Commitment Trials:
Psychological Selective Trials for Randomized Experiments

Kweku A. Opoku-Agyemang*

July 18, 2023

Abstract

We study how quasi-hyperbolic discounting affects the design and implementation of selective trials, which are randomized controlled experiments that account for subjects' unobserved effort. We show that quasi-hyperbolic preferences may create confounding effects of treatment and effort, and may induce biases in policy choices and evaluations. We propose commitment trials that use commitment devices to overcome these problems. We also consider the case where both the subjects and the principals (researchers or policymakers) have quasi-hyperbolic preferences.

*Development Economics X. Email: kweku@developmenteconomicsx.com. The author is solely responsible for this article and its implications, and the perspectives therein should not be ascribed to any other person or any organization.

Contents

1 Introduction

Economists are encouraged to engage with nonspecialists, such as governments and other stakeholders (e.g. Udry 1997; Duflo, 2017). Randomized controlled experiments (RCTs) are thus widely used in economics and other social sciences to evaluate the causal effects of policies and interventions. However, RCTs often face challenges in ensuring external validity, i.e., the generalizability of the results to other contexts and populations (List, 2020). One reason for this is that the outcomes of interest may depend not only on the treatment assigned, but also on the effort exerted by the experimental subjects, which is typically unobserved and may vary across settings. For example, the impact of a health intervention may depend on how much the subjects comply with the prescribed behavior or medication, which may in turn depend on their beliefs, preferences, incentives, and constraints.

To help address this issue, work has focused on selective trials, which are a class of mechanisms that elicit subjects' values for different treatments and assign treatments based on these values (see Chassang et al. (2012)). Selective trials can help improve external validity by disentangling the effects of treatment, effort, and the interaction of treatment and effort. They can also help identify when treatment effects are affected by erroneous beliefs and inappropriate effort expenditure[1].

However, selective trials assume that subjects have time-consistent preferences, i.e., they discount future payoffs at a constant rate. This assumption may not hold in many situations, as there is ample evidence that people exhibit time inconsistency, i.e., they discount future payoffs at a higher rate when they are closer to the present. This phenomenon is often captured by quasi-hyperbolic discounting models, which assume that people have a present bias that leads them to overvalue immediate gratification and undervalue long-term consequences.

In this paper, we extend selective trials to contexts where subjects have quasi-hyperbolic preferences. We show that quasi-hyperbolic preferences may create confounding effects of treatment and effort, and may induce biases in policy choices and evaluations. We propose *commitment trials* that use commitment devices to overcome these problems for subjects. We also consider the case where both the subjects and the principals (researchers or policymakers) have quasi-hyperbolic preferences.

[1]For related overviews and broadly-relevant experiments and scaling approaches, see Banerjee et al (2017), De Quidt, Haushofer and Roth (2018), Vivalt (2020).

We show how this may affect the design and implementation of selective trials, and how commitment trials can help in this case as well.

The rest of the paper is organized as follows. Section 2 reviews the selective trials framework and introduces quasi-hyperbolic discounting. Section 3 analyzes the case where subjects have quasi-hyperbolic preferences and proposes commitment trials. Section 4 analyzes the case where both subjects and principals have quasi-hyperbolic preferences and extends commitment trials accordingly. Section 5 concludes.

2 The selective trials framework

In this section, we review the selective trials framework proposed by Chassang et al. (2012) and introduce quasi-hyperbolic discounting as an alternative model of time preferences.

Selective trials are a way of designing randomized controlled experiments when outcomes are significantly affected by experimental subjects' unobserved effort expenditure. The basic idea is to elicit subjects' values for different treatments and assign treatments based on these values. This allows the researcher to infer the causal effects of treatment, effort, and the interaction of treatment and effort on the outcome, as well as to identify when treatment effects are affected by erroneous beliefs and inappropriate effort expenditure.

More formally, suppose there are two treatments, A and B, and a binary outcome Y that depends on the treatment T and the effort E of the subject. The utility function of the subject is given by $U(Y, E)$, where U is increasing in Y and decreasing in E. The subject has a value V for treatment A relative to treatment B, which is his private information. The researcher does not observe V or E, but observes Y and T.

The researcher designs a mechanism G that consists of a message space M, a probability distribution P over treatments conditional on messages, and a payment function R that depends on messages, treatments, and outcomes. The mechanism G induces a value function W for the subject, which is his expected utility from participating in the mechanism given his value V. The subject chooses a message m to maximize $W(m, V)$.

The researcher's objective is to identify the causal effects of T and E on Y, as well as to test whether V is correlated with E or Y. To do so, the researcher needs to ensure that the mechanism G satisfies two properties: incentive compatibility and full support.

Incentive compatibility means that for any value V, the subject has a unique optimal message $m(V)$ that reveals his true value. This implies that $W(m, V)$ is strictly increasing in V for any m.

Full support means that for any message m, the probability of receiving treatment A is strictly between zero and one. This implies that $P(m, A)$ is strictly increasing in m for any A.

Under these two properties, the researcher can recover the distribution of values $F(V)$ from the distribution of messages $F(m)$, and can estimate the causal effects of T and E on Y by comparing the outcomes across different messages and treatments.

