The Timing of Choice-Enhancing Policies*

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Abstract

Recent studies investigate policies motivating consumers to make an active choice as a way to protect unsophisticated consumers. We analyze the optimal timing of such choice-enhancing policies when a firm can strategically react to them. In our model, a firm provides an automatic enrollment or renewal to consumers. We show that a conventional choice-enhancing policy, which decreases consumers' switching costs when they are initially enrolled, can be detrimental to consumer and social welfare. By contrast, an alternative policy that decreases consumers' switching costs when the firm charges a higher price for the service increases consumer and social welfare more robustly.

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1 Introduction

Automatic enrollments and renewals are prevalent in many service industries. For example, cell-phone companies offer fixed-term contracts with automatic renewals.[1] Internet-connection providers automatically enroll their customers into anti-virus options with some grace period.[2] Retail banks often promote credit cards with very low interest rates for an initial teaser period, after which the interest rate rises.[3] With mounting evidence that some consumers exhibit systematic behavioral biases, there is concern that automatic enrollments and renewals may be used to exploit unsophisticated consumers. In response, choice-enhancing policies have been called for to protect such consumers.[4] Recent studies such as Carroll, Choi, Laibson, Madrian and Metrick (2009), Keller, Harlam, Loewenstein and Volpp (2011), and Chetty, Friedman, Leth-Petersen, Nielsen and Olsen (2014) have shown that motivating consumers to make an active choice can improve consumer welfare. However, two issues associated with such policies have been under-investigated. First, is there any adverse effect when firms can respond to such a policy? Second, if consumers can opt out of a service at different points in time, when should a policymaker motivate consumers to make an active choice?

This paper analyzes the welfare consequences of policies when a firm can change its pricing strategy in response to the policies. Section 2 introduces an illustrative model. A firm automatically enrolls consumers into a service. Some consumers are (partially or fully) naive present-biased à la O'Donoghue and Rabin (2001), whereas all others are time-consistent and rational. Each consumer incurs a positive switching cost when she opts out of the service, and she can do so at multiple points in time. By employing a choice-enhancing policy (e.g., by requiring firms to send an email with a simple cancellation format or to prominently inform how consumers can cancel the service), a policymaker can reduce the switching cost in a certain period.

Section 3 analyzes the illustrative model and presents our main results. If there is no policy

[1] In many countries, cell-phone companies offer a two-year contract with a mobile discount and automatic renewals of the contract. Although the loss these companies incur by offering the mobile discount is typically recouped by the monthly fees, some continue to charge the same monthly fees even after the initial two years.

[2] As a specific example, Kabel Deutschland, one of the largest Internet-connection providers in Germany, provided an optional three months of free antivirus software, a firewall, and parental control software with an automatic enrollment. After the first three months, the cost rose to €3.98 per month. See `http://www.kabel-internet-telefon.de/news/7214-kabel-deutschland-mit-neuem-sicherheitscenter-kabelsicherheit-de` (accessed March 1, 2016).

[3] Ausubel (1991) and DellaVigna and Malmendier (2004) document the evidence.

[4] To protect consumers, many countries have recently started using behavioral economics to improve policies. For example, the UK government created the Behavioral Insights Team (known as the Nudge Unit) and the US government built the Social and behavioral Science Team.

intervention, the firm may exploit naive present-biased consumers by charging a high price for the service after a grace period.[5] We first analyze the effect of a policy that decreases the switching cost when consumers are enrolled. For example, in many countries firms are required to prominently inform consumers about how to cancel their service when they enroll consumers.[6] If the firm's pricing strategy is fixed, then such a conventional policy always (weakly) increases each consumer's utility. By contrast, we show that if the firm can change its pricing strategy in response, then this conventional policy can strictly decrease consumer welfare. Intuitively, because naive consumers may procrastinate their switching decision, time-consistent consumers are more responsive to the policy (i.e., more likely to opt out of the firm's service in response to the policy) than naive present-biased consumers. Then, the policy may increase the proportion of naive consumers among consumers who stay enrolled in the service. In response, the firm increases its prices to exploit naive consumers, thereby reducing naive consumers' long-run utility. This is a perverse result, as such policies typically aim to protect these unsophisticated consumers. In this case social welfare also decreases, because time-consistent consumers switch and thus incur a (socially wasteful) switching cost.

As an alternative policy, we then investigate a policy that decreases the switching cost whenever the firm increases the price for its service (or when the free-trial period ends). As a practical example of such an alternative policy, a firm could be required to prominently inform consumers about how to cancel its service upon an (expected or unexpected) price increase.[7] We show that—in contrast to the above conventional policy—this alternative policy always increases consumer (and social) welfare. Intuitively, because all consumers plan to switch in the same period under the alternative policy, the policy does not change the proportion of naive consumers who stay enrolled in the service. Hence, the firm's trade-off between exploiting naive consumers by setting a high price and serving to all consumers by setting a moderate price is unaffected. As a result, the alternative policy does not have the perverse effect of inducing the firm to increase its price. We also show that if there is a per-period cost of decreasing the switching costs, the proposed alternative policy

[5] Although this paper focuses on the case in which automatic enrollments or renewals can be used to exploit naive consumers, we note that automatic enrollment or renewal itself can be valuable for consumers in a general framework. We discuss this issue in Sections 5 and 6.

[6] This makes it easier for consumers to cancel at the time of the enrollment rather than to cancel later, because in the latter case they have to remember or find out how to cancel it.

[7] Note that in most countries, firms are required to announce an unexpected price increase or an unexpected termination of a free trial to their customers. Here, the firm is required to announce and provide a simple cancellation procedure even upon a known price increase or a previously-announced termination of the free-trial period.

is better than decreasing the switching costs in all periods.

Section 4 analyzes some extensions of the model. As a primary extension, we endogenize consumers' decisions of signing up to the enrollment and analyze the case in which a firm can charge fees for its service multiple times. In this model, the firm sells a base product necessary to use the add-on service. Consumers who decide to purchase the base product are automatically enrolled into the firm's service. We show that if the number of periods the firm can charge its add-on fee is high, the firm is more likely to exploit naive consumers, resulting in higher total payments by them. Similar to the illustrative model, a conventional policy that decreases the switching when consumers are enrolled can decrease consumer and social welfare, whereas the alternative policy that decreases the switching cost whenever the firm increases its price always (weakly) increases consumer and social welfare. We also examine the robustness of our results to incorporating competition among firms, a fraction of sophisticated present-biased consumers, and heterogeneous product valuations among consumers.

Section 5 discusses potential alternative policies: reminders, automatic terminations of a service, regulating prices, and deadlines. We also discuss how each policy can interact with other potential behavioral biases such as forgetting or inattention to a switching opportunity. Section 6 concludes. Proofs are provided in the Appendix.

Related Literature This paper contributes to the literature on behavioral public policy.[8] As the most closely related studies, Carroll et al. (2009), Keller et al. (2011), and Chetty et al. (2014) investigate the policy effects on active choice. These studies focus on cases in which a policymaker either decreases consumers' switching costs to zero or forces consumers to make an explicit choice. In contrast to these studies, we investigate the case in which a policymaker can reduce consumers' switching costs, but the reduced switching cost is still positive and consumers themselves decide whether to switch. We discuss the real-world applications and interpretations of such a policy in Section 2.2.

This paper is also related to two theoretical literatures: pricing for unsophisticated present-biased consumers and the equilibrium effects of policies. First, the literature on behavioral indus-

[8] O'Donoghue and Rabin (2003, 2006) investigate the welfare effects of tax/subsidy policies under present bias and naivete. Baicker, Mullainathan and Schwartzstein (2015) analyze the design of health insurance under behavioral biases. For surveys of behavioral public policy, see, for examples, Mullainathan, Nöth and Schoar (2012) and Chetty (2015).

trial organization has studied how firms can exploit consumers' time inconsistency and naivete.[9] Building upon this stream of the literature, we focus on the policy implications of enhancing active choice and analyze how the timing of policies can affect consumer and social welfare.

Second, recent theoretical and empirical studies have analyzed the equilibrium effects of policies when consumers are inattentive.[10] To the best of our knowledge, however, the timing of employing choice-enhancing policies and the resulting welfare effects have not been investigated in the previous literature. Complementing this literature, we thus highlight the adverse welfare effect of a conventional policy, analyze how the timing of policies affects welfare, and suggest an alternative policy that mitigates the adverse welfare effect and hence can more robustly improve welfare.

2 Illustrative Model

This section introduces our illustrative model. Section 2.1 sets up the model. Section 2.2 discusses key assumptions on procrastination and on consumers' switching costs.

2.1 Setup

A risk-neutral firm provides a service to a continuum of risk-neutral consumers (normalized to measure one). There are three periods: $t = 1, 2, 3$. In $t = 1$, the firm automatically enrolls consumers into the service which they value at $a > 0$ in each $t = 2, 3$. The firm offers a free trial: the price for the service $p^a \geq 0$ is charged at the end of the game (i.e., $t = 3$), and p^a is not charged if consumers opt out of the firm's service either in $t = 1$ (i.e., when consumers are enrolled into the service) or in $t = 2$ (i.e., when consumers use the free-trial service). This automatic-enrollment setting also encompasses the case in which a firm automatically renews a consumer's existing contract or provides a consumer's default option with a grace period; we analyze the case in

[9] See, for example, DellaVigna and Malmendier (2004), Kőszegi (2005), Gottlieb (2008), Heidhues and Kőszegi (2010), and Heidhues and Kőszegi (2015).

[10] For the theoretical literature, see Armstrong, Vickers and Zhou (2009), Armstrong and Chen (2009), Piccione and Spiegler (2012), Grubb (2015), de Clippel, Eliaz and Rozen (2014), Ericson (2014), and Spiegler (2015). For the empirical literature, see Duarte and Hastings (2012), Handel (2013), Grubb and Osborne (2015), and Damgaard and Gravert (2016). Relatedly, based on Gabaix and Laibson's (2006) shrouded-attribute model, Kosfeld and Schüwer (2014) analyze the effect of increasing the proportion of sophisticated consumers in the market and show that such an intervention can lower welfare. Intuitively, this intervention can increase the proportion of consumers who (socially inefficiently) substitute away from an add-on consumption. By contrast, we investigate how the timing of enacting a policy affects welfare when some consumers are naive present-biased and derive an alternative policy that robustly improves welfare.

which consumers endogenously make their initial enrollment decisions in Section 4.1. A competitive fringe also provides a service with the same value. For simplicity, we assume that the production cost of the service—and hence the price of the competitive fringe—is zero. Each consumer incurs a switching cost k_t by changing from the firm to the competitive fringe in period $t = 1, 2$.[11] At the beginning of the game, the policymaker decides whether to enact a choice-enhancing policy for each period. Without any such policy, $k_t = \overline{k} > 0$ for all t.[12] If a policymaker enacts the policy in period t, then the switching cost of that period is reduced to $k_t = \underline{k} \in (0, \overline{k})$. Denote by $\Delta_k := \underline{k}/\overline{k} \in (0, 1)$.

Following O'Donoghue and Rabin (1999a, 2001), we assume that a proportion α of consumers are present-biased and (partially or fully) naive, whereas the remaining proportion of consumers are time-consistent and rational. To explain this, suppose that u_t is a consumer's period-t utility. In each period $t = 1, 2$, time-consistent consumers decide whether to opt out of the firm's service based on $u_t + \sum_{s=t+1}^{3} \delta^{s-t} u_s$, and they correctly expect their future behavior. By contrast, present-biased consumers decide whether to opt out based on $u_t + \beta \sum_{s=t+1}^{3} \delta^{s-t} u_s$, where $\beta \in (0, 1)$ represents the degree of their present bias. These present-biased consumers are (partially) naive about their future self-control problem: in $t = 1$, they think that their future present bias will be equal to $\hat{\beta} \in (\beta, 1]$ and that they will behave as if $\beta = \hat{\beta}$ in $t = 2$. When $\hat{\beta} = 1$, these consumers are unaware of their self-control problem; when $\hat{\beta} \in (\beta, 1)$, they are aware of it, but not to the full extent.[13] In what follows, we set $\delta = 1$ without loss of generality.

