the table, we can see that all signs are preserved and the main conclusion does not change.

Table 6 Total utility determinants, subgroup OLS regression

	TotalUtility	TotalUtility
Patience	-0.436	-0.490
	(0.31)	(0.32)
NoSelfControl	-1.628	-1.703
	(2.45)*	(2.42)*
Age		-0.674
		(0.46)
Female		-5.639
		(1.24)
Grad		-1.667
		(0.22)
Asian		-1.224
		(0.19)
_cons	103.171	122.710
	(11.85)**	(3.59)**
R2	0.14	0.19
N	41	41

* p<0.05; ** p<0.01

To sum up, we find that there is no significant correlation between individuals' performance in the addiction game and their time preference. The subjects' performance in the addiction game is negatively correlated with their addictive consumption level according to the survey results. Their time preference is also negatively correlated with their addictive consumption level.

3.6 Conclusion

This paper provides the first direct evidence of the relationship between time preference and intertemporal choices of addictive consumption. By connecting individuals' behaviors in an incentivized intertemporal choice game with their choices in a time preference task, it shows that the above two variables are not directly correlated. On the other hand, individuals' choice in the time preference task is significantly correlated with the addictive consumption level elicited from their answers in the survey questions. It suggests that the addictive consumption in the everyday life is a complicated procedure. Our next step is to decompose this procedure so that one can tell which part is determined by intertemporal decision making and which part of it is determined by other variables.

CHAPTER IV

CONCLUSIONS AND FUTURE RESEARCH

In this dissertation, I mainly discuss the relationship between time preference and addictive consumption. To this end, I adopt both the theoretical approach and the experimental approach. By imposing an induced utility function of the rational addiction model on subjects, we are able to identify some of the key components of subjects' behaviors in the addiction game, and therefore imply their addictive consumption in the real life. Then I construct a general equilibrium model to study the taxation problem of addictive goods and how it is related to the other sources of externalities of addictive consumption.

Some of my main conclusions are:

1. Addictive consumption is positively related to impulsiveness, but not significantly related to the patience level.

2. The addiction game captures some features of the addictive consumption and is useful in terms of studying individuals' addictive behaviors.

The next step is to develop a general equilibrium model of consumption of addictive goods. As we can tell from the experimental results, the model should be based on the assumption that individuals give extra weight to well-being now over well-being at any future moment. It leads to over consumption of addictive goods and provides room for government regulation. Besides, an optimal taxation rule incorporating the internality issue caused by addicts could be derived. Therefore, an optimal tax rate should incorporate all three aspects of inefficiency. Compared with previous literate that focus on consumer's problem, the optimal tax rate should be lower when taking into consideration the impact of imperfect competition in highly concentrated market. It may even be possible that an optimal tax is negative if the last effect completely offset the first two.

Lastly, there are several ways that I can extend the model. First, government regulation of addictive consumption is not only limited to taxation, but also certain restrictions on time and location, or complete illegalization. Therefore, it is possible to compare the welfare impact of different policy instrument and find the optimal policy instrument or combination over consumption of addictive goods. Second, we assume consumers are fully aware of their time-inconsistent problem. However, it is possible that consumers do not fully anticipate their self-control problem at the time of making consumption decisions. In fact, O'Donoghue and Rabin (1999) assume there are two types of consumers: nave who is unaware of future self-control problem; sophisticated who is aware of future self-control problem; and found different consumption patterns of different type of consumers. It is also interesting to see the impact of incorporating naive consumers in the model. Finally, numerical calibration is needed to examine the optimal tax rate given the market concentration, and the externality and internality of certain addictive good.

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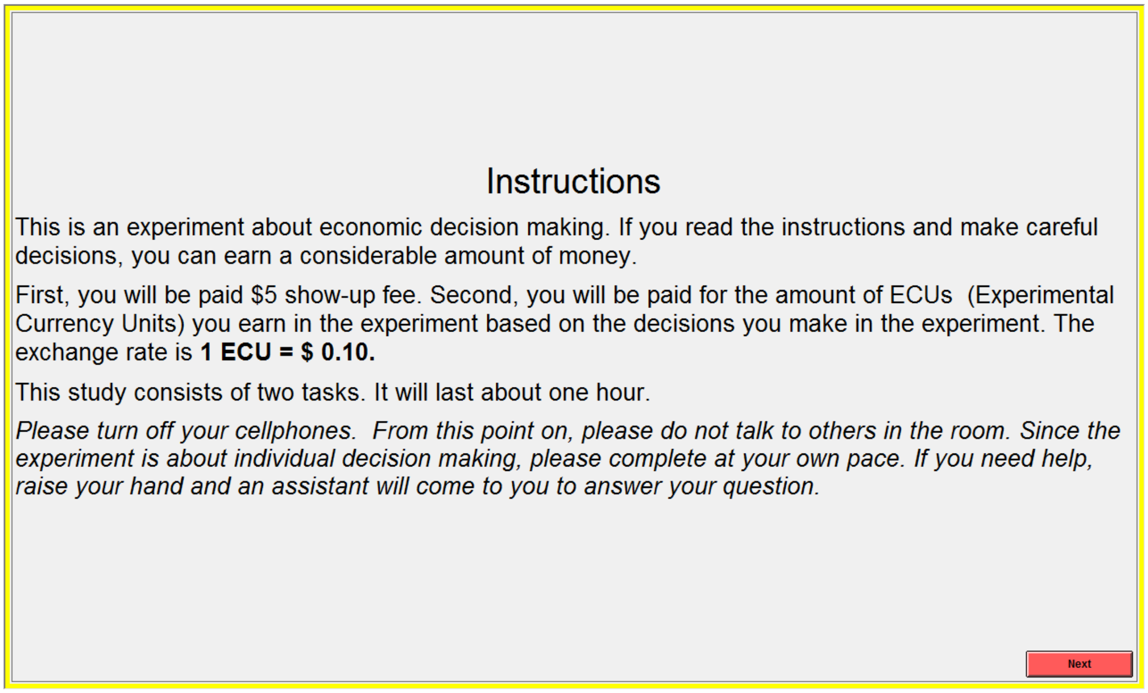
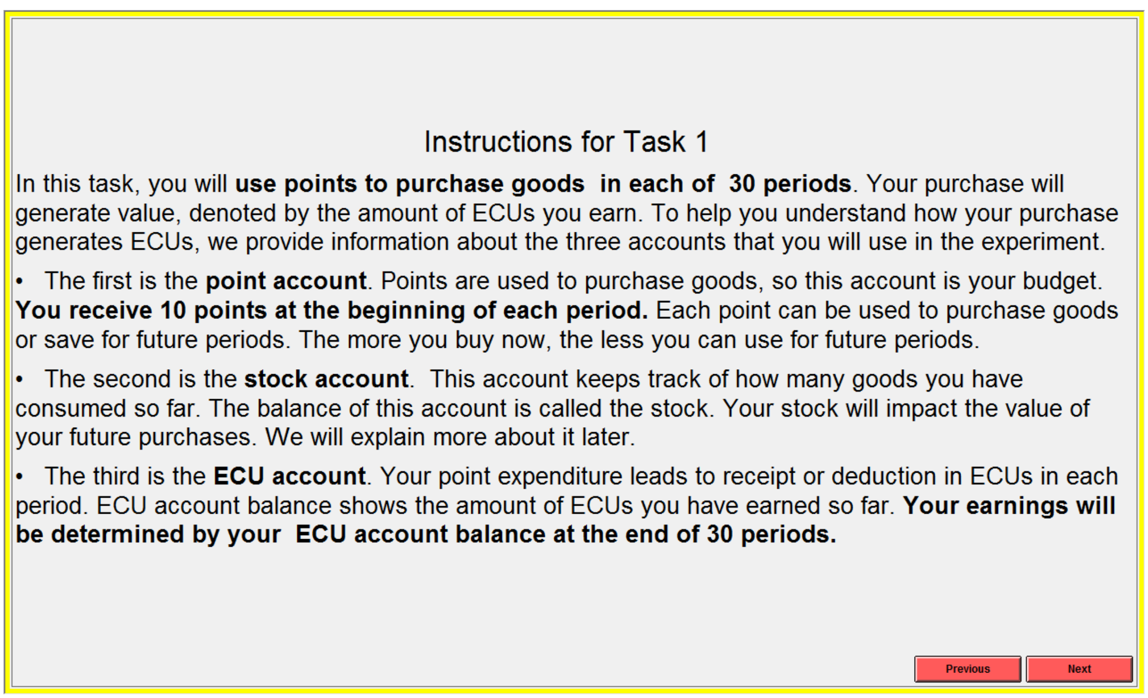
APPENDIX

SCREENSHOT OF THE EXPERIMENT





How to make purchasing decisions

Each period you have to decide how many points to spend on purchasing goods. To maximize the amount of ECUs you earned by the end of 30 periods, you need to understand how your ECU account balance changes with your purchase in each period.