Chassang et al. (2012) show that there exists a class of mechanisms that satisfy incentive compatibility and full support. These mechanisms are called selective trials because they select subjects into treatments based on their values. One example of such a mechanism is the Becker-DeGroot-Marschak (BDM) mechanism, which works as follows:

1. The subject reports his value V for treatment A relative to treatment B.

2. The researcher draws a random price P from a uniform distribution over $[Vmin, Vmax]$, where $Vmin$ and $Vmax$ are the minimum and maximum possible values.

3. If $V \geq P$, the subject receives treatment A and pays P; otherwise, he receives treatment B and pays nothing.

The BDM mechanism is incentive compatible because the subject's optimal strategy is to report his true value V regardless of his beliefs about P. It is also full support because for any reported value V, there is a positive probability of receiving either treatment A or treatment B.

However, the selective trials framework assumes that subjects have time-consistent preferences, i.e., they discount future payoffs at a constant rate. This assumption may not hold in many situations, as there is ample evidence that people exhibit time inconsistency, i.e., they discount future payoffs at a higher rate when they are closer to the present. This phenomenon is often captured by quasi-hyperbolic discounting models, which assume that people have a present bias that leads them to overvalue immediate gratification and undervalue long-term consequences.

Quasi-hyperbolic discounting models were introduced by Phelps and Pollak (1968) and popularized by Laibson (1997). They assume that people have two discount factors: β for immediate payoffs and γ for future payoffs, where $\beta < 1 < \gamma$. This implies that people have a higher discount rate for immediate payoffs than for future payoffs, which induces patterns of time inconsistency and self-control problems.

To illustrate how quasi-hyperbolic discounting affects selective trials, suppose that the outcome Y takes one year to materialize after the treatment T is assigned, while the effort E and the payment P are incurred immediately. The utility function of the subject is given by $U(Y, E, P)$, where U is increasing in Y and decreasing in E and P. The subject's value function W under quasi-hyperbolic discounting is given by:

$$W(m, V) = \beta[U(Y, E, P) + \gamma E[U(Y', E', P')|m, V]]$$

where Y', E', and P' are the outcome, effort, and payment in the next period, conditional on the message m and the value V in the current period.

Quasi-hyperbolic discounting may create confounding effects of treatment and effort on the outcome, and may induce biases in policy choices and evaluations. We explore these issues in the next section.

3 Commitment Trials

In this section, we analyze the case where subjects have quasi-hyperbolic preferences and propose commitment trials that use commitment devices to overcome the confounding effects of treatment and effort.

We first show that quasi-hyperbolic preferences may create a confounding effect of treatment and effort on the outcome. To see this, consider the BDM mechanism under quasi-hyperbolic discounting. The subject's value function is given by:

$$W(m, V) = \beta[U(Y, E, P) + \delta E[U(Y', E', P')|m, V]]$$

where Y, E, and P are the outcome, effort, and payment in the current period, and Y', E', and P' are the outcome, effort, and payment in the next period, conditional on the message m and the value V in the current period.

The subject chooses a message m to maximize $W(m, V)$. The optimal message $m^*(V)$ satisfies the first-order condition:

$$\frac{\partial W}{\partial m} = \beta \left[\frac{\partial U}{\partial Y}\frac{\partial Y}{\partial m} + \frac{\partial U}{\partial E}\frac{\partial E}{\partial m} - P' \right] + \beta\delta \left[\frac{\partial E[U(Y', E', P')|m, V]}{\partial m} \right] = 0$$

where P' is the marginal payment for reporting a higher value.

The second term in the first-order condition captures the intertemporal trade-off between the current and the next period. If $\beta = 1$, this term is positive, as reporting a higher value increases the expected utility in the next period. However, if $\beta < 1$, this term is discounted by β, which reduces the incentive to report a higher value.

The first term in the first-order condition captures the intratemporal trade-off between the outcome, effort, and payment in the current period. If $\beta = 1$, this term is zero, as reporting a higher value does not affect the utility in the current period. However, if $\beta < 1$, this term is negative, as reporting a higher value increases the effort and payment in the current period.

Therefore, quasi-hyperbolic discounting may induce the subject to underreport his true value for treatment A relative to treatment B, as he is more sensitive to the immediate costs than to the future benefits. This may lead to a lower probability of receiving treatment A and a lower effort level when receiving treatment A. As a result, the outcome Y may be lower than it would be under time-consistent preferences.

To overcome this confounding effect, we propose commitment trials that use commitment devices to align the subject's incentives across time periods. A commitment device is a choice or action that the subject takes in the present to restrict his future options and overcome his self-control problems. For example, a commitment device could be a contract that specifies a penalty for not exerting enough effort or for changing one's message.

We assume that commitment devices are available and enforceable in our setting. We also assume that commitment devices are costly to implement, either in terms of money or utility. We denote by C(m) the cost function of a commitment device conditional on message m.

We modify the BDM mechanism by adding a commitment device option. The subject can choose whether or not to use a commitment device when reporting his value for treatment A relative to treatment B. If he chooses to use a commitment device, he pays an additional cost C(m) and commits to exerting an effort level E(m) that is increasing in m. If he chooses not to use a commitment device, he pays no additional cost and exerts an effort level E'(m) that is decreasing in m.

The subject's value function under commitment trials is given by:

$$W(m, V, c) = \beta[U(Y, E, P, C) + \delta E[U(Y', E', P')|m, V, c]]$$

where c is an indicator variable for using a commitment device, and E and C depend on c.

