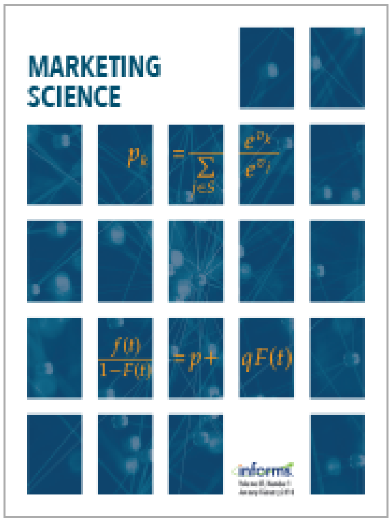

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Slippage in Rebate Programs and Present-Biased Preferences

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Present-biased preferences capture the idea that individuals may find immediate payoffs significantly more salient than any future payoffs, rather than simply discounting the future in a time-consistent manner. In this paper we show that consumers' present-biased preferences can generate slippage, and we explore whether this can explain firms' use of mail-in rebates. We assume that the consumer population comprises members who have various degrees of present bias. The model demonstrates that if consumers have homogeneous willingness to pay for a product (and thus rebates do not serve as a mechanism for traditional price discrimination) rebates may still profitably exploit slippage, but to do so they must generate very high slippage rates. This is, because the rebate must greatly exceed the price markup because the rebate must compensate consumers for the cost of redemption and the delay in receiving the rebate. The ability of rebate programs to take advantage of present-biased consumers is quite limited in settings where there is significant variance in the degree of present bias within the population unless the extent of consumers' present bias is highly correlated with their rebate redemption costs.

Key words: present-biased preferences; rebates; slippage; price discrimination
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1. Introduction

The classic explanation for retail rebates is that they provide sellers with a mechanism for price discrimination much like coupons, with which rebates are typically grouped (Narasimhan 1984, Houston and Howe 1985, Nagle 1995). A more recent literature has shown that rebates (and coupons as well) may arise for strategic reasons in the distribution channel as a means of offering a price cut directly to consumers and preventing retailers from undermining a manufacturer's efforts at intertemporal price discrimination (Gerstner and Hess 1991a, b; Ault et al. 2000).[1] Although these theories clearly explain some of the logic of rebate programs, they fail to explain one of the central characteristics of consumer mail-in rebates: that the consumer must complete redemption forms after making a purchase, then wait (often for several months) to receive the refund of a portion of the purchase price. As others have pointed out (Chen et al. 2005, Lu and Moorthy 2007), it is this sequence of timing that distinguishes rebates from other price promotions. This has given rise to a number of alternative theories for the profitability of rebates, some of which focus on "slippage" as an explanation for the value of rebate programs. Slippage occurs when consumers are induced by the rebate to make a purchase but later fail to redeem the rebate. The failure of consumers to perfectly foresee their future redemption behavior distinguishes models of slippage from the traditional price-discrimination model. In models where a rebate serves to price-discriminate among consumers with different willingness to pay for a good, some consumers redeem the rebate while others do not, but this arises because of heterogeneity in redemption costs, which are assumed to be correlated with consumers' willingness to pay for the product, and all consumers correctly foresee at the time of purchase whether they will redeem.

This paper models slippage arising because consumers perceive the payoffs associated with the rebate program differently at the time of purchase than when choosing whether to redeem. In this vein Soman (1998) argues that the delayed incentive characteristic of rebates is advantageous to sellers because consumers' purchasing decisions are more responsive to the face value of the rebate than to the effort involved in redemption, whereas redemption behavior is more responsive to the effort cost than the face value. Soman discusses several behavioral theories that support the view that at the time of purchase the cost of future effort is underestimated relative to the face

[1] In a somewhat related model, Bruce et al. (2006) show that rebates may be used by durable goods manufacturers to entice consumers to replace a good (such as an automobile) in which they have negative equity.

value of the rebate. For example, Soman cites Mowen and Mowen (1991) and Thaler (1981) in arguing that consumers may discount future losses (the effort cost of redemption) more than future gains (the rebate refund) and argues that consumers may be overconfident in their estimate of the probability of completing a future task such as redeeming a rebate based on the work of Hoch (1985) and Kahneman and Lovallo (1993). Soman also cites Akerlof (1991) to argue that consumers may have perceptual distortions akin to procrastination that lead them to underestimate the cost of taking an action in the future relative to taking the same action immediately. Implicit in these arguments is the notion that consumers fail to accurately foresee future redemption behavior. However, consumers' preferences are not modeled, and the relationship between any specific behavioral theory and rebate redemption behavior is not formalized. Consequently, it is not determined whether and to what extent any particular behavioral theory can explain the prevalence of rebates in consumer markets.

Silk (2008) experimentally examines slippage in rebate programs and finds evidence that slippage results from a discrepancy between consumers' subjective probability of redemption (their beliefs at the time of purchase about whether they will redeem the rebate) and their actual redemption behavior. This study provides evidence that behavioral factors play an important role in rebate redemption. Among subjects who failed to redeem a rebate offer after purchase, the most common self-reported reasons given were "I procrastinated and the deadline passed before I applied," and "I procrastinated and eventually forgot to apply." Also, subjects' "redemption confidence," their self-reported subjective probability that they would redeem the rebate, was essentially identical for those who did redeem as for those who did not, indicating a lack of self-awareness. Even more compelling than self-reported explanations for behavior is the fact that redemption rates decreased when subjects were offered a longer redemption period, although longer redemption periods increased the number of subjects who purchased the good offered for sale with a rebate. This strongly indicates that subjects are failing to correctly anticipate future behavior and in particular that they fail to foresee that a longer redemption period may exacerbate self-control problems associated with procrastination.

