DISCUSSION PAPER SERIES

No. 5757

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Francesco Drago and Dora Kadar

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ISSN 0265-8003

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Francesco Drago, University of Naples, Parthenope
Dora Kadar, University of Siena

Discussion Paper No. 5757
July 2006

Centre for Economic Policy Research
90–98 Goswell Rd, London EC1V 7RR, UK
Tel: (44 20) 7878 2900, Fax: (44 20) 7878 2999
Email: cepr@cepr.org, Website: www.cepr.org

CEPR Discussion Paper No. 5757

July 2006

ABSTRACT

Rebate or Bait? A Model of Regret and Time Inconsistency in Consumer Behaviour*

In this paper we develop a theory of time-inconsistency and regret that is motivated by evidence on a 'price discrimination' technique widespread in the United States, namely mail-in-rebate promotions. Our model combines partial naivete about future self-control problems and the sunk-cost effect (regret). We assume that agents deviating from their past choices suffer a certain emotional disutility from having brought a bad decision in the past and that this emotional disutility is negatively related to the length of the period between the choice made and the deviation from it. In the context of our application the model explains why in a multi period setting a large number of consumers respond to the rebate offers intending to redeem the rebate and then fail to provide the necessary effort when it comes to collect their money. Moreover, consumer failure to accomplish a task planned in the past (e.g. redeeming the rebate) is more likely when the deadline of completion is longer. This prediction is supported by experimental studies on various forms of procrastination and by field and experimental evidence on mail-in-rebates. We review a number of areas for which the theory may have important implications.

JEL Classification: C70, D11 and D91
Keywords: mail-in-rebate, naivete, regret and time inconsistency

Francesco Drago
Departimento di Studi Economici
Università di Napoli, Parthenope
Via Medina 40
80133 Napoli
Italy
Email: Drago2@unisi.it

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Dora Kadar
Departimento di Economia Politica
Università di Siena
Piazza s. Francesco 7
53100 Siena
Italy
Email: kadar@unisi.it

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* This paper is produced as part of CEPR's European Network for the Advancement of Behavioural Economics. We would like to thank Michele Bernasconi, Sam Bowles, Glenn Ellison, Simon Gaechter, Andrew Schotter, Paul Seabright, Klaus Schmidt, Monika Schnitzer, and seminar participants at the University of Munich, University of Bologna and International Workshop on Behavioural Game Theory in Capua for useful comments and discussions. Francesco Drago gratefully acknowledges financial support from the European Network for the Advancement of Behavioural Economics (ENABLE) and MURST. All errors are our own.

Submitted 27 June 2006

1 Introduction

Consumers repeatedly make mistakes, get frustrated and feel regret over their choices. They fear paying too much and they particularly dislike the thought that they could be better off having made a different choice in the past. Their concern is not at all unfounded as several recent studies demonstrate that consumers could be better off by making wiser choices: i.e. paying for their gym usage on a pay-per-visit basis instead of subscribing for a membership, avoiding expensive add-ons by learning firms' pricing strategies or ignoring irrelevant information when placing a bid at E-bay's auctions (DellaVigna and Malmendier, 2006; Gabaix and Laibson, 2006; Ahlee and Malmendier, 2005). These are just a few examples that belong to an emerging field recently termed as "the economics of paying too much".

A few studies examined how rational firms respond to deviations from standard preferences and biases in decision making. Membership charges in health clubs and subscription fees in the magazine market have found to be particularly profitable devices when consumers have present biased preferences. Our study adds a new item, mail-in-rebate promotions, to the toolkit applied by profit-maximizing firms as a response to such biases. We argue that the evidence on mail-in-rebate promotions can hardly be explained by standard theories and offer a theory of regret and time inconsistency that accounts for the observed consumer behavior.

In this paper mail-in-rebates are defined as "a money-refund offer available to consumers who mail in a proof-of-purchase and other forms to a manufacturer who mails back a portion of the price paid by the consumer". Ample empirical and anecdotal evidence show that a large number of consumers respond to mail-in-rebate promotions fully intending to get back part of the purchase price but fail to exert the necessary effort to collect their money subsequently. "Manufacturers love rebates because redemption rates are close to none...they get people into stores, but when it comes time to collect, few people follow through. And this is just what the manufacturer has in mind" (Greenman, 1999). Indeed, low redemption rates are among the most important factors contributing to the profitability of the rebate programs (Dhar and Hoch, 1996). This phenomenon - i.e. consumers buy the product anticipating the reward but they fail to redeem the rebate afterwards - is termed in the literature as "breakage" or "slippage" (Jolson et al. 1987; Bulkeley, 1998). A recent marketing study involving numerous companies that frequently work with rebate programs reports a mean breakage rate over 60 percent (PMA, 2005). Similar rates were found by Jolson et al. (1987).

High breakage rates are crucial for the viability of companies that base their entire business strategy on free-after-rebate promotions. Several firms on the Internet offer free-after-rebate opportunities - including, for example, Sony and Microsoft - and according to fulfillment companies even these deals receive only 50 percent redemptions on average. Failure to redeem is especially puzzling in this case, since the prices of the free-after-rebate products are often widely inflated. A wireless phone, for example, that can be found without promotion for 70 dollars may be offered for as much as 700 dollars under a free-after-rebate program.

Even such high failure rates would not be worrisome if they were a result of consumers' uncertainty about their future costs of redemption, an uncertainty that they rationally take into account when they respond to the rebate offer. However, there are serious concerns about the validity of this argument. First, manufacturers would have no reason to choose rebates featuring delayed incentives over a coupon scheme (or over instant rebates) if consumers did not overestimate their probability of redemption. In fact, coupons would be a cheaper way to provide money refunds to consumers who have correct beliefs about their cost of redemption. Second, if consumers had uncertainty about their future redemption costs, manufacturers would need to compensate them for the probability of no redemption (as well as for the fact that the reward is delayed) in the form of higher rebate sizes. Simple calibration demonstrates that in order not to claim such significant rewards, consumers would need to have implausibly high cost realizations when it came to collect their money. (Note the contradiction with the concept behind rebate programs, i.e. to offer lower prices to consumers who have low costs of redemption.) Moreover, the above reasoning cannot explain the existence of the various strategies that manufacturers use to make redemptions harder, such as delayed rebate programs[1] as these would have an equal (deterring) effect on the decision to buy the promoted product.

We provide an explanation based on present-biased preferences and naivete about future self-control that rationalizes the empirical evidence connected to rebate promotions. Our focus on present biased preferences is justified by the following reasons. First, rebates feature important characteristics, in particular they involve immediate costs (the effort to redeem) and future benefits (the face value of the rebate), that have been shown to lead to suboptimal choices in the presence of such preferences. Second, a simple hyperbolic discounting model where agents have a certain degree of naivete about future willpower can replicate well the results that some consumers will fail to redeem even if at the time of purchase they are fully convinced that they will carry through. Third, it has been demonstrated that firms effectively tailor their pricing strategies to profit from this type of consumer bias.

For example, in the health clubs surveyed by DellaVigna and Malmendier (2006) the majority of consumers subscribe for membership even if the comparatively high per-visit charge would be cheaper for most of them given their rare gym attendance. They show that present biased preferences play an important role in driving consumers opt for the ex post more expensive fee structure. When agents have $\beta - \delta$ preferences (Phelps and Pollack, 1967; Laibson, 1997) they give higher weight to the cost of exercising when the time comes to work-out as compared to when they plan their future gym attendance. While fully naive consumers are unaware of this

[1] Under delayed rebate programs the necessary forms must be sent to the manufacturer no earlier than e.g. 150 days and no later than 180 days from the date of purchase.

inconsistency the partially naive and sophisticated ones take their future self-control problems into account (Akerlof, 1991; ODonoghue and Rabin, 1999, 2001).

The mechanism is very similar in the case of rebate promotions. Our present biased consumers give lower weight to the cost of redemptions when they purchase their product as compared to when the time comes to exert the effort. Due to their perfect foresight sophisticated consumers will only choose the promoted product if they truly redeem the rebate subsequently. However, naives and partially naives overestimate their future willpower and thus the attractiveness of the promotion. The higher is the difference between their perceived and their actual future willpower the higher the probability is that they fail to collect their money.

Mail-in-rebate promotions are especially interesting as firms have various opportunities to influence consumer behavior. Breakage rates can be manipulated by varying rebate values, the length of the rebate redemption periods, the extent of the effort required to redeem, just to name a few. Variation in the redemption deadlines has been shown to produce some nontrivial behavioral consequences but has not yet been formally investigated (Ho, Lim and Camerer, 2005). Silk's (2005) experimental study has found that a significantly higher proportion of consumers buy the rebated product but a significantly lower proportion succeed in redeeming the rebates when the redemption deadline is longer. Field data also confirm the lower redemption rates under the less restrictive conditions (PMA, 2005).[2]

What can account for the deteriorating performance under longer deadlines? Several psychological and economic studies show that our present actions are not independent of our past choices (Thaler, 1980; Thaler and Johnson, 1990; Shefrin, 2000). The widely observed sunk cost effect essentially states that once we invested in something we are reluctant to pull out because of the loss that we will make. In other words, we regret having brought a bad decision in the past, and this regret confers an emotional disutility on the self that is considering deviating from the past decision. This may be especially relevant in the rebate context since consumers partly choose this option to prove that they are smart shoppers. The choice of not redeeming therefore brings not only a monetary but also a self-image loss.