The way your ECUs change is summarized in a table called the transformation scheme. A complete table is included in your handout. Each number in the table denotes the change in ECUS at a given expenditure (shown across the top of the table) and a given stock (shown along the left side of the table).

In the following, we provide two examples and have marked them on the table in your handout. Please look up the table and solve the following examples.

Example One: *Your current stock is 30. Expenditure of 10 points leads to an increase of* ***3.7*** *ECUs.*

Now suppose you spend 25 points instead, your ECUs will increase by

Example Two: *Your current stock is 0. Expenditure of 5 points leads to an increase of* ***2.9*** *ECUs.*

Suppose your stock is 70, you still spend 5 points. your ECUs will ***decrease*** *by*

Therefore it is possible for your ECU account balance to decrease when you purchase goods (The number in the table is negative.)

Also note that, in general, your account will be impacted even if you decide not to purchase any goods in the current period.

Previous Next

How to make purchasing decisions (Continued)

To summarize, the transformation scheme follows two rules:

First, in general, the more points you spend, the more ECUs you will generate for the current period.

Second, higher spending in the current period leads to higher stock. The higher the stock, the less earnings you will generate from EACH point spent in the future.

Borrowing from future

You can spend more than your current point balance by borrowing points from future. The maximum you can spend is your current available points plus the maximum you can borrow from all future periods, i.e., you cannot borrow more than you can repay.

In addition, a higher expenditure in the current period leads to less points for future use. If all your future points are used up in the current period, the experiment will be forced to end.

Previous Next

Structure and interface of the experiment

The experiment is made up of one real round and several practice rounds. **One complete round contains 30 periods.**

Each period you will **make a decision of how much to spend on the point account**. You will see part of the transformation scheme that is relevant to your decision making in the current period on your screen.

After you have chosen the number of goods to purchase in the current period, you can review changes in each of your accounts on the screen. If you are satisfied with your decision, you can click **confirm** and be directed to the next period. Once you do, you cannot go back to the previous period.

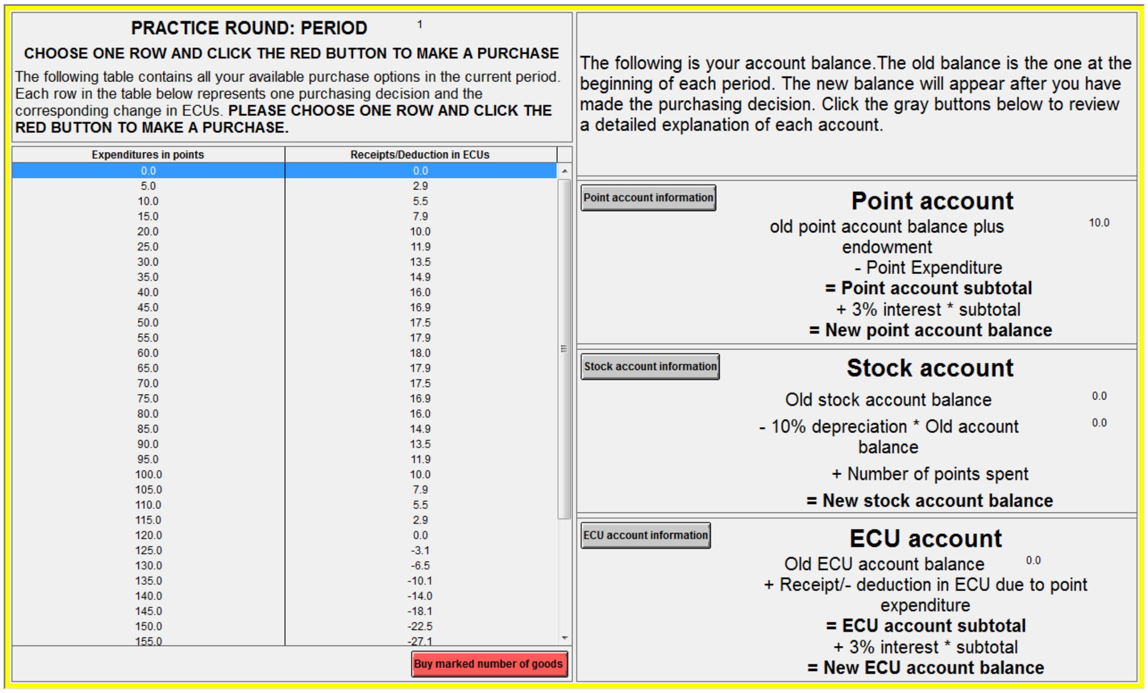
Before the real round, you will have a chance to practice. The practice round will neither affect your earnings nor your account balance in the real round.

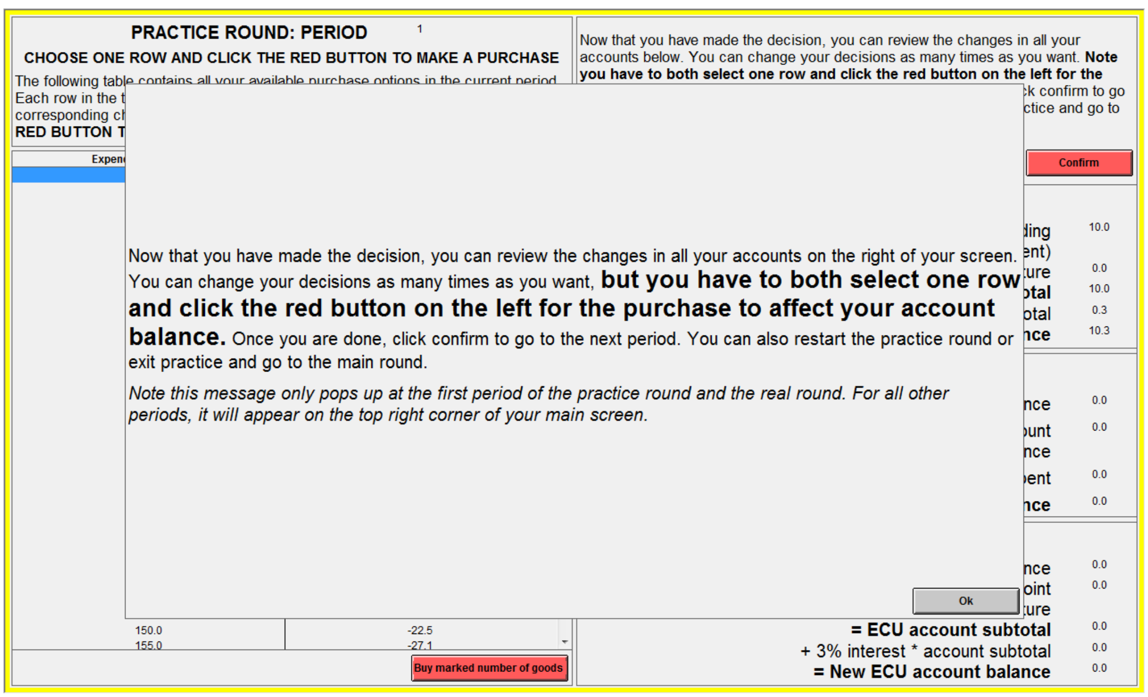
The practice round contains a maximum of 60 periods. But it will automatically restart every 30 periods to mimic the real round. You can **restart** it yourself as many times as you want, up to a total of 60 periods (You can not restart the real round.) Once you restart, your account balance will be the same as the balance when you first start the experiment. You can also choose to **exit** practice and begin the real round any time during the practice.