We investigate perception-perfect equilibria: each player maximizes her perceived utility in each subgame (O'Donoghue and Rabin 2001). We evaluate consumer welfare based on each consumer's long-run utility (i.e., $\sum_{t=1}^{3} u_t$). Figure 1 illustrates the timeline of the firm's pricing and consumers' decisions.

[11] As shown below, consumers have no incentive to switch back from the competitive fringe to the firm.

[12] If k_t is endogenously chosen by the firm, then the firm would set it to the maximal amount. Without loss of generality, we can think of $\overline{k}$ as that amount.

[13] We discuss how our results are robust to incorporating perfectly sophisticated consumers (i.e., $\hat{\beta} = \beta < 1$) into the model in Section 4.3.

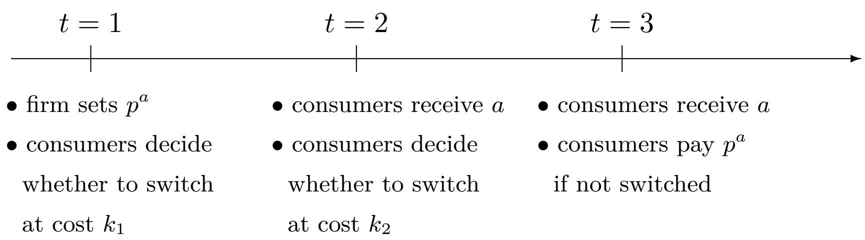

Figure 1: Timeline of the model.

2.2 Discussion of Key Assumptions

This subsection discusses two key assumptions made in this paper. First, some consumers may procrastinate their switching decisions.[14] Second, a policymaker can decrease consumers' switching costs by employing a choice-enhancing policy (but the policymaker may be unable to decrease them to zero).

Procrastination Recent empirical and experimental studies have shown that people often procrastinate their decisions.[15] In our model, consumers incur the switching cost now but make the payment later. Because of this discrepancy in the timing, naive present-biased consumers may procrastinate their switching decisions. This assumption is plausible in our real-world examples (Internet-connection providers, cell-phone companies, and retail banks), because customers incur an immediate effort cost to switch a service, whereas the change in the bill typically comes later (e.g., at the beginning of the following month). Moreover, the assumption on the timing can be relaxed when consumers possibly incur the payments multiple times, as we extend the model in Section 4.1.[16]

Choice-Enhancing Policies The literature on choice-enhancing and active-choice policies has focused on either of the following cases: (i) the policy enables consumers to make a switching deci-

[14] Following O'Donoghue and Rabin (2001) and DellaVigna (2009), we classify that a consumer "procrastinates" if ex-ante she anticipates switching in some period but does not actually switch in that period.

[15] See, for examples, Ariely and Wertenbroch (2002), DellaVigna and Malmendier (2006), and Skiba and Tobacman (2008).

[16] Intuitively, even when consumers incur the payment of the service now (rather than later), they may still think that they will opt out later to avoid future payments. Hence, if consumers possibly incur payments multiple times, our results hold qualitatively even when consumers face the switching cost and payment at the same time. By contrast, if consumers incur the payments for the service at most once (as in our illustrative model), our timing assumption is crucial.

sion without incurring any switching cost or (ii) the policy forces all consumers to make a switching decision. In contrast to the literature, this paper analyzes the case in which a choice-enhancing policy decreases consumers' switching costs (but the switching cost can still be positive) and consumers themselves decide whether to switch. For example, suppose that a firm can automatically enroll its customers into an additional service and that customers need to take an extra action (e.g., register their personal information) if they want to use the additional service of another firm. In this case, a policymaker can decrease the switching cost (e.g., by requiring a simple cancellation format), but cannot decrease it to zero because of the cost of the new registration.

In practice, such automatic enrollments are illegal unless firms offer a grace period for the service. Along with this interpretation, we assume that a firm that automatically enrolls consumers charges no price for the first usage of the service (i.e., $p^a = 0$ in $t = 2$).[17]

Beyond automatic enrollments, our main logic and results are applicable to situations in which consumers find it easier to register with one firm compared with others. As an example, for customers of a retail bank, signing up for a credit card associated with the bank is often easier than doing so at other firms because the bank can use the customer information that it already holds.

3 Analysis

Consumer behavior We first characterize each consumer's behavior given prices and switching costs. Note that consumers do not take any action in $t = 3$. Note also that in the context of our model, consumers do not have an incentive to switch back from the competitive fringe to the firm.

If time-consistent consumers are still enrolled in the firm's service at the beginning of period 2, they switch to the competitive fringe if and only if $-k_2 + a > a - p^a$ or equivalently $p^a > k_2$. That is, time-consistent consumers switch in $t = 2$ if and only if the price exceeds the switching cost as in the classical switching-cost literature (Farrell and Klemperer 2007). Given this, period 1's switching behavior can be divided into the following two cases. First, if $p^a \leq k_2$, time-consistent consumers switch in period 1 if and only if $a - k_1 + a > a + (a - p^a)$ or equivalently $p^a > k_1$. Second, if $p^a > k_2$, time-consistent consumers switch in period 1 if and only if $a - k_1 + a > a + (a - k_2)$

[17] In Section 4.1, we show that this is without loss in a model with endogenous consumer enrollments because the initial payment upon enrollment is indistinguishable from a payment for the service in $t = 2$. In addition, a firm may have an incentive to offer a low introductory price (Shapiro 1983) or a free trial (Murooka 2016) if the service is an experience good.

or equivalently $k_2 > k_1$. Intuitively, when the switching cost in the second period is sufficiently high, time-consistent consumers switch in period 1 if the price exceeds the switching cost in the first period; otherwise, they switch in period 1 if the switching cost in that period is lower than that in period 2.

If present-biased consumers are still enrolled in the firm's service at the beginning of period 2, they switch to the competitive fringe if and only if $-k_2+\beta a > \beta(a-p^a)$ or equivalently $p^a > \frac{k_2}{\beta}$. In contrast to time-consistent consumers, present-biased consumers may not switch even if the price exceeds the switching cost. Note also that $\hat{\beta}$ does not affect consumer behavior in period 2. Because these consumers underestimate their future self-control problem, in period 1 they think they will switch in the next period if and only if $\hat{\beta}p^a > k_2$. Given this belief, period 1's switching behavior can be divided into the following two cases. First, if $\hat{\beta}p^a \leq k_2$, naive present-biased consumers think they will keep using the firm's service in period 2. Hence, they switch in period 1 if and only if $a-k_1+\beta a > a+\beta(a-p^a)$ or equivalently $p^a > \frac{k_1}{\beta}$. Second, if $\hat{\beta}p^a > k_2$, these consumers think they will switch in period 2. Hence, they switch in period 1 if and only if $a-k_1+\beta a > a+\beta(a-k_2)$ or equivalently $\beta k_2 > k_1$. Intuitively, naive present-biased consumers are less likely to switch in period 2 because they procrastinate switching in period 1 as they underestimate their future impatience and because they are more impatient than time-consistent consumers. It is worth emphasizing that if $p^a = \frac{k_2}{\beta}$, then $\hat{\beta}p^a > k_2$ holds for *any* $\hat{\beta} > \beta$.

Firm behavior and Policy Effects We now analyze the optimal pricing of the firm and the effects of choice-enhancing policies. We first investigate the situation in which the policymaker does not employ any policy, i.e., $k_1 = k_2 = \overline{k}$. The firm faces a trade-off between exploiting naive consumers at a high price ($p^a = \frac{1}{\beta}\overline{k}$) and selling its service to all consumers at a moderate price ($p^a = \overline{k}$). The result is summarized as follows:

Lemma 1. *Suppose $k_1 = k_2 = \overline{k}$.*

If $\alpha > \beta$, the firm sets $p^a = \frac{1}{\beta}\overline{k}$. Time-consistent consumers do not pay p^a, whereas naive consumers pay p^a. The profits of the firm are $\pi = \frac{\alpha}{\beta}\overline{k}$.

If $\alpha \leq \beta$, the firm sets $p^a = \overline{k}$. All consumers pay p^a. The profits of the firm are $\pi = \overline{k}$.

The intuition is simple: the firm is more likely to exploit naive consumers if there are more naive consumers (larger α) or if naive consumers suffer from a more severe present bias (smaller β).

Because naive consumers pay a high price, which they initially did not anticipate paying, consumer welfare is lower when the firm sells only to naive consumers than when it sells to both naive and time-consistent consumers. Social welfare is also lower because time-consistent consumers pay the switching cost.

The result in Lemma 1 does not depend on the extent to which naive consumers are aware of their present bias. To see the intuition, suppose that the firm sets $p^a = \frac{k_2}{\beta}$. Note first that the consumer behavior in $t = 2$ does not depend on $\hat{\beta}$. In $t = 1$, partially naive consumers think that they will switch in $t = 2$ if and only if $p^a > \frac{k_2}{\hat{\beta}}$. Since $\frac{k_2}{\beta} > \frac{k_2}{\hat{\beta}}$ for any $\hat{\beta} > \beta$, these naive consumers do not switch in $t = 1$ if and only if $k_1 \geq \beta k_2$. Consequently, consumer behavior in both $t = 1$ and $t = 2$ does not depend on $\hat{\beta}$ when the firm sets $p^a = \frac{k_2}{\beta}$. Hence, akin to Heidhues and Kőszegi (2010), the firm can make partially naive consumers procrastinate and can exploit them at the same amount irrespective of $\hat{\beta}$.[18] This intuition is also applied to the following results.

We next investigate the situation in which the switching cost is decreased in the first period, i.e., $k_1 = \underline{k}$, $k_2 = \overline{k}$. This is the case if the policymaker employs a policy that reduces the switching cost when consumers are enrolled. The firm still faces the same type of trade-off as above. The equilibrium cut-off condition becomes different, however. On the one hand, time-consistent consumers switch in period 1 if $p^a > \underline{k}$. On the other hand, naive consumers in period 1 prefer to switch in period 2 rather than immediately if $-\underline{k} \leq -\beta\overline{k}$ or equivalently $\Delta_k \geq \beta$. In this case, the firm can set $p^a = \frac{1}{\beta}\overline{k}$ and naive consumers end up paying the price. The result is summarized as follows:

Lemma 2. *Suppose* $k_1 = \underline{k}, k_2 = \overline{k}$.

(i) Suppose $\Delta_k \geq \beta$. *If* $\alpha > \beta\Delta_k$, *the firm sets* $p^a = \frac{1}{\beta}\overline{k}$. *Time-consistent consumers switch in period* 1 *and do not pay* p^a, *whereas naive consumers pay* p^a. *The profits of the firm are* $\pi = \frac{\alpha}{\beta}\overline{k}$. *If* $\alpha \leq \beta\Delta_k$, *the firm sets* $p^a = \underline{k}$. *All consumers pay* p^a. *The profits of the firm are* $\pi = \underline{k}$.

(ii) Suppose $\Delta_k < \beta$. *If* $\alpha > \beta$, *the firm sets* $p^a = \frac{1}{\beta}\underline{k}$. *Time-consistent consumers switch in period* 1 *and do not pay* p^a, *whereas naive consumers pay* p^a. *The profits of the firm are* $\pi = \frac{\alpha}{\beta}\underline{k}$. *If* $\alpha \leq \beta$, *the firm sets* $p^a = \underline{k}$. *All consumers pay* p^a. *The profits of the firm are* $\pi = \underline{k}$.