In this paper we explore slippage and the profitability of a rebate program while employing a model of consumer behavior, present-biased preferences, that, as noted above, has been suggested (but not formalized) as an explanation for slippage.[2] This theory is especially relevant because of the view expressed by Soman (1998) and Silk (2008) that procrastination may play a role in explaining slippage, because present-biased preferences have been used to model the behavior of individuals who tend to procrastinate. Present-biased preferences capture the idea that individuals may find immediate payoffs significantly more salient than any payoffs that lie in the future. When present-biased individuals face intertemporal choices they may behave in a time-inconsistent manner, making a different choice depending on when the decision is evaluated. Furthermore, the theoretical work in this area has emphasized the importance of naïveté. A naïve consumer fails to foresee that he will evaluate payoffs differently in the future than he does today. It is this naïveté that may enable a seller to induce a consumer to make a purchase because of a rebate but later fail to redeem the rebate, thus generating slippage.

By modeling consumer responses to a rebate program when consumers exhibit present-biased preferences we gain an understanding of the extent to which slippage, and the profitability of rebates, can in fact be explained by this theory. We assume that the consumer population comprises members who have various degrees of present bias. We show that it is possible for a firm in a simple selling model to profitably exploit these behavioral preferences using rebates that generate slippage. Our model illustrates that, even if consumers have homogeneous willingness to pay for a firm's product (and thus rebates do not serve as a mechanism for traditional price discrimination), rebates may nevertheless be profitable. However, the model also shows that the ability of rebate programs to take advantage of naïvely present-biased consumers is quite limited in settings where there is significant heterogeneity regarding the degree of present bias within the population. The profitability of a rebate program that does not serve as a mechanism for price discrimination relies on a high rate of slippage to offset the fact that the refund must compensate consumers for the cost of redemption and delay in receiving the refund. We find that sufficiently high slippage rates occur only when a large mass of consumers have similar present-biased preferences or when these preferences are highly correlated with individuals' rebate redemption costs. Thus, although the model shows that present-biased preferences can result in slippage in rebate programs, it also illustrates that fairly special circumstances are required for a rebate to be desirable for a seller based solely on exploitation of the consumer behavior modeled here.

In addition to behavioral theories of slippage, there has been recent work seeking to explain the advantage of rebate programs while relying on strictly rational consumer behavior. Lu and Moorthy (2007)

[2] Present-biased preferences are essentially a formalization of the behavioral ideas first discussed by Akerlof (1991) and cited by Soman (1998) as mentioned above.

address the question of why sellers prefer rebates over coupons as a mechanism for price discrimination in some settings, whereas in others coupons are preferred. They argue that redemption costs (for both rebates and coupons) are uncertain, but rebates and coupons differ with regard to when the uncertainty is resolved. They show that either rebates or coupons can be preferred depending on the size of different segments of the consumer population (high or low reservation price), the distribution of redemption costs, and other factors. Chen et al. (2005) seek to explain consumer behavior in a rational framework by showing that rebates offer consumers an opportunity for "utility arbitrage." At the time of purchase consumers face uncertainty regarding the future state of nature and resultant utility they will derive from consuming the good. The presence of the rebate provides consumers the possibility of redeeming if their marginal utility of income is in the future revealed to be high, and not doing so if it is revealed to be low (thus making the refund not worth the effort of redemption).

We do not reject the theories discussed above; in particular we do not contend that a behavioral model of rebates is superior to a "rational" model. Instead, we seek to further the understanding of what role behavioral factors may play by rigorously exploring what the specific behavioral theory of present-biased preferences implies about consumer responses to rebate offers and the implications for rebate programs. As in Chen et al. (2005), we present a theory that explains why rebates may arise in markets where they are not functioning as a mechanism for traditional price discrimination. In the conclusion we argue that rebates may serve multiple purposes, with exploitation of time-inconsistent consumer behavior yielding slippage being one factor among several.

The rebates we have in mind in this paper are mail-in rebates that are offered at the time of purchase to all consumers. The rebate typically requires that the consumer mail in a rebate form together with proof of purchase such as the register receipt and often the bar code from the product packaging. The consumer must then wait, typically from one to three months, before receiving the rebate check. This type of consumer rebate ranges in value from approximately \$2 on products such as motor oil to \$50 or more on many consumer electronics products, with \$50 being a common figure (Spencer 2002). Mail-in rebate programs, even those at the upper end of the value range mentioned above, appear to be characterized by redemption rates well below 100%. For example, BDS Marketing found that redemption rates ranged from 5% for low-value rebates to an average of 40% for high-value electronics rebates (Spencer 2002). Interestingly, some of these markets (such as that for RAM chips for personal computers) do not appear to be characterized by significant market power on the part of either manufacturers or retailers, suggesting that the motivation for rebates may lie elsewhere than price discrimination based on consumers' valuations of the product.

This paper is organized as follows. Section 2 briefly describes the theory of present-biased preferences and illustrates how such preferences can generate slippage and make a rebate program profitable in a simple selling model in which the seller knows a consumer's preferences and how much he values the good for sale. This section also addresses whether a rebate can exploit present-biased preferences in the context of a consumer population in which the degree of present bias varies, shows how the optimal rebate offer depends on the population distribution, and characterizes circumstances under which a rebate program will be advantageous for the seller. Section 3 considers the possibility that present-biased preferences and rebate redemption costs may be correlated and shows that this can yield sufficiently high slippage rates to render a rebate desirable even when consumers' preferences are highly varied. Section 4 concludes the paper with a summary of the results and a discussion of the many alternative rationales for rebate programs, the role of slippage generated by naïve consumer behavior in that context, and whether this type of slippage can persist in the long run.

