The Timing of Active-Choice Policy*

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Abstract

This paper analyzes welfare consequences of active-choice policies when a firm can change its strategy in response to a policy. In the model, a firm automatically enrolls consumers in a service and potentially exploits procrastination on their switching decisions. We show that an active-choice policy which has been used in some industries—enabling consumers to make an active choice when they sign a contract—can decrease consumer and social welfare. This is because only sophisticated consumers may opt out of the service under the policy, and hence the firm may increase its future prices for the service to exploit unsophisticated consumers. In contrast, an alternative active-choice policy—enabling consumers to make an active choice when the firm charges a higher price for the service—does not have such a perverse effect of selecting unsophisticated consumers, and hence can increase consumer and social welfare. Our results highlight that the timing of enabling an active choice matters when firms can respond to a policy.

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1 Introduction

Consumers often exhibit inertia about product usage. One way for firms to exploit this inertia is to use an automatic enrollment, i.e., first automatically putting consumers into a service with a free-trial period, and after that charging positive fees to consumers who do not opt out. Indeed, automatic enrollments to an additional service are prevalent in some industries. For example, many providers of an Internet connection in Germany have automatically enrolled consumers to own anti-virus options with some grace period when consumers contract for an Internet connection.[1] According to one of the most popular newspapers in Germany, more than 80 percent of customers who have not opted out of the anti-virus option and paid the fee did not even activate the option.[2]

To protect unsophisticated consumers from such exploitation, an active-choice policy—enabling consumers to make an active choice about a service—has been highlighted. Recent studies have shown that enabling consumer to make an active choice can enhance consumer and social welfare (Carroll, Choi, Laibson, Madrian and Metrick 2009, Keller, Harlam, Loewenstein and Volpp 2011, Chetty, Friedman, Leth-Petersen, Nielsen and Olsen 2014). However, two issues on active-choice policies have been under-investigated. First, is there any adverse effect when firms can change their strategies in response to an active-choice policy? Second, if there are multiple timings consumers can opt out of a service, when should a policymaker enable consumers to make an active choice?

This paper analyzes the welfare consequences of active-choice policies when a firm can respond to a policy. In our basic model, a monopoly firm automatically enrolls consumers to its add-on service. A fraction of consumers are naive present-biased as in O'Donoghue and Rabin (1999a), whereas the rest of the consumers are time-consistent. Each consumer incurs a positive switching cost whenever opting out of the add-on service. When a policymaker enacts an active-choice policy, the switching cost in that period decreases (but may still be positive). We first illustrate that, akin to the existing literature on naive present-bias, the firm may exploit naive consumers by setting a high add-on price. Then, we show that an active-choice policy which has been used in some industries—enabling consumers to make an active choice when they sign a contract—

[1] As a specific example, Kabel Deutschland, one of the largest providers in Germany, had the following automatic enrollment in 2010. The option included an anti-virus software, a firewall, and a parental control software. It had to be activated in a customer web portal. It was free for the first three months and cost €3.98 per month after that. The option could be canceled with a notice period of four weeks. See http://www.kabel-internet-telefon.de/news/7214-kabel-deutschland-mit-neuem-sicherheitscenter-kabelsicherheit-de (accessed March 1, 2015).

[2] BILD.de, April 16, 2010: http://www.bild.de/digital/internet/darauf-muessen-sie-achten-12199746.bild.html (accessed March 1, 2015).

can decrease consumer and social welfare. The main logic is as follows. As the switching cost decreases, time-consistent consumers are more likely to opt out of the firm's add-on service than naive present-biased consumers. Hence, when the decrease of the switching cost by an active-choice policy is not sufficient, only time-consistent consumers may opt out of the add-on service under the policy. As a result, the firm may increase its add-on prices in response to the policy to exploit naive consumers who stay enrolled in the add-on service. In contrast, we show that an alternative active-choice policy—enabling consumers to make an active choice whenever the firm increases the add-on price—does not have such a perverse effect of selecting naive consumers, and hence can increase consumer and social welfare. Our results indicate that the timing of an active-choice policy matters for consumer and social welfare.

Our findings are robust to incorporating multiple payments for the add-on. We show that as the number of add-on payments increases, the firm is more likely to exploit naive consumers. In addition, the total add-on payments of naive consumers are increasing and unbounded. We demonstrate that a policy which forces firms to enable consumers to make an active choice whenever there is a price increase is as effective as a policy which forces firms to always enable consumers to make an active choice. We also analyze the case in which a policymaker can impose a deadline, after which consumers cannot switch, as well as decreasing switching costs. In this case, it is optimal to combine the two interventions: the policymaker enacts an active-choice policy in the second period and also imposes the deadline in that period.

This paper builds on two theoretical literatures: pricing under naive present-bias and the equilibrium effects of policies. First, the literature in behavioral industrial organization has studied how firms can exploit consumers' time inconsistency and naivete.[3] Building upon the literature, we focus on the policy implications of enabling an active choice and analyze how the timing of active-choice policy can affect consumer and social welfare. Second, recent theoretical and empirical literatures have analyzed the adverse effects of policies when consumers are inattentive.[4] To the

[3] See, for examples, DellaVigna and Malmendier (2004), Kőszegi (2005), Gottlieb (2008), Heidhues and Kőszegi (2010), and Heidhues and Kőszegi (2014).

[4] 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 (2013), Ericson (2014), and Spiegler (2014). For the empirical literature, see Handel (2013), Grubb and Osborne (2015), and Duarte and Hastings (2012). Relatedly, building upon Gabaix and Laibson's (2006) hidden-attribute model, Kosfeld and Schüwer (2011) analyze the effect of increasing the fraction of sophisticated consumers in the market. They show that such an intervention can increase consumers who take a costly step to avoid an extra payment and hence can lower welfare. In contrast, we focus on how firms' equilibrium response to a policy can cause an adverse consequence and suggest an alternative policy when some consumers are naive present-biased.

best of our knowledge, however, the timing of an active-choice policy has not been investigated in the literatures. By investigating the naive present-bias model, we show the adverse welfare effect of a conventional active-choice policy, analyze how the timing of active-choice policy affects welfare, and suggest an alternative policy which mitigates the adverse welfare effect.

The rest of this paper is organized as follows. Section 2 sets up the model and discusses its key assumptions. Section 3 analyzes the basic model in which consumers pay for the usage of an add-on at most once. Section 4 analyzes models in which consumers possibly incur multiple payments for the add-on usage. Section 5 examines further extensions and modifications of the model. Section 6 concludes. Proofs are provided in the Appendix.