[18] Specifically, Heidhues and Kőszegi (2010) show that in a general contracting setting, an ex-ante incentive compatibility constraint (in our model, the condition that partially naive consumers procrastinate switching in $t = 1$) does not bind for any $\hat{\beta} > \beta$ if an ex-post incentive compatibility constraint (in our model, the condition that partially naive consumers do not switch in $t = 2$) binds.

Lemma 2 (i) means that the firm may still be able to charge a high price and exploit naive consumers even if the switching cost in $t = 1$ is decreased. Intuitively, naive consumers procrastinate switching if the decrease in the switching cost in period 1 is not large ($\Delta_k \geq \beta$): in period 1, they do not switch because they prefer to switch in period 2 and (wrongly) think that they will do so. In period 2, however, naive consumers actually do not switch if $p^a \leq \frac{1}{\beta}\overline{k}$. By contrast, Lemma 2 (ii) shows that when $\Delta_k < \beta$, the policy in $t = 1$ can decrease the price and increase consumer welfare. Intuitively, if naive consumers do not procrastinate switching, the firm needs to decrease its price in response to the policy.

Comparing Lemma 1 with Lemma 2 leads to our first main result:

Proposition 1. *Suppose the choice-enhancing policy is employed in $t = 1$. If $1 \geq \frac{\alpha}{\beta} > \Delta_k \geq \beta$, the policy increases the equilibrium price and decreases naive consumers' welfare and social welfare. If in addition $\frac{\alpha}{\beta} + (1 - \alpha)\Delta_k > 1$, it also decreases consumer welfare.*

Proposition 1 highlights that the policy that decreases the switching cost when consumers are enrolled can lower naive consumers' welfare and social welfare. Intuitively, the firm faces a trade-off between exploiting naive consumers at a high price and selling to all consumers at a moderate price. Because the policy reduces the maximum price time-consistent consumers are willing to pay, it makes exploiting naive consumers relatively more attractive for the firm. When the firm changes its pricing strategy in response to the policy, time-consistent consumers pay the switching cost, which decreases social welfare. Precisely, this perverse result occurs when naive consumers procrastinate switching ($\Delta_k \geq \beta$), the firm sells to both types of consumers without the policy ($\beta \geq \alpha$), and it sells only to naive consumers and exploits them with the policy ($\alpha > \beta\Delta_k$). Under these parameters, the policy also lowers naive consumers' long-run utility and can lower consumer welfare when the proportion of naive consumers is sufficiently large.

Figure 2 shows how the policy decreasing the switching cost in $t = 1$ changes the firm's equilibrium pricing when the reduction in the switching cost is insufficient (i.e., when $\Delta_k \geq \beta$). There are three cases depending on the proportion of naive consumers. When most consumers are time-consistent (i.e., $\alpha \leq \beta\Delta_k$), the firm always chooses a price at which no consumers pay a switching cost, and hence the policy decreases the equilibrium price. When most consumers are naive (i.e., $\alpha > \beta$), the firm sets a high price both before and after the policy and time-consistent consumers pay a switching cost. When the composition of consumers is in-between, however, the firm increases

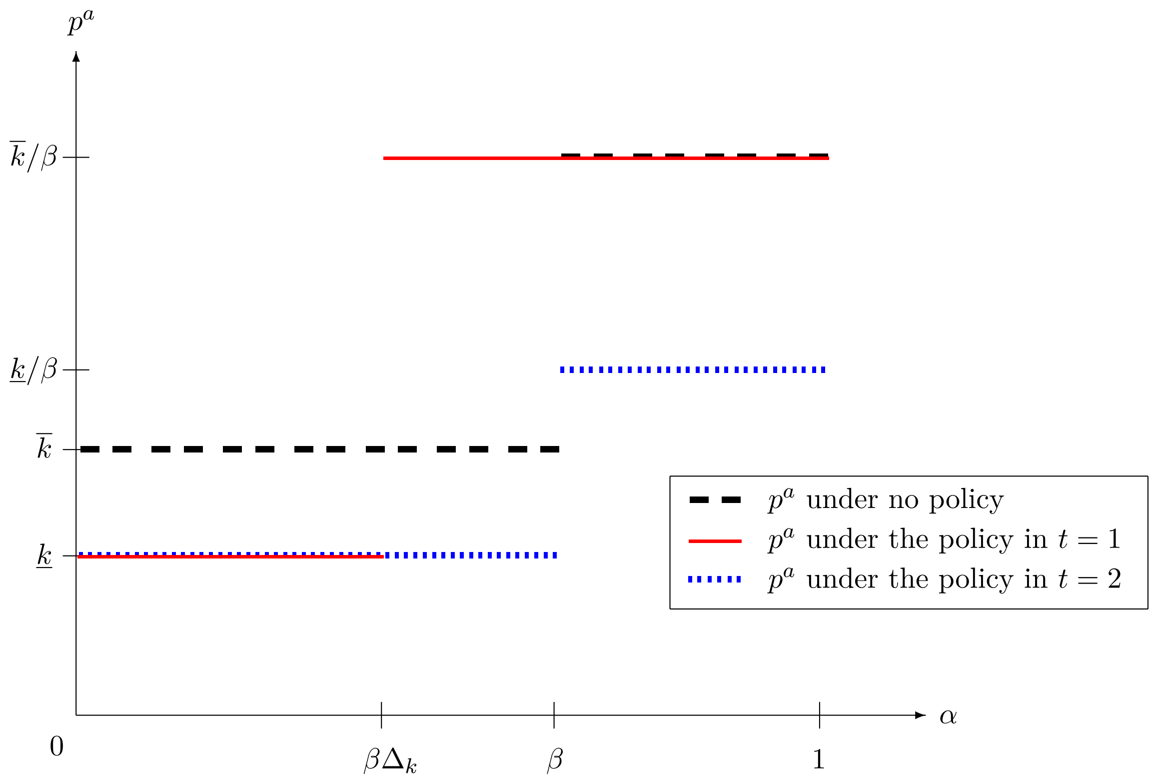

Figure 2: Equilibrium price under different policies when $\Delta_k \geq \beta$.

its price in response to the policy—adversely affecting welfare—as stated in Proposition 1.

As an alternative policy, we investigate the situation in which the switching cost is decreased in the second period, i.e., $k_1 = \overline{k}$, $k_2 = \underline{k}$. This is the case if the policymaker decreases the switching cost whenever the firm starts charging a (higher) price. Similar to the above analysis, the firm faces a trade-off between exploiting naive consumers at a high price ($p^a = \frac{1}{\beta}\underline{k}$) and selling its service to all consumers at a moderate price ($p^a = \underline{k}$). The result is summarized as follows:

Lemma 3. *Suppose* $k_1 = \overline{k}, k_2 = \underline{k}$.

If $\alpha > \beta$, *the firm sets* $p^a = \frac{1}{\beta}\underline{k}$. *Time-consistent consumers switch in period* 2 *and do not pay* p^a, *whereas naive consumers pay* p^a. *The profits of the firm are* $\pi = \frac{\alpha}{\beta}\underline{k}$.

If $\alpha \leq \beta$, *the firm sets* $p^a = \underline{k}$. *All consumers pay* p^a. *The profits of the firm are* $\pi = \underline{k}$.

The parameters under which the firm chooses to exploit the naive consumers (i.e., $\alpha > \beta$) are the same as the ones under no policy. By comparing Lemma 1 with Lemma 3, we have the following result:

Proposition 2. *Suppose the choice-enhancing policy is employed in $t = 2$. This policy always strictly increases consumer welfare and weakly increases social welfare. It strictly increases social welfare if $\alpha > \beta$.*

Proposition 2 implies that the policy that decreases the switching cost when a firm increases the price (in this case, when a firm starts charging a positive fee) does not have the perverse effect as described in Proposition 1. As depicted in Figure 2, such a policy always decreases the equilibrium price. Thus, it always strictly increases consumer welfare relative to the no-policy case. It also increases social welfare when time-consistent consumers pay a switching cost in equilibrium, because the policy directly reduces the switching cost.

Furthermore, the comparison between Lemma 2 and Lemma 3 leads to the following result:

Proposition 3. *Under any parameters, both consumer and social welfare are weakly higher when enacting the choice-enhancing policy in $t = 2$ than when enacting it in $t = 1$. Consumer welfare is strictly higher if $\frac{\alpha}{\beta} > \Delta_k \geq \beta$, and social welfare is strictly higher if in addition $1 \geq \frac{\alpha}{\beta}$.*

Proposition 3 highlights that the timing of enacting the policy matters for both consumer and social welfare. If a policymaker enacts a choice-enhancing policy when consumers are enrolled, then a firm may change its pricing strategy in response to the policy, and hence the perverse welfare effect can occur. By contrast, as depicted in Figure 2, the alternative policy does not have such an adverse effect, and hence is welfare enhancing.

It is worth emphasizing that the choice-enhancing policy in $t = 2$ increases consumer and social welfare robustly to the proportion of naive consumers α, whereas that in $t = 1$ does not. In this sense, our proposed policy is in line with "asymmetric paternalism," which benefits consumers who make errors, while it imposes no (or relatively little) harm on consumers who are fully rational (Camerer, Issacharoff, Loewenstein, O'Donoghue and Rabin 2003).

Optimal Choice-Enhancing Policy We have thus far compared policies reducing the switching cost in $t = 1$ and $t = 2$. Another natural candidate policy is to reduce the switching cost in both periods. Corollary 1 summarizes the comparison between the policy employed in $t = 2$ and that employed in both periods:

Corollary 1. *(i) If there is no cost of decreasing the switching costs, then social welfare under a policy that reduces the switching cost only in $t = 2$ is equal to social welfare under a policy that* *reduces the switching cost in both $t = 1$ and $t = 2$.*

(ii) If there is a per-period cost of decreasing the switching costs, then social welfare under a policy that reduces the switching cost only in $t = 2$ is higher than social welfare under a policy that reduces the switching cost in both $t = 1$ and $t = 2$.

In summary, if there is no cost of implementing such a policy (as we assumed), a policy that reduces the switching cost only in $t = 2$ has the same effect as a policy that reduces the switching cost in all periods. If there is a positive per-period implementation cost, however, reducing the switching cost only in $t = 2$ is uniquely optimal unless the implementation cost is very high. If the implementation cost is very high, then implementing no policy is optimal.

4 Extensions

This section investigates extensions and modifications of our illustrative model. Section 4.1 endogenizes consumers' enrollment decisions and incorporates the possibility of multiple payments by assuming that the firm offers a base product and can enroll consumers in an add-on subscription when consumers buy the base product. Section 4.2 incorporates base-product competition among firms. Section 4.3 discusses models incorporating sophisticated present-biased consumers and heterogeneous (base-product or add-on) values among consumers.

4.1 Endogenous Enrollment and Multiple Payments

We have thus far assumed that consumers are enrolled into the firm's service and that the firm only decides how to price the service. We now modify the model such that consumers endogenously decide whether they take up a base product that automatically enrolls them into an add-on service, while the firm decides how to price both the base product and the add-on service. We also extend the model such that consumers may use the add-on service in multiple periods—which is plausible in the context of add-on subscriptions—and this allows us to derive additional comparative statics.

Suppose $T+1$ periods: $t = 0, 1, 2, \cdots, T$ where $T \geq 3$. The firm produces two types of products: a base product and an add-on. Consumers value the base product at $v > 0$ and can consume it only once in $t = 1$. The firm automatically enrolls consumers who buy the base product into its add-on service. Consumers value the add-on at $a > 0$ in each $t = 2, \cdots, T$, where they can use the add-on only combined with the base product. If consumers do not buy the base product, they receive an outside option with utility $\bar{u} \in [0, v)$ in period T. The production cost of the base product is $c^v \in (0, v - \bar{u})$. Both the firm and a competitive fringe can produce the same add-on at zero cost.