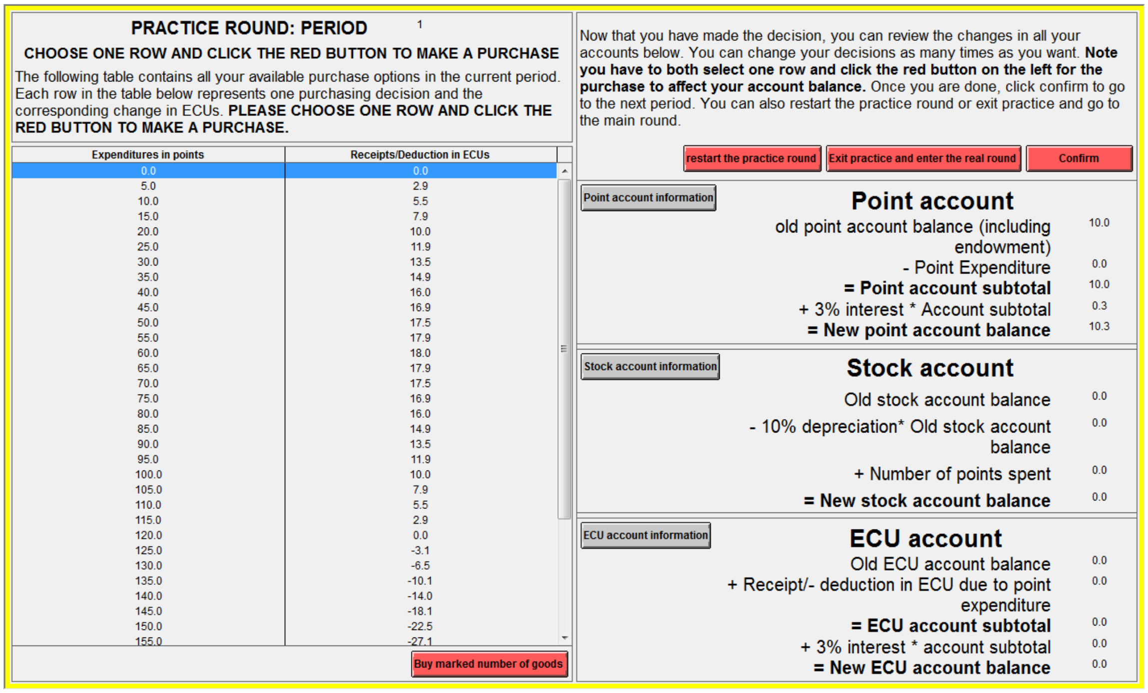
Previous Next

Now you can begin Task 1.

Previous Next


PRACTICE ROUND: PERIOD 1
CHOOSE ONE ROW AND CLICK THE RED BUTTON TO MAKE A PURCHASE
The following table contains all your available purchase options in the current period. Each row in the table below represents one purchasing decision and the corresponding change in ECUs. PLEASE CHOOSE ONE ROW AND CLICK THE RED BUTTON TO MAKE A PURCHASE.
Expenditures in points
Receipts/Deduction in ECUs
0.0 0.0
5.0 2.9
10.0 5.5
15.0 7.9
20.0 10.0
25.0 11.9
30.0 13.5
35.0 14.9
40.0 16.0
45.0 16.9
50.0 17.5
55.0 17.9
60.0 18.0
65.0 17.9
70.0 17.5
75.0 16.9
80.0 16.0
85.0 14.9
90.0 13.5
95.0 11.9
100.0 10.0
105.0 7.9
110.0 5.5
115.0 2.9
120.0 0.0
125.0 -3.1
130.0 -6.5
135.0 -10.1
140.0 -14.0
145.0 -18.1
150.0 -22.5
155.0 -27.1
Buy marked number of goods
The following is your account balance. The old balance is the one at the beginning of each period. The new balance will appear after you have made the purchasing decision. Click the gray buttons below to review a detailed explanation of each account.
Point account information
Point account
old point account balance plus endowment 10.0
- Point Expenditure
= Point account subtotal
+ 3% interest * subtotal
= New point account balance
Stock account information
Stock account
Old stock account balance 0.0
- 10% depreciation * Old account balance 0.0
+ Number of points spent
= New stock account balance
ECU account information
ECU account
Old ECU account balance 0.0
+ Receipt/- deduction in ECU due to point expenditure
= ECU account subtotal
+ 3% interest * subtotal
= New ECU account balance


PRACTICE ROUND: PERIOD 1
CHOOSE ONE ROW AND CLICK THE RED BUTTON TO MAKE A PURCHASE
Now that you have made the decision, you can review the changes in all your accounts below. You can change your decisions as many times as you want. Note you have to both select one row and click the red button on the left for the
Confirm
Now that you have made the decision, you can review the changes in all your accounts on the right of your screen. You can change your decisions as many times as you want, but you have to both select one row and click the red button on the left for the purchase to affect your account balance. Once you are done, click confirm to go to the next period. You can also restart the practice round or exit practice and go to the main round.
Note this message only pops up at the first period of the practice round and the real round. For all other periods, it will appear on the top right corner of your main screen.
Ok
150.0 -22.5
155.0 -27.1
Buy marked number of goods
= ECU account subtotal 0.0
+ 3% interest * account subtotal 0.0
= New ECU account balance 0.0



PRACTICE ROUND: PERIOD 1

CHOOSE ONE ROW AND CLICK THE RED BUTTON TO MAKE A PURCHASE

The following table contains all your available purchase options in the current period. Each row in the table below represents one purchasing decision and the corresponding change in ECUs. **PLEASE CHOOSE ONE ROW AND CLICK THE RED BUTTON TO MAKE A PURCHASE.**

Expenditures in points	Receipts/Deduction in ECUs
0.0	0.0
5.0	2.9
10.0	5.5
15.0	7.9
20.0	10.0
25.0	11.9
30.0	13.5
35.0	14.9
40.0	16.0
45.0	16.9
50.0	17.5
55.0	17.9
60.0	18.0
65.0	17.9
70.0	17.5
75.0	16.9
80.0	16.0
85.0	14.9
90.0	13.5
95.0	11.9
100.0	10.0
105.0	7.9
110.0	5.5
115.0	2.9
120.0	0.0
125.0	-3.1
130.0	-6.5
135.0	-10.1
140.0	-14.0
145.0	-18.1
150.0	-22.5
155.0	-27.1

Buy marked number of goods

Now that you have made the decision, you can review the changes in all your accounts below. You can change your decisions as many times as you want. **Note you have to both select one row and click the red button on the left for the purchase to affect your account balance.** Once you are done, click confirm to go to the next period. You can also restart the practice round or exit practice and go to the main round.

restart the practice round | Exit practice and enter the real round | Confirm

Point account information

Point account

old point account balance (including endowment)	10.0
- Point Expenditure	0.0
= Point account subtotal	10.0
+ 3% interest * Account subtotal	0.3
= New point account balance	10.3