2. Slippage with Present-Biased Preferences

O'Donoghue and Rabin (1999a) coined the term "present-biased" preferences to refer to a class of time-inconsistent preferences in which individuals, when considering trade-offs between two future moments, give greater weight to the earlier moment as it gets closer. A simple model, referred to as "quasi-hyperbolic" or (β, δ)-preferences, has been broadly used in recent literature to capture the salience of the present over the future.[3] Let u_t be the instantaneous utility an individual receives at period t. Then the following utility function, U^t, represents his intertemporal preferences at time t:

$$U^t(u_t, u_{t+1}, \ldots, u_T) \equiv \delta^t u_t + \beta \sum_{\tau=t+1}^{T} \delta^\tau u_\tau.$$

The parameter δ is the usual time-consistent discounting term, whereas $\beta \in (0, 1]$ captures the possible

[3] Examples of papers utilizing this preference structure are Phelps and Pollak (1968), O'Donoghue and Rabin (1999a, b), Laibson (1997), Caillaud and Jullien (2000), Della Vigna and Malmendier (2004), and Gilpatric (2008).

time-inconsistent preference for present-period utility compared to all future periods. An individual for whom $\beta < 1$ is said to be present-biased.

The standard approach to modeling individuals with time-inconsistent preferences is to consider a person at each time period a separate agent who maximizes utility with regard to his current preferences while his "future selves" will determine future behavior according to the preferences that then prevail (O'Donoghue and Rabin 1999a). An important question that follows from this assumption is what does a person believe about his future selves' preferences? At one extreme individuals may be sophisticated, meaning that they have rational expectations about their future preferences and know exactly what their future selves will prefer even though these preferences differ from those of the current self. At the other extreme individuals may be described as naïve because at each moment in time they believe that their future preferences will be identical to their current preferences, systematically failing to realize that as an event becomes closer in time their preferences will change.[4] Economists have debated whether to model individuals as naïve or sophisticated. The assumption of sophistication entails rational expectations of future behavior, whereas naïveté captures the often-observed human tendency to put off unpleasant tasks today in the belief that tomorrow we will have the willpower or self-discipline to do them.[5] It is the possibility of consumer naïveté that drives the analysis in this paper. A naïvely present-biased consumer, a "naif" (as characterized by O'Donoghue and Rabin 1999a), may purchase a product in the mistaken belief that his future self will complete and submit the rebate when in fact he will not because of the present-biased preferences of his future self (which are not foreseen by the naif). Time-consistent consumers (for whom $\beta = 1$) or present-biased but sophisticated consumers, on the other hand, will always correctly anticipate their future selves' preferences and consequently correctly foresee their future actions when deciding whether to purchase or not. In this paper we study a consumer population consisting of naifs (who may vary in their degree of present bias) and possibly time-consistent consumers (or "TCs"). For simplicity of exposition we ignore the presence of sophisticated present-biased consumers in our model.[6] In the conclusion we discuss the implications of self-awareness or sophistication among consumers and the possibility of growing self-awareness over time.

A market in which a rebate is offered exhibits the following timeline: at time 1 the consumer chooses whether to purchase the product, at time 2 the consumer chooses whether to redeem the rebate by submitting the required forms, and at time 3 the consumer receives a rebate check if the rebate was submitted. Consider a consumer who values a product at v and must choose whether to purchase the good at price p. Suppose that the seller offers a rebate of amount r contingent on the submission of redemption forms. If the consumer purchases the product at time 1, then at time 2 he must choose whether to redeem the rebate by exerting the effort necessary to submit the forms, which has a cost of c.

Assume that consumers have present-biased preferences as described above. For simplicity we will assume throughout that the time-consistent discounting parameter $\delta = 1$, an assumption that does not qualitatively affect our results and may be made more palatable by recalling that the time between purchase, rebate submission, and receipt of the rebate is not likely to exceed six months.[7] A consumer's decision whether to purchase the product at time 1 depends on whether he believes that he will later redeem the rebate if he makes the purchase. At time 2 the consumer chooses to redeem the rebate if the discounted value of the refund exceeds the immediate cost of redemption: $\beta r > c$ (we assume that ties are broken by nonredemption). However, because at time 1 a naïve individual (a naif) believes that his future preferences will be time-consistent, a naif at time 1 will believe that he will redeem the rebate if the value of the refund simply exceeds the effort cost: $r > c$. Thus, for a naif with present-bias preference parameter β and redemption cost c a rebate offer that satisfies the following condition will lead the consumer to believe that he will redeem the rebate if he purchases the product at time 1, but he will fail to do so at time 2:

$$c < r \leq \frac{c}{\beta}. \tag{1}$$

A consumer who believes that he will redeem the rebate will purchase the good if the value of the product plus the discounted refund value net of effort cost

[4] Of course it is possible as well to model individuals as being somewhat but not fully naïve—that is, they expect their future selves to have a $\beta < 1$, but their expectation is nevertheless above the actual value (see O'Donoghue and Rabin 2001).

[5] For much more discussion of the implications of modeling individuals as naïve or sophisticated and the arguments for each, see O'Donoghue and Rabin (1999a).

[6] It is straightforward to show that when the consumer population consists of sophisticated individuals as well as TCs and naifs, this reduces the desirability of rebate programs. A formalization of this result is available from the author.

[7] The lower the δ, the less profitable it will be to employ a rebate because this increases the refund that must be offered to induce a willingness to pay any given markup at the time of sale (without contributing to slippage in the way that a lower β does). However, for δ close to 1 (as appropriate for our context) the effect is small. Assuming $\delta = 1$ also allows us to ignore the issue of period length, which would otherwise be a consideration because the time between purchase and submission of the rebate form is likely to differ from the time between submission and receipt of the refund.

exceeds the price:

$$v + \beta(r - c) \geq p. \tag{2}$$

For a naif, if the condition in (1) is met, then $\beta(r - c) > 0$, which together with (2) implies that the naif may purchase although he values the product less than the price, $v < p$. In other words, a naif may be induced by the rebate offer to make a purchase although he values the good at less than the sale price (gross of the rebate) but then fail to redeem the rebate. This slippage result is a consequence of the naif's failure to foresee his future present-biased preferences.