2 Model

This section introduces our model. Section 2.1 sets up the model. Section 2.2 discusses key assumptions throughout this paper.

2.1 Setup

There are $T \geq 3$ periods: $t = 1, 2, \cdots, T$. One risk-neutral firm sells its products to a continuum of measure one of risk-neutral consumers. 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. Consumers value the add-on at $a > 0$ in each $t = 2, \cdots, T-1$, where they can use the add-on only combined with the base product. While only the firm can produce the base product, a competitive fringe also provides an add-on with the same value.[5] The production cost of the base product is $c^v \in (0, v)$. We normalize the production cost of the additional good—and hence the add-on price of the competitive fringe—to be zero.

The firm automatically enrolls consumers who buy the base product into the add-on service with a free trial or a grace period. At the beginning of period 1, the firm sets and commits to its prices: a price of the base product $p^v \geq 0$ and prices of the add-on $p^a_t \geq 0$ where $t = 2, \cdots, T-1$.[6] In each $t = 1, 2, \cdots, T-1$, consumers can switch from the firm to the competitive fringe for the add-on by incurring a switching cost $k_t > 0$. Without any action, $k_t = \overline{k} > 0$ for all t. If the firm

[5] In Section 5, we analyze a model incorporating competition on the base product.

[6] Given the timing of payments, the price for first-period add-on usage is indistinguishable from p_v whenever the firm automatically enrolls consumers.

or a policymaker enacts an active-choice policy in t, it decreases the switching cost to $k_t = \underline{k}$ where $\underline{k} \in (0, \overline{k})$. For example, $\underline{k}$ can be a sign-up cost to the competitive fringe, and $\overline{k} - \underline{k}$ represents a cost for cancellation which the firm or a policymaker can remove by employing an active-choice policy. Define $\Delta_k := \underline{k}/\overline{k} \in (0, 1)$. In the basic model, we also assume that the add-on is sufficiently valuable for all consumers: $a \geq \frac{\overline{k}}{T-1}$.[7]

Following O'Donoghue and Rabin (1999a, 1999b), we assume that a fraction α of consumers are naive present-biased whereas the remaining fraction of consumers are time-consistent.[8] Let u_t denote a consumer's period-t utility. In each period s, time-consistent consumers maximize $u_s + \sum_{t=s+1}^{T} \delta^{t-s} u_t$ and correctly expect their future behavior. Naive present-biased consumers maximize $u_s + \beta \sum_{t=s+1}^{T} \delta^{t-s} u_t$ in each period s, where $\beta \in (0, 1]$ represents the degree of their present bias. Also, these present-biased consumers believe that they will behave as if $\beta = 1$ in any period $t > s$: they are naive about their future self-control. We investigate perception-perfect equilibria in which each player maximizes her perceived utility in each subgame (O'Donoghue and Rabin 1999a). In what follows, we set $\delta = 1$.

The timing of the game is as follows. First of all, both the firm and a policymaker decide and commit whether or not to enact an active-choice policy for each period. If both of them do not enact the policy for period t, a switching cost in period t is $k_t = \overline{k} > 0$; otherwise, it is $k_t = \underline{k} \in (0, \overline{k})$. Then, in period 1, the firm sells the base product and commits to all prices $(p^v, p_2^a, \cdots, p_{T-1}^a)$. After observing the prices and switching costs, consumers decide whether or not to buy the base product.[9] Consumers who buy the base product receive v and pay p^v in period 2. If consumers buy the base product, they also decide whether or not to switch the add-on at a switching cost k_1 incurred in period 1. Consumers who choose to use the add-on in period 1 receive a in period 2. Then, in each period $t = 2, \cdots, T-1$, consumers make their switching decision for the add-on. Consumers who choose to use the add-on in period t receive a in period $t+1$, but those who subscribe to the add-on of the firm also pay p_t^a in period $t+1$. The game ends at the end of period T. The timeline of the game when $T = 3$ is described in Figure 1.

[7] Section 5 analyzes the case in which add-on demand is heterogeneous among consumers and $a < \frac{\overline{k}}{T-1}$ for some consumers.

[8] As discussed in Section 5, our results are robust to incorporating partial sophistication on own future self-control.

[9] Notice that the firm cannot sort consumers by offering a menu contract, because naive consumers believe that they will behave as if they were time-consistent.

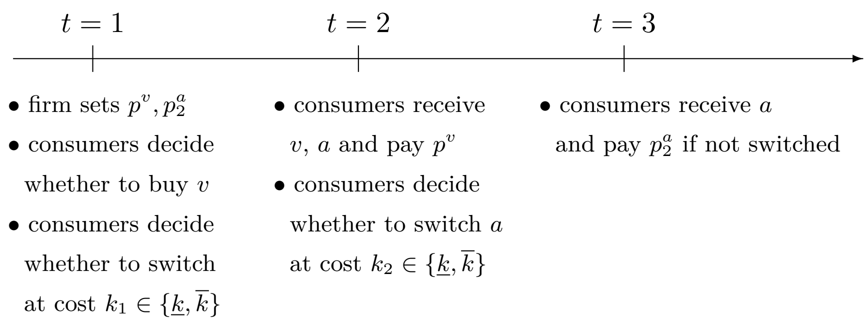

Figure 1: Timeline when $T = 3$.

2.2 Discussion of Key Assumptions

This subsection discusses two key assumptions throughout this paper. First, a fraction of consumers may procrastinate their switching decisions.[10] Second, policymakers may not be able to remove all switching costs once a firm automatically enrolls consumers.

Procrastination Recent empirical and experimental literature shows that people often procrastinate.[11] A key assumption of our model is that consumers incur the switching cost now but the payment later. This assumption is plausible in our industrial examples because a cancellation procedure takes time but the cancellation does not affect an immediate payment (e.g., the cancellation is only effective from the next month). Due to the discrepancy of the timing, naive present-biased consumers may procrastinate their switching decisions.[12]

For expositional simplicity, we also assume that all consumption benefits come later. Our results are, however, qualitatively robust to the timing of consumption.