The timing of the game is modified as follows. In period 0, both the firm and the policymaker decide and commit whether to enact the policy (i.e., decreasing consumers' switching cost) for each period. If either or both of them enact the policy for period t, the switching cost in period t is $k_t = \underline{k}$; otherwise, it is $k_t = \overline{k}$. Then, the firm sets and commits to its prices: a price for the base product $p^v \geq 0$, which is charged in period 1 and prices for the add-on $p_t^a \geq 0$ which are charged in $t = 3, \cdots, T$.[19] After observing the prices and switching costs, consumers decide whether to buy the base product at the end of period 0. In period 1, consumers who bought the base product receive v and pay p^v. They also decide whether to opt out of the firm's add-on (and buy the add-on from the competitive fringe) at switching cost k_1. Then, in each period $t = 2, \cdots, T$, consumers who use the add-on receive a. In addition, in period $t = 2, \cdots, T-1$, if consumers have not opted out of the firm's add-on, they decide either to opt out at the switching cost k_t incurred in period t or to pay p_{t+1}^a in period $t+1$. The game ends at the end of period T.

As in Proposition 1, the policy that decreases the switching cost when consumers are enrolled into the add-on service can lower social welfare. In contrast to Proposition 1, however, the firm needs to appropriately discount its base-product price to attract consumers. As a result, the policy also decreases consumer welfare whenever it decreases social welfare:

Proposition 4. *Suppose that a policymaker enacts a choice-enhancing policy in $t = 1$. If $1 \geq \frac{\alpha + (T-3)(1-\beta)\alpha}{\beta} > \Delta_k \geq \beta$, the policy increases the equilibrium add-on prices and decreases both consumer and social welfare.*

We next investigate an alternative policy. Interestingly, merely imposing a low switching cost in period 2 is insufficient to unambiguously improve welfare, because the firm could react to the policy by setting a low p_3^a, leading naive consumers not to switch in that period, and exploiting consumers afterwards.[20] Hence, we propose a policy in which the policymaker forces the firm to lower the switching cost whenever it increases the add-on price. As an example, suppose that the

[19] As discussed in Section 2, $t = 2$ is a free-trial period and hence $p_2^a = 0$.

[20] Formally, consider the case in which naive consumers face a switching decision in period 2, $k_2 = \underline{k}$, and $k_t = \overline{k}$ for all $t \geq 3$. In this case, naive consumers (wrongly) think that they will switch in period 3 if $p_4^a = \frac{1-\beta}{\beta}\overline{k}$. Given that, they do not switch in period 2 if $-\underline{k} \leq -\beta(p_3^a + \overline{k})$. Hence, if $\Delta_k \geq \beta$, the firm can make naive consumers procrastinate their switching decisions by lowering its add-on price.

firm sets $p_3^a > 0$. Since the add-on price increases from $p_2^a = 0$ to $p_3^a > 0$, the policy requires lowering consumers' switching costs in $t = 2$. In practice, a policymaker could force firms to send an email with a simple cancellation format to consumers upon a price increase, even when the price increase was known and previously announced to consumers.

Under such a policy, the firm may have an incentive to voluntarily decrease its switching cost to $\underline{k}$ in all periods after it is forced to do so. Intuitively, voluntarily lowering switching costs makes naive consumers more likely to believe that they will switch in the future and hence it makes them more likely to procrastinate their switching decision.[21] The welfare effects of the alternative policy are summarized as follows:

Proposition 5. *Suppose the policymaker enacts a policy that requires the firm to lower its switching cost whenever it increases the add-on price. The policy always weakly increases consumer and social welfare. It strictly increases consumer and social welfare if* $\alpha + (T-3)(1-\beta)\alpha > \beta$.

Note that the policy in Proposition 5, which requires the firm to lower the switching cost whenever the firm raises add-on prices, is more likely to increase consumer and social welfare as T rises.

Furthermore, the following result demonstrates that it is not necessary to force the firm to reduce the switching cost in every period to improve welfare; a milder intervention as in Proposition 5 has the same consequence.

Proposition 6. *The equilibrium outcomes under a policy that forces the firm to reduce the switching cost whenever the firm increases the add-on price are the same as those under a policy that forces the firm to reduce the switching cost in every period.*

Hence, akin to the results in Corollary 1, our suggested policy may be preferable when there is a positive cost for forcing firms to reduce a switching cost.

4.2 Competition on the Base Product

In Section 4.1, we assumed that only one firm can provide the base product. In this subsection, we analyze the case in which $N \geq 2$ firms sell a homogeneous base product. We investigate a

[21] To see this, suppose that naive consumers face a switching decision in period t with $k_t = \underline{k}$ because of the increase in the add-on price and the policy. In period t, the condition for naive consumers to procrastinate switching to the next period is $-\underline{k} \leq -\beta(p_{t+1}^a + k_{t+1})$. Note that naive consumers always switch in period t if $\Delta_k < \beta$ and $k_{t+1} = \overline{k}$. Hence, if $\Delta_k < \beta$, the firm decreases k_{t+1} from $\overline{k}$ to $\underline{k}$ voluntarily in order to lead naive consumers to procrastinate their switching decisions. Interestingly, even if $\Delta_k \geq \beta$, the firm has an incentive to decrease k_{t+1} under that policy; see the proof of Lemma 6 for details.

symmetric pure-strategy equilibrium in which all firms offer the same contract in $t = 0$ and equally split each type of consumers in the case of tie-breaking. For simplicity, we focus on the case in which $T = 3$.

Under competition on the base product, market outcomes depend on whether setting negative prices is feasible or not. We first discuss the case in which firms can set any base-product prices:

Proposition 7. *Suppose there are $N \geq 2$ firms selling the base product and $p^v \in \mathbb{R}$.*

Then, all firms earn zero profits in any equilibrium. Under any parameters, both consumer and social welfare are weakly higher when enacting the choice-enhancing policy in $t = 2$ than when enacting it in $t = 1$. Consumer welfare is strictly higher if $\frac{\alpha}{\beta} > \Delta_k \geq \beta$, and social welfare is strictly higher if in addition $1 \geq \frac{\alpha}{\beta}$.

Intuitively, if firms can compete down their base-product prices, they will do so as in standard Bertrand-type price competition. Although all profits from exploitation are passed on to consumers and all firms earn zero profits, the timing of the policies still matters. In addition, a cross-subsidization from naive consumers to time-consistent consumers may occur under competition, because the presence of naive consumers decreases the equilibrium base-product price (Gabaix and Laibson 2006).

In practice, however, firms may be unable to profitably set overly low prices. Heidhues, Kőszegi, and Murooka (2016a, 2016b) investigate how the possibility of arbitrage can endogenously generate a price floor of the base product.[22] To investigate such a case in a simple manner, suppose that a base-product price is restricted to $p^v \geq 0$. In this case, firms may earn positive profits even under competition:

Proposition 8. *Suppose there are $N \geq 2$ firms selling the base product and $p^v \geq 0$.*

When the choice-enhancing policy is enacted in $t = 2$ or when it is enacted in $t = 1$ and $\Delta_k < \beta$, a positive-profit equilibrium in which $(p^v = 0, p_3^a = \frac{1}{\beta}\underline{k})$ exists if $\frac{1}{N}(\frac{\alpha}{\beta}\underline{k} - c^v) > \max\{\underline{k} - c^v, 0\}$. When the choice-enhancing policy is enacted in $t = 1$ and $\Delta_k \geq \beta$, a positive-profit equilibrium in which $(p^v = 0, p_3^a = \frac{1}{\beta}\overline{k})$ exists if $\frac{1}{N}(\frac{\alpha}{\beta}\overline{k} - c^v) > \max\{\underline{k} - c^v, 0\}$.

Under any parameters, both consumer and social welfare are weakly higher when enacting the choice-enhancing policy in $t = 2$ than when enacting it in $t = 1$. Consumer and social welfare are strictly higher if $\Delta_k \geq \beta$ and $\frac{1}{N}(\frac{\alpha}{\beta}\overline{k} - c^v) > \max\{\underline{k} - c^v, 0\} \geq \frac{1}{N}(\frac{\alpha}{\beta}\underline{k} - c^v)$.

[22] See also Armstrong and Vickers (2012) and Grubb (2015) for an analysis with price floors for the base product.

To see the intuition, suppose that $k_1 = k_2 = k > \frac{\beta}{\alpha} c^v$. Then, each firm earns profits $\frac{1}{N}(\frac{\alpha}{\beta}k - c^v) > 0$ by setting $(p^v = 0, p_3^a = \frac{k}{\beta})$ and charging the add-on price only to naive consumers. While no firm can decrease p^v, each firm can still attract consumers by lowering p^a. From the deviation, however, each firm would earn profits of at most $k - c^v$. Hence, such deviations may not be profitable for firms.[23] The effects on policies are qualitatively the same as those in Section 4.1.

4.3 Further Extensions

Incorporating Sophisticated Consumers We have thus far assumed that all present-biased consumers are (either partially or fully) unaware of their self-control problem. When sophisticated consumers ($\beta = \hat{\beta} < 1$) are also in the market, the condition in which the firm chooses to exploit naive consumers changes.[24] Intuitively, sophisticated consumers might make no purchase if they are afraid of being exploited because of a high add-on price. Our policy implications are, however, still valid in that the policy in $t = 1$ can be worse than no policy whereas the policy in $t = 2$ is better than no policy. The analysis is provided in the Supplementary Material.

Heterogeneous Demand We now discuss the cases in which consumers' valuation of the base product or of the add-on is heterogeneous. In this case, the equilibrium base-product price may differ. Similar to Grubb (2015), under downward-sloping demand, a choice-enhancing or an active-choice policy may increase the equilibrium base-product price. The intuition is as follows. As in a simple monopoly problem, a firm faces a trade-off between charging a high price for the base product (but only serving few consumers) and serving many consumers by setting a low price for the base product (but only making a small profit per consumer). In addition to the profits from the base product, the firm makes extra profits from the add-on. If a policy reduces the profits from the add-on, serving many consumers becomes less profitable for the firm. Hence, the policy may increase the base-product price, which can be detrimental to consumer welfare. This effect would not arise under competition on the base product, however. The analysis is provided in the Supplementary Material.

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[23] Here, the logic of the existence of the positive-profit equilibrium is close to that of Heidhues, Kőszegi and Murooka (2016b), although our model is dynamic and firms do not have an option to educate naive consumers.

[24] Nocke and Peitz (2003) analyze the durable-good market in the presence of sophisticated present-biased consumers.

5 Discussion

In this section, we discuss the effects and potential limitations of other policies—reminders, automatic terminations of subscriptions, regulating prices, and deadlines—in turn. We also discuss how our suggested policy (and other policies) can interact with other behavioral biases, such as forgetting or inattention to a switching opportunity.

Reminder A policymaker could send a reminder or provide more information for consumers. Note that if consumers have a self-control problem, merely providing additional information does not prevent their procrastination. Further, even if consumers also have other biases such as forgetting or inattention to their switching opportunities, our suggested policy—sending an email with a simple cancellation format upon increasing a price—would also work as a reminder. In this sense, our suggested policy is robust to such other behavioral biases.

Automatic Termination A policymaker may be able to impose an automatic termination of subscriptions of a service after a free-trial period (or, equivalently, employ an opt-in policy as a default). Although such an automatic termination policy would work in our basic model, consumers who want to keep using the current firm's service would have to sign up again, and hence the policy may generate unnecessary re-registration costs. In addition, if a service is automatically terminated, then present-biased consumers (or consumers who may forget to re-subscribe to the service) may fail to sign up again, which harms consumer and social welfare. By contrast, a policy decreasing consumers' switching costs does not have these drawbacks.