Consider how a seller making an offer to a single consumer whose valuation v and preference parameter β were known to the seller could optimally design a rebate. The seller can use the rebate to obtain a price greater than the consumer's valuation although the consumer will not redeem the rebate. Denote the markup as $z \equiv p - v$. Expression (2) above indicates that the maximum markup consistent with purchase is $\beta(r - c) = z$, whereas expression (1) indicates the maximum rebate that will result in slippage is $r = c/\beta$. Combining these expressions yields the result that the markup obtainable utilizing a rebate program that generates slippage is $z = \beta(c/\beta - c) = c(1 - \beta)$. Note that the markup z is much less than the rebate r. The smallest differential occurs for $\beta = 1/2$, for which $r = 4z$. The rebate must greatly exceed the markup because it must compensate the consumer for his redemption cost c and is discounted by the consumer at the time of purchase when r lies in the future but z is immediate.

Although it is clear from the preceding discussion that a seller with full knowledge of a particular buyer's preferences can take advantage of a naïve present-biased consumer by offering a rebate, it is not evident that this remains true when the seller faces many buyers with various preferences (even assuming that all consumers are present-biased to some degree and that they are all naïve in failing to foresee their future present-biased behavior). The problem for the seller is that the rebate offer that best exploits some consumers' preferences leads others to either fail to purchase or to purchase and redeem the rebate, and both of these outcomes are costly to the seller. We consider a firm in a market of many consumers, all of whom have identical valuations and redemption costs (v and c as before). We normalize the total measure of consumers to be 1. Consumers vary in the degree of present bias, and this is represented by $F(\beta)$, the cumulative distribution function representing the present-bias preferences in the population, and $f(\beta)$ representing the associated probability density function. Assume also that the firm has constant marginal costs, which we normalize to be zero, and that it seeks to maximize its profit from sales to the market. The question is, can the firm do better by charging a price above v and offering a rebate than by simply selling at price v?

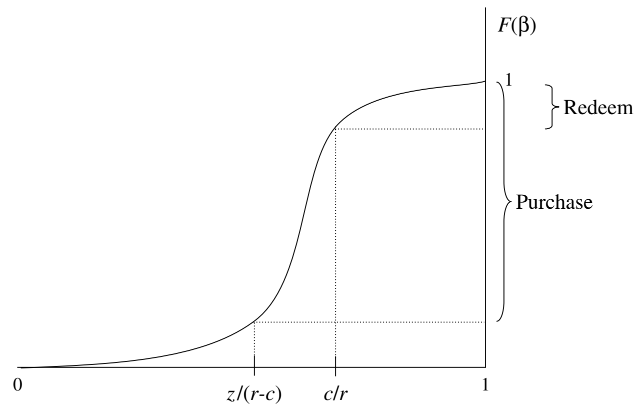
The firm chooses two parameters, the markup z and the rebate amount r. These choices will determine the portion of the population that purchases the product and the portion that redeems the rebate. A consumer will purchase at time 1 in the expectation of redeeming the rebate if $\beta \geq z/(r - c)$; therefore, the share of the population who purchases is $(1 - F(z/(r - c)))$. Notice that it is highly present-biased consumers (those with low β) who may not purchase because the value of the rebate as perceived at time 1 is too small. Those consumers for whom $\beta > c/r$ will redeem the rebate if they purchase; therefore, the share of the population who redeem is $(1 - F(c/r))$. The firm will choose z and r to maximize its profits:

$$\pi(z, r) = (\text{number of purchases})(v + z) - (\text{number of redemptions})(r), \quad \text{or}$$

$$\pi(z, r) = \left(1 - F\left(\frac{z}{r - c}\right)\right)(v + z) - \left(1 - F\left(\frac{c}{r}\right)\right)(r). \tag{3}$$

Before describing the conditions for maximization of this function it is useful to graphically illustrate the nature of the firm's problem (refer to Figure 1). Through the choice of z and r the firm can create a group of consumers, represented by a region of the β preference distribution, who purchase the good but do not redeem; i.e., it creates a region where slippage occurs. Consumers whose β is sufficiently high will fall outside this region of slippage because they will purchase but *will* redeem the rebate—they are not sufficiently present-biased to fail to redeem. Consumers whose β is too low will fall outside the slippage region because they will not purchase the good at all—they are so present-biased that the increased immediate cost of the markup z outweighs the future value of the refund net of redemption cost $(r - c)$. Of course, the share who purchase must be

Figure 1 **A Distribution of Consumer Present-Biased Preferences and Resulting Slippage**



greater than the share who redeem, which requires that $z/(r-c) < c/r$, implying that $r > c^2/(c-z)$ in any rebate program that induces slippage. Holding the markup z constant, as the firm increases the rebate value r above $r = c^2/(c-z)$, the cutoff for purchase, $z/(r-c)$, falls more rapidly than the cutoff for redemption, c/r, creating an interior region between these points where slippage will occur. More precisely, slippage as a share of total purchases will be

$$\left[F\left(\frac{c}{r}\right) - F\left(\frac{z}{r-c}\right)\right] \Big/ \left[1 - F\left(\frac{z}{r-c}\right)\right].$$

If the firm can create a region of slippage where a sufficient share of the consumers fall, then the rebate will be profitable. Whether or not it is possible to do so depends on the distribution of preferences, F. If consumer preferences exhibit little variance, a rebate is likely to be profitable, but when preferences are more varied, a rebate is less likely to succeed. Figure 1 illustrates a continuous distribution of consumer β preferences exhibiting positive density on the entire unit interval but with consumers' preferences concentrated in a narrow range that is targeted for slippage by the rebate.