Switching Costs Unlike the previous literature, we analyze the case in which a policymaker may not be able to decrease the switching cost to zero. For example, suppose that a firm can automatically enroll its customers to an additional service and that the customers need to take an extra action (e.g., register their information) if they want to use the additional service of some

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

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

[12] The assumption that all add-on payments come later can be relaxed when consumers pay the add-on prices multiple times. In this case, our results hold qualitatively even when consumers face the switching cost and the per-period add-on payment at the same time.

other firm. In this case, a policymaker can decrease the switching cost (e.g., by mandating a simpler cancellation format), but cannot decrease it to zero.

In practice, such automatic enrollments are not illegal because firms can offer free trials of the additional services. Along with this interpretation, we assume that the firm charges no additional price in the first period ($p_1^a = 0$).

3 Analysis under Single Add-on Payment

To highlight our results and underlying intuitions, this section analyzes the case in which consumers pay the add-on price at most once (i.e., $T = 3$). The case of $T > 3$ is analyzed in Section 4.

3.1 Consumer Behavior

Here we characterize consumer behavior given prices and switching costs. Note that consumers do not take any action in $t = 3$. Note also that consumers never have an incentive to switch back from the competitive fringe to the firm. For notational simplicity, let β^i be each consumer's short-run discount where $i \in \{TC, N\}$, $\beta^{TC} = 1$, and $\beta^N = \beta$.

We first analyze the switching decision regarding the add-on in $t = 2$. Suppose that consumers bought the base product and did not switch the add-on in $t = 1$. Then, consumers do not switch to the competitive fringe if and only if $-k_2 + \beta^i a \leq \beta^i(a - p_2^a)$ or equivalently $p_2^a \leq \frac{k_2}{\beta^i}$.

We next analyze consumer behavior in $t = 1$. Because naive consumers (wrongly) think that they will be time-consistent in $t = 2$, all consumers think that they will not switch in period 2 if and only if $p_2^a \leq k_2$ if they do not switch in period 1. Given this belief, consumers' switching behavior in period 1 can be divided into the following two cases. First, if $p_2^a \leq k_2$, consumers think they will not switch in period 2. Given this, they do not switch in period 1 if and only if $p_2^a \leq \frac{k_1}{\beta^i}$. Second, if $p_2^a > k_2$, consumers think they will switch in period 2. Given this, they do not switch in period 1 if and only if $k_1 \geq \beta^i k_2$. Given these, each consumer buys the base product in $t = 1$ if and only if her perceived utility is equal to or greater than zero.

3.2 Optimal Pricing and Welfare Effects of Active-Choice Policy

We now analyze the optimal pricing of the firm and the effects of active-choice policies.

We first investigate the situation in which switching costs are high in both periods, i.e., $k_1 = k_2 = \overline{k}$. This is the case if a policymaker does not employ an active-choice policy. The firm faces a trade-off between exploiting naive consumers with a high add-on price ($p_2^a = \frac{\overline{k}}{\beta}$) or selling its add-on to all consumers with a moderate add-on price ($p_2^a = \overline{k}$). The result is summarized as follows:

Lemma 1. Suppose $T = 3$ and $k_1 = k_2 = \overline{k}$.

If $\alpha \geq \beta$, the firm sets $p^v = v$, $p_2^a = \frac{\overline{k}}{\beta}$. Time-consistent consumers switch either in period 1 or 2, whereas naive consumers do not switch. The profits of the firm are $\pi = v - c^v + \alpha\frac{\overline{k}}{\beta}$ and the long-run utility of each type of consumer is $u^N = 2a - \frac{\overline{k}}{\beta}$ and $u^{TC} = 2a - \overline{k}$. If $\alpha < \beta$, the firm sets $p^v + p_2^a = v + \overline{k}$ with $p_2^a \leq \overline{k}$. No consumer switches. The profits of the firm are $\pi = v - c^v + \overline{k}$ and the long-run utility of each consumer is $u^N = u^{TC} = 2a - \overline{k}$.

The intuition is simple. The firm is more likely to exploit naive consumers if the fraction of naive consumers is higher (larger α) or if naive consumers suffer from a severer present bias (smaller β). Consumer welfare is lowered under such exploitation because naive consumers pay the high add-on price which they have not anticipated to pay. Social welfare is also lowered because time-consistent consumers incur $\overline{k}$ in order to switch the add-on.

We next investigate the situation in which the switching cost is lower in the first period, i.e., $k_1 = \underline{k}$, $k_2 = \overline{k}$. This is the case if the firm or a policymaker employs an active-choice policy when consumers sign a contract for the purchase of a base product.

The firm still faces the same type of trade-off as above. The equilibrium cut-off condition is different, however. On the one hand, time-consistent consumers switch in period 1 if $p_2^a > \underline{k}$. 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 $p_2^a = \frac{\overline{k}}{\beta}$ and naive consumers end up paying the add-on price. The result is summarized as follows:

Lemma 2. Suppose $T = 3$ and $k_1 = \underline{k}, k_2 = \overline{k}$.

(i) Suppose $\Delta_k \geq \beta$. If $\alpha \geq \beta\Delta_k$, the firm sets $p^v = v$, $p_2^a = \frac{\overline{k}}{\beta}$. Time-consistent consumers switch in period 1, whereas naive consumers do not switch. The profits of the firm are $\pi = v - c^v + \alpha\frac{\overline{k}}{\beta}$ and the long-run utility of each type of consumer is $u^N = 2a - \frac{\overline{k}}{\beta}$ and $u^{TC} = 2a - \underline{k}$. If $\alpha < \beta\Delta_k$, the firm sets $p^v + p_2^a = v + \underline{k}$ with $p_2^a \leq \underline{k}$. No consumer switches. The profits of the firm are $\pi = v - c^v + \underline{k}$ and the long-run utility of each consumer is $u^N = u^{TC} = 2a - \underline{k}$.

(ii) Suppose $\Delta_k < \beta$. If $\alpha \geq \beta$, the firm sets $p^v = v$, $p_2^a = \frac{\underline{k}}{\beta}$. Time-consistent consumers switch in period 1, whereas naive consumers do not switch. The profits of the firm are $\pi = v - c^v + \alpha\frac{\underline{k}}{\beta}$ and the long-run utility of each type of consumer is $u^N = 2a - \frac{\underline{k}}{\beta}$ and $u^{TC} = 2a - \underline{k}$. If $\alpha < \beta$, the firm sets $p^v + p_2^a = v + \underline{k}$ with $p_2^a \leq \underline{k}$. No consumer switches. The profits of the firm are $\pi = v - c^v + \underline{k}$ and the long-run utility of each consumer is $u^N = u^{TC} = 2a - \underline{k}$.