Price Regulation A policymaker could directly regulate the price for a service. Note that in our illustrative model, simply imposing $p_t^a = 0$ for all t maximizes social welfare, and setting any price ceiling below $\frac{\overline{k}}{\beta}$ would (weakly) increase consumer welfare. In practice, however, it is often hard for the policymaker to know the firm's cost function for the service. If the policymaker inaccurately estimates the cost function, then direct price regulation can decrease welfare. In summary, although imposing mild price regulation may prevent firms' exploitation and hence increase welfare, imposing a stringent price regulation would be difficult and questionable.

Deadline A policymaker may be able to impose a strict deadline for consumers' switching decisions. Indeed, if consumers may incur multiple add-on payments as in Section 4.1, then imposing such a deadline increases welfare. This finding is in line with the theoretical literature that analyzes the effects of imposing deadlines (O'Donoghue and Rabin 1999b, Herweg and Müller 2011). Unlike a policy decreasing switching costs, however, one should be cautious about imposing such a deadline in practice. Imposing a deadline may be harmful if the add-on values or switching costs change over time. In addition, if consumers are inattentive to or forget their switching opportunities, then imposing such a deadline would decrease consumer and social welfare. Furthermore, imposing a deadline might be infeasible if the firm can circumvent the deadline by (pretendedly) changing the product features of the add-on such that consumers receive extraordinary termination rights. The analysis is provided in the Supplementary Material.

6 Concluding Remarks

We investigate the welfare consequences of policies that reduce consumers' switching costs when a firm can change its strategy in response to a policy. We show that a conventional policy—reducing the switching cost when consumers are enrolled into a service—can decrease consumer and social welfare. We also show that an alternative policy—reducing the switching cost when a firm charges a higher price for the service—always (weakly) increases welfare compared with no policy or a conventional policy. Our welfare and policy implications shed light on the design of choice-enhancing and active-choice policies. The logic of our model and its policy implications seem applicable when rational consumers are more responsive to a change in the economic environment than consumers who have behavioral biases.

We conclude by discussing two important issues related to (but beyond the scope of) this paper. First, how to detect consumer naivete and an adverse policy effect from market data is both theoretically and practically important. One difficulty—as briefly discussed in Section 5—is that an automatic enrollment itself may not harm consumer and social welfare. For example, naive consumers may procrastinate taking up a valuable additional service if there are costs for registration and no automatic enrollment. In such a case, the automatic enrollment itself is valuable, although it may allow the firm to exploit consumers as analyzed in this paper. As a potential future direction, investigating usage as well as purchase data could help identify consumer naivete and exploitation.

Second, this paper focuses on the present bias as a source of procrastination. Although present bias is one of the most prevalent behavioral biases and our policy implications seem applicable whenever rational consumers are more responsive to a policy than naive consumers, empirically identifying the type of consumer bias is an important issue. Further, designing an optimal policy depends on the types of consumer biases in general. Identifying the type of consumer biases from market data and investigating an optimal policy in a model with multiple sources of consumer biases are left for future research.

Appendix: Proofs

Proof of Lemma 1.

In what follows, we analyze a slightly more general case in which $k_1 = k_2 = k$. We divide the analysis into two cases.

First, suppose that the firm sells the service only to naive consumers. In this case, the firm sets $p^a = \frac{1}{\beta}k$. Naive consumers do not switch, whereas time-consistent consumers switch either in period 1 or in period 2. The firm's profits are $\pi = \frac{\alpha}{\beta}k$ and the consumers' long-run utilities are $u^N = \bar{u} - \frac{1}{\beta}k + 2a$ and $u^{TC} = \bar{u} - k + 2a$.

Second, suppose that the firm sells the service to both naive and time-consistent consumers. In this case, the firm sets $p^a = k$. The firm's profits are k and the consumers' long-run utilities are $u^N = u^{TC} = \bar{u} - k + 2a$.

By comparing the above two cases, we obtain the result. $\square$

Proof of Lemma 2.

(i) Note that time-consistent consumers do not switch in period 1 if and only if $p^a \leq \underline{k}$. Naive consumers do not switch in period 1 because $-\underline{k} \leq -\beta\overline{k}$.

First, suppose that the firm sells the service only to naive consumers. In this case, the firm sets $p^a = \frac{1}{\beta}\overline{k}$. Naive consumers do not switch, whereas time-consistent consumers switch in period 1. The firm's profits are $\pi = \frac{\alpha}{\beta}\overline{k}$ and the consumers' long-run utilities are $u^N = \bar{u} - \frac{1}{\beta}\overline{k} + 2a$ and $u^{TC} = \bar{u} - \underline{k} + 2a$.

Second, suppose that the firm sells the service to both naive and time-consistent consumers. In this case, the firm sets $p^a = \underline{k}$. The firm's profits are $\pi = \underline{k}$ and the consumers' long-run utilities are $u^N = u^{TC} = \bar{u} - \underline{k} + 2a$.

By comparing the above two cases, we obtain the result.

(ii) Note that time-consistent consumers do not switch in period 1 if and only if $p^a \leq \underline{k}$. Naive consumers do not switch in period 1 if and only if $p^a \leq \frac{1}{\beta}\underline{k}$.

First, suppose that the firm sells the service only to naive consumers. In this case, the firm sets $p^a = \frac{1}{\beta}\underline{k}$. Naive consumers do not switch, whereas time-consistent consumers switch in period 1. The firm's profits are $\pi = \frac{\alpha}{\beta}\underline{k}$ and the consumers' long-run utilities are $u^N = \bar{u} - \frac{1}{\beta}\underline{k} + 2a$ and $u^{TC} = \bar{u} - \underline{k} + 2a$.

Second, suppose that the firm sells the service to both naive and time-consistent consumers. In this case, the firm sets $p^a = \underline{k}$. The firm's profits are $\pi = \underline{k}$ and the consumers' long-run utilities are $u^N = u^{TC} = \bar{u} - \underline{k} + 2a$.

By comparing the above two cases, we obtain the result. □

Proof of Proposition 1.

The conditions in which the policy in $t = 1$ increases the equilibrium price and decreases social welfare, $1 \geq \frac{\alpha}{\beta} > \Delta_k \geq \beta$, are immediate from Lemma 1 and Lemma 2.

Given $1 \geq \frac{\alpha}{\beta} > \Delta_k \geq \beta$, the total consumer surplus under no policy is $\bar{u} + 2a - \bar{k}$, whereas under the policy in $t = 1$ it is $\bar{u} + 2a - \alpha \frac{1}{\beta} \overline{k} - (1 - \alpha)\underline{k}$. Comparing these two cases, we get the condition in which the policy in $t = 1$ decreases consumer welfare if and only if $\frac{\alpha}{\beta} + (1 - \alpha)\Delta_k > 1$. □

Proof of Lemma 3.

We divide the analysis into two cases.

First, suppose that the firm sells the service only to naive consumers. In this case, the firm sets $p^a = \frac{1}{\beta}\underline{k}$. Naive consumers do not switch, whereas time-consistent consumers switch in period 2. The firm's profits are $\pi = \frac{\alpha}{\beta}\underline{k}$ and the consumers' long-run utilities are $u^N = \bar{u} - \frac{1}{\beta}\underline{k} + 2a$ and $u^{TC} = \bar{u} - \underline{k} + 2a$.

Second, suppose that the firm sells the service to both naive and time-consistent consumers. In this case, the firm sets $p^a = \underline{k}$. The firm's profits are $\pi = \underline{k}$ and the consumers' long-run utilities are $u^N = u^{TC} = \bar{u} - \underline{k} + 2a$.

By comparing the above two cases, we obtain the result. □

Proof of Proposition 2.

Immediate from Lemma 1 and Lemma 3. □

Proof of Proposition 3.

Immediate from Lemma 2 and Lemma 3. □

Proof of Corollary 1. Note that consumers do not have an incentive to change their behavior, if not only k_2 but also k_1 is reduced to $\underline{k}$ for the equilibrium prices. Hence, the firm does not have an incentive to change its pricing strategy. If reducing a period's switching cost is costly, social welfare is lower when the switching cost is reduced in two periods compared to when the switching cost is reduced in only in $t = 2$. $\square$

Proof of Proposition 4.

Before the proof, we characterize the consumer switching behavior. For notational simplicity, let β^i be consumer i's degree of present bias where time-consistent consumers have $\beta^{TC} = 1$ and (partially) naive present-biased consumers have $\beta^N = \beta < 1$. Similarly, let $\hat{\beta}^i$ be consumer i's belief about her degree of present bias where $\hat{\beta}^{TC} = 1$ and $\hat{\beta}^N = \hat{\beta} \in (\beta, 1]$.

Note that consumers do not take any action in $t = T$. We first analyze the switching decision in $t = T - 1$. Suppose that consumers bought the base product and kept using the firm's add-on. Then, consumers do not switch to the competitive fringe if and only if $-k_{T-1} + \beta^i a \leq \beta^i(a - p_T^a)$ or equivalently $p_T^a \leq \frac{k_{T-1}}{\beta^i}$. We next analyze consumer behavior in period $\tau < T - 1$. Consumers think that they will not switch in any future period if and only if $\hat{\beta}^i \sum_{i=t+1}^{T} p_i^a \leq k_t$ for all $t > \tau$. Given this belief, consumers' switching behavior in period τ can be divided into the following two cases. First, if $\hat{\beta}^i \sum_{i=t+1}^{T} p_i^a \leq k_t$ for all $t > \tau$, consumers do not switch in period τ if and only if $\beta^i \sum_{i=t+1}^{T} p_i^a \leq k_\tau$ because they think that they will never switch in any future period $t > \tau$. Second, if there exists a period $t > \tau$ such that $\hat{\beta}^i \sum_{i=t+1}^{T} p_i^a > k_t$, by backward induction consumers form a belief about whether they will switch or not in each future period, and as a result, they think they will switch in period $\hat{t} > \tau$. Given $\hat{t}$, they do not switch in period τ if and only if $k_\tau > \beta^i \left(k_{\hat{t}} + \sum_{i=\tau+1}^{\hat{t}} p_i^a\right)$.

Given these, each consumer buys the base product in $t = 0$ if and only if her perceived utility is equal to or greater than the outside option. We here explicitly describe the consumer behavior on the purchase of the base product in $t = 0$. Given the switching decisions regarding the add-on, each consumer takes up the base product in $t = 0$ if and only if one (or both) of the following two conditions is satisfied; (i) the total perceived utility of buying the base product and the add-on from the monopoly firm exceeds the outside option: $\beta^i[v + (T-1)a - p^v - \sum_{t=3}^{T} p_t^a] \geq \beta^i \bar{u}$, (ii) the total perceived utility of buying the base product and switching in period $\hat{t}$ exceeds the outside option for some $\hat{t} \in \{2, \cdots, T-1\}$: $\beta^i \left[v + (T-1)a - p^v - k_{\hat{t}} - \sum_{t=3}^{\hat{t}} p_t^a\right] \geq \beta^i \bar{u}$. Note that (i) is equivalent to $p^v \leq V_T - \sum_{t=3}^{T} p_t^a$, where $V_T := v + (T-1)a - \bar{u}$ denotes the total net consumption value of the product.

It is easy to show that the firm sells its add-on to some consumers in every period: $p_t^a \leq \frac{k_t}{\beta^i}$.

It is also easy to show that if time-consistent consumers pay p_t^a, then naive consumers also pay p_t^a. From the above two participation constraints in $t = 0$, we can divide the firm's maximization problem into two cases: $p^v \leq V_T - \sum_{t=3}^T p_t^a$ and $V_T - \sum_{t=3}^T p_t^a < p^v \leq V_T - \min_s[k_s + \sum_{t=3}^s p_t^a]$. In the former case, it is optimal for the firm to sell the add-on to both naive and time-consistent consumers. In the latter case, the firm sells the add-on only to naive consumers from period $\hat{t}$ on.

We now analyze the optimal pricing of the firm. Note that if no consumer had an option to opt out of the add-on, the firm would set its total price equal to its overall consumption value minus the consumers' outside option, i.e., $p^v + \sum_{t=3}^T p_t^a = V_T$.