If an interior solution exists involving a nonzero rebate and markup, it must satisfy the first-order conditions as follows:

$$\frac{\partial \pi(z,r)}{\partial z} = 1 - (v+z) f\left(\frac{z}{r-c}\right)\left(\frac{1}{r-c}\right) - F\left(\frac{z}{r-c}\right) = 0, \tag{4}$$

$$\frac{\partial \pi(z,r)}{\partial r} = \frac{z(v+z)}{(r-c)^2} f\left(\frac{z}{r-c}\right) + F\left(\frac{c}{r}\right) - \left(f\left(\frac{c}{r}\right)\right)\left(\frac{c}{r}\right) - 1 = 0. \tag{5}$$

Note that these are necessary, but not sufficient, conditions for an optimum nonzero rebate. In general the profit function may have multiple local maxima.

The analysis to this point illustrates how a rebate can be profitable by generating a group of consumers (represented by a range of β values) who will purchase the product at a price greater than the value they place on it but for whom slippage will occur. Whether a rebate offer is profitable for the seller then depends on whether the slippage group is sufficiently large relative to the group of consumers who will no longer purchase the product (because of the markup and a very low β, which leads them to greatly discount the refund when choosing whether to purchase) and the group of consumers who purchase and do redeem the refund (those with a high β or little present bias). To illustrate this we conduct a simulation modeling the distribution of consumer preferences as a beta distribution. This shows that a rebate can be profitable, but only when the preference parameter β is distributed with little variance, thus allowing the rebate to generate high slippage rates.

Before turning to the simulation, it is helpful to consider a benchmark case when the population consists entirely of consumers with a common β value of 1/2. This is the most favorable possible case for a seller because, as noted earlier, this β value allows for the largest rebate consistent with nonredemption and thus the largest markup. With no heterogeneity in preferences, the firm can offer a rebate of $r = c/\beta = 2c$ that is never redeemed and obtain a markup of $z = c(1-\beta) = c/2$ while selling to the entire population. Note that in this case the firm would earn a profit of $\pi = v + c/2$. Also, the fact that in the best-case scenario the markup is a quarter of the rebate implies that the slippage rate must exceed 75% in any case when employing a rebate is profitable (i.e., if more than one-fourth of consumers redeem the rebate this will more than offset the gain from the markup). A formalization of this result based on assuming that the population consists of two groups of consumers, mass points at $\beta = 1/2$ and at $\beta = 1$, is given in the proof of Proposition 1 in the appendix.

PROPOSITION 1. *The minimum slippage rate for which a rebate is profitable solely as a mechanism for exploiting present-biased consumers is* 75%, *which occurs when there is no variance in the preferences among present-biased consumers and these consumers have a preference parameter of* $\beta = 1/2$.

We employ the beta distribution in our simulation because by varying the parameters of the distribution (a, b) we can vary the degree to which the present bias of consumers is concentrated around a particular point. The beta distribution is defined by the density function $f(\beta; b, a) = (1/B(a,b))\beta^{a-1}(1-\beta)^{b-1}$. Maintaining $a = b$ but increasing the value of these parameters yields a density that is symmetric around a peak at $\beta = 1/2$ but with decreasing variance.[8]

We can solve for the optimal rebate program or (z^*, r^*) pair for a given population distribution. In this simulation we assume $v = 0$. This assumption generates the most favorable setting for a rebate offer because it implies that the firm has no opportunity cost of lost sales that result from the rebate offer. This can be thought of as the case of a competitive market where v equals the firm's marginal cost, which is

[8] Conducting the simulations with $a = b$ illustrates the most favorable circumstance for rebate profitability because this assumption places the mode of the preference distribution at $\beta = 1/2$, which is the point at which a rebate can best exploit present-biased preferences (as discussed above). Relaxing this assumption would move the mode of the distribution, in which case the variance in preferences required to make a rebate profitable would be lower than in our simulation.

Table 1 **Optimal Rebate Program for Various Beta Distributions of Present-Biased Preferences**

a, b	Variance	z^* (as a percentage of c)	r^* (as a percentage of c)	Slippage rate (%)	Profit (as a percentage of c)
1	0.0833	0	0	n.a.	n.a.
3.04	0.0353	5.1	112.8	98.3	2.2
4	0.0277	7.2	118.5	98.1	3.6
5	0.0227	8.9	123.2	98.0	5.0
10	0.0119	14.4	137.2	98.1	9.9
100	0.00124	31.2	171.5	99.1	28.5
1,000	0.000125	41.9	188.5	99.7	40.9

normalized to zero. The optimal rebate r^*, markup z^*, and profit are given as a percentage of the cost of redemption c. Table 1 shows the optimal rebate program and resulting slippage rate and profit for various values of (a, b). For low values of (a, b), where the distribution is relatively close to uniform, a rebate is not profitable. We include $a, b = 3.04$ in the table because this is the lowest value at which a rebate is profitable. The distribution must be quite concentrated for a rebate offer to be advantageous because only then is the slippage rate sufficiently high that the gain from the markup obtained on consumers who fail to redeem outweighs the loss on consumers who do purchase and redeem.

To interpret the results of the simulation it is helpful to compare them to the benchmark case noted earlier with a degenerate distribution at $\beta = 1/2$. As the variance of the distribution shrinks the simulation yields results that approach the benchmark case in the limit: $r = 2c$, $z = c/2$, $\pi = c/2$. However, extremely little variance is required to begin to approximate this limiting result. Even with fairly little variance, e.g., $a, b = 10$, the firm does best to offer a much smaller rebate (137.2% of c) and to charge a much smaller markup (only 14.4% of c). This is because increasing the rebate results in too much of an increase in the number of very costly redemptions. Less than 2% of consumers redeem, but the rebate is nearly 10 times greater than the markup.