The connection between deadlines and the sunk cost effect is provided by the findings of several researchers, which suggest that the sunk cost effect is not persistent through time (Thaler, 1999; Gourville and Soman, 1998). When the investment is still fresh in our minds, it effectively influences our subsequent choices, but it ceases to have an effect, when past payments fade from our memory. Thus, the initial investment can be thought of as a commitment device, albeit imperfect for agents with severe self-control problems and decreasingly effective for those who engage in endless procrastination.

We incorporate the sunk-cost effect in the simple quasi-hyperbolic model. In line with the empirical evidence, we assume that the sunk cost effect (or the emotional disutility from not

[2]Evidence for better performances under shorter deadlines is given in the next section.

redeeming) is decreasing over time (see section 2). In the model a quasi-hyperbolic consumer who responds to a rebate promotion has a finite number of periods to redeem, which is fixed by the deadline she faces. At each period, when she decides whether to complete the task or not, the emotional disutility that would result from no redemption turns out to be an incentive to exert the effort. We first address the problem of how the deadline affects the consumer's behavior given that she responded to the rebate promotion. We show that, for sufficiently long deadlines, a sophisticated consumer always completes the task early independently of the deadline. On the other hand an exponential (time-consistent) consumer completes the task immediately, irrespective of the deadline.

For naives, the longer deadlines deteriorate their performance. The intuition for this result rests on the fact that a naive might unforeseeably and repeatedly delay to complete the task. At present, she delays because she believes she will accomplish the task with a tolerable delay in the future. However, she underestimates her future tolerable delay, so when the future arrives she tolerates more delay than she expected. In the framework of O'Donoghue and Rabin (2001) the lack of deadlines allows this process to continue infinitely leading to procrastination.[3] In our case we first derive an important result without assuming the presence of deadline. A naive may fail to complete the task altogether, but cannot fool herself for ever. When she has delayed the task for long enough, i.e. the sunk cost effect has ceased to provide enough incentives to redeem, she realizes that she will not complete the task; at that time she suffers the emotional disutility. The presence of the deadline has an important role in the course of this process: if at the time of the last opportunity the sunk cost effect is large enough to induce the naive consumer to exert the effort, she will redeem. We show, that even with a mild degree of naivete the probability of redemption is decreasing with the deadline. We emphasize that in an exponential model the introduction of the sunk cost effect would not deliver the results we obtain with our model.

When we allow consumers to have some uncertainty about their future self-control problems, the model provides predictions about the purchase behavior that are in line with the empirical evidence. In particular, when consumers understand that with some probability they overestimate their future will-power, longer deadlines decrease the extent of emotional disutility that consumers eventually suffer when the uncertainty resolves. This in turn leads more consumers to buy the rebated product under the extended deadline condition. Hence, in the presence of uncertainty consumers try to avoid choices that involve more ex-post regret as in previous regret theories (e.g. Loomes and Sugden, 1982).

This paper contributes to two different strands of literature. First, by describing another example of how firms exploit naivete we contribute to the growing literature on behavioral

[3] In this terminology, procrastination means that the task is delayed forever, i.e. it is never completed. Delay, on the other hand, does not necessarily mean that the task will not be completed at a future point in time.

industrial organization and more specifically to its subfield, "economics of paying too much". In so doing we offer an explanation for the overall pattern of rebate redemptions that has not yet been explored in the literature. However, our analysis is not limited to rebate promotions. In the last section we discuss several applications where our theory has important implications. Our paper also contributes to the nascent literature on procrastination (O'Donoghue and Rabin, 2001). The latter paper predicts that if the monetary costs and benefits associated to a task do not change over time, imposing any kind of deadlines will induce all agents, even the ones with severe self-control problems, to complete the task in question. As such it does not explain why we frequently observe that people fail to accomplish what they plan even in the presence of deadlines. We provide a more realistic explanation for procrastination. In particular, procrastination needs not to be driven by persistent optimistic future beliefs since a partially naive may understand well before the deadline that she will never complete the task. This also means that, in case of partial naivete, the presence of deadlines is not sufficient for successful task completion in our model.

We proceed in Section 2 by reviewing the relevant empirical and experimental literature. In Section 3 and 4 we set up our model. Section 5 discusses several areas for which the theory has important implications and concludes.

2 Evidence

This paper is motivated by two empirical regularities connected to mail-in-rebate promotions that we mentioned in the introduction: high breakage rates and deteriorating performance under longer deadlines. In order to explain these phenomena we concentrate on time inconsistent preferences and naivete about future self-control. Moreover we assume that consumers' present choices are not independent of their past actions, in other words, they are subject to the so-called sunk cost effect.

A number of empirical papers provide strong direct and indirect evidence for present biased preferences (this literature is surveyed by Frederick et al. 2002). Recently O'Donoghue and Rabin (1999) and (2001) provided theoretical papers to analyze economic behavior of agents that are only in part aware of their future time inconsistency. This strand of literature emphasizes the role of naivete in such phenomena as procrastination and status quo bias. Procrastination has also been cited as a potential cause of breakage (e.g., Jolson et al. 1987; Soman 1998, Silk 2005).

As we mentioned above, a mild degree of naivete explains why consumers participate in rebate programs and systematically fail to redeem. Naivete in time-inconsistency explains several empirical regularities in many fields such as retirement plans (Madrian and Shea, 2001), health club attendance (DellaVigna and Malmendier, 2006), magazine subscription (Olster and Morton, 2005), credit card use (Ausubel and Shiu, 2004), among others.

Besides investigating the causes of the failure of redemption our study focuses on the question why fewer consumers redeem the rebates when the redemption deadline is longer. The phenomenon that in the longer deadline condition more agents fail to complete a task has already been advocated by experimental studies. Shafir and Tversky (1992) offered students 5 dollars to return a long questionnaire by a given date. The students were randomly assigned to one of three deadline groups - the first group had 5 days, the second group 3 weeks, and the third group had no deadline. The respective rates of returning the questionnaire for the three groups were 60, 42 and 25 percent. Thus, the more time people had to complete the task, the less likely they were to do it. In an experiment Ariely and Wertenbroch (2002) show that people are willing to self-impose costly deadlines in order to overcome procrastination. These self-imposed deadlines turned out to be effective in improving task performance even if not optimal to achieve maximum accomplishment. The experiment of Silk (2005) was specifically designed to replicate consumers' redemption behavior. Six hundred undergraduate students were offered the following choice options: purchase two movie tickets at 13 dollars less a mail-in rebate or purchase two movie tickets for a discounted price of 11 dollars or decline both offers[4]. Participants were randomly assigned to the six experimental conditions which resulted from the two different rebate sizes (6 or 9 dollars) and the three redemption deadlines (1 day, 7 days or 21 days). The results confirmed that the number of purchases was positively correlated with the rebate size and a significantly higher proportion of consumers purchased when the redemption period was longer. However, a significantly lower proportion of consumers applied for the rebate when the redemption period was 21 days than when it was either 7 days or 1 day. Participants reported that the most important reasons for failing to apply for the rebate were that they had procrastinated until the deadline passed, the savings did not seem worth the effort required or they simply forgot to redeem. Field evidence also confirms that longer deadlines exhibit lower redemption rates (PMA, 2005).

In order to capture the effect of deadlines we draw on the extensive psychological literature on the so-called "sunk cost effect" and its decreasing relevance over time. Various researchers have found that costs that have been paid (or "sunk") in the past affect people's behavior in ways that are not consistent with economic theory (Thaler 1980; Thaler and Johnson 1990; Shefrin 2000, Eyster 2002). The following example of Thaler (1980) clarifies the point:

> "A family pays 40 dollars for tickets to a basketball game to be played 60 miles from their home. On the day of the game there is a snowstorm. They decide to go

[4] The movie tickets were valid for any movie and show time for a year and a regular price of a ticket at the box office was 12 dollars.

anyway, but note in passing that had the tickets been given to them, they would have stayed home." Thaler (1980, p. 11).

If they were thinking rationally, at the point of deciding whether to attend the game the family should ignore how much they paid for the tickets and should only take into account the future costs and benefits of attending the game. This economic logic is justified by the argument that because no action (current or future) can avert or reduce a sunk cost, no sunk cost can be attributed to or have any relevance to current or future action.

In a series of experiments, Arkes and Blumer (1985) demonstrated that monetary sunk costs matter to individuals when making decisions. In hypothetical situations and in situations involving actual money, subjects in these experiments made decisions not on the basis of expected marginal costs and benefits, but on the basis of expenses already incurred.