To complete the proof, we show two lemmas. We first investigate the situation in which switching costs are high in all periods, i.e., $k_t = \overline{k}$ for all $t \in \{1, \cdots, T-1\}$. This is the case when the policymaker does not employ any policy. The firm faces a trade-off between exploiting naive consumers with a high add-on price and selling its add-on to all consumers with a moderate add-on price. Note that the add-on prices can be different between periods. Lemma 4 summarizes the result of the case:

Lemma 4. *Suppose $k_t = \overline{k}$ for all $t \in \{1, \cdots, T-1\}$.*

If $\alpha + (T-3)(1-\beta)\alpha > \beta$, the firm sets $p^v = V_T - \overline{k}$, $p_t^a = \frac{1-\beta}{\beta}\overline{k}$ in $t \in \{3, \cdots, T-1\}$, and $p_T^a = \frac{1}{\beta}\overline{k}$. Time-consistent consumers switch before paying any add-on price, whereas naive consumers never switch. The firm's profits are $\pi = V_T - c^v + (\frac{\alpha}{\beta} - 1)\overline{k} + (T-3)\frac{\alpha}{\beta}(1-\beta)\overline{k}$ and the consumers' long-run utilities are $u^N = \bar{u} - (T-2)\frac{1-\beta}{\beta}\overline{k}$ and $u^{TC} = \bar{u}$.

If $\alpha + (T-3)(1-\beta)\alpha \leq \beta$, the firm sets $p^v + \sum_{t=3}^T p_t^a = V_T$ with $\sum_{t=3}^T p_t^a \leq \overline{k}$. No consumer switches. The firm's profits are $\pi = V_T - c^v$ and the consumers' long-run utilities are $u^N = u^{TC} = \bar{u}$.

Proof. In what follows, we analyze a slightly more general case in which $k_t = k$ for all t. We divide the analysis into two cases.

First, suppose that the firm sells the add-on only to naive consumers. In this case, the maximal add-on price the firm can charge to naive consumers is $p_T^a = \frac{1}{\beta}k$ as we showed in Lemma 1. Given this, in period $t = T-2$ naive consumers prefer switching in the next period $t+1$ to switching in the current period t if and only if $\beta(-p_t^a - k) \geq -k$ or equivalently $p_t^a \leq \frac{1-\beta}{\beta}k$. Also, note that if the firm sets $p_t^a = \frac{1-\beta}{\beta}k$, then for any $\hat{\beta} > \beta$ naive consumers (wrongly) believe that they will switch in t. By recursively applying this argument for $t < T-2$, the firm sets $p^v = V_T - k$, $p_T^a = \frac{1}{\beta}k$, and $p_t^a = \frac{1-\beta}{\beta}k$ for all $t \in \{3, \cdots, T-1\}$. Naive consumers do not switch, whereas time-consistent consumers switch before paying any add-on price. The firm's profits are $\pi = V_T - c^v + (\frac{\alpha}{\beta} - 1)k + (T-3)\frac{\alpha}{\beta}(1-\beta)k$ and the consumers' long-run utilities are $u^N = \bar{u} - (T-2)\frac{1-\beta}{\beta}k$ and $u^{TC} = \bar{u}$.

Second, suppose that the firm sells the add-on to both naive and time-consistent consumers. In this case, the firm sets $p^v + \sum_{t=3}^{T} p_t^a = V_T$ with $\sum_{t=3}^{T} p_t^a \leq k$.[25] The firm's profits are $\pi = V_T - c^v$ and the consumers' long-run utilities are $u^N = u^{TC} = \bar{u}$.

By comparing the above two cases, we obtain the result. $\square$

We next analyze the situation in which the switching cost is lower only in the first period, i.e., $k_1 = \underline{k}$, $k_t = \overline{k}$ for all $t \in \{2, \cdots, T-1\}$. This is the case if the policymaker employs the policy when consumers are enrolled in the add-on service. Lemma 5 summarizes the result of this case:

Lemma 5. *Suppose $k_1 = \underline{k}, k_t = \overline{k}$ for all $t \in \{2, \cdots, T-1\}$.*

(i) Suppose $\Delta_k \geq \beta$. If $\alpha + (T-3)(1-\beta)\alpha > \beta\Delta_k$, the firm sets $p^v = V_T - \underline{k}$, $p_t^a = \frac{1-\beta}{\beta}\overline{k}$ in $t \in \{3, \cdots, T-1\}$, and $p_T^a = \frac{1}{\beta}\overline{k}$. Time-consistent consumers switch in period 1, whereas naive consumers never switch. The firm's profits are $\pi = V_T - c^v - \underline{k} + \frac{\alpha}{\beta}[1 + (T-3)(1-\beta)]\overline{k}$ and the consumers' long-run utilities are $u^N = \bar{u} + \underline{k} - \frac{1}{\beta}[1 + (T-3)(1-\beta)]\overline{k}$ and $u^{TC} = \bar{u}$.

If $\alpha + (T-3)(1-\beta)\alpha \leq \beta\Delta_k$, the firm sets $p^v + \sum_{t=3}^{T} p_t^a = V_T$ with $\sum_{t=3}^{T} p_t^a \leq \underline{k}$. No consumer switches. The firm's profits are $\pi = V_T - c^v$ and the consumers' long-run utilities are $u^N = u^{TC} = \bar{u}$.

(ii) Suppose $\Delta_k < \beta$. If $\alpha > \beta$, the firm sets $p^v = V_T - \underline{k}$, $p_t^a = \frac{1-\beta}{\beta}\underline{k}$ in $t \in \{3, \cdots, T-1\}$, and $p_T^a = \frac{1}{\beta}\underline{k}$. Time-consistent consumers switch in period 1, whereas naive consumers never switch. The firm's profits are $\pi = V_T - c^v + (\frac{\alpha}{\beta} - 1)\underline{k}$ and the consumers' long-run utilities are $u^N = \bar{u} - \frac{1-\beta}{\beta}\underline{k}$ and $u^{TC} = \bar{u}$.

If $\alpha \leq \beta$, the firm sets $p^v + \sum_{t=3}^{T} p_t^a = V_T$ with $\sum_{t=3}^{T} p_t^a \leq \underline{k}$. No consumer switches. The firm's profits are $\pi = V_T - c^v$ and the consumers' long-run utilities are $u^N = u^{TC} = \bar{u}$.

Proof. (i) Notice that time-consistent consumers do not switch in period 1 if and only if $\sum_{t=3}^{T} p_t^a \leq \underline{k}$. Because $-\underline{k} < -\beta\overline{k}$, naive consumers do not switch in period 1.

First, suppose that the firm sells the add-on only to naive consumers. In this case, the firm sets $p^v = V_T - \underline{k}$, $p_T^a = \frac{1}{\beta}\overline{k}$, and $p_t^a = \frac{1-\beta}{\beta}\overline{k}$ for all $t \in \{3, \cdots, T-1\}$ as in Lemma 4. Naive consumers do not switch, whereas time-consistent consumers switch in period 1. The firm's profits

[25] In addition to ($p^v = V_T - k$, $\sum_{t=3}^{T} p_t^a = k$), there are multiple equilibria for charging a higher p^v and a lower $\sum_{t=3}^{T} p_t^a$. We can pin down the equilibrium base-product price to $p^v = V_T - k$ by assuming that a tiny proportion of consumers exits the market at the end of $t = 1$ and cannot use the add-on. The same argument can be applied to the subsequent lemmas.

are $\pi = V_T - c^v - \underline{k} + \frac{\alpha}{\beta}[1 + (T-3)(1-\beta)]\overline{k}$ and the consumers' long-run utilities are $u^N = \bar{u} + \underline{k} - \frac{1}{\beta}[1 + (T-3)(1-\beta)]\overline{k}$ and $u^{TC} = \bar{u}$.

Second, suppose that the firm sells the add-on to both naive and time-consistent consumers. In this case, the firm sets $p^v + \sum_{t=3}^{T} p_t^a = V_T$ with $\sum_{t=3}^{T} p_t^a \leq \underline{k}$. The firm's profits are $\pi = V_T - c^v$ and the consumers' long-run utilities are $u^N = u^{TC} = \bar{u}$.

By comparing the above two cases, we obtain the result.

(ii) Notice that time-consistent consumers do not switch in period 1 if and only if $\sum_{t=3}^{T} p_t^a \leq \underline{k}$. Naive consumers do not switch in period 1 if and only if $\beta \sum_{t=3}^{T} p_t^a \leq \underline{k}$, because given $-\underline{k} \geq -\beta\overline{k}$ naive consumers always prefer switching in period 1 to switching in any subsequent period.

First, suppose that the firm sells the add-on only to naive consumers. In this case, the firm sets $p^v = V_T - \underline{k}$ and $\sum_{t=3}^{T} p_t^a = \frac{1}{\beta}\underline{k}$. Naive consumers do not switch, whereas time-consistent consumers switch in period 1. The firm's profits are $\pi = V_T - c^v + (\frac{\alpha}{\beta} - 1)\underline{k}$ and the consumers' long-run utilities are $u^N = \bar{u} - \frac{1-\beta}{\beta}\underline{k}$ and $u^{TC} = \bar{u}$.

Second, suppose that the firm sells the add-on to both naive and time-consistent consumers. In this case, the firm sets $p^v + \sum_{t=3}^{T} p_t^a = V_T$ with $\sum_{t=3}^{T} p_t^a \leq \underline{k}$. The firm's profits are $\pi = V_T - c^v$ and the consumers' long-run utilities are $u^N = u^{TC} = \bar{u}$.

By comparing the above two cases, we obtain the result. $\square$

Comparing Lemmas 4 and 5 completes the proof of Proposition 4. $\square$

Proof of Proposition 5.

Lemma 6 summarizes the result of the alternative policy:

Lemma 6. *Suppose $k_t = \underline{k}$ for any t which satisfies $p_{t+1}^a > p_t^a$ with $p_2^a = 0$.*

If $\alpha + (T-3)(1-\beta)\alpha > \beta$, the firm sets $p^v = V_T - \underline{k}$, $p_t^a = \frac{1-\beta}{\beta}\underline{k}$ in $t \in \{3, \cdots, T-1\}$, and $p_T^a = \frac{1}{\beta}\underline{k}$. Time-consistent consumers switch before paying any add-on price, whereas naive consumers never switch. The firm's profits are $\pi = V_T - c^v + (\frac{\alpha}{\beta} - 1)\underline{k} + (T-3)\frac{\alpha}{\beta}(1-\beta)\underline{k}$ and the consumers' long-run utilities are $u^N = \bar{u} - (T-2)\frac{1-\beta}{\beta}\underline{k}$ and $u^{TC} = \bar{u}$.

If $\alpha + (T-3)(1-\beta)\alpha \leq \beta$, the firm sets $p^v + \sum_{t=3}^{T} p_t^a = V_T$ with $\sum_{t=3}^{T} p_t^a \leq \underline{k}$. No consumer switches. The firm's profits are $\pi = V_T - c^v$ and the consumers' long-run utilities are $u^N = u^{TC} = \bar{u}$.

Proof. Note that consumer behavior in each case is described in the proof of Proposition 4. We divide the analysis into two cases.

We first analyze the case in which the firm sells the add-on to both naive and time-consistent consumers. In this case, the firm sets $p^v + \sum_{t=3}^{T} p_t^a = V_T$ with $\sum_{t=3}^{T} p_t^a \leq \underline{k}$. The firm's profits are $\pi = V_T - c^v$ and the consumers' long-run utilities are $u^N = u^{TC} = \bar{u}$.