Stock account information

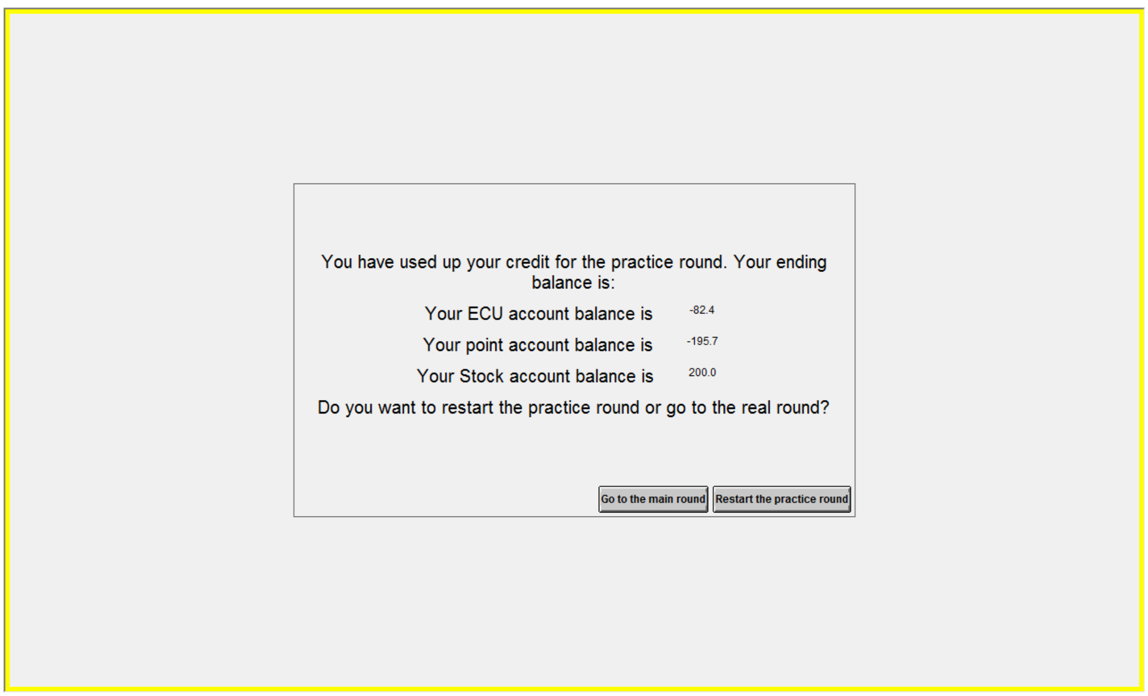
Stock account

Old stock account balance	0.0
- 10% depreciation* Old stock account balance	0.0
+ Number of points spent	0.0
= New stock account balance	0.0

ECU account information

ECU account

Old ECU account balance	0.0
+ Receipt/- deduction in ECU due to point expenditure	0.0
= ECU account subtotal	0.0
+ 3% interest * account subtotal	0.0
= New ECU account balance	0.0



You have used up your credit for the practice round. Your ending balance is:

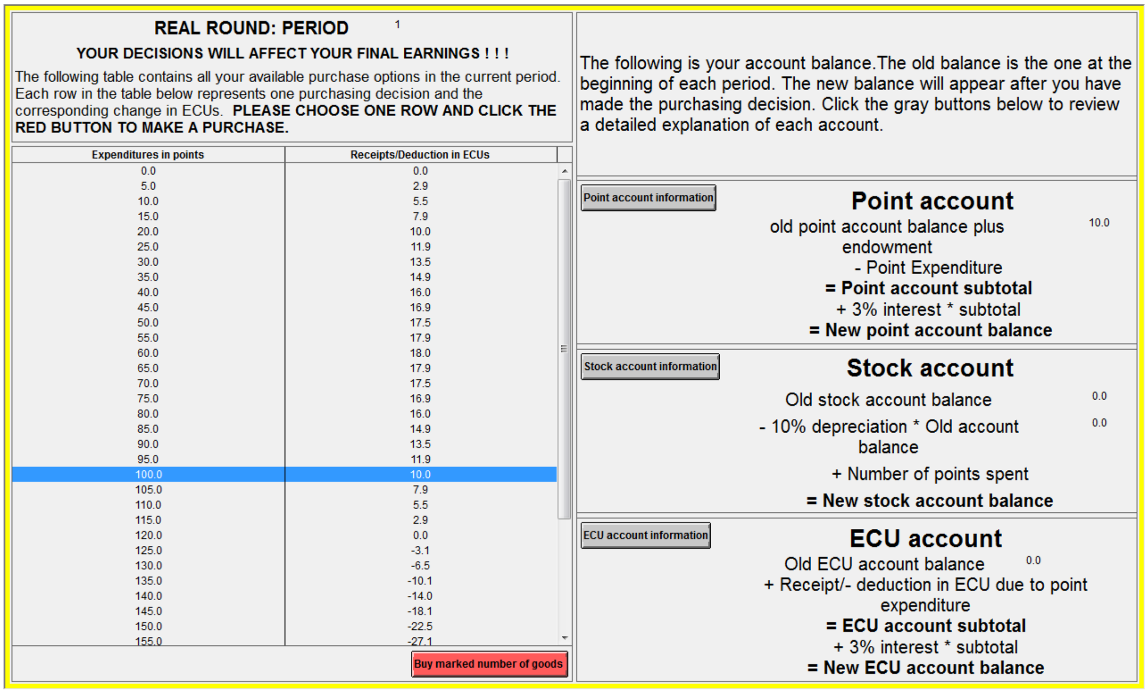
Your ECU account balance is -82.4

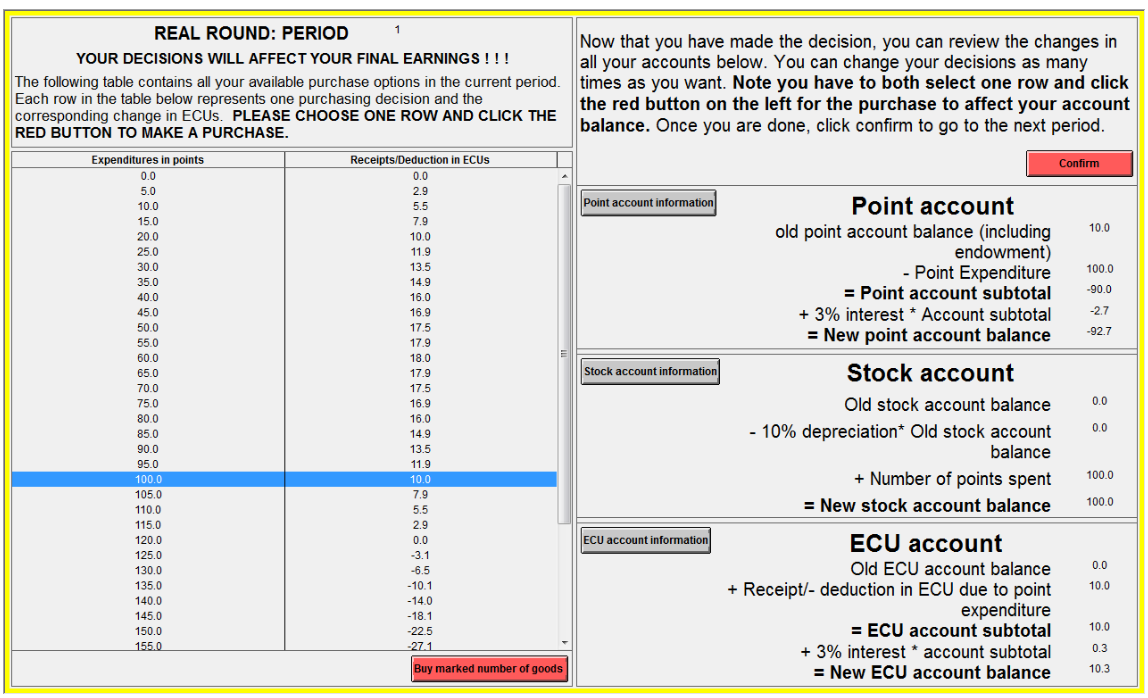
Your point account balance is -195.7

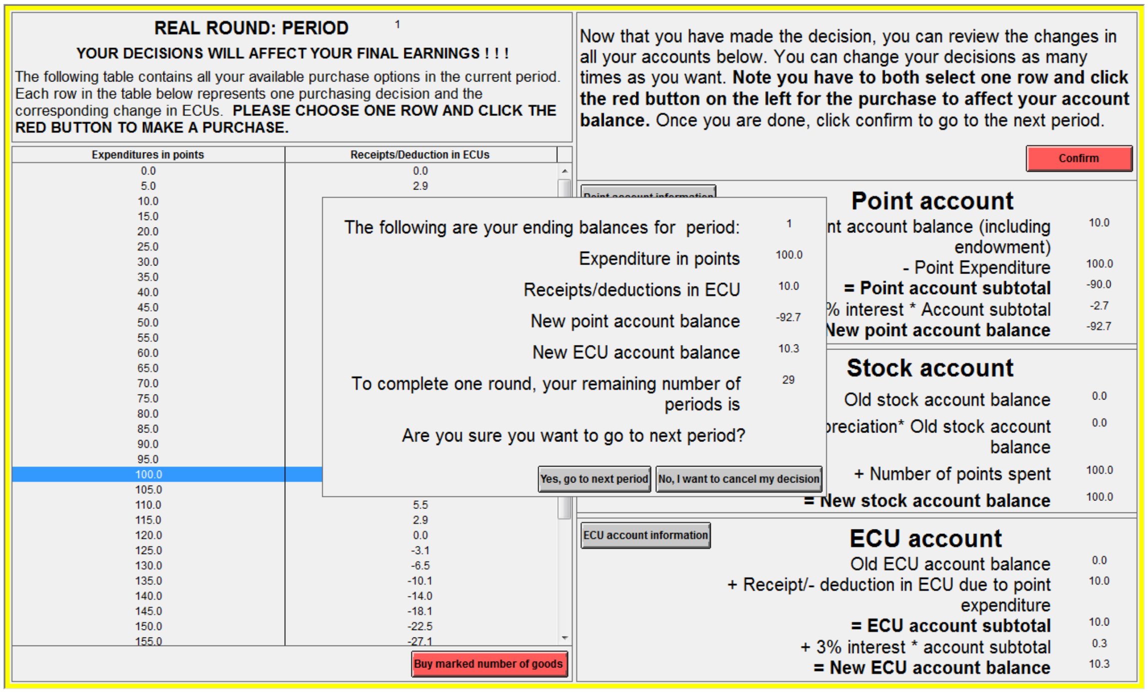
Your Stock account balance is 200.0

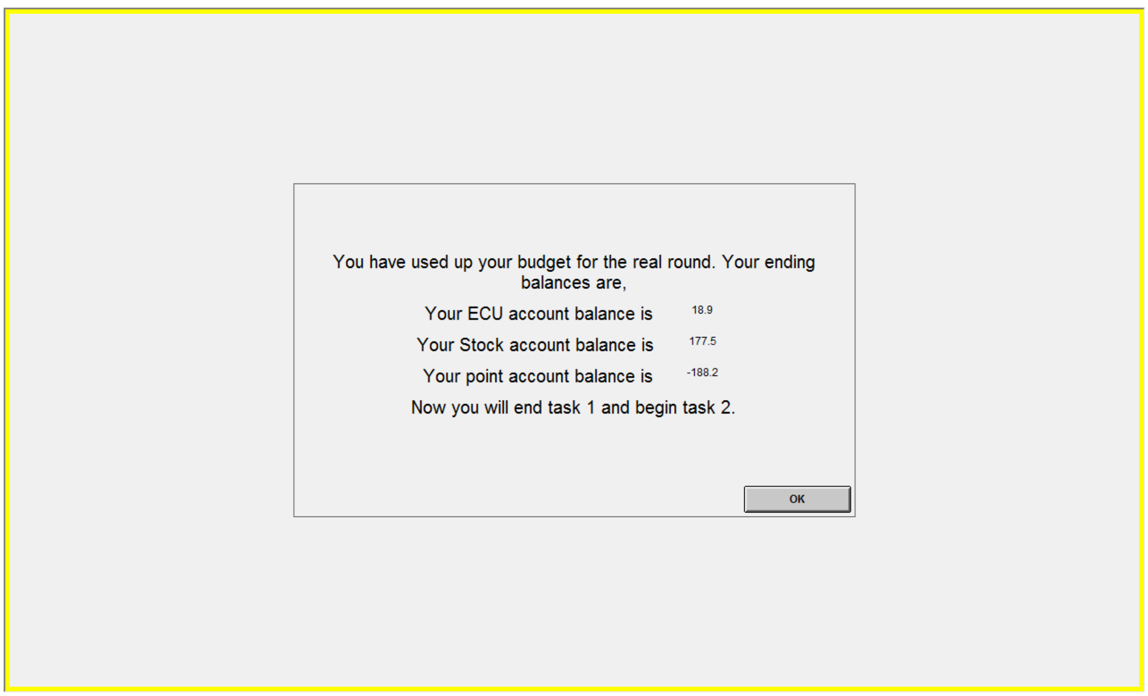
Do you want to restart the practice round or go to the real round?

Go to the main round | Restart the practice round


REAL ROUND: PERIOD 1
YOUR DECISIONS WILL AFFECT YOUR FINAL EARNINGS ! ! !
The following table contains all your available purchase options in the current period. Each row in the table below represents one purchasing decision and the corresponding change in ECUs. PLEASE CHOOSE ONE ROW AND CLICK THE RED BUTTON TO MAKE A PURCHASE.
Expenditures in points
Receipts/Deduction in ECUs
0.0 0.0
5.0 2.9
10.0 5.5
15.0 7.9
20.0 10.0
25.0 11.9
30.0 13.5
35.0 14.9
40.0 16.0
45.0 16.9
50.0 17.5
55.0 17.9
60.0 18.0
65.0 17.9
70.0 17.5
75.0 16.9
80.0 16.0
85.0 14.9
90.0 13.5
95.0 11.9
100.0 10.0
105.0 7.9
110.0 5.5
115.0 2.9
120.0 0.0
125.0 -3.1
130.0 -6.5
135.0 -10.1
140.0 -14.0
145.0 -18.1
150.0 -22.5
155.0 -27.1
Buy marked number of goods
The following is your account balance. The old balance is the one at the beginning of each period. The new balance will appear after you have made the purchasing decision. Click the gray buttons below to review a detailed explanation of each account.
Point account information
Point account
old point account balance plus endowment 10.0
- Point Expenditure
= Point account subtotal
+ 3% interest * subtotal
= New point account balance
Stock account information
Stock account
Old stock account balance 0.0
- 10% depreciation * Old account balance 0.0
+ Number of points spent
= New stock account balance
ECU account information
ECU account
Old ECU account balance 0.0
+ Receipt/- deduction in ECU due to point expenditure
= ECU account subtotal
+ 3% interest * subtotal
= New ECU account balance


REAL ROUND: PERIOD 1
YOUR DECISIONS WILL AFFECT YOUR FINAL EARNINGS ! ! !
The following table contains all your available purchase options in the current period. Each row in the table below represents one purchasing decision and the corresponding change in ECUs. PLEASE CHOOSE ONE ROW AND CLICK THE RED BUTTON TO MAKE A PURCHASE.
Expenditures in points
Receipts/Deduction in ECUs
0.0 0.0
5.0 2.9
10.0 5.5
15.0 7.9
20.0 10.0
25.0 11.9
30.0 13.5
35.0 14.9
40.0 16.0
45.0 16.9
50.0 17.5
55.0 17.9
60.0 18.0
65.0 17.9
70.0 17.5
75.0 16.9
80.0 16.0
85.0 14.9
90.0 13.5
95.0 11.9
100.0 10.0
105.0 7.9
110.0 5.5
115.0 2.9
120.0 0.0
125.0 -3.1
130.0 -6.5
135.0 -10.1
140.0 -14.0
145.0 -18.1
150.0 -22.5
155.0 -27.1
Buy marked number of goods
Now that you have made the decision, you can review the changes in all your accounts below. You can change your decisions as many times as you want. Note you have to both select one row and click the red button on the left for the purchase to affect your account balance. Once you are done, click confirm to go to the next period.
Confirm
Point account information
Point account
old point account balance (including endowment) 10.0
- Point Expenditure 100.0
= Point account subtotal -90.0
+ 3% interest * Account subtotal -2.7
= New point account balance -92.7
Stock account information
Stock account
Old stock account balance 0.0
- 10% depreciation* Old stock account balance 0.0
+ Number of points spent 100.0
= New stock account balance 100.0
ECU account information
ECU account
Old ECU account balance 0.0
+ Receipt/- deduction in ECU due to point expenditure 10.0
= ECU account subtotal 10.0
+ 3% interest * account subtotal 0.3
= New ECU account balance 10.3