A few empirical studies provide evidence of the sunk cost effect in stock markets by observing trade volume decreases when prices fall. The decline in volume with lower prices is attributed in part to the reluctance of asset owners to sell at a loss or at a price less than one previously prevailing (e.g. see Thaler, 1980 and Shefrin, 2000). Investors treat the price paid for their investment, even though it is sunk, as a cost they would like to recover (Chip, Heath and Lang, 1999).

Although sunk costs influence subsequent decisions, they truly sink in our memories after a sufficiently long time. The gradual reduction in the effect of past expenditures is termed "payment depreciation" by Gourville and Soman (1998). They obtained usage data from the members of a health club that charges the fees to its members twice a year. Attendance rates were highest in the month in which the fees were paid and then declined over the next five months, only to jump again when the next bill came out. Their conclusion is that the members felt driven to justify their fee by using the health club, a feeling that decreases over time.

The decreasing sunk-cost effect is consistent with the findings of DellaVigna and Malmendier (2006) according to which monthly payment members were much more likely to continue using a health club after their first year. These members were still exercising at the end of the year, when the yearly members had stopped attending. By paying each month, they were reminding themselves to attend often, making the club more useful to them. Hence they were more willing to sign up again at the end of the year.

Similar findings are reported by Arkes and Blumer (1985). In their experiment people who were ready to buy season tickets to a campus theater group were randomly placed into three groups: one group paid full price, one group got a small (13 percent) discount, and one group received a large (47 percent) discount. The experimenters then monitored how often the participants attended plays during the season. In the first half of the season, those who paid full price attended significantly more plays than those who received discounts, but in the second half of the season there was no difference among the groups.

The fact that the family in Thaler's example decide to attend the baseball game despite the snowstorm can be interpreted that they are not willing to suffer the regret that they would feel for having made a bad decision in the past. As mentioned in the introduction, our paper is also related to the literature on regret theory (Bell, 1982; Fishburn, 1982; Loomes and Sugden, 1982 and 1983). In these papers, regret is a psychological reaction to a choice of a prospect whose performance is worse than the performance of a forgone prospect. A recent study that incorporates this aspect of consumer choice is Eyster (2002). In his model people dislike the thought of being better off having made different choices in the past. Instead of simply regretting their mistakes, they may bring suboptimal decisions in the present in order to make their past choices look better. That is, they rationalize their past choices through their current choices. They exhibit a preference for consistency, which may give rise to the sunk cost effect. In Eyster's formulation a choice situation is required to involve meaningful uncertainty about the future states of the world in order for the preference of consistency to arise. We show that when agents discount the future hyperbolically and are (partially) naive about their future self-control, the possibility of time inconsistency gives rise to preference for consistency even without uncertainty about the future.

3 Preliminaries of the Model

In this section we set up a three period model of consumer behavior and we allow consumers to have time inconsistent preferences and overconfidence about their future self-control problems. At time 0 the consumer decides whether to buy a product that includes a rebate promotion. We distinguish consumers based on their willingness to pay for the product in question. In particular, consumers who have a high willingness to pay would buy the product even without the rebate promotion, their valuation of the product, v, is higher than or equal to its shelf price, p. Those consumers who have low willingness to pay do not find it worth to pay the original price for the product, for them $p > v$.

We formulate the decision problem of whether to reply to the rebate offer by comparing the payoff consequences of the consumers' choices to their next best alternative. For the consumers who have high willingness to pay the next best alternative is to buy the product without a rebate promotion. Given that the purchase price is the same with and without the rebate promotion, their immediate payoff from deciding for the promoted product is zero. On the other hand, consumers who would not buy the product without the rebate promotion incur a cost $p - v$ at time 0.

We denote the $t = 0$ payoff consequence of replying to the rebate promotion by Δ, which, according to the above discussion equals $|min(v - p, 0)|$. To simplify the discussion here we assume that a consumer who purchased the product with the rebate offer is required to send back the proof-of-purchase and the other forms to the manufacturer at a given future date, $t = 1$. The analysis of the consumers' behavior when they have multiple opportunities to complete this task is deferred to the next section.

Upon replying to the rebate offer the consumer decides whether to redeem the rebate or not. If she decides to redeem she incurs cost c at $t = 1$ and receives a portion of the purchase price, $B > \Delta$, at $t = 2$.[5] In case she decides not to redeem, she attains payoff 0 at time 1 and at time 2. Similarly, the payoffs of her next best alternative (irrespective of whether it is buying the product without a rebate promotion or not buying at all) is zero in both periods.

Suppose the individual has $\beta - \delta$ time preferences (Phelps and Pollack, 1967 and Laibson, 1997). In this case the present value of a flow of future utilities $(u_t)_{t \geq 0}$ is

$$u_0 + \beta \sum_{t=1}^{\infty} \delta^t u_t.$$

For $\beta < 1$ we have quasi-hyperbolic discounting which implies time-inconsistency: the discount factor between the current period and the next one is $\beta\delta$, while the discount factor between any two periods in the future is δ. Assume that $\beta < 1$ and that the consumer at each period has a belief about future self-control $\hat{\beta} \geq \beta$. Following O'Donoghue and Rabin (2001) we term as sophisticated the consumer who has beliefs $\hat{\beta} = \beta$, naive the consumer for whom $\hat{\beta} = 1$, and partially naive the one with $\beta < \hat{\beta} < 1$. Given these preferences a consumer will buy the promoted product if and only if at time 0 the following two conditions are satisfied:

(Buying conditions)

$$-\Delta + \beta\delta(-c + \delta B) \geq 0$$

$$-c + \hat{\beta}\delta B \geq 0$$

The first condition requires that at $t = 0$ the net present value of purchasing the product conditional on redeeming the rebate in period 2 be non-negative. This formulation implies that a consumer whose valuation of the product is lower than its prevailing price would not buy the rebated product if she did not believe to redeem later. The second condition shows that whether the consumer believes to redeem at $t = 1$ depends on her perceived future self control problem. A consumer who bought the promoted product will fail to redeem if at time 1 the following condition does not hold:

[5] Throughout the analysis we assume that consumers receive the face value of the rebate, B, a certain period (e.g. 6 weeks) after they have mailed the various forms to the manufacturer. Our results carry over to the case when manufacturers first collect all the rebate claims and send the checks to the consumers at a certain date after the redemption deadline.

(Redemption condition)

$$-c + \beta\delta B \geq 0$$

It is clear from the above conditions that sophisticated consumers will never fail to redeem due to their perfect foresight ($\hat{\beta} = \beta$). Therefore they only buy the promoted product if they redeem subsequently. On the other hand, naifs and partially naifs may purchase the product fully intending to redeem the rebate, but may fail to act at $t = 1$ according to their $t = 0$ wishes. The higher is the discrepancy between the actual and perceived future self control problems, in other words the more confident is the consumer about her future willpower, the more probable it is that she will fail to complete the task in the future. This simple benchmark is useful to derive further results.

4 The Model

We assume that the consumers are subject to the so called sunk-cost effect and we explore the behavioral consequences of this assumption in the context of our application. We first introduce the sunk-cost effect in the framework above, then we extend the analysis to the case when consumers have several opportunities to complete the task. Consider a consumer who has bought the good with the rebate promotion $t = 0$, and has a valuation of the product that is lower than the shelf-price ($\Delta > 0$). If she does not redeem the rebate at $t = 1$ she suffers an emotional disutility from having brought a bad decision in the past. We assume the emotional disutility to be proportional to the net cost paid at time 0, Δ.[6] The following expressions state the payoffs associated to the two choices, i.e. to accomplish or not the task.

$$-c + \beta\delta B \quad \texttt{in case of redemption}$$

$$-\gamma\Delta \quad \texttt{in case of no redemption,}$$

where $\Delta = |min(v - p, 0)|$ as explained in the previous section and γ is a discount factor at which emotional disutility decays over time. We discussed the behavioral foundations for the assumption that the emotional disutility decreases over time in section 2. We assume that the consumer perfectly predicts how the emotional disutility decreases irrespective of the degree of naivete.[7] This formulation has the implication that the consumer accomplishes the task if and only if:

[6] Although this is a very natural assumption, we emphasize that our results are not sensitive to the assumed relation between Δ and the emotional disutility.

[7] As it will be clear, assuming naivete about how the emotional disutility affects future utility just strengthens our results.

(Redemption condition with sunk-cost effect)

$$-c + \beta\delta B + \gamma\Delta \geq 0.$$

The above condition reflects the incentive provided by the sunk cost effect. For a consumer whose valuation of the product is lower than its shelf price ($\Delta > 0$) the thought that she could have been better off by not responding to the rebate offer effectively increases the utility from redemption. Hence, redemption generates two sources of utility: a standard physical utility, and another, emotional one, which results from being consistent with past decisions. The emotional utility can also be interpreted as ego-utility which is the counterpart of the self-image loss in case of failure.