The subject chooses a message m and an indicator c to maximize $W(m, V, c)$. The optimal message $m^*(V, c)$ satisfies the first-order condition:

$$\frac{\partial W}{\partial m} = \beta \left[\frac{\partial U}{\partial Y} \frac{\partial Y}{\partial m} + \frac{\partial U}{\partial E} \frac{\partial E}{\partial m} - P' - C' \right] + \beta\delta \left[\frac{\partial E[U(Y', E', P')|m, V, c]}{\partial m} \right] = 0$$

where P' and C' are the marginal payments and costs for reporting a higher value.

The optimal indicator $c^*(V, m)$ satisfies the condition:

$$W(m, V, c^*) \geq W(m, V, c) \quad \forall c$$

We show that commitment trials can eliminate the confounding effect of treatment and effort on the outcome, and can induce the subject to report his true value for treatment A relative to treatment B.

First, we show that if the subject chooses to use a commitment device, he will report his true value. To see this, suppose that the subject reports a value m that is different from his true value V. Then, he will face a positive or negative payment $P'(m-V)$ and a positive or negative cost $C'(m-V)$. These payments and costs will cancel out the utility gain or loss from receiving treatment A or B. Therefore, the subject will be indifferent between any message m and his true value V. However, since the cost function C(m) is increasing in m, the subject will prefer to report a lower value rather than a higher value. Thus, the subject's optimal message is $m^*(V, c) = V$.

Second, we show that if the subject reports his true value, he will choose to use a commitment device. To see this, suppose that the subject reports his true value V. Then, he will face no payment or cost for reporting a higher or lower value. Therefore, the subject will only care about the effect of the commitment device on his effort level and outcome. Since the commitment device induces a higher effort level than no commitment device, and since a higher effort level increases the outcome, the subject will prefer to use a commitment device rather than not. Thus, the subject's optimal indicator is $c^*(V, m) = 1$.

Therefore, under commitment trials, the subject will report his true value and use a commitment device. This implies that he will receive treatment A with probability P(V,A) and exert effort E(V) when receiving treatment A. As a result, the outcome Y will be higher than it would be under selective trials without commitment devices.

We conclude that commitment trials can overcome the confounding effect of treatment and effort on the outcome under quasi-hyperbolic discounting. They can also help improve external validity by revealing the true distribution of values F(V) and by inducing consistent effort levels across settings.

4 Commitment trials for the principals

In this section, we extend selective trials to contexts where the principals (researchers or policymakers) who design and implement the selective trials have quasi-hyperbolic preferences. We show that quasi-hyperbolic preferences may induce biases in policy choices and evaluations. We propose commitment trials that use commitment devices to overcome these problems. We also consider the case where both the subjects and the principals have quasi-hyperbolic preferences, and show how commitment trials can help in this case as well.

4.1 Quasi-hyperbolic preferences of the principals

In this subsection, we analyze the case where the principals (researchers or policymakers) who design and implement the selective trials have quasi-hyperbolic preferences. We show that quasi-hyperbolic preferences may induce biases in policy choices and evaluations.

We assume that the principals have the same quasi-hyperbolic discounting model as the subjects, i.e., they have two discount factors: β for immediate payoffs and δ for future payoffs, where $\beta < 1 < \delta$. We also assume that the principals have a social welfare function that depends on the outcome Y and the payment P of the subjects, as well as their own cost C of implementing the mechanism G. The social welfare function is given by W(Y,P,C), where W is increasing in Y and decreasing in P and C.

The principals choose a mechanism G to maximize their expected social welfare, given their beliefs about the distribution of values F(V) and the behavior of the subjects. The optimal mechanism G*(F(V)) satisfies the first-order condition:

$$\frac{\partial E[W(Y,P,C)|G,F(V)]}{\partial G} = 0$$

where E is the expectation operator.

We show that quasi-hyperbolic discounting may affect the choice of the mechanism G in two ways. First, it may affect the trade-off between the current and the future payoffs of the principals. If $\beta < 1$, the principals may discount the future social welfare more than they would under time-consistent preferences. This may lead them to choose a mechanism that has higher current benefits but lower future benefits, such as a mechanism that has lower implementation costs but lower outcome quality.

Second, it may affect the trade-off between the outcome and the payment of the subjects. If $\beta < 1$, the principals may discount the future outcome more than they would under time-consistent preferences. This may lead them to choose a mechanism that has lower outcome but higher payment, such as a mechanism that has lower effort incentives but higher value elicitation incentives.

Therefore, quasi-hyperbolic discounting may induce biases in policy choices and evaluations under selective trials. The principals may favor policies that have immediate benefits over those that have long-term benefits, even if the latter are more efficient or equitable.

4.2 Commitment trials for the principals

In this subsection, we propose commitment trials for the principals to overcome the biases induced by quasi-hyperbolic discounting. We show that commitment trials can help the principals to choose mechanisms that are closer to their long-term objectives.

We assume that commitment devices are available and enforceable for the principals as well as for the subjects. We also assume that commitment devices are costly to implement, either in terms of money or utility. We denote by C(G) the cost function of a commitment device conditional on mechanism G.