Lemma 2 (i) means that the firm may still earn high add-on prices from naive consumers after enacting an active-choice policy in $t = 1$. Intuitively, in period 1 naive consumers procrastinate switching if the decrease of the switching cost in period 1 is not large ($\Delta_k \geq \beta$): they think that they do not switch this period but will switch next period. However, in period 2 naive consumers again do not switch if $p_2^a \leq \frac{\overline{k}}{\beta}$.

In contrast, Lemma 2 (ii) shows that an active-choice policy in $t = 1$ can decrease add-on prices, and hence increase consumer welfare. Intuitively, if naive consumers do not procrastinate switching, the firm needs to decrease its add-on price in response to the policy.

Comparing Lemma 1 and Lemma 2 leads to our first main result. An active-choice policy in period 1 lowers social welfare through the increase of the add-on price if (i) the firm sells to both types of consumers without the policy: $\beta \geq \alpha$, (ii) the firm sells only to naive consumers with the policy: $\alpha \geq \beta\Delta_k$, and (iii) naive consumers procrastinate switching: $\Delta_k \geq \beta$. Moreover, the policy may also lower consumer welfare.

Proposition 1. Suppose $T = 3$ and an active-choice policy is employed in $t = 1$. If $1 \geq \frac{\alpha}{\beta} \geq \Delta_k \geq \beta$, the policy increases the equilibrium add-on price. Social welfare decreases under the policy. If in addition $\beta(1 - \alpha)\Delta_k > \beta - \alpha$, consumer welfare also decreases under the policy.

We then investigate the situation in which the switching cost is lower in the second period, i.e., $k_1 = \overline{k}$, $k_2 = \underline{k}$. This is the case if the firm or a policymaker employs an active-choice policy whenever the firm increases its add-on price.

Again, the firm faces a trade-off between exploiting naive consumers with a high add-on price ($p_2^a = \frac{\underline{k}}{\beta}$) or selling its add-on to all consumers with a moderate add-on price ($p_2^a = \underline{k}$). The result is summarized as follows:

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

If $\alpha \geq \beta$, the firm sets $p^v = v$, $p_2^a = \frac{\underline{k}}{\beta}$. Time-consistent consumers switch in period 2, whereas naive consumers do not switch. The profits of the firm are $\pi = v - c^v + \alpha\frac{\underline{k}}{\beta}$ and the long-run utility of each type of consumer is $u^N = 2a - \frac{\underline{k}}{\beta}$ and $u^{TC} = 2a - \underline{k}$. If $\alpha < \beta$, the firm sets $p^v + p_2^a = v + \underline{k}$ with $p_2^a \leq \underline{k}$. No consumer switches. The profits of the firm are $\pi = v - c^v + \underline{k}$ and the long-run utility of each consumer is $u^N = u^{TC} = 2a - \underline{k}$.

Note that the circumstances under which the firm chooses to exploit the naive consumers ($\alpha \geq \beta$) are the same as without any active-choice policy. The price for the add-on is lower than without any active-choice policy independent of the fraction of naive consumers and the severity of the present bias. By comparing Lemma 1 and Lemma 3, we have the following result:

Proposition 2. Suppose $T = 3$ and an active-choice policy is employed in $t = 2$. The policy always strictly increases consumer welfare and weakly increases social welfare. It strictly increases social welfare if $\alpha > \beta$.

Proposition 2 implies that an active-choice policy in $t = 2$ does not have the perverse effect of selecting naive consumers as described in Proposition 1. Furthermore, the comparison between Lemma 2 and Lemma 3 leads to the following result:

Proposition 3. Suppose $T = 3$. The firm never prefers to employ an active-choice policy by itself. Under any parameters, both consumer and social welfare are weakly higher when enacting an active-choice policy in $t = 2$ than when enacting an active-choice policy in $t = 1$. Consumer welfare is strictly higher if $\frac{\alpha}{\beta} \geq \Delta_k \geq \beta$, and social welfare is strictly higher if in addition $1 \geq \frac{\alpha}{\beta}$.

Proposition 3 highlights that the timing of enacting an active-choice policy matters for both consumer and social welfare. If a policymaker enacts an active-choice policy when consumers sign a contract, then a firm may change its pricing strategy in response to the policy, and hence the perverse welfare effect can occur. In contrast, if a policymaker enacts an active-choice policy when a firm starts charing a positive fee on its add-on, then the policy always strictly increases consumer welfare.

It is also worth emphasizing that if $\frac{\alpha}{\beta} \geq \Delta_k \geq \beta$, then the ex-post utility of time-consistent consumers is the same under the different policies whereas that of naive consumers strictly increases. Note that the first inequality always holds if the fraction of naive consumers α is sufficiently large. Hence, the timing of enacting an active-choice policy affects consumer welfare whenever there are sufficiently many naive consumers in the market and the reduction of the switching cost by the policy is not large.

4 Analysis under Multiple Add-on Payments

This section analyzes models when $T > 3$: consumers possibly incur multiple payments for the add-on usage.

4.1 Consumer Behavior

Here we characterize consumer behavior given prices and switching costs. Note that consumers do not take any action in $t = T$.

First, we analyze the switching decision regarding the add-on in $t = T - 1$. Suppose that consumers bought the base product and did not switch the add-on in any previous period. Then, consumers do not switch to the competitive fringe if and only if $-k_{T-1} + \beta^i a \leq \beta^i(a - p^a_{T-1})$ or equivalently $p^a_{T-1} \leq \frac{k_{T-1}}{\beta^i}$.

Second, we analyze consumer behavior in period $\tau < T-1$. Because naive consumers (wrongly) think that they are time-consistent, all consumers think that they will not switch in any future period if and only if $\sum_{i=t}^{T-1} p^a_i \leq k_t$ for all $t > \tau$. Given this belief, consumers' switching behavior in period τ can be divided into the following two cases. First, if $\sum_{i=t}^{T-1} p^a_i \leq k_t$ for all $t > \tau$, consumers do not switch in period τ if and only if $\sum_{i=\tau}^{T-1} p^a_i \leq \frac{k_\tau}{\beta^i}$ because they think that they will never switch in any future period $t > \tau$. Second, if there exists $t > \tau$ such that $\sum_{i=t}^{T-1} p^a_i > k_t$, consumers think they will switch in period $\hat{t} \in \text{argmin}_{t \geq \tau+1}(k_t + \sum_{i=\tau}^{t-1} p^a_i)$. Given $\hat{t}$, they do not switch in period τ if and only if $k_\tau \geq \beta^i \left(k_{\hat{t}} + \sum_{i=\tau}^{\hat{t}-1} p^a_i\right)$. Given these, each consumer buys the base product in $t = 1$ if and only if her perceived utility is equal to or greater than zero.