REAL ROUND: PERIOD 1
YOUR DECISIONS WILL AFFECT YOUR FINAL EARNINGS ! ! !
The following table contains all your available purchase options in the current period. Each row in the table below represents one purchasing decision and the corresponding change in ECUs. PLEASE CHOOSE ONE ROW AND CLICK THE RED BUTTON TO MAKE A PURCHASE.
Expenditures in points
Receipts/Deduction in ECUs
0.0 0.0
5.0 2.9
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
85.0
90.0
95.0
100.0
105.0
110.0 5.5
115.0 2.9
120.0 0.0
125.0 -3.1
130.0 -6.5
135.0 -10.1
140.0 -14.0
145.0 -18.1
150.0 -22.5
155.0 -27.1
Buy marked number of goods
Now that you have made the decision, you can review the changes in all your accounts below. You can change your decisions as many times as you want. Note you have to both select one row and click the red button on the left for the purchase to affect your account balance. Once you are done, click confirm to go to the next period.
Confirm
Point account
nt account balance (including endowment) 10.0
- Point Expenditure 100.0
= Point account subtotal -90.0
% interest * Account subtotal -2.7
New point account balance -92.7
Stock account
Old stock account balance 0.0
preciation* Old stock account balance 0.0
+ Number of points spent 100.0
= New stock account balance 100.0
ECU account information
ECU account
Old ECU account balance 0.0
+ Receipt/- deduction in ECU due to point expenditure 10.0
= ECU account subtotal 10.0
+ 3% interest * account subtotal 0.3
= New ECU account balance 10.3
The following are your ending balances for period: 1
Expenditure in points 100.0
Receipts/deductions in ECU 10.0
New point account balance -92.7
New ECU account balance 10.3
To complete one round, your remaining number of periods is 29
Are you sure you want to go to next period?
Yes, go to next period
No, I want to cancel my decision


You have used up your budget for the real round. Your ending balances are,
Your ECU account balance is 18.9
Your Stock account balance is 177.5
Your point account balance is -188.2
Now you will end task 1 and begin task 2.
OK

Instructions for Task 2

Thank you for completing Task 1. Now we will begin Task 2.

For this task, you will make six different decisions. One of these will be randomly selected for payment. You will earn money in ECUs. Each ECU you earn will be translated to cash payment at a rate of 1 ECU=0.1 Dollar.

Each deicision has two options: Option A:an amount of money paid to you tomorrow (1 day), Option B: a larger amount paid to you one month later (31 days). You must choose the sooner or later option for each question.

Example: *Player #2 was chosen to be paid for task 2. She chooses option A for Decision 1, A for Decision 2, B for Decision 3, B for question 4, B for Decision 5, and B for Decision 6 (or A, A, B, B, B, B). In the hallway after the choices are made Player #2 rolls a "4" on a six-sided die. Decision 4 asks a player to choose between receiving 100 ECU in 1 day or receiving 125 ECU in 31 days. Since she chose option B, Player #2 will receive 125 ECU (or $12.5) in 31 days.*

Next

Instructions for Task 2 (Continued)

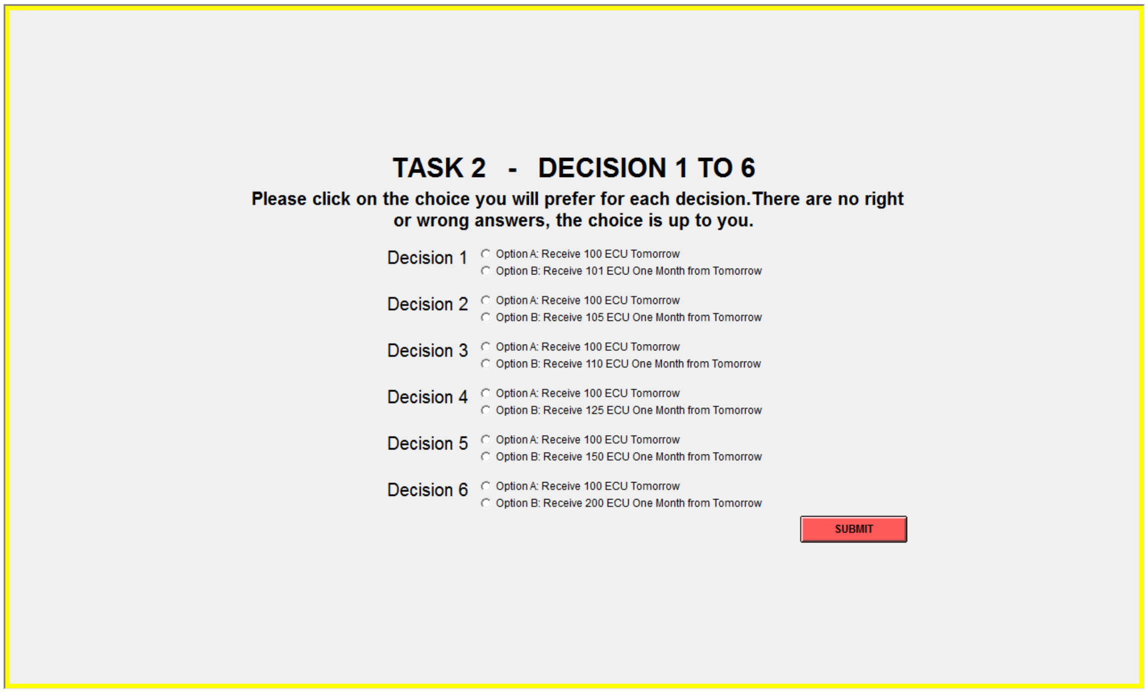
Two people will be selected at random and paid for task 2. If you are chosen to be paid for task 2, the experimenter will notify you when you recieve your payment. In addition, you will be asked to roll a six-sided die at the check-in desk to determine which of the six questions will be paid.

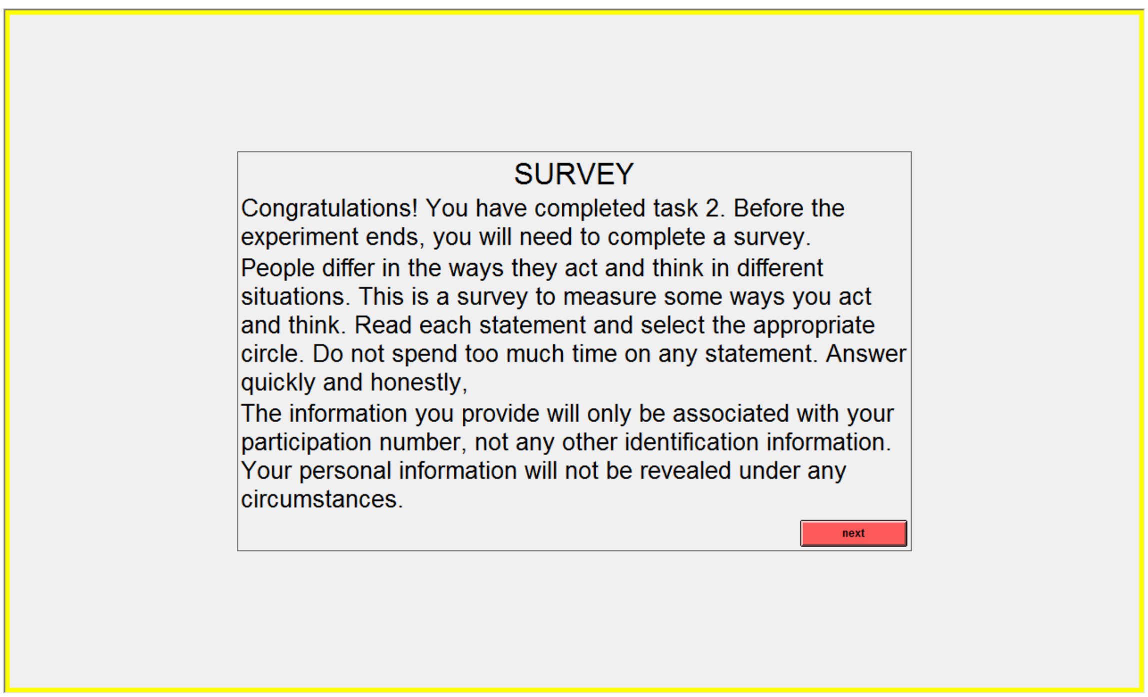
On the scheduled day of payment (tomorrow or one month from tomorrow, depending on which one you choose, a check will be placed for delivery. All payment you receive will arrive to your mailbox at the address you provide to us. If your address has changed before the pay day, please contact the experimenter immediately either by mail or by phone. The dates are marked on the calendar in your handout.