We modify the selective trials framework by adding a commitment device option for the principals. The principals can choose whether or not to use a commitment device when designing and implementing a mechanism G. If they choose to use a commitment device, they pay an additional cost C(G) and commit to implementing a mechanism G that is fixed in advance. If they choose not to use a commitment device, they pay no additional cost and implement a mechanism G that is flexible and can be changed over time.

The principals' value function under commitment trials is given by:

$$V(G,c) = \beta[E[W(Y,P,C)|G,F(V)] + \delta E[V(G',c')|G,F(V),c]]$$

where c is an indicator variable for using a commitment device, C depends on c, and G' and c' are the mechanism and indicator in the next period, conditional on G, $F(V)$, and c in the current period.

The principals choose a mechanism G and an indicator c to maximize V(G,c). The optimal mechanism G*(F(V),c) satisfies the first-order condition:

$$\frac{\partial V}{\partial G} = \beta\left[\frac{\partial E[W(Y,P,C)|G,F(V)]}{\partial G} - C'\right] + \beta\delta\left[\frac{\partial E[V(G',c')|G,F(V),c]}{\partial G}\right] = 0$$

where C' is the marginal cost for implementing a different mechanism.

The optimal indicator c*(F(V),G) satisfies the condition:

$$V(G,c^*) \geq V(G,c) \quad \forall c$$

We show that commitment trials can eliminate or reduce the biases in policy choices and evaluations under quasi-hyperbolic discounting. They can help the principals to choose mechanisms that are closer to their long-term objectives.

First, we show that if the principals choose to use a commitment device, they will choose a mechanism that maximizes their future social welfare. To see this, suppose that the principals use a commitment device and choose a mechanism G that is different from the mechanism G' that maximizes their future social welfare. Then, they will face a positive or negative cost $C'(G - G')$ and a positive or negative utility gain or loss

$$E[W(Y, P, C)|G, F(V)] - E[W(Y, P, C)|G', F(V)]$$

. These costs and utility gains or losses will cancel out the future utility gain or loss from implementing G or G'. Therefore, the principals will be indifferent between any mechanism G and the mechanism G' that maximizes their future social welfare. However, since the cost function $C(G)$ is increasing in G, the principals will prefer to implement a lower mechanism rather than a higher mechanism. Thus, the principals' optimal mechanism is $G^*(F(V), c) = G'$.

Second, we show that if the principals choose a mechanism that maximizes their future social welfare, they will choose to use a commitment device. To see this, suppose that the principals choose a mechanism G that maximizes their future social welfare. Then, they will face no cost or utility gain or loss for implementing a different mechanism. Therefore, the principals will only care about the effect of the commitment device on their flexibility and time consistency. Since the commitment device reduces their flexibility but increases their time consistency, the principals will prefer to use a commitment device rather than not. Thus, the principals' optimal indicator is $c^*(F(V), G) = 1$.

Therefore, under commitment trials, the principals will use a commitment device and implement a mechanism that maximizes their future social welfare. This implies that they will design and implement mechanisms that have higher outcome quality and lower payment incentives than they would under selective trials without commitment devices.

We conclude that commitment trials can overcome the biases in policy choices and evaluations under quasi-hyperbolic discounting. They can help the principals to choose mechanisms that are closer to their long-term objectives.

4.3 Commitment trials for both subjects and principals

In this subsection, we consider the case where both the subjects and the principals have quasi-hyperbolic preferences. We show how this may affect the design and implementation of selective trials, and how commitment trials can help in this case as well.

We assume that both the subjects and the principals have the same quasi-hyperbolic discounting model as before, i.e., they have two discount factors: β for immediate payoffs and δ for future payoffs, where $\beta < 1 < \delta$. We also assume that both the subjects and the principals have access to commitment devices that are costly to implement.

We modify the selective trials framework by adding a commitment device option for both the subjects and the principals. The subjects can choose whether or not to use a commitment device when reporting their values for different treatments. The principals can choose whether or not to use a commitment device when designing and implementing a mechanism. The value functions of both agents depend on their own and each other's commitment choices.

The subject's value function under commitment trials is given by:

$$W(m, V, c_s, c_p) = \beta[U(Y, E, P, C_s) + \delta E[U(Y', E', P')|m, V, c_s, c_p]]$$

where c_s is an indicator variable for using a commitment device by the subject, c_p is an indicator variable for using a commitment device by the principal, E and C_s depend on c_s, and P depends on c_p.

The principal's value function under commitment trials is given by:

$$V(G, c_p, c_s) = \beta[E[W(Y, P, C_p)|G, F(V), c_p, c_s] + \delta E[V(G', c_p', c_s')|G, F(V), c_p, c_s]]$$

where C_p depends on c_p, P depends on c_s, and G', c_p', and c_s' are the mechanism and indicators in the next period, conditional on G, $F(V)$, c_p, and c_s in the current period.

The subject chooses a message m and an indicator c_s to maximize $W(m, V, c_s, c_p)$. The principal chooses a mechanism G and an indicator c_p to maximize $V(G, c_p, c_s)$.

We show that commitment trials can improve the outcome and welfare of both agents under quasi-hyperbolic discounting. They can help both agents to align their incentives across time periods and across agents.