4.2 Optimal Pricing and Welfare Effects of Active-Choice Policy

We now analyze the optimal pricing of the firm and the effects of active-choice policies.

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 if a policymaker does not employ any policy. The firm faces a trade-off between exploiting naive consumers with a high add-on price or selling its add-on to all consumers with a moderate add-on price. Note that the add-on prices can be different for different periods. The result is summarized as follows:

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

If $\alpha+(T-3)(1-\beta)\alpha \geq \beta$, the firm sets $p^v = v$, $p_t^a = \frac{(1-\beta)\overline{k}}{\beta}$ in $t \in \{2, \cdots, T-2\}$, and $p_{T-1}^a = \frac{\overline{k}}{\beta}$. Time-consistent consumers switch in period 1, whereas naive consumers never switch. The profits of the firm are $\pi = v - c^v + \frac{\alpha}{\beta}[(T-3)(1-\beta)\overline{k} + \overline{k}]$ and the long-run utility of each type of consumer is $u^N = (T-1)a - \frac{1}{\beta}[(T-3)(1-\beta)\overline{k} + \overline{k}]$ and $u^{TC} = (T-1)a - \overline{k}$.

If $\alpha + (T-3)(1-\beta)\alpha < \beta$, the firm sets $p^v + \sum_{t=2}^{T-1} p_t^a = v + \overline{k}$ with $\sum_{t=2}^{T-1} p_t^a \leq \overline{k}$. No consumer switches. The profits of the firm are $\pi = v - c^v + \overline{k}$ and the long-run utility of each consumer is $u^N = u^{TC} = (T-1)a - \overline{k}$.

The intuition is similar to the case when $T = 3$. The discrepancy of add-on prices between p_{T-1}^a and p_t^a where $t = 2, \cdots, T-2$ is due to the different decision problems consumers face in different periods. In period $T-1$ naive consumers cannot procrastinate their switching decision. In periods 2 to $T-2$, naive consumers (wrongly) expect to cancel the subscription in the next period such that they do not have to make any further payments. Moreover, the cut-off when the firm decides to exploit the naive consumers is increasing in T:

Corollary 1. For given α, β, as T increases, the firm is more likely to provide the add-on only to naive consumers. Also, if $\alpha + (T-3)(1-\beta)\alpha \geq \beta$, the firm's equilibrium profits are strictly increasing in T.

Firms are more likely to exploit naive consumers when T is larger. Furthermore, the firm's resulting profits in this case are strictly increasing in T. In contrast to the classical argument that a monopolist can extract rents from consumers only once, but akin to O'Donoghue and Rabin (2001) in the sense that people can procrastinate multiple periods, in our model the firm can exploit naive consumers more as T increases.

In what follows, we 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 a policymaker employs an active-choice policy when consumers sign a contract for purchasing a base product. The result is summarized as follows:

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 $\alpha + (T-3)(1-\beta)\alpha \geq \beta\Delta_k$, the firm sets $p^v = v$, $p_{T-1}^a = \frac{\overline{k}}{\beta}$, and $p_t^a = \frac{(1-\beta)\overline{k}}{\beta}$ for all $t \in \{2, \cdots, T-2\}$. Time-consistent consumers switch in period 1, whereas naive consumers never switch. The profits of the firm are $\pi = v - c^v + \frac{\alpha}{\beta}[(T-3)(1-\beta)\overline{k} + \overline{k}]$

and the long-run utility of each type of consumer is $u^N = (T-1)a - \frac{1}{\beta}[(T-3)(1-\beta)\overline{k} + \overline{k}]$ and $u^{TC} = (T-1)a - \underline{k}$. If $\alpha + (T-3)(1-\beta)\alpha < \beta\Delta_k$, the firm sets $p^v + \sum_{t=2}^{T-1} p_t^a = v + \underline{k}$ with $\sum_{t=2}^{T-1} p_t^a \leq \underline{k}$. No consumer switches. The profits of the firm are $\pi = v - c^v + \underline{k}$ and the long-run utility of each consumer is $u^N = u^{TC} = (T-1)a - \underline{k}$.

(ii) Suppose $\Delta_k < \beta$. If $\alpha \geq \beta$, the firm sets $p^v = v$, $\sum_{t=2}^{T-1} p_t^a = \frac{\underline{k}}{\beta}$. Time-consistent consumers switch in period 1, whereas naive consumers never switch. The profits of the firm are $\pi = v - c^v + \frac{\alpha}{\beta}\underline{k}$ and the long-run utility of each type of consumer is $u^N = (T-1)a - \frac{\underline{k}}{\beta}$ and $u^{TC} = (T-1)a - \underline{k}$. If $\alpha < \beta$, the firm sets $p^v + \sum_{t=2}^{T-1} p_t^a = v + \underline{k}$ with $\sum_{t=2}^{T-1} p_t^a \leq \underline{k}$. No consumer switches. The profits of the firm are $\pi = v - c^v + \underline{k}$ and the long-run utility of each consumer is $u^N = u^{TC} = (T-1)a - \underline{k}$.

As an alternative policy, merely imposing a low switching cost in period 2 is not sufficient. This is because the firm would simply set a low price p_2^a and start exploiting consumers afterwards. To see this in a simple way, 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 $p_3^a = \frac{(1-\beta)\overline{k}}{\beta}$. Given that, they do not switch in period 2 if $-\underline{k} \leq -\beta(p_2^a + \overline{k})$. Hence, if $\Delta_k \geq \beta$, the firm can make naive consumers procrastinate their switching decisions by lowering its add-on price in the period with a low switching cost.

We now investigate an alternative policy in which the policymaker forces the firm to lower the switching cost whenever it increases the add-on price. This is the case if a firm needs to get an additional explicit consent whenever increasing its add-on price. The result is as follows:

Lemma 6. Suppose $k_t = \underline{k}$ for any t which satisfies $p_t^a > p_{t-1}^a$ with $p_1^a = 0$.