3. Correlated Preferences and Redemption Costs

Models of price discrimination commonly assume that consumers' willingness to pay for a product (or demand elasticity in models where consumers may consume more than a single unit) is correlated with their cost of redeeming a rebate or obtaining a coupon (e.g., Narasimhan 1984). This correlation will exist if those consumers who have a greater willingness to pay are also typically those whose opportunity cost of taking the time to redeem the rebate is greatest. We have assumed that all consumers have an equal willingness to pay for the product. However, in this section we consider a case in which consumers' cost of redeeming the rebate is correlated with the preference parameter β. Just as consumers with a higher willingness to pay may typically have a greater opportunity cost of redemption, consumers who are less present-biased may also plausibly have a greater opportunity cost of redemption. Indeed, such a correlation could arise for very similar reasons. β can be interpreted as capturing self-control and self-discipline, or an individual's ability to make choices that are best in the long-run rather than serving immediate gratification. These qualities that are associated with less present bias (a higher β) may also be associated with greater income and wealth. Just as with standard price-discrimination models of rebates and coupons, it is logical to assume that greater wealth and income are associated with an individual's having a higher opportunity cost of redemption. Therefore, a higher β may be correlated with a higher redemption cost.

In this section we show that when consumers' preferences β and cost of redemption c are correlated, this makes a rebate offer far more likely to be profitable even if there is great variance in β. In particular, we develop a model assuming that consumers value the product at $v = 0$, as we did in our simulation in the previous section, to show that in this most favorable case some rebate offer will always be profitable for any distribution of β preferences in the population when redemption costs are *perfectly* correlated with β. Here, we assume a strictly positive lower support of the $F(\beta)$ distribution denoted $\underline{\beta}$ and assume that redemption costs are defined by the function $c(\beta) = (\beta/\underline{\beta})\underline{c}$. Thus, $\underline{c}$ represents the lowest redemption cost that occurs for the most-present-biased consumers. After developing the model we will discuss the consequences if redemption costs are not perfectly correlated with β or follow a different functional form.

Based on the results in the preceding section, we know that an individual β type will behave in the following manner: he will not purchase the product if $r < c(\beta)$ and $z > 0$ (because he will foresee that he will not redeem the rebate) or if $r > c(\beta)$ and $z > \beta(r - c(\beta))$ (because although he believes he will redeem the rebate, the markup is too great); if $c(\beta) < r \leq c(\beta)/\beta$ and $z \leq \beta(r - c(\beta))$, he will purchase the product but will not redeem the rebate; or if $r > c(\beta)/\beta$ and $z \leq \beta(r - c(\beta))$, he will purchase the product and will also redeem the rebate. Because of the assumption regarding the correlation between preferences and redemption costs, the maximum rebate that a consumer will fail to redeem is identical for all types: $r^* = c(\beta)/\beta = \underline{c}/\underline{\beta}$. Offering this rebate ensures that no consumers will redeem. The markup z will then determine which consumers purchase the product. A consumer of type β will purchase if $z \leq \beta(r - c(\beta))$. Substituting $r = \underline{c}/\underline{\beta}$ this reduces to $z \leq \beta(1 - \beta)(\underline{c}/\underline{\beta})$.

As the firm increases the markup z, it reduces the number of consumers who purchase. Note that the maximum of $\beta(1-\beta)$ occurs at $\beta = 1/2$, so as z increases the firm loses sales to consumers at the extremes of the preference distribution. Let $\gamma = \beta(1-\beta)$ with $G(\gamma)$ representing the distribution in the population on $[0, 1/4]$, which of course is directly dependent on the $F(\beta)$ distribution. Then the condition that a consumer of type β purchases if $z \leq \beta(1-\beta)(\underline{c}/\underline{\beta})$ implies that for a given z the number of consumers who purchase is $1 - G(z\underline{\beta}/\underline{c})$. The firm's optimization problem is then

$$\max_z \pi = z\left(1 - G\left(\frac{z\underline{\beta}}{\underline{c}}\right)\right). \tag{6}$$

The solution to this problem implicitly defines the optimal markup z^*,

$$z^* = \left(\frac{\underline{c}}{\underline{\beta}}\right)\frac{1 - G(z^*\underline{\beta}/\underline{c})}{g(z^*\underline{\beta}/\underline{c})}. \tag{7}$$

Intuitively, if there is a lot of mass in the preference distribution near $\beta = 1/2$, then it will be optimal to charge a high markup because the firm can do so without losing many sales. The maximum markup would occur if the distribution were degenerate with all mass at $\beta = 1/2$, in which case $z^* = (\underline{c}/\underline{\beta})/4$, which, as discussed earlier, is a quarter of the rebate. If more mass is located toward the extremes of the distribution, the optimal markup will be lower because a high markup will cause the firm to lose too many sales. But notice that, given our assumption that $v = 0$, regardless of the distribution of preferences, offering a rebate is profitable for the firm. The firm's profit absent a rebate is zero, and a rebate always yields a positive profit because some consumers can be induced to purchase the product with a markup, but none redeem the rebate. This is a direct consequence of the perfect correlation between β and redemption costs, which allows the firm to offer a rebate that will not be redeemed by any consumers.