First, we show that if both agents choose to use commitment devices, they will report or implement their true values or mechanisms. To see this, suppose that the subject reports a value m that is different from his true value V, or the principal implements a mechanism G that is different from the mechanism G' that maximizes his future social welfare. Then, they will face positive or negative payments, costs, or utility gains or losses for reporting or implementing different values or mechanisms. These payments, costs, or utility gains or losses will cancel out the future utility gain or loss from receiving or implementing different treatments or mechanisms. Therefore, both agents will be indifferent between any value or mechanism and their true value or mechanism. However, since the cost functions $C_s(m)$ and $C_p(G)$ are increasing in m and G, both agents will prefer to report or implement lower values or mechanisms rather than higher values or mechanisms. Thus, both agents' optimal values or mechanisms are $m^*(V, c_s, c_p) = V$ and $G^*(F(V), c_p, c_s) = G'$.

Second, we show that if both agents report or implement their true values or mechanisms, they will choose to use commitment devices. To see this, suppose that both agents report or implement their true values or mechanisms. Then, they will face no payment, cost, or utility gain or loss for reporting or implementing different values or mechanisms. Therefore, both agents will only care about the effect of the commitment devices on their effort levels and outcomes. Since the commitment devices induce higher effort levels and outcomes than no commitment devices, both agents will prefer to use commitment devices rather than not. Thus, both agents' optimal indicators are $c_s^*(V, m, c_p) = 1$ and $c_p^*(F(V), G, c_s) = 1$.

Therefore, under commitment trials, both agents will use commitment devices and report or implement their true values or mechanisms. This implies that they will receive or implement treatments that are optimal for their long-term objectives and exert consistent effort levels across time periods and across agents.

We conclude that commitment trials can improve the outcome and welfare of both agents under quasi-hyperbolic discounting. They can help both agents to align their incentives across time periods and across agents.

5 Discussion

In this paper, we have extended selective trials to contexts where subjects and/or principals have quasi-hyperbolic preferences. We have shown that quasi-hyperbolic preferences may create confounding effects of treatment and effort on the outcome, and may induce biases in policy choices and evaluations. We have proposed commitment trials that use commitment devices to overcome these problems. We have also considered the case where both subjects and principals have quasi-hyperbolic preferences, and have shown how commitment trials can help in this case as well.

Our paper has important implications for policy evaluation and design in both developing and developed countries. We illustrate these implications by discussing some examples of selective trials that could benefit from commitment trials.

One example is the evaluation of health interventions that require long-term adherence or behavior change, such as HIV prevention, malaria prevention, or smoking cessation. These interventions often face challenges in ensuring external validity, as the outcomes may depend not only on the treatment assigned, but also on the effort exerted by the subjects, which may vary across settings and populations. Moreover, these interventions may be affected by time inconsistency and self-control problems, as the subjects may have present-biased preferences that lead them to undervalue the long-term benefits of the intervention and overvalue the immediate costs or temptations.

Commitment trials can help improve the external validity and efficiency of these interventions by disentangling the effects of treatment, effort, and the interaction of treatment and effort on the outcome. They can also help overcome time inconsistency and self-control problems by inducing the subjects to report their true values for different treatments and to exert consistent effort levels across settings. For example, a commitment trial for HIV prevention could elicit the subjects' values for different prevention methods, such as condoms, circumcision, or pre-exposure prophylaxis (PrEP), and assign treatments based on these values. The subjects could also choose to use a commitment device that would incentivize them to adhere to the prevention method or penalize them for not doing so.

Another example is the evaluation of education interventions that require long-term investment or behavior change, such as school enrollment, attendance, or performance. These interventions also face challenges in ensuring external validity, as the outcomes may depend not only on the treatment assigned, but also on the effort exerted by the subjects, which may vary across settings and populations. Moreover, these interventions may be affected by time inconsistency and self-control problems, as the subjects may have present-biased preferences that lead them to undervalue the long-term benefits of education and overvalue the immediate costs or temptations.

Commitment trials can help improve the external validity and efficiency of these interventions by disentangling the effects of treatment, effort, and the interaction of treatment and effort on the outcome. They can also help overcome time inconsistency and self-control problems by inducing the subjects to report their true values for different education options, such as scholarships, cash transfers, or tutoring, and to exert consistent effort levels across settings. For example, a commitment trial for school enrollment could elicit the subjects' values for different enrollment incentives, such as vouchers, uniforms, or books, and assign treatments based on these values. The subjects could also choose to use a commitment device that would incentivize them to enroll in school or penalize them for not doing so.

A third example is the evaluation of environmental interventions that require long-term cooperation or behavior change, such as conservation, or recycling. These interventions also face challenges in ensuring external validity, as the outcomes may depend not only on the treatment assigned, but also on the effort exerted by the subjects, which may vary across settings and populations. Moreover, these interventions may be affected by time inconsistency and self-control problems, as the subjects may have present-biased preferences that lead them to undervalue the long-term benefits of the environment and overvalue the immediate costs or temptations.

Commitment trials can help improve the external validity and efficiency of these interventions by disentangling the effects of treatment, effort, and the interaction of treatment and effort on the outcome. They can also help overcome time inconsistency and self-control problems by inducing the subjects to report their true values for different actions, such as subsidies, or donations, and to exert consistent effort levels across settings. For example, a commitment trial for nonprofit support could elicit the subjects' values for different options, such as social media marketing, email, or phone calls, and assign treatments based on these values. The subjects could also choose to use a commitment device that would incentivize them to elevate their efforts or penalize them for not doing so.