In order to account for the sunk cost effect, the optimal conditions for a consumer to reply to the rebate promotion need to be modified. The consumer finds the rebate promotion attractive if and only if:

(Buying conditions with sunk-cost effect)

$$-\Delta + \beta\delta[-c + \delta B + \gamma\Delta] \geq 0$$

$$-c + \hat{\beta}\delta B + \gamma\Delta \geq 0$$

These modified buying conditions reflect that the consumer anticipates that in case of redemption she will experience the emotional utility from being consistent with past decisions (or, from avoiding regret resulting from past mistakes). This utility is experienced at $t = 1$ and hence it is discounted by $\beta\delta$. To clarify the point, we set up a simple example that we will carry on throughout the analysis. Suppose that a partially naive consumer with self-control problems $\beta = 0.65$ and beliefs $\hat{\beta} = 0.7$ considers buying a DVD-player that includes 17 dollars rebate offer. Assume also that she values the product 5 dollars less than its original price and it costs her 11 dollars to complete and mail the required forms. Moreover, suppose that $\delta = \gamma = 0.90$. In this case, $c = 11$, $\Delta = 5$, and $B = 17$. The two buying conditions are satisfied.[8] In this example, the partially naive consumer will reply to the rebate promotion at $t = 0$ and will redeem the rebate at $t = 1$ because also the redemption condition is satisfied.[9] A sophisticated with $\hat{\beta} = 0.65 = \beta = 0.65$ will behave similarly as the second buying condition is satisfied also for $\beta = 0.65$.[10] Now we turn to the case when consumers have several opportunities to redeem

[8] The first buying condition is $-5 + 0.65 \cdot 0.90[-11 + 0.90 \cdot 17 + 0.90 \cdot 5] = 0.148$, while the second condition is $-11 + 0.90 \cdot 0.70 \cdot 17 + 0.90 \cdot 5 = 4.21$.

[9] In particular, $-11 + 0.90 \cdot 0.65 \cdot 17 + 0.90 \cdot 5 = 3.445$.

[10] For the sophisticated, the second buying condition is equivalent to her redemption condition, which is the same redemption condition of the partially naive.

preceding the deadline T.

4.1 Redemption decisions with deadlines

In the followings we utilize the framework provided by O'Donoghue and Rabin (2001) to analyze choice and procrastination. In each period t the consumer decides whether to do the task in t. We denote with a_t the action taken at period t; if $a_t = 1$ she accomplishes the task and if $a_t = 0$ she does not. We denote with the strategy $\alpha(t, \hat{\beta}) = (\hat{a}^t_{t+1}, \hat{a}^t_{t+2}, ..., \hat{a}^t_T)$ the consumer's period-t belief about when she will redeem the rebate, given that she does not accomplish the task in period t, i.e. given that $a_t = 0$. For example, $\hat{a}^t_{t+2} = 1$ means that at period t the consumer believes to redeem two periods later, i.e. at $t + 2$. Although the consumer can complete the task at most once, a strategy specifies an action for all periods. The strategy $\alpha(t, \hat{\beta}) = (0, 0, ..., 0)$ plays an important role in the analysis, saying that the consumer believes that she will not redeem by the deadline T. We denote such a strategy with $\alpha(t, \hat{\beta}) = \oslash$. Let $V_t[\alpha(t, \hat{\beta}), \beta, \delta]$ be the period-t preferences over current actions conditional on following strategy $\alpha(t, \hat{\beta})$:

$$V_t[\alpha(t, \hat{\beta}), \beta, \delta] = -c + \beta\delta B + \gamma^t \Delta \quad \texttt{if} \quad a_t = 1$$

$$V_t[\alpha(t, \hat{\beta}), \beta, \delta] = \beta\delta^{\tau - t}(-c + \delta B + \gamma^{t+\tau}\Delta) \quad \texttt{if} \quad a_t = 0, \tau \equiv min\left\{d > 0 | \hat{a}^t_{t+d} = 1\right\} \quad \texttt{exists}$$

$$V_t[\alpha(t, \hat{\beta}), \beta, \delta] = -\gamma^t \Delta \quad \texttt{if} \quad a_t = 0, \quad \texttt{and}\ \alpha(t, \hat{\beta}) = \oslash$$

The consumer at each period t chooses an action that maximizes her current preferences $V^t[\alpha(t, \hat{\beta}), \beta, \delta]$ given her current beliefs about strategy $\alpha(t, \hat{\beta})$. In the first case, the consumer redeems at time t, incurs the immediate cost and experiences the delayed benefit and the emotional utility. In the second case, the consumer does not redeem at time t but thinks to redeem τ periods later so that both the cost and the benefits are discounted by β. In the third case, the consumer does not redeem at time t and understands that she will not redeem by the deadline T. The consequence is that she suffers the emotional disutility from having made a bad decision in the past.

We require that the individual strategy $\alpha(t, \hat{\beta})$ be optimal given the individual beliefs $\hat{\beta}$: $\alpha(t, \hat{\beta})$ =arg max$V^{t'}_t[\alpha(t, \hat{\beta}), \hat{\beta}, \delta]$ for all t', where $V^{t'}_t[\alpha(t, \hat{\beta}), \hat{\beta}, \delta]$ are the period-t preferences the consumer perceives will have in the future $t + t'$. That is, the action taken at each period is optimal given the perceived future behavior and incentives that are determined by the perception $\hat{\beta}$. The optimal strategy $\alpha(t, \hat{\beta})$ is essentially equivalent to the perfect perfection strategy of O'Donoghue and Rabin (2001).[11] We characterize the optimal strategy and we prove some of the results derived in this section in the Appendix.

In order to clarify how the optimal beliefs $\alpha(t, \hat{\beta})$ are formed, let $\widetilde{V}_t[\tau, \beta, \delta]$ be the values for the period-t intertemporal utility from completing the task in period $\tau \geq t$. For $\tau = t$, $\widetilde{V}_t[\tau, \beta, \delta] = -c + \beta\delta B + \gamma^t \Delta$, while for for $\tau > t$, $\widetilde{V}_t[\tau, \beta, \delta] = \beta\delta^{\tau-t}[-c + \delta B + \gamma^{t+\tau}\Delta]$. In our example if we set $t = 1$ we have:

$$
\begin{aligned}
\widetilde{V}_t[\tau = 1, \beta, \delta] &= -11 + (.65)(.90)17 + (.90)5 &&= 3.445 \\
\widetilde{V}_t[\tau = 2, \beta, \delta] &= (0.65)(.90)[-11 + (.90)17 + (.90)^2 5] &&= 4.8847 \\
\widetilde{V}_t[\tau = 3, \beta, \delta] &= (.65)(.90)^2[-11 + (.90)17 + (.90)^3 5] &&= 4.1830 \\
\widetilde{V}_t[\tau = 4, \beta, \delta] &= (.65)(.90)^3[-11 + (.90)17 + (.90)^4 5] &&= 3.592 \\
\widetilde{V}_t[\tau = 5, \beta, \delta] &= (.65)(.90)^4[-11 + (.90)17 + (.90)^5 5] &&= 3.0929
\end{aligned}
$$

As it is clear from this example, due to the presence of β, delaying the task to period 2 is preferable to doing the task now (at $t = 1$). Whether the consumer actually delays now depends on how she perceives future behavior. In particular, she delays now if, based on her perceived future behavior, she believes that she will accomplish the task in the future with no more than a maximum tolerable delay. The maximum tolerable delay that the consumer tolerates in the above example is 3 periods because after the 4th period the value of redemption is lower than the value if she completes the task today (at $t = 1$).[12] Hence, the consumer delays at $t = 1$ if she believes to redeem in no more than 4 periods. For a consumer with self-control β and beliefs $\hat{\beta}$ we denote the maximum tolerable delay at time t with $d_t(\beta|\hat{\beta})$:

$$
d_t(\beta|\hat{\beta}) \equiv max \left\{ d \in \{0, 1, 2, ..., T\} \,|\, -c + \beta\delta B + \gamma^t \Delta < \beta\delta^d(-c + \delta B + \gamma^{d+t}\Delta) \right\}
$$

The definition of the maximum tolerable delay incorporates two effects that work in opposite directions. The first is created by the presence of β and leads to prefer a high delay (because it makes the cost less salient), the other is created by the the long-run discount factor δ and renders the delay less pleasant (because it decreases the perceived utility of B in the future). After a critical date the computation of the maximum tolerable delays at different points in

[11] In this case, however, we do not need to impose the restriction of external consistency according to which a person's beliefs must be consistent across periods, i.e. a person's belief of what she will do in period τ must be the same in all $t < \tau$. In this paper we deal with a finite period model so that the external consistency always holds.