The model above shows that if present-biased preferences and redemption costs are highly correlated, a rebate offer may be profitable for the seller regardless of the distribution of preferences. In this case less-present-biased consumers are deterred from redeeming by their high redemption costs. However, it is unlikely that present-biased preferences and redemption costs are *perfectly* correlated as we assumed in the model. The presence of some highly present-biased consumers who also have high redemption costs will result in these consumers choosing not to purchase the product and thus reduce profits somewhat but would not render offering a rebate unprofitable (given $v = 0$). However, consumers with little present bias (high β types) who have lower redemption costs than specified above may purchase the product and redeem the rebate, resulting in less than 100% slippage. Because the rebate greatly exceeds the markup, these redemptions are very costly to the firm. The viability of the rebate offer therefore relies on very few consumers having both low redemption costs and little present bias to achieve the necessarily high slippage rate. As discussed in the previous section, a rebate that is redeemed by more than 25% of the population can never be profitable because the markup can never exceed one-fourth of the rebate.

In addition to assuming that present-biased preferences and redemption costs are perfectly correlated, the model assumed a particular functional form of the relationship, that $c(\beta) = (\beta/\underline{\beta})\underline{c}$. If redemption costs rise less rapidly with β than this form implies (even if still perfectly correlated), the firm may face some redemptions by high β type consumers if the markup is sufficiently small that they purchase the good. However, these redemptions could be avoided by either increasing the markup (recall that for a given rebate the markup a consumer will pay declines with β for values above $\beta = 1/2$) or reducing the rebate value (which would in turn lower the markup that all types would willingly pay). The functional form we assumed is the best case for rebate profitability. However, if preferences and redemption costs are perfectly correlated, there will exist a combination of rebate and markup that results in some consumers (those closest to $\beta = 1/2$) purchasing the product and none redeeming. Therefore, a rebate will be profitable for v sufficiently close to zero.

4. Conclusion

The model presented here demonstrates that behavior consistent with present-biased preferences together with an inability to perfectly foresee one's future actions (i.e., naïveté) can generate slippage and thus provide an explanation for the use of rebates. However, the model also illustrates that for a rebate to be profitable when its sole purpose is to exploit these types of preferences, consumers must have little variance in their preferences, or redemption costs that are highly correlated with preferences, so that a rebate offer can be structured in a manner that generates a very high slippage rate. From this perspective, observed redemption rates in the neighborhood of 40% may be surprisingly *high*. One possible conclusion from our analysis is that the behavioral characteristics modeled here are not by themselves sufficient to explain the widespread use of rebates by manufacturers because it seems unlikely that consumer preferences would be distributed as required and observed redemption rates are higher than the model predicts. However, rebates may often have multiple underlying rationales, and exploitation of consumer naïveté that yields slippage may be an important component of the overall motivation for rebate programs. As discussed in the introduction, rebates have been shown to be a device that can serve many purposes including price discrimination, channel coordination (i.e., a manufacturer's bypassing wholesale markets to offer discounts directly to consumers), and utility arbitrage, quite apart from the possibility that rebates generate slippage per se, i.e., that they induce consumers to purchase a good in the expectation that they will redeem the rebate but they later do not. So, for example, rebates may be very common on consumer electronics because they simultaneously serve to price-discriminate and to generate behaviorally based slippage. The ability to generate slippage of the type modeled here may be an important reason for choosing a rebate over a coupon or other mechanism for price discrimination. This would be particularly likely if present-biased preferences are correlated with consumers' product valuations such that consumers with a low willingness to pay are also more likely to be present-biased. If rebates also serve to price-discriminate, higher redemption rates may occur without rendering the rebate unprofitable.[9]

Because the focus of this paper has been on demonstrating the possibility that rebates can exploit slippage resulting from present-biased preferences, we assumed consumers to be naïve, lacking self-awareness of the possibility that they may fail to redeem a rebate in the future that they currently find appealing. We have seen that even with fully naïve consumers it is far from universally true that rebates can profitably exploit consumers, but of course consumers may have at least partial self-awareness or sophistication.[10] Even if consumers do not perfectly foresee their future preferences and consequent behavior, they may be aware that they will not be perfectly time consistent. Clearly, self-awareness will further limit the ability of rebates to exploit slippage resulting from present-biased preferences. This raises the question of whether consumers are likely to become more self-aware over time and less prone to rebate slippage. Certainly, one might expect that if consumers encounter very similar rebate offers repeatedly over time, they may become more self-aware about their intertemporal preferences and the redemption choices these lead to. Such learning could lead consumers either to decline to purchase goods that incorporate a rebate offer in the expectation that they will fail to redeem or to employ commitment devices to raise the probability that they will redeem future rebates (which could be as simple as not allowing oneself to use the product until the rebate form has been submitted), both of which would reduce slippage and the profitability of rebate offers to sellers.

It is beyond the scope of the present paper to model growing self-awareness among consumers over time and how this would affect slippage and rebate profitability, but an important component of such a model would be to assume that the cost of redemption (which is a known value c in our model) varies over time and that consumers are uncertain at the time of purchase about the redemption cost. This assumption is employed by Lu and Moorthy (2007) in studying when rebates are superior to coupons as a mechanism for price discrimination. Such uncertainty is important for understanding learning over time because it obscures the lesson that consumers learn from past behavior. A consumer may recall past rebate offers, and whether he redeemed them or not, and gain some knowledge of his behavioral tendencies with which to predict his future likelihood of redemption. But past failures to redeem may be interpreted as high realized redemption costs rather than an indication of naïveté. The particular characteristics of each offer a consumer encounters may differ, especially when rebates serve different purposes for sellers. A consumer may encounter a $50 rebate on a product, and he may have a mixed redemption history on past offers of various amounts. He may have difficulty recalling why he failed to redeem past offers, may be unsure whether the redemption failure was driven by an optimal decision (the refund really was not worth the realized effort cost) or driven by a self-control problem such as present bias, and may in fact be unaware of his failure to redeem some rebates in the past because he failed to redeem them precisely because he simply forgot about them. Of course, he may simply believe that his preferences have changed, i.e., that he has learned to be more careful about following through on tasks of this sort. This may leave him unable to completely eliminate bias in his estimate of his future behavioral preferences and probability of redemption. Thus, although complete naïveté among consumers is unlikely, it is not unreasonable to expect that consumers may persistently lack complete self-awareness and be unable to perfectly foresee (or unbiasedly estimate) future behavior, in which case slippage can arise and be a factor driving rebate usage.