These examples illustrate how commitment trials can enhance the validity and efficiency of policy evaluation and design under quasi-hyperbolic preferences. They can help reveal the true distribution of values and preferences of the subjects, and induce consistent and optimal effort levels across settings. They can also help overcome the confounding effects of treatment and effort on the outcome, and the biases in policy choices and evaluations induced by time inconsistency and self-control problems.

Of course, commitment trials are not a panacea for all the challenges faced by selective trials. They may have some limitations or drawbacks, such as ethical concerns, implementation costs, or unintended consequences. For instance, commitment devices may raise ethical issues regarding informed consent, coercion, or paternalism. They may also entail implementation costs, such as monitoring, enforcement, or verification. Moreover, they may have unintended consequences, such as crowding out intrinsic motivation, creating moral hazard, or inducing strategic behavior.

Therefore, commitment trials should be used with caution and care. They should be tailored to the specific context and population of interest. They should also be complemented by other methods and tools to ensure robustness and validity. We hope that our paper can provide some guidance and inspiration for future research on how to design and implement commitment trials in practice.

6 Conclusions

In this paper, we have extended selective trials to contexts where subjects and/or principals have quasi-hyperbolic preferences. We have shown that quasi-hyperbolic preferences may create confounding effects of treatment and effort on the outcome, and may induce biases in policy choices and evaluations. We have proposed commitment trials that use commitment devices to overcome these problems. We have also considered the case where both subjects and principals have quasi-hyperbolic preferences, and have shown how commitment trials can help in this case as well.

Our paper contributes to the literature on selective trials and behavioral economics by incorporating time inconsistency and self-control problems into the design and implementation of randomized controlled experiments. We hope that our paper can stimulate further research on how to improve the validity and efficiency of policy evaluation under realistic assumptions about human behavior.

For instance, it is possible that the last case (where both researchers and agents have time-inconsistency problems) may lead to general equilibrium effects. For example, the commitment trials may affect the supply and demand of the treatments or the commitment devices, which may in turn affect the prices, quantities, and welfare of the agents and the researchers. Moreover, the commitment trials may affect the behavior and expectations of other agents or researchers who are not directly involved in the trials, but who may observe or learn from them.

Commitment trials may help to mitigate or correct some of these general equilibrium effects, by aligning the incentives and objectives of the agents and the researchers across time periods and across agents. For example, commitment trials may reduce the price distortions or externalities caused by time-inconsistent preferences, by inducing the agents and the researchers to report or implement their true values or mechanisms. Commitment trials may also increase the information and learning spillovers from the trials, by inducing consistent and optimal effort levels across settings.

However, commitment trials may not be able to eliminate or address all of these general equilibrium effects, as some of them may be beyond the scope or control of the trials. For example, commitment trials may not be able to prevent or counteract the strategic behavior or manipulation of other agents or researchers who may have different or conflicting interests or preferences. Commitment trials may also not be able to account for or incorporate all of the relevant factors or variables that may affect the outcome or welfare of the agents or the researchers.

Therefore, commitment trials should be aware of and attentive to these potential general equilibrium effects. They should also be combined with other methods and tools to ensure robustness and validity. For instance, commitment trials could use randomized controlled experiments, natural experiments, or quasi-experiments to identify and estimate the causal effects of the treatments or the commitment devices. We also think that this scenario is more empirical and contextual than theoretical and general, and may benefit more from data analysis and case studies than from mathematical proofs per se.

We leave these issues for future research. We hope that our paper can stimulate further research on how to design and implement commitment trials in practice.

7 References

- Ashraf, N., Karlan, D., and Yin, W. (2006). Tying Odysseus to the mast: Evidence from a commitment savings product in the Philippines. The Quarterly Journal of Economics, 121(2):635–672.

- Augenblick, N., Niederle, M., and Sprenger, C. (2013). Working over time: Dynamic inconsistency in real effort tasks. Technical report, National Bureau of Economic Research.

- Banerjee, Abhijit, Rukmini Banerji, James Berry, Esther Duflo, Harini Kannan, Shobhini Mukerji, Marc Shotland, and Michael Walton (2017). From proof of concept to scalable policies: Challenges and solutions, with an application. Journal of Economic Perspectives, 31(4): 73-102.

- Chassang, S., Padro i Miquel, G., and Snowberg, E. (2012). Selective trials: A principal-agent approach to randomized controlled experiments. American Economic Review, 102(4):1279–1309.

- DellaVigna, S. and Malmendier, U. (2004). Contract design and self-control: Theory and evidence. The Quarterly Journal of Economics, 119(2):353–402.

- DellaVigna, S. and Malmendier, U. (2006). Paying not to go to the gym. American Economic Review, 96(3):694–719.

- De Quidt, Jonathan, Johannes Haushofer, and Christopher Roth (2018). Measuring and bounding experimenter demand. American Economic Review, 108(11): 3266-3302.

- Duflo, E. (2017). The Economist as Plumber. American Economic Review, 107(5): 1-26.

- Frederick, S., Loewenstein, G., and O'donoghue, T. (2002). Time discounting and time preference: A critical review. Journal of economic literature, 40(2):351–401.

- Gine, X., Karlan, D., and Zinman, J. (2010). Put your money where your butt is: A commitment contract for smoking cessation. American Economic Journal: Applied Economics, 2(4):213–35.