[12] The maximum tolerable delay above is 3 if $T > 3$, otherwise the maximum tolerable delay is set by the deadline itself.

time delivers $d_{t+1}(\beta|\hat{\beta}) \geq d_{t+2}(\beta|\hat{\beta}) \geq d_{t+3}(\beta|\hat{\beta}) \geq ... \geq d_T(\beta|\hat{\beta})$ (see the Appendix). Some of the inequalities will hold with certainty if at any point in time the maximum tolerable delay is greater than 0. This is because at the deadline (at the last opportunity of redemption) the consumer will surely not tolerate any further delay, i.e. $d_T(\beta|\hat{\beta}) = 0$. Another factor contributing to the decreasing maximum tolerable delay is provided by the decreasing payoff from redemption, a result of the sunk-cost effect. It is important to note, however, that the changes in the maximum tolerable delays do not affect the overall analysis. The predictions of the model hold for any kind of patterns that the maximum tolerable delays may exhibit.

Now, in order to understand whether a consumer with a maximum tolerable delay greater than 0 is willing to delay the redemption, we need to know what she thinks about her future behavior. This in turn is determined by her beliefs about her maximum tolerable delay in the future. At time t we denote the perceived maximum tolerable delay in the future $t+\tau$, with $d_t^\tau(\hat{\beta}|\hat{\beta})$:

$$d_t^\tau(\hat{\beta}|\hat{\beta}) \equiv max\left\{d \in \{0,1,...,T\} \,|\, -c + \hat{\beta}\delta B + \gamma^{t+\tau}\Delta < \hat{\beta}\delta^d(-c + \delta B + \gamma^{d+t+\tau}\Delta)\right\}$$

Given her perceived future maximum tolerable delay the consumer sets her redemption strategy by assigning an action (0 or 1) to each future period. Before describing the consumer's redemption strategy we need to introduce the following notation:

$$n_{\hat{\beta}} \equiv min\left\{n \in [1,2,...,T] | -c + \hat{\beta}\delta B + \gamma^{n_{\hat{\beta}}+1}\Delta \leq 0\right\}$$

We term $n_{\hat{\beta}}$ the perceived payoff-worth deadline since the consumer foresees that at any $t > n_{\hat{\beta}}$ the net future payoff from doing the task is negative. Note that $n_{\hat{\beta}}$ depends on $\hat{\beta}$, so that the true payoff-worth deadline may differ from the perceived one, if $\hat{\beta}$ is not equal to β. We term the true payoff-worth deadline n_β and calculate using β in place of $\hat{\beta}$ in the above definition.

Now consider the sophisticated with $\beta = \hat{\beta}$ and $n_{\hat{\beta}} = n_\beta$. Sophistication also implies that $d_t^\tau(\hat{\beta}|\hat{\beta}) = d_{t+\tau}(\beta|\hat{\beta})$ which means that her perceived future maximum delay is equal to the actual future maximum tolerable delay. We first analyze the case when $n_{\hat{\beta}} = n_\beta < T$. In the example above for the sophisticated with $\beta = \hat{\beta} = 0.65$, $n_\beta = 14$ as at period 15th, $-c + \hat{\beta}\delta B + \gamma^{15}\Delta$ is negative.[13]. The optimal strategy of the sophisticated is found by solving the problem by backward induction. Since in period t she redeems only if she predicts that she will delay more than $d_t^\tau(\hat{\beta}|\hat{\beta})$ periods, her strategy will feature completing the task in each

[13]The relevant calculations are $-c + \hat{\beta}\delta B + \gamma^{14}\Delta = -11 + (.65)(.90)17 + (.90)^{14}5 = 0.08881$ and at period 15th $-c + \hat{\beta}\delta B + \gamma^{15}\Delta = -11 + (.65)(.90)17 + (.90)^{15}5 = -0.02554$

$d_t^{\tau}(\hat{\beta}|\hat{\beta}) + 1$ period. In the above example, assume for simplicity that the actual maximum tolerable delay is constant for all the periods.[14] Applying this reasoning, the sophisticated plans to complete the task in each 4th period calculating backwards from the perceived payoff-worth deadline $n_{\hat{\beta}} = 14$. Accordingly, her strategy is to redeem in periods 2nd, 6th, 10th, 14th. Given this strategy, the sophisticated passes the opportunity to redeem in period 1 since she believes to redeem in period 2 and she can tolerate a 3 period delay ($d_t(\beta|\hat{\beta}) = 3$). In period 2, she predicts that if she delays now she will redeem in period 6. As this would lead to a delay of 4 periods, that she can not tolerate, she redeems in period 2.

Note that this outcome crucially depends on the fact that $d_t^{\tau}(\hat{\beta}|\hat{\beta}) = d_{t+\tau}(\beta|\hat{\beta})$. The analysis is very similar in case $T < n_{\hat{\beta}} = n_{\beta}$ with the only difference that the calculation goes from T backwards. Now we state the first result for sophisticated and exponential consumers.

Proposition 1 ***(Behavior of exponential and sophisticated consumers)*** *An exponential consumer completes the task immediately independently of the deadline as she has a maximum tolerable delay equal to zero. A sophisticated may have a positive maximum tolerable delay which defines her redemption strategy $\alpha(t, \hat{\beta})$. Given that for a sophisticated $d_t^{\tau}(\hat{\beta}|\hat{\beta}) = d_{t+\tau}(\beta|\hat{\beta})$, it never happens that she fails to redeem by the deadline T. For $T > n_{\hat{\beta}} = n_{\beta}$, the optimal strategy of a sophisticated is independent of the redemption deadline, T. For both $T < n_{\hat{\beta}} = n_{\beta}$ and $T > n_{\hat{\beta}} = n_{\beta}$ the sophisticated will redeem at the earliest redemption date set by her strategy.*

As we anticipated in the introduction a purely exponential model with sunk-cost effect would not deliver redemption failure, which is confirmed by Proposition 1. On the contrary, as exponentials have a maximum tolerable delay equal to zero not only do not they procrastinate, but they do not even allow for any delay. The presence of hyperbolic discounting implies a behavior of the sophisticated consumer that is observationally non-equivalent to that of an exponential consumer. At the same time, the presence of the sunk-cost effect renders exponentials and sophisticated more similar with respect to the timing of redemption. The presence of the emotional disutility generates a taste for consistency that makes the maximum tolerable delay lower and thus closer to that of the exponentials.

Now consider the case of the partially naive for whom $\hat{\beta} > \beta$. Note that for a partially naive the perceived payoff-worth deadline, $n_{\hat{\beta}}$, may not be the same as the true one n_{β}. This is because she overestimates her future gains from redemption. Under general conditions $n_{\hat{\beta}} > n_{\beta}$, and this will be our focus in the subsequent analysis.

We again start with binding payoff-worth deadline, i.e. $n_{\hat{\beta}} < n_{\beta} < T$. Consider the previous example with a partially naive having $\hat{\beta} > \beta$ and $\hat{\beta} = 0.7 > \beta = 0.65$. Her actual tolerable

[14] In reality, as we mentioned before, the maximum tolerable delay may vary over time. Considering this would only complicate the exposition and would not not affect our results qualitatively. The proof is deferred to the Appendix.

delay, $d_t(\beta|\hat{\beta})$, is the same as that of the sophisticated before, i.e. 3. However, her perceived future maximum delay, $d_t^{\tau}(\hat{\beta}|\hat{\beta})$, can be lower than her actual future maximum delay, $d_{t+\tau}(\beta|\hat{\beta})$, due to the fact that $\hat{\beta} > \beta$. In order to see this, we calculate her perceived future $(t+1)$ value of redemption from the perspective of period t, denoted with $\widetilde{V}_t^{t+1}[\tau, \hat{\beta}, \delta]$, as follows. $\widetilde{V}_t^{t+1}[\tau, \hat{\beta}, \delta] = -c + \hat{\beta}\delta B + \gamma^{t+1}\Delta$ for $\tau = t+1$ and $\widetilde{V}_t^{t+1}[\tau, \hat{\beta}, \delta] = \hat{\beta}\delta^{\tau-t+1}[-c + \delta B + \gamma^{t+\tau}\Delta]$ for $\tau > t+1$. For $t = 1$:

$$\begin{aligned}
\widetilde{V}_t^{t+1}[\tau = 2, \hat{\beta}, \delta] &= -11 + (.7)(.90)17 + (.90)^2 5 &&= 3.76 \\
\widetilde{V}_t^{t+1}[\tau = 3, \hat{\beta}, \delta] &= (.7)(.90)[-11 + (.90)17 + (.90)^3 5] &&= 5.0053 \\
\widetilde{V}_t^{t+1}[\tau = 4, \hat{\beta}, \delta] &= (.7)(.90)^2[-11 + (.90)17 + (.90)^4 5] &&= 4.2981 \\
\widetilde{V}_t^{t+1}[\tau = 5, \hat{\beta}, \delta] &= (.7)(.90)^3[-11 + (.90)17 + (.90)^5 5] &&= 3.7009
\end{aligned}$$