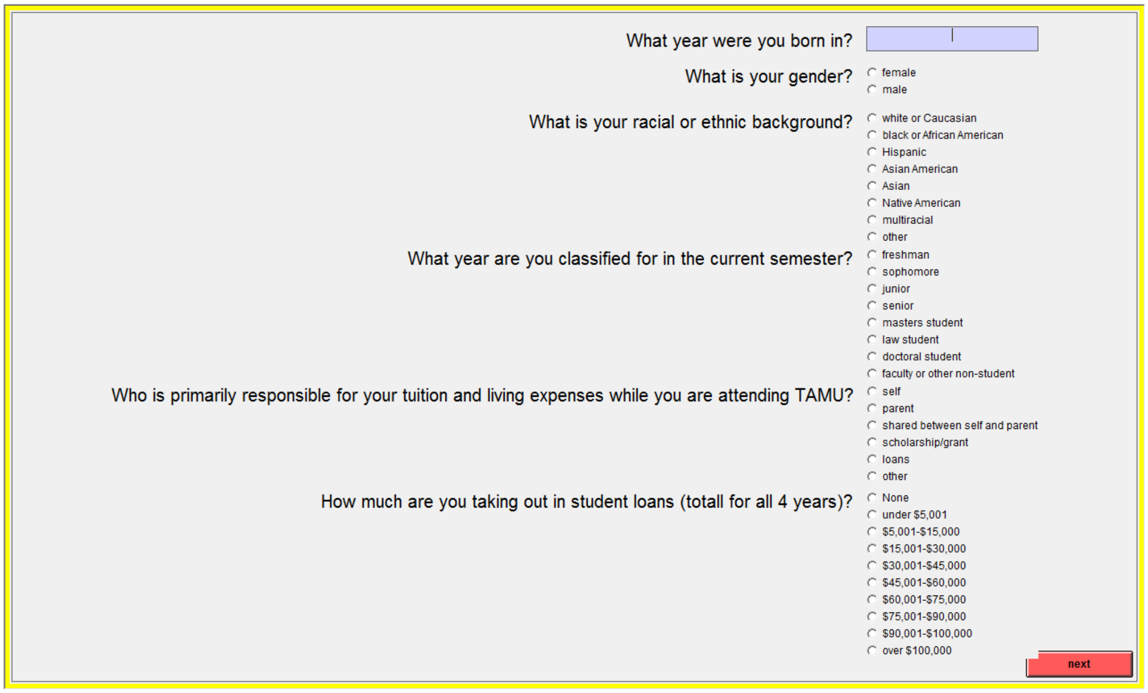
You can also choose to come to ERL yourself and pick up the check at the scheduled pay day.

If you have any questions, you can raise your hand and the experimenter will come to you. If you have no more questions, you can begin Task 2.

Previous Next


TASK 2 - DECISION 1 TO 6
Please click on the choice you will prefer for each decision.There are no right or wrong answers, the choice is up to you.
Decision 1
Option A: Receive 100 ECU Tomorrow
Option B: Receive 101 ECU One Month from Tomorrow
Decision 2
Option A: Receive 100 ECU Tomorrow
Option B: Receive 105 ECU One Month from Tomorrow
Decision 3
Option A: Receive 100 ECU Tomorrow
Option B: Receive 110 ECU One Month from Tomorrow
Decision 4
Option A: Receive 100 ECU Tomorrow
Option B: Receive 125 ECU One Month from Tomorrow
Decision 5
Option A: Receive 100 ECU Tomorrow
Option B: Receive 150 ECU One Month from Tomorrow
Decision 6
Option A: Receive 100 ECU Tomorrow
Option B: Receive 200 ECU One Month from Tomorrow
SUBMIT


SURVEY
Congratulations! You have completed task 2. Before the experiment ends, you will need to complete a survey.
People differ in the ways they act and think in different situations. This is a survey to measure some ways you act and think. Read each statement and select the appropriate circle. Do not spend too much time on any statement. Answer quickly and honestly,
The information you provide will only be associated with your participation number, not any other identification information. Your personal information will not be revealed under any circumstances.
next



What year were you born in?

What is your gender?
- female
- male

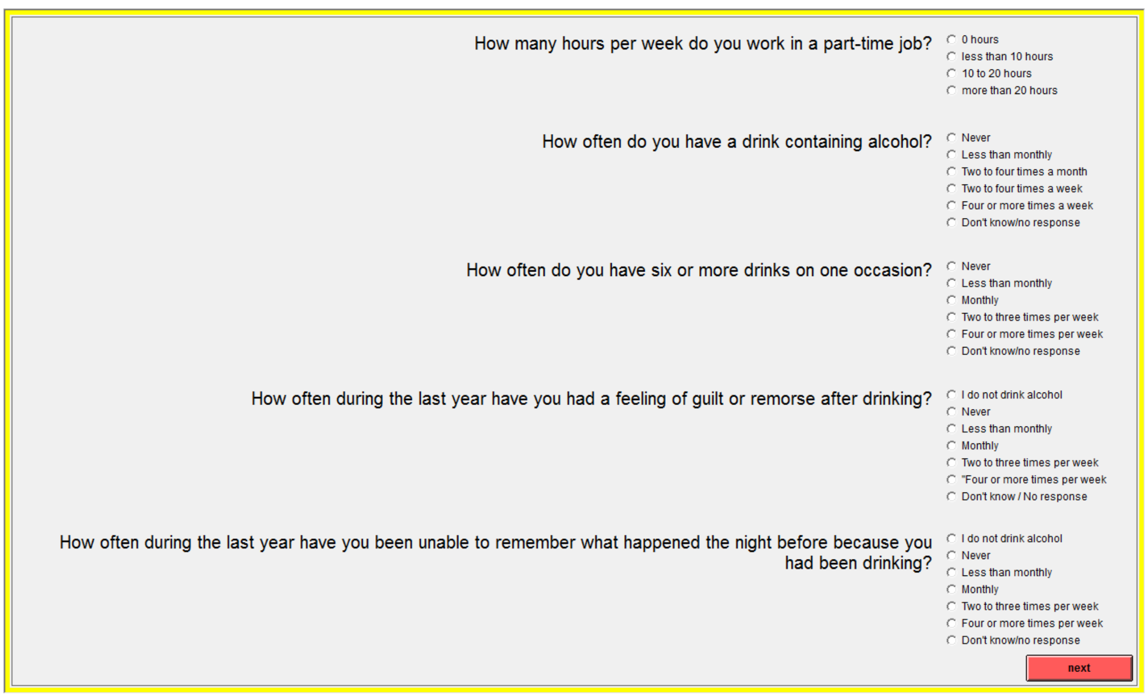
What is your racial or ethnic background?
- white or Caucasian
- black or African American
- Hispanic
- Asian American
- Asian
- Native American
- multiracial
- other

What year are you classified for in the current semester?
- freshman
- sophomore
- junior
- senior
- masters student
- law student
- doctoral student
- faculty or other non-student

Who is primarily responsible for your tuition and living expenses while you are attending TAMU?
- self
- parent
- shared between self and parent
- scholarship/grant
- loans
- other

How much are you taking out in student loans (totall for all 4 years)?
- None
- under $5,001
- $5,001-$15,000
- $15,001-$30,000
- $30,001-$45,000
- $45,001-$60,000
- $60,001-$75,000
- $75,001-$90,000
- $90,001-$100,000
- over $100,000

next



How many hours per week do you work in a part-time job?
- 0 hours
- less than 10 hours
- 10 to 20 hours
- more than 20 hours