- Houser, D., Schunk, D., Winter, J., and Xiao, E. (2010). Temptation and commitment in the laboratory. Technical report, Institute for the Study of Labor (IZA).
- Kaur, S., Kremer, M., and Mullainathan, S. (2010). Self-control and the development of work arrangements. American Economic Review: Papers and Proceedings 2010,, 100(2):624–628.
- Laibson, D. (1997). Golden eggs and hyperbolic discounting. The Quarterly Journal of Economics, 112(2):443–477.
- List, J. (2020). Non est Disputandum de Generalizability? A Glimpse into The External Validity Trial. National Bureau of Economic Research Working Paper 27535.
- Milkman, K. L., Minson, J. A., and Volpp, K. G. (2012). Holding the hunger games hostage at the gym: An evaluation of temptation bundling. Technical report.
- O'Donoghue, T. and Rabin, M. (1999). Doing it now or later. American Economic Review, 89(1):103–124.
- Phelps, E. S. and Pollak, R. A. (1968). On second-best national saving and game-equilibrium growth. The Review of Economic Studies,, 35(2):185–199.
- Royer, H., Stehr, M., and Sydnor, J. (2012). Incentives, commitments and habit formation in exercise: Evidence from a field experiment with workers at a fortune-500 company. Technical report.
- Udry, C. (1997). Recent advances in empirical microeconomic research in poor countries: An annotated bibliography. Journal of Economic Education, 28(1), 58-75.
- Vivalt, Eva. (2020). How much can we generalize from impact evaluations? Journal of the European Economic Association, 18(6): 3045-3089.

8 Appendix

A.1 Proof of incentive compatibility and full support of the BDM mechanism

We prove that the BDM mechanism satisfies incentive compatibility and full support under time-consistent preferences, i.e., when $\beta = 1$.

Incentive compatibility: The subject's value function under the BDM mechanism is given by:

$$W(m, V) = E[U(Y, E, P)|m, V] = P(m, A)U(Y_A, E_A, P) + P(m, B)U(Y_B, E_B, 0)$$

where $P(m, A)$ and $P(m, B)$ are the probabilities of receiving treatment A and B, respectively, conditional on message m, and Y_A, E_A, P, Y_B, and E_B are the outcome, effort, and payment under treatment A and B, respectively.

The subject chooses a message m to maximize W(m,V). The optimal message m*(V) satisfies the first-order condition:

$$\frac{\partial W}{\partial m} = [U(Y_A, E_A, P) - U(Y_B, E_B, 0)] \frac{\partial P}{\partial m} - P' = 0$$

where P' is the marginal payment for reporting a higher value.

Solving for P', we obtain:

$$P' = [U(Y_A, E_A, P) - U(Y_B, E_B, 0)] \frac{\partial P}{\partial m}$$

This implies that the subject's optimal strategy is to report his true value V regardless of his beliefs about P. To see this, suppose that the subject reports a value m that is different from his true value V. Then, he will face a positive or negative payment P' (m - V). This payment will exactly cancel out the utility gain or loss from receiving treatment A or B. Therefore, the subject will be indifferent between any message m and his true value V. Thus, the subject's optimal message is m*(V) = V.

Full support: The probability of receiving treatment A under the BDM mechanism is given by:

$$P(m, A) = Pr(P \leq m) = \frac{m - V_{min}}{V_{max} - V_{min}}$$

where V_{min} and V_{max} are the minimum and maximum possible values.

This implies that for any message m, the probability of receiving treatment A is strictly between zero and one. To see this, note that $V_{min} < m < V_{max}$ by definition. Therefore,

$$0 < \frac{m - V_{min}}{V_{max} - V_{min}} < 1$$

Thus, P(m,A) is strictly increasing in m for any A.

Similarly, the probability of receiving treatment B under the BDM mechanism is given by:

$$P(m, B) = Pr(P > m) = \frac{V_{max} - m}{V_{max} - V_{min}}$$

This implies that for any message m, the probability of receiving treatment B is strictly between zero and one. To see this, note that $V_{min} < m < V_{max}$ by definition. Therefore,

$$0 < \frac{V_{max} - m}{V_{max} - V_{min}} < 1$$

Thus, P(m,B) is strictly decreasing in m for any B.

Therefore, the BDM mechanism satisfies full support, as for any message m, the probability of receiving either treatment A or treatment B is strictly between zero and one. Q.E.D.

A.2 Proof of the confounding effect of treatment and effort under quasi-hyperbolic discounting

We prove that quasi-hyperbolic discounting may create a confounding effect of treatment and effort on the outcome under the BDM mechanism.

We assume that the subjects have the same quasi-hyperbolic discounting model as before, i.e., they have two discount factors: β for immediate payoffs and δ for future payoffs, where $\beta < 1 < \delta$. We also assume that the subjects have a utility function that depends on the outcome Y, the effort E, and the payment P. The utility function is given by U(Y,E,P), where U is increasing in Y and decreasing in E and P.

The subject's value function under the BDM mechanism is given by:

$$W(m, V) = \beta[U(Y, E, P) + \delta E[U(Y', E', P')|m, V]]$$

where Y, E, and P are the outcome, effort, and payment in the current period, and Y', E', and P' are the outcome, effort, and payment in the next period, conditional on the message m and the value V in the current period.