It is easy to see that the perceived future tolerable delay is $d_t^{\tau}(\hat{\beta}|\hat{\beta}) = 2$ that is lower than the true one, $d_{t+\tau}(\beta|\hat{\beta}) = 3$. Moreover, the perceived deadline for the partially naive is $n_{\hat{\beta}} = 27$ as at period 28 her perceived future value from redemption becomes negative.[15] Her strategy will feature completing the task in each $d_t^{\tau}(\beta|\hat{\beta}) + 1$ period. Accordingly, the strategy $\alpha(t, \hat{\beta})$ of the consumer is to redeem in periods 3rd, 6th,..., 27th (assuming again that the delay does not change over time). Hence, the partially naive will not redeem in the first two periods because she believes to complete the task in period 3. However, in period 3 she again fails to redeem because, based on her strategy, she believes to do the task in period 6 and she can actually tolerate (and prefers) 3 periods of delay, $(d_t(\beta|\hat{\beta}) = 3)$. The same reasoning applies to each redemption date set by her strategy except for the last one. At the perceived deadline $(n_{\hat{\beta}} = 27th)$ she understands that she will not redeem in the future. However, she fails to complete the task even at the last opportunity because the net payoff from redemption has already become negative ($-c + \beta\delta B + \gamma^{27}\Delta$ is negative and equal to -0.2882). This is because the actual deadline until which redeeming is profitable (the payoff-worth deadline, n_β) is the same as that of the sophisticated, i.e. 14. The failure of the partially naive is thus the result of two forces: unforeseeable and repeated delays and overestimation of the deadline until which there are enough incentives to complete the task. Finally, at the perceived payoff worth-deadline 27, $\alpha(t, \hat{\beta}) = \oslash$ and she experiences the emotional disutility $\gamma^{27}\Delta = 0.05814 \cdot 5 = 0.2907$. The analysis is essentially the same when $n_\beta < T < n_{\hat{\beta}}$, with the difference that the calculations go from the redemption deadline, T, backwards. The partially naive will delay the task until T, at which point it is not profitable to complete the task. Now it is possible to state the second result.

[15] The relevant calculations in this case are $-c + \hat{\beta}\delta B + \gamma^{27}\Delta = -11 + (.7)(.90)17 + (.90)^{27}5 = 0.000075$ at period 27 and $-c + \hat{\beta}\delta B + \gamma^{28}\Delta = 11 + (.7)(.90)17 + (.90)^{28}5 = -0.028$ at period 28th.

Proposition 2 ***(Behavior of partially naive with binding payoff-worth deadline)*** *Assume $T > n_{\hat{\beta}} > n_\beta$. A partially naive for whom $d_t^\tau(\hat{\beta}|\hat{\beta}) + 1 \leq d_{t+\tau}(\beta|\hat{\beta})$ delays to complete the task until $n_{\hat{\beta}}$. At that period there are no incentives to complete the task, she does not redeem and she suffers the emotional disutility $\gamma^{n_{\hat{\beta}}}\Delta$. The extent of the emotional disutility that a partially naive eventually suffers is decreasing with the degree of naivete, $\hat{\beta} - \beta$. For $n_\beta < T < n_{\hat{\beta}}$, the partially naive for whom $d_t^\tau(\hat{\beta}|\hat{\beta}) + 1 \leq d_t(\beta|\hat{\beta})$ delays until T and at that period she does not complete the task. In this case, the extent of the emotional disutility she suffers is independent of $\hat{\beta} - \beta$ and decreasing with T. The behavior of a partially naive for whom $d_t^\tau(\hat{\beta}|\hat{\beta}) + 1 = d_t(\beta|\hat{\beta}) + 1$ is the same as that of a sophisticated.*

This result differs from that of O'Donoghue and Rabin (2001) in two important aspects. There, without deadlines, partially naives may delay a task infinitely without ever realizing that they will never complete it. While our theoretical prediction delivers the result that the agent may fail to complete the task, here this behavior needs not be enforced by persistent optimistic beliefs in future willpower. Moreover, in the framework of O'Donoghue and Rabin (2001) the introduction of a deadline would lead all agents to accomplish the task, since even partially naives, for whom $d(\hat{\beta}|\hat{\beta}) + 1 < d(\beta|\hat{\beta})$, will succeed to do it at the last opportunity. As such, that framework can not explain why in reality we frequently observe that people fail to accomplish what they plan even in the presence of deadlines. In our case, the sunk cost effect creates a payoff-worth deadline until which it is profitable to complete the task. In principle, we should also get the result that at the payoff-worth deadline even partially naives succeed in providing the necessary effort. However, due to the fact that their $\hat{\beta} > \beta$, partially naives overestimate the length of the payoff-worth deadline because they overweight their future benefit from redemption. This will lead them to delay the task until a misperceived payoff-worth deadline, at which point they do not find it profitable to complete the task. Interestingly, a partially naive may give up to complete the task even before the redemption deadline, T, expires.

Now we consider the case where $T < n_\beta < n_{\hat{\beta}}$, i.e. the redemption deadline is binding. In the example above, assume that $T = 12$ (maintaining that $n_\beta = 14$ and $< n_{\hat{\beta}} = 27$). The strategy of the partially naive who has a $d_t(\hat{\beta}|\hat{\beta}) = 2$ is to accomplish the task in periods 3rd, 6th,...,9th, 12th. Using the logic above, since $d_t^\tau(\hat{\beta}|\hat{\beta}) + 1 \leq d_{t+\tau}(\beta|\hat{\beta})$, she will delay until period 12. At that period she will complete the task because $-c + \beta\delta B + \gamma^{12}\Delta > 0$.

Proposition 3 ***(Behavior of partially naives with binding redemption deadline)*** *Assume $T < n_\beta < n_{\hat{\beta}}$. A partially naive for whom $d_t^\tau(\hat{\beta}|\hat{\beta}) + 1 \leq d_{t+\tau}(\beta|\hat{\beta})$ delays to complete the task until T. At that period she does redeem. A partially naive for whom $d_t^\tau(\hat{\beta}|\hat{\beta}) + 1 = d_{t+\tau}(\beta|\hat{\beta}) + 1$ redeems at the earliest redemption date of her strategy.*

An implication of the last two propositions is that for a partially naive with a certain degree of naivete $\hat{\beta} - \beta$, the probability of redemption is decreasing with the deadline. This theoretical prediction matches the empirical evidence discussed in the introduction. The main results concerning delay and failure in redemption are driven by naivete in future self-control problems. In the example we have discussed even a small degree of naivete, i.e. $\hat{\beta} - \beta = 0.7 - 0.65$, led the consumer to postpone the task until the last possible period.

4.2 Buying decision with deadlines

In this sub-section we study the buying conditions given that the consumer can accomplish the task in any of the periods preceding the deadline T. At period 0 the consumer computes her maximum tolerable delay that she believes to have in the future, $d_t^{\tau}(\hat{\beta}|\hat{\beta})$. Accordingly, her strategy is to complete the task in each $d_t^{\tau}(\hat{\beta}|\hat{\beta}) + 1$ periods and she expects to complete the task at the earliest redemption date of her strategy. Define $\mu^* = n_{\hat{\beta}} - z^*(d_t^{\tau}(\hat{\beta}|\hat{\beta}) + 1)$, where $z^* \equiv max\left\{z \in [1, 2, ..., T-1] | n_{\hat{\beta}} - z d_t^{\tau}(\hat{\beta}|\hat{\beta}) \geq 1\right\}$, for $T < n_{\hat{\beta}}$.[16] Then, the buying conditions are:

(Buying conditions with sunk-cost effect)

$$-\Delta + \beta\delta^{\mu^*}[-c + \delta B + \gamma^{\mu^*}\Delta] \geq 0$$

$$-c + \hat{\beta}\delta B + \gamma^{\mu^*}\Delta \geq 0$$

As we documented in section 2, with longer deadline more consumers reply to the rebate promotion. As such, however, these conditions do not provide any insight about the relationship between the extent of the deadline and the incentive to buy. At period 0, both the sunk-cost effect and the extent of the deadline can have an effect on the decision to buy if the consumer anticipates how her emotional disutility varies with the deadline in case of no redemption. As we showed in the previous sub-section, in case of failure the emotional disutility is decreasing with the length of the redemption deadline (if the deadline is binding) and decreasing with $\hat{\beta}$ (in case of binding payoff-worth deadline). Therefore if the consumer takes this into account, longer deadlines should generate more incentives to buy. In order to formalize this intuition we need to introduce uncertainty at period 0 about future willpower. Note that uncertainty about the "state of nature" in the future is a key and necessary assumption of regret theories for the analysis of anticipated regret on current actions.