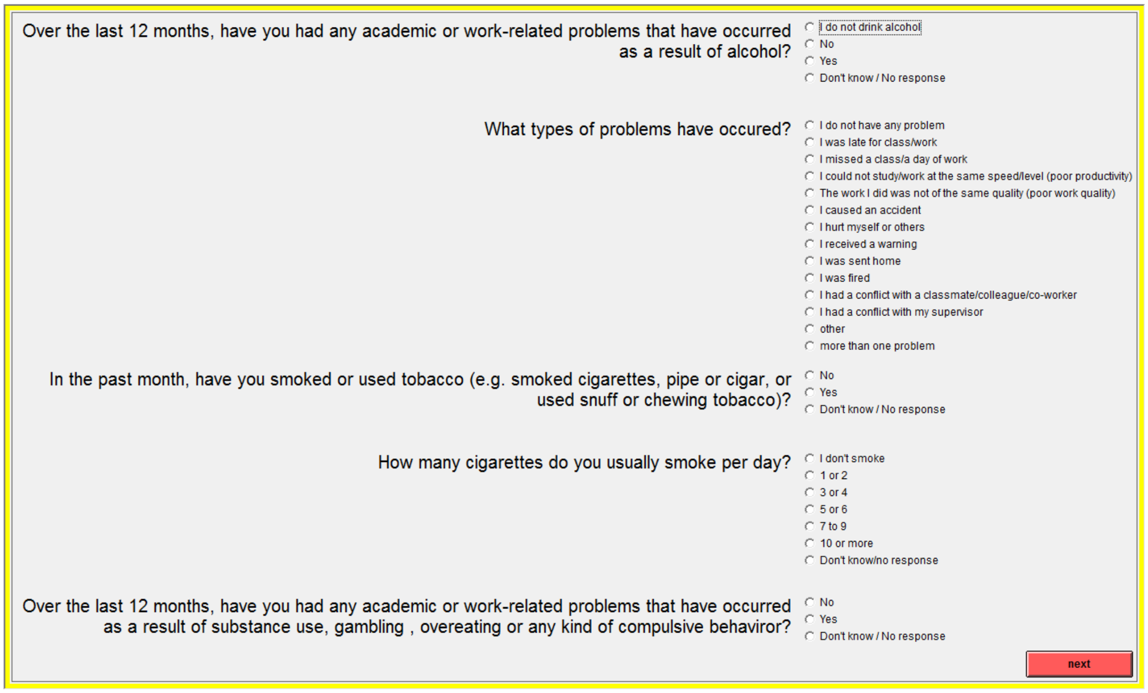
How often do you have a drink containing alcohol?
- Never
- Less than monthly
- Two to four times a month
- Two to four times a week
- Four or more times a week
- Don't know/no response

How often do you have six or more drinks on one occasion?
- Never
- Less than monthly
- Monthly
- Two to three times per week
- Four or more times per week
- Don't know/no response

How often during the last year have you had a feeling of guilt or remorse after drinking?
- I do not drink alcohol
- Never
- Less than monthly
- Monthly
- Two to three times per week
- "Four or more times per week
- Don't know / No response

How often during the last year have you been unable to remember what happened the night before because you had been drinking?
- I do not drink alcohol
- Never
- Less than monthly
- Monthly
- Two to three times per week
- Four or more times per week
- Don't know/no response

next



Over the last 12 months, have you had any academic or work-related problems that have occurred as a result of alcohol?

- I do not drink alcohol
- No
- Yes
- Don't know / No response

What types of problems have occured?

- I do not have any problem
- I was late for class/work
- I missed a class/a day of work
- I could not study/work at the same speed/level (poor productivity)
- The work I did was not of the same quality (poor work quality)
- I caused an accident
- I hurt myself or others
- I received a warning
- I was sent home
- I was fired
- I had a conflict with a classmate/colleague/co-worker
- I had a conflict with my supervisor
- other
- more than one problem

In the past month, have you smoked or used tobacco (e.g. smoked cigarettes, pipe or cigar, or used snuff or chewing tobacco)?

- No
- Yes
- Don't know / No response

How many cigarettes do you usually smoke per day?

- I don't smoke
- 1 or 2
- 3 or 4
- 5 or 6
- 7 to 9
- 10 or more
- Don't know/no response

Over the last 12 months, have you had any academic or work-related problems that have occurred as a result of substance use, gambling , overeating or any kind of compulsive behaviror?

- No
- Yes
- Don't know / No response

next

I plan tasks carefully.

- Rarely/Never
- Occassionally
- Often
- Almost Always/Always

I do things without thinking.

- Rarely/Never
- Occassionally
- Often
- Almost Always/Always

I make-up my mind quickly.

- Rarely/Never
- Occassionally
- Often
- Almost Always/Always

I am happy -go-lucky.

- Rarely/Never
- Occassionally
- Often
- Almost Always/Always

I plan trips well ahead of time.

- Rarely/Never
- Occassionally
- Often
- Almost Always/Always

I have racing thoughts.

- Rarely/Never
- Occassionally
- Often
- Almost Always/Always

I don't pay attention.

- Rarely/Never
- Occassionally
- Often
- Almost Always/Always

I am self controlled.

- Rarely/Never
- Occassionally
- Often
- Almost Always/Always

next


I concentrate easily.
- Rarely/Never
- Occassionally
- Often
- Almost Always/Always

I save regularly.
- Rarely/Never
- Occassionally
- Often
- Almost Always/Always

I "squirm" at plays or lectures.
- Rarely/Never
- Occassionally
- Often
- Almost Always/Always

I am a careful thinker.
- Rarely/Never
- Occassionally
- Often
- Almost Always/Always

I plan for job security.
- Rarely/Never
- Occassionally
- Often
- Almost Always/Always

I say things without thinking.
- Rarely/Never
- Occassionally
- Often
- Almost Always/Always

I like to think about complex problems.
- Rarely/Never
- Occassionally
- Often
- Almost Always/Always

next


I change jobs.
- Rarely/Never
- Occassionally
- Often
- Almost Always/Always

I act "on impulse".
- Rarely/Never
- Occassionally
- Often
- Almost Always/Always

I get easily bored when solving thought problems.
- Rarely/Never
- Occassionally
- Often
- Almost Always/Always

I act on the spur of the moment.
- Rarely/Never
- Occassionally
- Often
- Almost Always/Always

I am a steady thinker.
- Rarely/Never
- Occassionally
- Often
- Almost Always/Always

I change residences.
- Rarely/Never
- Occassionally
- Often
- Almost Always/Always

I buy things on impulse.
- Rarely/Never
- Occassionally
- Often
- Almost Always/Always

I can only think about one thing at a time.
- Rarely/Never
- Occassionally
- Often
- Almost Always/Always

next

I change hobbies.
- Rarely/Never
- Occassionally
- Often
- Almost Always/Always

I spend or charge more than I earn.
- Rarely/Never
- Occassionally
- Often
- Almost Always/Always

I often have extraneous thoughts when thinking.
- Rarely/Never
- Occassionally
- Often
- Almost Always/Always

I am more interested in the present than the future.
- Rarely/Never
- Occassionally
- Often
- Almost Always/Always

I am restless at the theater or lectures.
- Rarely/Never
- Occassionally
- Often
- Almost Always/Always

I like puzzles.
- Rarely/Never
- Occassionally
- Often
- Almost Always/Always

I am future oriented.
- Rarely/Never
- Occassionally
- Often
- Almost Always/Always

Submit

Congratulations! You have finished the experiment.

The following are your payment information.

Your show up fee= $5.

Your payment for task 1(ECU ending balance* exchange rate)=$ 0.00

If you are chosen to be paid for task 2, one of the following six decisions will be paid to you at the scheduled pay day.

Your payment for decision 1 in task 2 is $ 10.0

Your payment for decision 2 in task 2 is $ 10.5

Your payment for decision 3 in task 2 is $ 11.0

Your payment for decision 4 in task 2 is $ 12.5

Your payment for decision 5 in task 2 is $ 15.0

Your payment for decision 6 in task 2 is $ 20.0

Please raise your hand to notify the experimenter that you have finished the experiment. Wait in your seat while the experiment write your receipt form and hand it to you. Then you can collect your belongs and go to the check-in desk where an assistant will guide you through the payment procedule.

Please do not disturb others while you are in the lab. Thanks!