If $\alpha + (T-3)(1-\beta)\alpha \geq \beta$, the firm sets $p^v = v$, $p_{T-1}^a = \frac{\underline{k}}{\beta}$, and $p_t^a = \frac{(1-\beta)\underline{k}}{\beta}$ for all $t \in \{2, \cdots, T-2\}$. Time-consistent consumers switch in period 1, whereas naive consumers never switch. The profits of the firm are $\pi = v - c^v + \frac{\alpha}{\beta}[(T-3)(1-\beta)\underline{k} + \underline{k}]$ and the long-run utility of each type of consumer is $u^N = (T-1)a - \frac{1}{\beta}[(T-3)(1-\beta)\underline{k} + \underline{k}]$ and $u^{TC} = (T-1)a - \underline{k}$. If $\alpha + (T-3)(1-\beta)\alpha < \beta$, the firm sets $p^v + \sum_{t=2}^{T-1} p_t^a = v + \underline{k}$ with $\sum_{t=2}^{T-1} p_t^a \leq \underline{k}$. No consumer switches. The profits of the firm are $\pi = v - c^v + \underline{k}$ and the long-run utility of each consumer is $u^N = u^{TC} = (T-1)a - \underline{k}$.

Interestingly, under the policy in Lemma 6, the firm may have an incentive to voluntarily decrease the switching cost to $\underline{k}$ in the periods after it is forced to do so; this makes naive consumers more likely to believe that they will switch in future, and hence makes them more likely to procrastinate their switching decision. To see this, consider that naive consumers face a switching decision in period t with $k_t = \underline{k}$ due to the increase of the add-on price and the policy. In period t, the condition for naive consumers to procrastinate switching to the next period is $-\underline{k} \leq -\beta(p_t^a + k_{t+1})$. Notice that naive consumers never do such procrastination if $\Delta_k < \beta$ and $k_{t+1} = \overline{k}$. Hence, when $\Delta_k < \beta$, the firm may induce naive consumers to procrastinate their switching decisions by decreasing k_{t+1} from $\overline{k}$ to $\underline{k}$ voluntarily. Moreover, even when $\Delta_k \geq \beta$, the firm has an incentive to decrease k_{t+1} from $\overline{k}$ to $\underline{k}$ voluntarily. On the one hand, by keeping $k_{t+1} = \overline{k}$, the firm could potentially exploit naive consumers more in period $t+1$. However, the firm has to lower k_{t+1} under the policy when it increases p_{t+1}^a, and hence the condition for naive consumers to procrastinate switching in period $t+1$ becomes $-\underline{k} \leq -\beta(p_{t+1}^a + k_{t+2})$. To satisfy this inequality, the firm cannot charge a higher price than in period t if $p_t^a \leq \frac{\underline{k}}{\beta} - k_{t+1} \leq \frac{(1-\beta)\underline{k}}{\beta}$. On the other hand, by setting $k_{t+1} = \underline{k}$, the firm can charge a higher p_t^a while keeping naive consumers procrastinate. As a result, the firm voluntarily decreases its future switching costs. This leads to the policy implication that a policymaker does not need to enforce a lower switching cost in every period, as we show in Proposition 5 later.

Analogous to the three-period case, comparing Lemmas 4, 5, and 6 leads to the following result:

Proposition 4. (i) Suppose that a policymaker enacts an active-choice policy in $t = 1$. If $1 \geq \frac{\alpha+(T-3)(1-\beta)\alpha}{\beta} \geq \Delta_k \geq \beta$, the policy increases the equilibrium add-on prices. Social welfare decreases under the policy. If in addition $\beta(1-\alpha)\Delta_k > \beta - [\alpha + (T-3)(1-\beta)\alpha]$, consumer welfare also decreases under the policy.
(ii) Suppose that a policymaker enacts a policy such that the firm has to lower the switching cost whenever it increases its add-on price. The policy always strictly increases consumer welfare and weakly increases social welfare. It strictly increases social welfare if $\alpha + (T-3)(1-\beta)\alpha > \beta$.

Note that the policy in Proposition 4 (ii), which requires to lower the switching cost when an add-on price increases, is more likely to increase social welfare as T becomes larger.

The following result shows that it is not necessary to reduce the switching cost in every period; a milder intervention as in Proposition 4 (ii) has the same consequence.

Proposition 5. Both consumer and social welfare under a policy which reduces the switching cost when an add-on price increases are the same as consumer and social welfare under a policy which reduces the switching cost in every period.

Hence, our suggested policy may be preferable when there is any cost for forcing firms to reduce the switching cost in practice.

4.3 Deadlines

So far, we have shown the consequences of active-choice 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 increase switching costs in certain periods sufficiently so that consumers cannot cancel their contract in those periods. By doing so, the policymaker can impose a deadline of switching decisions to consumers. Indeed, in our model it is optimal for the policymaker to prevent consumers from switching after the first two periods:

Proposition 6. 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 $t \in \mathfrak{T}$. Then, choosing $\mathfrak{T}^* = \{3, \cdots, T-1\}$ maximizes consumer and social welfare. If $\alpha + (T-3)(1-\beta)\alpha > \beta$ and $T \geq 4$, 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 6 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. 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).

Interestingly, this result implies that our three-period model captures the T-period case when the policymaker can impose an optimal deadline. In such a case, p_2^a is interpreted as the sum of all payments that have to be made after the second period. Our results of Subsection 3.2 directly apply. It is optimal for the policymaker to decrease the switching cost in the second period and impose the deadline so that consumers cannot switch after the second period: $k_2 = \underline{k}$ and $\mathfrak{T}^* = \{3, \cdots, T-1\}$ become the optimal policy intervention in such a case.

However, implementing such a deadline might not be feasible as the firm might be able to circumvent the deadline by pretendedly changing the add-on such that consumers 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 $\alpha + (T-3)(1-\beta)\alpha \geq \beta$ and $T \geq 4$, 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 condition of the add-on, the deadline policy in Proposition 6 may not be effective and the policymaker can only force the firm to lower the switching cost in certain periods—as we analyzed in the previous subsection.

5 Further Extensions and Discussion

This section discusses further extensions and modifications of the model. We discuss in turn a model incorporating (i) the possibility that naive consumers are partially aware of their self-control problems, (ii) competition on the base product, and (iii) heterogeneous base-product value or add-on value among consumers. The detailed analysis of each case is provided in the Supplementary Material.