In particular, at period 0 consider a consumer with self-control problems β and beliefs $\hat{\beta} > \beta$ and suppose that her perceived maximum tolerable delay is such that the two buying conditions above are satisfied. However, she believes with probability q that in replying to the rebate promotion she is making a mistake because her future willpower is such that she will

[16] In the definition of μ^*, if $T > n_{\hat{\beta}}$ it is necessary to substitute T for $n_{\hat{\beta}}$.

delay until the deadline T and at that period she will fail to redeem. On the other hand, with probability $1-q$ she believes that she will find enough incentives to redeem at the earliest redemption date of her strategy. Hence, the first buying condition in this case is the following:

(First buying condition with sunk-cost effect with uncertainty and $T < n_{\hat{\beta}}$***)***

$$-\Delta + q\left\{\beta\delta^{\mu^*}[-c+\delta B+\gamma^{\mu^*}\Delta]\right\} + (1-q)\left\{-\gamma^T\Delta\right\} \geq 0$$

It is possible to show that this condition is more easily satisfied for longer T, so that, for a given degree of naivete, there will be a positive relationship between the extent of deadline and the probability to reply to the rebate promotion. As before, in the case of binding payoff-worth deadline, it is necessary to substitute in the conditions $n_{\hat{\beta}}$ for T in the definition of μ^* and the the first buying condition is:

(First buying condition with sunk-cost effect with uncertainty and $T > n_{\hat{\beta}}$***)***

$$-\Delta + q\left\{\beta\delta^{\mu^*}[-c+\delta B+\gamma^{\mu^*}\Delta]\right\} + (1-q)\left\{-\gamma^{n_{\hat{\beta}}}\Delta\right\} \geq 0$$

Now we can state the last results of the model.

Proposition 4 ***(Buying decision with uncertainty)*** *Assume that the redemption deadline is binding, i.e.* $T < n_\beta < n_{\hat{\beta}}$. *A longer redemption deadline increases the consumer's incentives to reply to the rebate promotion.*

This proposition matches the empirical finding on rebates documented in section 2: more consumers are willing to respond to a rebate promotion when the deadline is longer. In line with regret theory where in the presence of uncertainty an agent chooses an action to minimize her ex-post regret, our consumer prefers to respond to a rebate promotion associated to a longer deadline because this may cause lower regret in the future.

5 Discussion

The above model shows how rational firms can strategically design the features of investment goods (the initial investment, the effort cost, the benefit and the deadlines) to achieve various goals. In particular by offering shorter deadlines the firm can maximize the number of candidates who complete the given task in question. By offering longer deadlines, the firm can achieve higher participation and lower success rates in a program. In this section we review some areas where this device can prove to be important.

Similarly to mail-in-rebates, lottery games feature the characteristics of the above described investment goods. Going to the lottery office, paying the price of the lottery ticket and filling it out can be considered as the initial investment. After the announcement of the winner numbers the agent can collect the amount gained within a certain period. It is natural to assume that the cost of collecting the reward and the size of the reward does not change over time. While previous models would predict that all participants succeed in claiming their prize, if not earlier than at the deadline, our own experience confirms that failure happens regularly. Our model not only implies that failure happens, but predicts that failure rates are higher under milder conditions, e.g. longer deadlines.

A different area for which our model has important predictions involves the various courses offered by educational institutions. In order to achieve a specific degree or a license in some field subjects are often required to complete a course and to sit for a final exam. In many cases the agent has several opportunities to complete the exam, e.g. the practical exam to get a driving license. In case of failing to pass the exam the substantial initial investment (the cost of the course and the effort to follow the classes) is lost. Considering that self control problems may not imply that a person is less able to drive a car safely, based on the predictions of our model it could be argued that the deadline in this case should not be set by private firms. Indeed, in practice we observe that the process of getting a driving license is under state regulation.

Our model also predicts that the same person will succeed in collecting a relatively low reward if the deadline is short and at the same time may forgo a much higher gain if the deadline is long enough. The implications of our theory are not limited to situations that involve deadlines. We can also explain a very general phenomenon, i.e. a person may procrastinate a task forever, with allowing her to realize at a certain point that she will never succeed in completing it. We believe that this is a more realistic description of why we fail to pick up a book that we ordered and already paid for, or why we do not manage to collect our gloves that we forgot in the movie theater (even if we swore to get them back the moment we realized our loss).

Appendix

In this Appendix we characterize the optimal strategy of the consumer and we show that a decreasing maximum tolerable delay (mentioned in subsection 4.1) does not change our results. It is important to note that in this paper, using the terminology of O'Donoghue and Rabin (2001), we analyzed only tasks that are $\hat{\beta}$-worthwhile. In the context of our application this implies that there exists at least a period $t < T$ for which $-c+\hat{\beta}\delta B+\gamma^t\Delta > 0$. In the followings we will consider the case of redemption deadlines that are not binding, i.e. $T > n_\beta$ as this is the one where the consumer may fail to redeem. The results concerning the optimal strategy, when it is necessary to substitute $n_{\hat{\beta}}$ for T, generalize to the case of binding redemption deadlines. Recall that $\alpha(t,\hat{\beta}) = (\hat{a}^t_{t+1}, \hat{a}^t_{t+2}, ..., \hat{a}^t_T)$ is the consumer's period-t belief about when she will accomplish the task and that $V_t[\alpha(t,\hat{\beta}),\beta,\delta]$ are the period-t preferences over current actions conditional on following strategy $\alpha(t,\hat{\beta})$. We first start with the following Lemma.

Lemma 1 *For any pair (B,T), for all t either $\alpha(t,\beta) = \oslash$ or there exists a unique cyclical strategy $\alpha(t,\hat{\beta})$. The strategy is to redeem every $d^\tau_t(\hat{\beta}|\hat{\beta})+1$ periods.*

Proof of Lemma 1. Given the definition of $\alpha(t,\hat{\beta})$, the proof of the first part of Lemma 1, i.e. the strategy is either $\alpha(t,\beta) = \oslash$ or $\alpha(t,\beta) \neq \oslash$ is trivial. The uniqueness of the strategy when this is different from the null one is based on the argument that there exists a unique equilibrium in the presence of a finite horizon.

The other part of the proof follows O'Donoghue and Rabin (2001). Given the definition of $d^\tau_t(\hat{\beta}|\hat{\beta})$, for any $d' \in \left\{t+\tau+1, t+\tau+2, ..., t+\tau+d^\tau_t(\hat{\beta}|\hat{\beta})\right\}$, if $\hat{a}^t_{t^*} = 1$ and $\hat{a}^t_{t^*-d} = 0$ for all $d \in \{1,2,...,d'-1\}$, then the action that maximizes the preference at t^*-d' from the perspective of period t is $a = 0$. For $d' = d^\tau_t(\hat{\beta}|\hat{\beta})+1$, if $\hat{a}^t_{t^*} = 1$ and $\hat{a}^t_{t^*-d} = 0$ for all $d \in \{1,2,...,d'-1\}$, then the action that maximizes the preference at t^*-d' from the perspective of period t is $a = 1$. It follows that the optimal strategy $\alpha(t,\hat{\beta})$ features completing the task every $d^\tau_t(\hat{\beta}|\hat{\beta})+1$ periods and not completing the task otherwise.

QED

If the perceived maximum tolerable delay resulting from the expressions given in the text, $d^\tau_t(\hat{\beta}|\hat{\beta})$, and the maximum tolerable delay, $d_t(\beta|\hat{\beta})$, are such that these are greater than $n_{\hat{\beta}}$, then $d^\tau_t(\hat{\beta}|\hat{\beta})$ and $d_t(\beta|\hat{\beta})$ are equal to $n_{\hat{\beta}}-(t+\tau)$ and to $n_{\hat{\beta}}-t$, respectively. This is the case whenever the maximum tolerable delay, $d_t(\beta|\hat{\beta})$, is such that $-c+\hat{\beta}\delta B+\gamma^{t+d_t(\beta|\hat{\beta})} < 0$ and the perceived maximum tolerable delay in the future $t+\tau$, $d^\tau_t(\hat{\beta}|\hat{\beta})$, is such that $-c+\hat{\beta}\delta B+\gamma^{t+\tau+d^\tau_t(\hat{\beta}|\hat{\beta})} < 0$. Define $\widetilde{d}^\tau_t(\hat{\beta}|\hat{\beta})$ and $\widetilde{d}_t(\beta|\hat{\beta})$ as the counterpart of $d^\tau_t(\hat{\beta}|\hat{\beta})$ and $d_t(\beta|\hat{\beta})$ when the conditions $-c+\hat{\beta}\delta B+\gamma^{t+d_t(\beta|\hat{\beta})}\Delta \geq 0$ and $-c+\hat{\beta}\delta B+\gamma^{t+\tau+d^\tau_t(\hat{\beta}|\hat{\beta})}\Delta \geq 0$ need not to be satisfied. We can term $\widetilde{d}^\tau_t(\hat{\beta}|\hat{\beta})$ and $\widetilde{d}_t(\beta|\hat{\beta})$ as the unconstrained maximum tolerable delays.