[9] When rebates act to price-discriminate consumers with a low willingness to pay may always redeem the rebate, but even if they constitute a large share of the population, the rebate may be profitable because it allows these consumers to be charged a lower price (above which they would not purchase) while not discounting the price paid by consumers willing to pay more (who do not redeem the rebate because they have higher redemption costs).

[10] Partial self-awareness regarding present-biased preferences has been modeled by O'Donoghue and Rabin (2001) and Gilpatric (2008).

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Appendix. Proofs

Proof of Proposition 1. Assume that the population of consumers has two mass points: a share α are naively present-biased with preference parameter $\beta^* < 1$ whereas the remainder are time consistent with $\beta = 1$. In this case the firm best exploits the present-biased consumers by offering the maximum rebate consistent with their failing to redeem, $r = c/\beta^*$, and marking up the price by the maximum amount consistent with their purchasing the good given this rebate, $z = \beta^*(r - c) = c(1 - \beta^*)$. The firm's profit from this rebate program will be consumers' willingness to pay plus the markup less the product of the rebate amount and the share of consumers who redeem it, which is the share that are time consistent:

$$\pi = v + z - (1 - \alpha)r. \tag{8}$$

After substituting for z and r, this yields

$$\pi = v + c\left(1 - \left(\frac{\beta^{*2} + 1 - \alpha}{\beta^*}\right)\right), \tag{9}$$

which will exceed v (the profit absent a rebate) if $\alpha > 1 - \beta^*(1 - \beta^*)$. The minimum of $[1 - \beta^*(1 - \beta^*)]$ on the unit interval over which β^* is defined is 0.75, which occurs at $\beta^* = 1/2$. Thus, we have the result that the minimum slippage rate consistent with the rebate program's being more profitable than the alternative of selling the product at price v is 75%.

References

Akerlof, G. 1991. Procrastination and obedience. *Amer. Econom. Rev.* **81** 1–19.

Ault, R., R. Beard, D. Laband, R. Saba. 2000. Rebates, inventories, and intertemporal price discrimination. *Econom. Inquiry* **38** 570–578.

Bruce, N., P. Desai, R. Staelin. 2006. Enabling the willing: Consumer rebates for durable goods. *Marketing Sci.* **25** 350–366.

Caillaud, B., B. Jullien. 2000. Modeling time-inconsistent preferences. *Eur. Econom. Rev.* **44** 1116–1124.

Chen, Y., S. Moorthy, Z. J. Zhang. 2005. Price discrimination after the purchase: Rebates as state-dependent discounts. *Management Sci.* **51** 1131–1140.

Della Vigna, S., U. Malmendier. 2004. Contract design and self-control: Theory and evidence. *Quart. J. Econom.* **119** 353–402.

Gerstner, E., J. Hess. 1991a. A theory of channel price promotions. *Amer. Econom. Rev.* **81** 872–886.

Gerstner, E., J. Hess. 1991b. Who benefits from large rebates: Manufacturer, retailer, or consumer? *Econom. Lett.* **36** 5–8.

Gilpatric, S. 2008. Present-biased preferences, self-awareness, and shirking. *J. Econom. Behav. Organ.* **67** 735–754.

Hoch, S. J. 1985. Counterfactual reasoning and accuracy in predicting personal events. *J. Exper. Psych. Learning, Memory Cognition* **11** 719–731.

Houston, D. A., J. S. Howe. 1985. An economic rationale for couponing. *Quart. J. Bus. Econom.* **24** 37–49.

Kahneman, D., D. Lovallo. 1993. Timid choices and bold forecasts: A cognitive perspective on risk taking. *Management Sci.* **39** 17–31.

Laibson, D. 1997. Golden eggs and hyperbolic discounting. *Quart. J. Econom.* **112** 442–477.

Lu, Q., S. Moorthy. 2007. Coupons versus rebates. *Marketing Sci.* **26** 67–82.

Mowen, J., M. Mowen. 1991. Time and outcome valuation: Implications for marketing decision making. *J. Marketing* **55** 54–62.

Nagle, T. 1995. *The Strategy and Tactics of Pricing*: *A Guide to Profitable Decision Making*. Prentice-Hall, Englewood Cliffs, NJ.

Narasimhan, C. 1984. A price discrimination theory of coupons. *Marketing Sci.* **3** 128–147.

O'Donoghue, T., M. Rabin. 1999a. Doing it now or later. *Amer. Econom. Rev.* **89** 103–124.

O'Donoghue, T., M. Rabin. 1999b. Incentives for procrastinators. *Quart. J. Econom.* **114** 769–816.

O'Donoghue, T., M. Rabin. 2001. Choice and procrastination. *Quart. J. Econom.* **116** 121–160.

Phelps, E. S., R. A. Pollak. 1968. On second-best national saving and game-equilibrium growth. *Rev. Econom. Stud.* **35** 185–199.

Silk, T. 2008. Getting started is half the battle: The influence of deadlines and consumer effort on rebate redemption. Working paper, Sauder School of Business, University of British Columbia, Vancouver, BC, Canada.

Soman, D. 1998. The illusion of delayed incentives: Evaluating future effort-money transactions. *J. Marketing Res.* **35** 427–437.

Spencer, J. 2002. Rejected! Rebates get harder to collect. *Wall Street Journal* (June 11) D1.

Thaler, R. 1981. Some empirical evidence on dynamic inconsistency. *Econom. Lett.* **8** 201–207.