5.1 Partial Naivete

In our model, we assume that naive consumers are fully unaware of their naivete. In this subsection, we discuss the model in which naive consumers are partially aware of their self-control problems.

Suppose that consumers pay the add-on price at most once (i.e., $T = 3$). Following O'Donoghue and Rabin (2001), assume that a fraction α of consumers are partially naive: they think in $t = 1$ that their present bias in $t = 2$ will be equal to $\hat{\beta} \in (\beta, 1)$. The remaining fraction of consumers are time-consistent.

Note that actual consumer behavior in $t = 2$ does not change because $\hat{\beta}$ is not relevant to her decision in $t = 2$. In $t = 1$, partially-naive consumers think that they will not switch in $t = 2$ if and only if $p_2^a \leq k_2/\hat{\beta}$ if they do not switch in period 1. Given this belief, consumers' switching behavior in period 1 can be divided into the following two cases. First, if $p_2^a \leq k_2/\hat{\beta}$, consumers think they will not switch in period 2. Given this, they do not switch in period 1 if and only if

$p_2^a \leq k_1/\beta^i$. Second, if $p_2^a > k_2/\hat{\beta}$, consumers think they will switch in period 2. Given this, they do not switch in period 1 if and only if $k_1 \geq \beta^i k_2$.

Note that $k_2/\hat{\beta} < k_2/\beta$ and that the firm always sets $p_2^a = k_2/\beta$ whenever naive consumers procrastinate in Section 3. Hence, akin to Heidhues and Kőszegi (2010), the firm can make partially-naive consumers procrastinate and exploit them by setting the same add-on price as in Section 3.[13] As a result, the equilibrium amount of exploitation is the same between naive and partially-naive consumers, and all equilibrium outcomes are the same for any $\hat{\beta} \in (\beta, 1]$.

5.2 Competition on Base Product

In the model, we have assumed that there is only one firm which can provide a base product. In this subsection, we discuss the case in which $N \geq 2$ firms sell the homogeneous base product.

If firms can completely compete down the base-product prices (i.e., firms can effectively set $p^v < 0$), then firms will do so as in the standard Bertrand price competition models. In equilibrium, firms earn zero profits and the ex-post utility of naive consumers is lower than that of time-consistent consumers; see, for example, Gabaix and Laibson (2006) for the discussion of such cross-subsidization between sophisticated and naive consumers. In this case, the timing of active-choice policies would not be crucial because under any parameters all profits from exploitation will be passed on to consumers.

In practice, however, firms may not be able to profitably set overly low prices (i.e., negative base-product prices); Heidhues, Kőszegi and Murooka (2012a, 2012b) investigate how the possibility of arbitrage or the presence of sophisticated consumers who can avoid the add-on payment can endogenously generate such a price floor. In this case, firms may earn positive profits even under competition.

To see the intuition, suppose that $T = 3$, $k_1 = k_2 = k$ and p^v is restricted to be non-negative. Then, a symmetric positive-profit equilibrium exists when $\frac{\alpha}{N}(\frac{k}{\beta} - c^v) \geq k - c^v$: each firm sets a high add-on price if and only if exploiting naive consumers by setting $(p^v = 0, p_2^a = \frac{k}{\beta})$ is more profitable than attracting both naive and time-consistent consumers from other firms by setting

[13] Specifically, Heidhues and Kőszegi (2010) show that in a general contracting or pricing setting, for any $\hat{\beta} > \beta$ the ex-ante incentive compatibility constraint (in our model, the condition that partially-naive consumers procrastinate switching out in $t = 1$) slacks so long as the ex-post incentive compatibility constraint (in our model, the condition that partially-naive consumers do not switch out in $t = 2$) binds.

$(p^v = 0, p_2^a = k)$.[14] Implications on active-choice policies in Section 3 qualitatively remain the same.

5.3 Continuous Distributions

Here we discuss the cases in which the consumers' valuation for the base product or for the add-on is heterogeneous in turn.

First, consider the case in which the valuation for the base product is heterogeneous. Like Grubb (2015), under downward-sloping base-product demand, even an active-choice policy in $t = 2$ may increase the equilibrium base-product price. 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 an active-choice 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. An additional inefficiency can arise when for some consumers valuation for the base product is less than $c_v - 2a$ and the firm sells the base product to these consumers below cost in order to enroll them in the add-on.

Second, we discuss the case in which the valuation for the add-on is heterogeneous. Suppose that the valuation of an add-on is independently distributed with support on $[\underline{a}, \overline{a}]$ where $\underline{a} \geq 0$. If the valuation for the add-on is sufficiently large for all consumers (i.e., $2\underline{a} \geq \min\{\frac{k_1}{\beta}, k_2\}$), the equilibrium prices of Section 3 do not change. If $2\underline{a} < \min\{\frac{k_1}{\beta}, k_2\}$ for some consumers, these consumers would not buy the base product at the equilibrium prices of Section 3.[15] Hence, the firm might want to reduce the price for the base product.

6 Conclusion

We investigate the welfare consequences of active-choice policies when a firm can change its strategy in response to a policy. We show that a conventional active-choice policy—enabling consumers to

[14] Here, the logic of the existence of the positive-profit equilibrium is close to that of Heidhues, Kőszegi and Murooka (2012a), although our model is dynamic and firms does not have an option to educate naive consumers by unshrouding.

[15] If $\underline{a} = \overline{a} = a = 0$ for all consumers, then our model is equivalent to an additional surcharge model in which naive consumers may incur unanticipated costs.

make an active choice when they sign a contract—can decrease consumer and social welfare. We also suggest an alternative active-choice policy—enabling consumers to make an active choice when the firm charges a higher price for the service. Our welfare and policy implications shed light on the design of active-choice policies.

We conclude by discussing a couple of questions related to, but beyond the scope of, this paper. First of all, how to detect consumer naivete and adverse policy effect from market data is both theoretically and practically important. One difficulty is that automatic enrollment itself may not be harmful to welfare. For example, naive consumers may procrastinate taking up a valuable product as well as switching out additional options. In such a case, automatic enrollment itself is valuable, though it also creates the possibility for a firm to exploit consumers as analyzed in this paper. Although how to detect exploitation would depend on the nature of the industry in general, sometimes it seems feasible. For example, as mentioned in Introduction, more than 80 percent of customers who signed a contract of an Internet connection in Germany paid the fees of its anti-virus option even when they did not even activate the option. In general, investigating the usage or activation data as well as the purchase data could be helpful to identify consumer naivete and exploitation.