Lemma 2 *The unconstrained maximum tolerable delays $\widetilde{d}_t^{\tau}(\hat{\beta}|\hat{\beta})$ and $\widetilde{d}_t(\beta|\hat{\beta})$ are not decreasing in τ and t.*

Proof of Lemma 2. To prove this Lemma it is sufficient to show that at time t, $d_t^{\tau}(\hat{\beta}|\hat{\beta})$ cannot be higher than $d_t^{\tau+1}(\hat{\beta}|\hat{\beta})$ without imposing the condition that $-c+\hat{\beta}\delta B+\gamma^{t+\tau+d_t^{\tau}(\hat{\beta}|\hat{\beta})} \geq 0$. Given the definition of $d_t^{\tau}(\hat{\beta}|\hat{\beta})$, it must be that:

$$\underbrace{-c+\beta\delta B+\gamma^{t+\tau}\Delta}_{A} > \underbrace{\beta\delta^{d_t^{\tau}(\hat{\beta}|\hat{\beta})+1}(-c+\delta B+\gamma^{d_t^{\tau}(\hat{\beta}|\hat{\beta})+1+t+\tau}\Delta)}_{B}$$

$$\underbrace{-c+\beta\delta B+\gamma^{t+\tau+1}\Delta}_{C} < \underbrace{\beta\delta^{d_t^{\tau+1}(\hat{\beta}|\hat{\beta})}(-c+\delta B+\gamma^{d_t^{\tau+1}(\hat{\beta}|\hat{\beta})+t+\tau+1}\Delta)}_{D}$$

Suppose that $d_t^{\tau}(\hat{\beta}|\hat{\beta}) > d_t^{\tau+1}(\hat{\beta}|\hat{\beta})$, we want to show that this is impossible. In particular, without loss of generality suppose that $d_t^{\tau}(\hat{\beta}|\hat{\beta}) = d_t^{\tau+1}(\hat{\beta}|\hat{\beta})+1$. By substituting $d_t^{\tau+1}(\hat{\beta}|\hat{\beta})$ for $d_t^{\tau}(\hat{\beta}|\hat{\beta})$ in D, we have $D = \beta\delta^{d_t^{\tau}(\hat{\beta}|\hat{\beta})-1}(-c+\delta B+\gamma^{d_t^{\tau}(\hat{\beta}|\hat{\beta})+t+\tau}\Delta)$. Hence, it is immediate that $B < D$. Notice that, given the definition of the generic $d_t^{\tau}(\hat{\beta}|\hat{\beta})$, $C > \beta\delta^{d_t^{\tau+1}(\hat{\beta}|\hat{\beta})+1}(-c+\delta B+\gamma^{d_t^{\tau+1}(\hat{\beta}|\hat{\beta})+t+\tau+2}\Delta)$. In this last expression, by substituting $d_t^{\tau+1}(\hat{\beta}|\hat{\beta})$ for $d_t^{\tau}(\hat{\beta}|\hat{\beta})$ we have $C > \beta\delta^{d_t^{\tau}(\hat{\beta}|\hat{\beta})}(-c+\delta B+\gamma^{d_t^{\tau}(\hat{\beta}|\hat{\beta})+t+\tau+1}\Delta)$ that implies that $C > B$. Hence, $d_t^{\tau}(\hat{\beta}|\hat{\beta}) > d_t^{\tau+1}(\hat{\beta}|\hat{\beta})$ implies $C > B$ and $B < D$ and in turn $C > D$ which is a contradiction. The result follows.

QED

Lemma 2 also implies that from $t = 1$ onwards the maximum tolerable delays are first increasing and then decreasing. The maximum tolerable delays are equal to the unconstrained maximum tolerable delays which are increasing over time as long as the conditions $-c+\hat{\beta}\delta B+\gamma^{t+d_t(\beta|\hat{\beta})}\Delta \geq 0$ and $-c+\hat{\beta}\delta B+\gamma^{t+\tau+d_t^{\tau}(\hat{\beta}|\hat{\beta})}\Delta \geq 0$ are satisfied. As mentioned before, when these conditions are not met, the maximum tolerable delays, $d_t^{\tau}(\hat{\beta}|\hat{\beta})$ and $d_t(\beta|\hat{\beta})$, are decreasing over time as these are equal to $n_{\hat{\beta}}-(t+\tau)$ and to $n_{\hat{\beta}}-t$, respectively.

Lemma 3 *The last date of the redemption strategy, $\alpha(t,\hat{\beta})$, is equal to the perceived payoff worth deadline, $n_{\hat{\beta}}$. The last but one date of the redemption strategy is $n_{\hat{\beta}}-(d_t^{\tau^*}(\hat{\beta}|\hat{\beta})+1)$ where $t+\tau^*$ is the first period backward from $n_{\hat{\beta}}$ such that $\widetilde{d}_t^{\tau^*}(\hat{\beta}|\hat{\beta}) = d_t^{\tau^*}(\hat{\beta}|\hat{\beta})$.*

Proof of Lemma 3. The last date of the redemption strategy is the deadline because at that date the agent cannot tolerate any further delay. The last but one date of the redemption strategy must be $n_{\hat{\beta}}-(\widetilde{d}_t^{\tau^*}(\hat{\beta}|\hat{\beta})+1)$ with τ^* as defined in the lemma. Any other period after $t+\tau^*$ but $n_{\hat{\beta}}$, indeed, can not be a date of the redemption strategy because in that period $d_t^{\tau}(\hat{\beta}|\hat{\beta}) < \widetilde{d}_t^{\tau}(\hat{\beta}|\hat{\beta})$ and $d_t(\beta|\hat{\beta}) < \widetilde{d}_t(\beta|\hat{\beta})$ as $d_t^{\tau}(\hat{\beta}|\hat{\beta})$ and $d_t(\beta|\hat{\beta})$ are equal to $n_{\hat{\beta}}-(t+\tau)$ and to $n_{\hat{\beta}}-t$, respectively. Hence, for any period after $t+\tau^*$ the agent can always tolerate a delay until $n_{\hat{\beta}}$. By using the previous lemmas, the first date in which she cannot tolerate a delay is $n_{\hat{\beta}}-(d_t^{\tau^*}(\hat{\beta}|\hat{\beta})+1)$. The result follows.

QED

Lemma 4 *If for all periods of the redemption strategy that precede n_β, $d_{t+\tau}(\beta|\hat{\beta})+1 \geq d_t^\tau(\hat{\beta}|\hat{\beta})$, then the consumer fails to redeem.*

Proof of Lemma 4. If $d_{t+\tau}(\beta|\hat{\beta})+1 \geq d_t^\tau(\hat{\beta}|\hat{\beta})$ then the consumer is a partially naive that misperceives also the perceived payoff worth deadline, i.e. $n_{\hat{\beta}} > n_\beta$. At any date of the redemption strategy after n_β, the consumer fails to redeem because she does not find enough incentives, i.e. $-c+\beta\delta B+\gamma^{n_{\hat{\beta}}+1}\Delta < 0$. Hence, it is necessary to show that the consumers procrastinate at least until n_β. Assume $d_{t+\tau}(\beta|\hat{\beta})+1 \geq d_t^\tau(\hat{\beta}|\hat{\beta})$. Since the consumer prefers to delay today, $V_t[\alpha(t,\hat{\beta}),\beta,\delta] = \beta\delta^{\tau+d-t}(-c++\gamma^{d+t+\tau}\Delta)$ for some $d \in [t+\tau+1, t+\tau+2, ..., \tau+t+d_t^\tau(\hat{\beta}|\hat{\beta})+1]$ and, since the current action is not to redeem, this expression must be equal or greater than $\beta\delta^{d_t^\tau(\hat{\beta}|\hat{\beta})+1}(-c+\delta B+\gamma^{d_t^\tau(\hat{\beta}|\hat{\beta})+1+t+\tau}\Delta)$. Note that the consumer plans to redeem at $t+\tau$ only if $-c+\beta\delta B+\gamma^{t+\tau}\Delta \geq \beta\delta^{d_t^\tau(\hat{\beta}|\hat{\beta})+1}(-c+\delta B+\gamma^{d_t^\tau(\hat{\beta}|\hat{\beta})+1+t+\tau}\Delta)$ but actually redeems at $t+\tau$ only if $-c+\beta\delta B+\gamma^{t+\tau}\Delta \geq \beta\delta^{d_{t+\tau}(\beta|\hat{\beta})+1}(-c+\delta B+\gamma^{d_{t+\tau}(\beta|\hat{\beta})+1+t+\tau}\Delta)$. Since the definition of $d_{t+\tau}(\beta|\hat{\beta})$ implies that $-c+\beta\delta B+\gamma^{t+\tau}\Delta < \beta\delta^d(-c+\delta B+\gamma^{d+t+\tau}\Delta)$, for any date of the redemption strategy τ and for any $d_{t+\tau}(\beta|\hat{\beta})$, if $d_{t+\tau}(\beta|\hat{\beta})+1 \geq d_t^\tau(\hat{\beta}|\hat{\beta})$ then the optimal action is not to redeem at any date of the redemption strategy $\alpha(t,\hat{\beta})$. The result follows.

QED

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