Second, suppose that the firm sells the add-on only to naive consumers. In this case, the firm sets $p^v = V_T - \underline{k}$, $p_T^a = \frac{1}{\beta}\underline{k}$, and $p_t^a = \frac{1-\beta}{\beta}\underline{k}$ for all $t \in \{3, \cdots, T-1\}$. The firm voluntarily reduces the switching cost to $\underline{k}$ in any period after the firm is forced to do so by the policy. To show this, suppose that $k_t = \underline{k}$. On the one hand, decreasing k_{t+1} makes naive consumers more likely to believe that they will switch in future, and hence makes them more likely to procrastinate their switching decision by relaxing the constraint of not switching in period t: $\underline{k} \geq \beta(p_{t+1}^a + k_{t+1})$ or equivalently $p_{t+1}^a \leq \frac{1}{\beta}k_t - k_{t+1}$. On the other hand, it tightens the constraint of not switching in period $t+1$: $k_{t+1} \geq \beta(p_{t+2}^a + k_{t+2})$. However, the latter constraint is not binding because under the policy the firm has to decrease its switching cost whenever charging a higher price. To see this, suppose that k_t was reduced due to the policy but the firm did not decrease k_{t+1} voluntarily (i.e., $k_t = \underline{k}, k_{t+1} = \overline{k}$). In such a case, the firm can charge at most $p_{t+1}^a \leq \frac{1}{\beta}\underline{k} - \overline{k}$, which is less than $\frac{1-\beta}{\beta}\underline{k}$. To make use of the relaxed constraint $k_{t+1} \geq \beta(p_{t+2}^a + k_{t+2})$, the firm would have to increase the price p_{t+2}^a. By doing so, however, the firm would also have to reduce k_{t+1} by the policy and can charge at most $p_{t+2}^a \leq \frac{1}{\beta}\underline{k} - k_{t+2} \leq \frac{1-\beta}{\beta}\underline{k}$. Hence, compared to the situation in which the firm sets the switching cost to $\underline{k}$ in any period after the policy is implemented, the firm cannot increase its profits by setting a higher switching cost under the policy. Given that, the firm charges a positive add-on price in $t = 3$, and then keeps the add-on prices constant with setting a low k. Naive consumers do not switch, whereas time-consistent consumers switch before paying any add-on price. The firm's profits are $\pi = V_T - c^v + (\frac{\alpha}{\beta} - 1)\underline{k} + (T-3)\frac{\alpha}{\beta}(1-\beta)\underline{k}$ and the consumers' long-run utilities are $u^N = \bar{u} - (T-2)\frac{1-\beta}{\beta}\underline{k}$ and $u^{TC} = \bar{u}$.

By comparing the above two cases, we obtain the result. □

Comparing Lemma 4 and Lemma 6 completes the proof of Proposition 5. □

Proof of Proposition 6.

Immediate from Lemma 4 with $k_t = \underline{k}$ for all t and Lemma 6. □

Proof of Proposition 7.

Suppose that a symmetric equilibrium exists in which firms earn positive profits. Then, each firm can profitably deviate by offering the same add-on price and a slightly lower base-product price, because the deviating firm can attract all consumers and each consumer's behavior regarding the add-on purchase does not change—a contradiction.

As firms make zero profits in equilibrium, the base-product price equals the production cost minus the total profits from the add-on. Similar to the analysis in Section 4.1, the outcomes are summarized as follows:

First, suppose that $k_1 \geq k_2$. If $\alpha > \beta$, there exists an equilibrium in which $p^v = c^v - \frac{\alpha}{\beta}k_2$ and $p_3^a = \frac{1}{\beta}k_2$. If $\alpha \leq \beta$, there exists an equilibrium in which $p^v = c^v - k_2$ and $p_3^a = k_2$.

Second, suppose that $k_1 = \underline{k} < \overline{k} = k_2$ and $\Delta_k \geq \beta$. If $\alpha > \beta\Delta_k$, there exists an equilibrium in which $p^v = c^v - \frac{\alpha}{\beta}\overline{k}$ and $p_3^a = \frac{1}{\beta}\overline{k}$. If $\alpha \leq \beta\Delta_k$, there exists an equilibrium in which $p^v = c^v - \underline{k}$ and $p_3^a = \underline{k}$.

Third, suppose that $k_1 = \underline{k} < \overline{k} = k_2$ and $\Delta_k < \beta$. If $\alpha > \beta$, there exists an equilibrium in which $p^v = c^v - \frac{\alpha}{\beta}\underline{k}$ and $p_3^a = \frac{1}{\beta}\underline{k}$. If $\alpha \leq \beta$, there exists an equilibrium in which $p^v = c^v - \underline{k}$ and $p_3^a = \underline{k}$.

By comparing the above three cases, we obtain the result. $\square$

Proof of Proposition 8.

The argument in the proof of Proposition 7 implies that in any positive-profit equilibrium firms set $p^v = 0$. Also, if all consumers pay the add-on price, then the standard Bertrand-type price competition argument leads to $p^v + p_3^a = c^v$. However, if only naive consumers pay the add-on price, then the firms may be able to earn positive profits because of the constraint $p^v \geq 0$. To see this, consider a candidate equilibrium $p^v = 0$ and $p_3^a = \frac{1}{\beta}k_2$. If a firm deviates from the candidate equilibrium and charges the add-on price to both naive and time-consistent consumers, the deviating firm can charge a total payment of at most $p^v + p_3^a = \min\{k_1, k_2\}$ in order to attract these consumers. The analysis of the case in which $p^v = 0$ and $p_3^a = \frac{1}{\beta}k_1$ is a candidate equilibrium is the same. Similar to the previous analysis, the outcomes are summarized as follows:

First, suppose that the policy is enacted in $t = 2$ or when the policy is enacted in $t = 1$ and $\Delta_k < \beta$. If $\frac{1}{N}(\frac{\alpha}{\beta}\underline{k} - c^v) > \max\{\underline{k} - c^v, 0\}$, there exists a positive-profit equilibrium in which $p^v = 0$ and $p_3^a = \frac{1}{\beta}\underline{k}$. If $\frac{1}{N}(\frac{\alpha}{\beta}\underline{k} - c^v) \leq \max\{\underline{k} - c^v, 0\}$, there exists a zero-profit equilibrium in which $p^v + p_3^a = c^v$.

Second, suppose that the policy is enacted in $t = 1$ and $\Delta_k \geq \beta$. If $\frac{1}{N}(\frac{\alpha}{\beta}\overline{k} - c^v) > \max\{\underline{k} - c^v, 0\}$, there exists a positive-profit equilibrium in which $p^v = 0$ and $p_3^a = \frac{1}{\beta}\overline{k}$. If $\frac{1}{N}(\frac{\alpha}{\beta}\overline{k} - c^v) \leq \max\{\underline{k} - c^v, 0\}$, there exists a zero-profit equilibrium in which $p^v + p_3^a = c^v$.

By comparing the above two cases, we obtain the result. $\square$

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Supplementary Material for
"The Timing of Choice-Enhancing Policies"
by Takeshi Murooka and Marco A. Schwarz
(not intended for publication)

In this supplementary material, we investigate further extensions of the model introduced in Section 4.1. First, we incorporate fully-sophisticated present-biased consumers into the model. Second, we analyze the model incorporating heterogeneous base-product demand or heterogeneous add-on demand. Finally, we investigate the effects and caveats of imposing deadlines.

A.1 Incorporating Sophisticated Consumers

We here analyze the model in which some present-biased consumers are perfectly aware of their self-control problems. Assume that a proportion $\alpha^s > 0$ of consumers is present-biased but is perfectly sophisticated about own present biasness: $\hat{\beta} = \beta < 1$. A proportion $\alpha^n > 0$ of consumers is naive present-biased and the remaining proportion $1 - \alpha^s - \alpha^n$ is time consistent. For simplicity we focus on the case in which $T = 3$. The result is summarized as follows:

Proposition 9. *Suppose that a proportion $\alpha^s > 0$ of consumers is sophisticated present-biased, a proportion $\alpha^n > 0$ of consumers is naive present-biased, and the remaining proportion $1 - \alpha^s - \alpha^n$ is time consistent.*

Then, a policy in $t = 1$ strictly decreases social welfare compared to no policy when $\frac{\alpha^n}{\beta} > \Delta_k \geq \beta$ and $\alpha^s(V_3 - c^v) \geq [\frac{\alpha^n}{\beta} - (1 - \alpha^s)]\bar{k}$. Under any parameters, a policy in $t = 2$ strictly increases consumer welfare and weakly increases social welfare compared to no policy.

Proposition 9 shows that the firm may have a stronger incentive to charge a relatively low add-on price under the presence of fully-sophisticated present-biased consumers. Intuitively, if these consumers want to plan but cannot commit to switch, they foresee that they will fail to do so and therefore either do not buy the base product or cancel the contract earlier. Our implications regarding the timing of policies, however, remain unchanged.

Proof of Proposition 9.

Note that actual consumer behavior in $t = 2$ does not change because $\hat{\beta}$ is not relevant to the consumer's actual decision in $t = 2$. In $t = 1$, sophisticated consumers think that they will not switch in $t = 2$ if and only if $p_3^a \leq k_2/\beta$. Conditional on this belief, these consumers' switching behavior in $t = 1$ can be divided into the following two cases. First, if $p_3^a \leq k_2/\beta$, consumers think they will not switch in $t = 2$; given this, they do not switch in $t = 1$ if and only if $p_3^a \leq k_1/\beta$. Second, if $p_3^a > k_2/\beta$, consumers think they will switch in $t = 2$; given this, they do not switch in $t = 1$ if and only if $k_1 > \beta k_2$. Note that the firm never sets $p_3^a > k_2/\beta$, because otherwise all consumers opt out of the firm's add-on.

Given the take up of the base product, sophisticated consumers opt out in $t = 1$ if $k_2 < p_3^a \leq k_2/\beta$ and $p_3^a < k_1/\beta$; otherwise, naive and sophisticated consumers receive the same ex-post utility. Selling the add-on only to naive and sophisticated consumers is not optimal, because sophisticated consumers would not buy the base product in $t = 0$ if their utility is less than $\bar{u}$ and hence, selling the add-on also to time-consistent consumers is more profitable. Note that when the firm sells the add-on to time-consistent consumers, then the firm can earn at most $\pi = V_3 - c^v$. Note also that whenever the firm sells only to naive consumers and sets $p_3^a = k_2/\beta$ in Section 4.1, naive consumers' long-run utility is less than $\bar{u}$. Since sophisticated consumers anticipate this, they do not buy the base product.

Under no policy, when the firm sells the add-on to all consumers, the profits are $\pi = V_3 - c^v$. When the firm sells the add-on with $p_3^a = \frac{1}{\beta}\overline{k}$, sophisticated consumers do not buy the base product in $t = 0$. The profits are $\pi = (1 - \alpha^s)(V_3 - c^v - \overline{k}) + \frac{\alpha^n}{\beta}\overline{k}$. Hence, the firm sells the add-on only to naive consumers if and only if $[\frac{\alpha^n}{\beta} - (1 - \alpha^s)]\overline{k} > \alpha^s(V_3 - c^v)$, and otherwise it sells the add-on to all consumers.

Suppose that there is a policy in $t = 1$ and $\Delta_k \geq \beta$. When the firm sells the add-on to all consumers, the maximal profits are $\pi = V_3 - c^v$. When the firm sells the add-on only to naive consumers, sophisticated consumers buy the base product and switch in $t = 1$. Hence the profits are at most $\pi = V_3 - c^v - \underline{k} + \frac{\alpha^n}{\beta}\overline{k}$. The firm sells the add-on only to naive consumers if and only if $\alpha^n > \beta\Delta_k$.

Suppose that there is a policy in $t = 1$ and $\Delta_k < \beta$. When the firm sells the add-on to all consumers, the maximal profits are $\pi = V_3 - c^v$. When the firm sells the add-on with $p_3^a = \frac{1}{\beta}\underline{k}$, sophisticated consumers do not buy the base product in $t = 0$. The profits are $\pi = (1-\alpha^s)(V_3-c^v-$

$\underline{k}) + \frac{\alpha^n}{\beta}\underline{k}$. Hence, the firm sells the add-on only to naive consumers if and only if $[\frac{\alpha^n}{\beta} - (1-\alpha^s)]\underline{k} > \alpha^s(V_3 - c^v)$, and otherwise it sells the add-on to all consumers.