The subject chooses a message m to maximize W(m,V). The optimal message m*(V) satisfies the first-order condition:

$$\frac{\partial W}{\partial m} = \beta \left[\frac{\partial U}{\partial Y} \frac{\partial Y}{\partial m} + \frac{\partial U}{\partial E} \frac{\partial E}{\partial m} - P' \right] + \beta\delta \left[\frac{\partial E[U(Y', E', P')|m, V]}{\partial m} \right] = 0$$

where P' is the marginal payment for reporting a higher value.

We show that quasi-hyperbolic discounting may affect the choice of the message m in two ways. First, it may affect the trade-off between the current and the future payoffs of the subjects. If $\beta < 1$, the subjects may discount the future outcome more than they would under time-consistent preferences. This may lead them to report a lower value for treatment A relative to treatment B, as they are more sensitive to the immediate payment than to the future outcome.

To see this, suppose that $\beta < 1$. Then, the second term in the first-order condition is discounted by β, which reduces the incentive to report a higher value. This implies that $\frac{\partial W}{\partial m}$ is negative for any $m > V$, and positive for any $m < V$. Therefore, the subject's optimal message is $m^*(V) < V$.

Second, it may affect the trade-off between the outcome and the effort of the subjects. If $\beta < 1$, the subjects may discount the future outcome more than they would under time-consistent preferences. This may lead them to report a lower value for treatment A relative to treatment B, as they are more sensitive to the immediate effort than to the future outcome.

To see this, suppose that $\beta < 1$. Then, the first term in the first-order condition is negative for any $m > V$, as reporting a higher value increases the effort and payment in the current period. This implies that $\frac{\partial W}{\partial m}$ is negative for any $m > V$, and positive for any $m < V$. Therefore, the subject's optimal message is $m^*(V) < V$.

Therefore, quasi-hyperbolic discounting may induce the subject to underreport his true value for treatment A relative to treatment B, as he is more sensitive to the immediate costs than to the future benefits. This may lead to a lower probability of receiving treatment A and a lower effort level when receiving treatment A. As a result, the outcome Y may be lower than it would be under time-consistent preferences. Q.E.D.

A.3 Proof of the elimination of the confounding effect under commitment trials

We prove that commitment trials can eliminate the confounding effect of treatment and effort on the outcome under quasi-hyperbolic discounting.

We assume that the subjects have the same quasi-hyperbolic discounting model and utility function as before. We also assume that commitment devices are available and enforceable in our setting, and that they are costly to implement. We denote by C(m) the cost function of a commitment device conditional on message m.

We modify the BDM mechanism by adding a commitment device option for the subjects. The subjects can choose whether or not to use a commitment device when reporting their value for treatment A relative to treatment B. If they choose to use a commitment device, they pay an additional cost C(m) and commit to exerting an effort level E(m) that is increasing in m. If they choose not to use a commitment device, they pay no additional cost and exert an effort level E'(m) that is decreasing in m.

The subject's value function under commitment trials is given by:

$$W(m, V, c) = \beta[U(Y, E, P, C) + \delta E[U(Y', E', P')|m, V, c]]$$

where c is an indicator variable for using a commitment device, and E and C depend on c.

The subject chooses a message m and an indicator c to maximize $W(m, V, c)$. The optimal message $m * (V, c)$ satisfies the first-order condition:

$$\frac{\partial W}{\partial m} = \beta\left[\frac{\partial U}{\partial Y}\frac{\partial Y}{\partial m} + \frac{\partial U}{\partial E}\frac{\partial E}{\partial m} - P' - C'\right] + \beta\delta\left[\frac{\partial E[U(Y', E', P')|m, V, c]}{\partial m}\right] = 0$$

where P' and C' are the marginal payments and costs for reporting a higher value.

The optimal indicator $c*(V,m)$ satisfies the condition:

$$W(m,V,c^*) \geq W(m,V,c) \quad \forall c$$

We show that commitment trials can eliminate the confounding effect of treatment and effort on the outcome, and can induce the subject to report his true value for treatment A relative to treatment B.

First, we show that if the subject chooses to use a commitment device, he will report his true value. To see this, suppose that the subject reports a value m that is different from his true value V. Then, he will face a positive or negative payment $P'(m-V)$ and a positive or negative cost $C'(m-V)$. These payments and costs will cancel out the utility gain or loss from receiving treatment A or B. Therefore, the subject will be indifferent between any message m and his true value V. However, since the cost function C(m) is increasing in m, the subject will prefer to report a lower value rather than a higher value. Thus, the subject's optimal message is $m^*(V,c) = V$.

Second, we show that if the subject reports his true value, he will choose to use a commitment device. To see this, suppose that the subject reports his true value V. Then, he will face no payment or cost for reporting a higher or lower value. Therefore, the subject will only care about the effect of the commitment device on his effort level and outcome.

Since the commitment device induces a higher effort level than no commitment device, and since a higher effort level increases the outcome, the subject will prefer to use a commitment device rather than not. Thus, the subject's optimal indicator is $c^*(V,m) = 1$.

Therefore, under commitment trials, the subject will report his true value and use a commitment device. This implies that he will receive treatment A with probability P(V,A) and exert effort E(V) when receiving treatment A. As a result, the outcome Y will be higher than it would be under selective trials without commitment devices. Q.E.D.