Suppose that there is a policy in $t = 2$. When the firm sells the add-on to all consumers, the profits are $\pi = V_3 - c^v$. When the firm sells the add-on with $p_3^a = \frac{1}{\beta}\underline{k}$, sophisticated consumers do not buy the base product in $t = 0$. The profits are $\pi = (1-\alpha^s)(V_3 - c^v - \underline{k}) + \frac{\alpha^n}{\beta}\underline{k}$. Hence, the firm sells the add-on only to naive consumers if and only if $[\frac{\alpha^n}{\beta} - (1-\alpha^s)]\underline{k} > \alpha^s(V_3 - c^v)$, and otherwise it sells the add-on to all consumers. □

A.2 Continuous Distributions

Here we analyze the case in which the valuation for the base product or the valuation for the add-on is heterogeneous. To illustrate the point in a simple manner, consider the case in which $T = 3$ and either v or a is uniformly distributed. With slightly abbreviating the notation, let $\tilde{v} = v + 2a - \bar{u}$ be uniformly distributed on $[\underline{v}, \overline{v}]$ (independent of whether consumers are time consistent or not). We denote the price for the base product when a policy is employed in period t by p^{vt} and the price for the base product when no policy is employed by p^{vn}.

The following proposition shows that imposing a policy may cause an increase in the base-product price. Similar to the logic of Grubb (2015), under downward-sloping base-product demand, even a policy in $t = 2$ may increase the equilibrium base-product price. Further, Proposition 10 shows that when all consumers sufficiently value both the base product and the add-on, the results of incorporating heterogeneities are qualitatively the same:

Proposition 10. *Suppose that the valuation for the base product or the valuation for the add-on is uniformly distributed and $a \geq \underline{k}$ and $\tilde{v} \geq c_v$ for all consumers.*

Then, the prices for the add-on are the same as in Section 4.1. Under any parameters, $p^{vn} \leq p^{v1}, p^{v2}$. If $1 \geq \frac{\alpha}{\beta} > \Delta_k \geq \beta$, then $p^{v1} < p^{v2}$; otherwise, $p^{v1} = p^{v2}$.

The intuition is as follows. As in a simple monopoly problem, a firm faces the trade-off between charging a high price for the base product (but only serving few consumers) and serving many consumers (but only making small profits per consumer). In addition to the profits with the base product, the firm makes a constant average profit per consumer from the add-on. If a policy reduces the average profit per consumer from the add-on, a higher number of consumers is less profitable for the firm, so the policy increases the price for the base product.

Note that an additional inefficiency can arise when $\tilde{v} + 2a < c_v$ for some naive consumers, but the firm sells the base product to these consumers below cost in order to enroll them in the add-on.

Also, if $a < \underline{k}$ for some consumers, these consumers would not take up the add-on of the competitive fringe after canceling the add-on from the firm (when we interpret $\underline{k}$ is the re-registration cost). As these consumers do not take up the add-on of the competitive fringe, under the policy in $t = 2$ they would not switch the firm's add-on if $p_3^a \leq a (< \underline{k})$. Hence, in this case the firm might want to reduce the price for the add-on.

Proof of Proposition 10.

Let $V(\tilde{v})$ be the cumulative distribution function of $\tilde{v}$, which is differentiable for the relevant values of $\tilde{v}$ (for other values, the firm would either not sell at all or sell to all consumers, in which case we would be back to Section 4.1). Because the distribution of $\tilde{v}$ is independent of whether consumers are time consistent or not, it can be shown that the optimal prices for the add-on are the same as in Section 4.1. Note that consumers buy the base product if and only if their perceived utility in $t = 0$ is greater than or equal to $\bar{u}$. The firm maximizes the number of consumers who buy the product times the profit per consumer which is given in Section 4.1.

If no policy is implemented and $\alpha \leq \beta$, consumers buy the base product if and only if $\tilde{v} \geq p^{vn} + p_3^a$. The firm solves $\max_{p^{vn}} [1 - V(p^{vn} + p_3^a)](p^{vn} + p_3^a - c^v) \Rightarrow (p^{vn} + p_3^a - c^v)(-V'(p^{vn} + p_3^a)) + [1 - V(p^{vn} + p_3^a)] = 0 \Rightarrow p^{vn} + p_3^a = \frac{\overline{v} + c^v}{2}$. If $\alpha > \beta$, $p^{vn} = \frac{\overline{v} + c^v - \left(1 + \frac{\alpha}{\beta}\right)\overline{k}}{2}$ and $p_3^a = \frac{1}{\beta}\overline{k}$.

If a policy in $t = 1$ is implemented, $\Delta_k \geq \beta$, and $\alpha > \beta\Delta_k$, then $p^{v1} = \frac{\overline{v} + c^v - \left(1 + \frac{\alpha}{\beta\Delta_k}\right)\underline{k}}{2}$ and $p_3^a = \frac{1}{\beta}\overline{k}$. If $\Delta_k \geq \beta$ and $\alpha \leq \beta\Delta_k$, then $p^{v1} + p_3^a = \frac{\overline{v} + c^v}{2}$. If $\Delta_k < \beta$ and $\alpha > \beta$, then $p^{v1} = \frac{\overline{v} + c^v - \left(1 + \frac{\alpha}{\beta}\right)\underline{k}}{2}$ and $p_3^a = \frac{1}{\beta}\overline{k}$. If $\Delta_k < \beta$ and $\alpha \leq \beta$, then $p^{v1} + p_3^a = \frac{\underline{v} + c^v}{2}$.

If a policy in $t = 2$ is implemented and $\alpha > \beta$, $p^{v2} = \frac{\overline{v} + c^v - \left(1 + \frac{\alpha}{\beta}\right)\underline{k}}{2}$ and $p_3^a = \frac{1}{\beta}\underline{k}$. If $\alpha \leq \beta$, $p^{v2} + p_3^a = \frac{\overline{v} + c^v}{2}$.

By comparing the above cases, we obtain the result. $\square$

A.3 Deadlines

So far, we have shown the consequences of policies which decrease consumers' switching costs in certain periods. Now we examine an alternative policy intervention. Specifically, in this subsection we analyze an extended model in which the policymaker can sufficiently increase switching costs in certain periods so that consumers cannot cancel their contract in those periods. By doing so, the policymaker can impose a deadline of switching decisions to consumers. In our illustrative model, it is optimal for the policymaker to prevent consumers from switching after the first two periods:

Proposition 11. *Assume that the policymaker can prohibit consumers to switch in certain periods: the policymaker chooses $\mathfrak{T} \subseteq \{2, \cdots, T-1\}$ such that $k_t = \infty$ for all $t \in \mathfrak{T}$. Then, choosing $\mathfrak{T}^* = \{3, \cdots, T-1\}$ maximizes consumer and social welfare. If $\alpha + (T-3)(1-\beta)\alpha > \beta$, consumer welfare is strictly larger than choosing $\mathfrak{T} = \emptyset$. If in addition $\beta > \alpha$, social welfare is also strictly larger than choosing $\mathfrak{T} = \emptyset$.*

The intuition of Proposition 11 is as follows: since consumers are not able to cancel after the second period under the policy, naive consumers cannot falsely believe that they will switch in a future period.[26] Given this, they will not procrastinate their switching decision if the total future payment for the add-on is high. This finding is in line with the theoretical literature which analyzes the effects of imposing deadlines (O'Donoghue and Rabin 1999b, Herweg and Müller 2011).

Proposition 11 implies that $(T+1)$-period models can be reduced to the four-period model when the policymaker can impose an optimal deadline. In such a case, p_3^a is interpreted as the sum of all payments that have to be made after the second period. If the policymaker cannot regulate the prices directly but can change the switching costs, decreasing the switching cost in the second period and imposing the deadline in the second period maximize social welfare in our basic model. Namely, when the policymaker cannot regulate the prices directly, imposing $k_2 = \underline{k}$ and $\mathfrak{T}^* = \{3, \cdots, T-1\}$ becomes the optimal policy.[27]

Unlike a choice-enhancing or an active-choice policy which decreases the switching costs, however, one should be very cautious about imposing such a strict deadline in practice. For example, imposing a deadline may decrease welfare if add-on values or switching costs are changing over time. Also, as we discussed in Section 5, imposing a deadline can be welfare harmful when consumers also have other psychological biases.

Furthermore, imposing a deadline might not be feasible as the firm might be able to circumvent the deadline by (pretendedly) changing the product features of the add-on such that consumers

[26] Note that imposing a deadline in $t = 1$ is also optimal, although the deadline in $t = 1$ does not seem to be legal in practice because consumers who get a free trial do not have an option to cancel the service later.

[27] Note that when the policymaker can regulate the prices directly, simply imposing $p_t^a = 0$ for all t maximizes the social welfare.

receive extraordinary termination rights. Corollary 2 states that the firm indeed has an incentive to do so:

Corollary 2. *Assume that the policymaker can prohibit consumers to switch in certain periods: she can choose* $\mathfrak{T} \subseteq \{2, \cdots, T-1\}$ *such that* $k_t = \infty$ *for all* $t \in \mathfrak{T}$. *If* $\alpha + (T-3)(1-\beta)\alpha > \beta$, *then profits of the firm under* $\mathfrak{T} = \emptyset$ *are strictly higher than under* $\mathfrak{T} = \{3, \cdots, T-1\}$.

Consequently, if the firm can credibly commit to pretendedly change its terms and conditions of the add-on, the deadline policy in Proposition 11 may not be effective and the policymaker can only force the firm to lower the switching cost in certain periods.

Proof of Proposition 11.

Note first that time-consistent consumers' utility is not affected by the policy and is always $u^{TC} = \bar{u}$.

Let $\underline{t}$ and $\bar{t}$ be the first and the last period of a sequence of periods such that $k_t = \infty$ for all $t \in \{\underline{t}, \cdots, \bar{t}\}$. Then, naive consumers do not switch in period $\underline{t} - 1$ if and only if $k_{\underline{t}-1} \geq \beta \left(\sum_{t=\underline{t}}^{\tau} p_t^a + k_\tau \right)$ for some $\tau \in \{\bar{t}+1, \cdots, T-1\}$ or $k_{\underline{t}-1} \geq \beta \left(\sum_{t=\underline{t}}^{T} p_t^a \right)$. So the maximum total payment the firm can charge (weakly) decreases when the number of periods in which consumers cannot switch increases. Charging lower prices potentially benefits naive consumers and potentially increases social welfare when time-consistent consumers do not switch anymore.

Analogous to Lemma 4 with $T = 3$, if $t = 2$ is the last period in which a consumer can cancel the contract and if $\alpha > \beta$, then the firm sets $p^v = V_T - \overline{k}$ and $\sum_{t=3}^{T} p_t^a = \frac{1}{\beta}\overline{k}$. Naive consumers do not switch, whereas time-consistent consumers switch either in period 1 or period 2. The firm's profits are $\pi = V_T - c^v + (\frac{\alpha}{\beta} - 1)\overline{k}$ and the consumers' long-run utilities are $u^N = \bar{u} - \frac{1-\beta}{\beta}\overline{k}$ and $u^{TC} = \bar{u}$. If $t = 2$ is the last period in which a consumer can cancel the contract and if $\alpha \leq \beta$, then the firm sets $p^v + \sum_{t=3}^{T} p_t^a = V_T$. The firm's profits are $\pi = V_T - c^v$ and the consumers' long-run utilities are $u^N = u^{TC} = \bar{u}$.

Comparing this to Lemma 4 delivers the result. $\square$