Second, this paper focuses on the present bias as a source of procrastination. Though the present bias is one of the most prevalent behavioral biases as discussed in Section 2.2, how to identify the type of consumer biases from data is an important topic. This is because different consumer biases often predict the same type of equilibrium outcomes but bring different policy implications. To be specific, suppose that consumers are not present-biased but may forget to cancel the option with some probability. In this case, the equilibrium pricing would be qualitatively the same as our model, but the optimal policy would comprise of some type of reminders rather than deadlines. Investigating an optimal policy in a model with different consumer biases and identifying the source of consumer biases from data are left for future research.

Appendix: Proofs

Proof of Lemma 1.

Before the proof, we explicitly describe the consumer behavior on the purchase of the base product $t=1$. Given the switching decisions regarding the add-on in the main text, each consumer buys the base product in $t=1$ if and only if one (or more) of the following three terms is greater than or equal to zero; (i) the total perceived utility of buying the base product and the add-on from the monopoly firm: $\beta^i(v-p^v+2a-p_2^a)$, (ii) the total perceived utility of buying the base product and switching in period 1: $-k_1+\beta^i(v-p^v+2a)$, or (iii) the total perceived utility of buying the base product and switching in period 2: $\beta^i(v-p^v+2a-k_2)$.

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 add-on to both naive and time-consistent consumers. In this case, the firm sets $p^v+p_2^a=v+k$.[16] The profits of the firm are $\pi=v-c^v+k$ and the long-run utility of each consumer is $u^N=u^{TC}=2a-k$.

Second, suppose that the firm sells the add-on only to naive consumers. In this case, the firm sets $p^v=v$ and $p_2^a=\frac{k}{\beta}$. Naive consumers do not switch, whereas time-consistent consumers switch either in period 1 or period 2. The profits of the firm are $\pi=v-c^v+\alpha\frac{k}{\beta}$ and the long-run utility of each type of consumer is $u^N=2a-\frac{k}{\beta}$ and $u^{TC}=2a-k$.

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

Proof of Lemma 2.

(i) Notice that time-consistent consumers do not switch in period 1 if and only if $p_2^a \leq \underline{k}$. Naive consumers do not switch in period 1 because switching in period 2 is always preferable: $-\underline{k} \leq -\beta\overline{k}$.

First, suppose that the firm sells the add-on to both naive and time-consistent consumers. In this case, the firm sets $p^v+p_2^a=v+\underline{k}$.[17] The profits of the firm are $\pi=v-c^v+\underline{k}$ and the long-run utility of each consumer is $u^N=u^{TC}=2a-\underline{k}$.

Second, suppose that the firm sells the add-on only to naive consumers. In this case, the firm sets $p^v=v$ and $p_2^a=\frac{\overline{k}}{\beta}$. Naive consumers do not switch, whereas time-consistent consumers switch

[16] There are actually multiple equilibria for charging higher p^v and lower p^a. We can eliminate other equilibria by assuming that a tiny fraction of consumers exits the market after $t=1$.

[17] Again, there are multiple equilibria for charging higher p^v and lower p^a.

in period 1. The profits of the firm are $\pi = v - c^v + \alpha\frac{\overline{k}}{\beta}$ and the long-run utility of each type of consumer is $u^N = 2a - \frac{\overline{k}}{\beta}$ and $u^{TC} = 2a - \underline{k}$.

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 $p_2^a \leq \underline{k}$. Naive consumers do not switch in period 1 if $p_2^a \leq \frac{\underline{k}}{\beta}$.

First, suppose that the firm sells the add-on to both naive and time-consistent consumers. In this case, the firm sets $p^v + p_2^a = v + \underline{k}$.[18] The profits of the firm are $\pi = v - c^v + \underline{k}$ and the long-run utility of each consumer is $u^N = u^{TC} = 2a - \underline{k}$.

Second, suppose that the firm sells the add-on only to naive consumers. In this case, the firm sets $p^v = v$ and $p_2^a = \frac{\underline{k}}{\beta}$. Naive consumers do not switch, whereas time-consistent consumers switch in period 1. The profits of the firm are $\pi = v - c^v + \alpha\frac{\underline{k}}{\beta}$ and the long-run utility of each type of consumer is $u^N = 2a - \frac{\underline{k}}{\beta}$ and $u^{TC} = 2a - \underline{k}$.

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

Proof of Proposition 1.

Immediate from Lemma 1 and Lemma 2. □

Proof of Lemma 3. Again, we divide the analysis into two cases.

First, suppose that the firm sells the add-on to both naive and time-consistent consumers. In this case, the firm sets $p^v + p_2^a = v + \underline{k}$.[19] The profits of the firm are $\pi = v - c^v + \underline{k}$ and the long-run utility of each consumer is $u^N = u^{TC} = 2a - \underline{k}$.

Second, suppose that the firm sells the add-on only to naive consumers. In this case, the firm sets $p^v = v$ and $p_2^a = \frac{\underline{k}}{\beta}$. Naive consumers do not switch, whereas time-consistent consumers switch in period 2. The profits of the firm are $\pi = v - c^v + \alpha\frac{\underline{k}}{\beta}$ and the long-run utility of each type of consumer is $u^N = 2a - \frac{\underline{k}}{\beta}$ and $u^{TC} = 2a - \underline{k}$.

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

Proof of Proposition 2.

Immediate from Lemma 1 and Lemma 3. □

[18] Again, there are multiple equilibria for charging higher p^v and lower p^a.

[19] Note: p_2^a should not be too high here and elsewhere. Again, there are multiple equilibria for charging higher p^v and lower p^a.

Proof of Proposition 3.

Immediate from Lemma 2 and Lemma 3. □

Proof of Lemma 4.

Before the proof, we explicitly describe the consumer behavior on the purchase of the base product in $t = 1$. Given the switching decisions regarding the add-on described in the main text, each consumer buys the base product in $t = 1$ if and only if one (or more) of the following three terms is greater than or equal to zero; (i) the total perceived utility of buying the base product and the add-on from the monopoly firm: $\beta^i(v - p^v + (T-1)a - \sum_{t=2}^{T-1} p_t^a)$, (ii) the total perceived utility of buying the base product and switching in period 1: $-k_1 + \beta^i(v - p^v + (T-1)a)$, or (iii) the total perceived utility of buying the base product and switching in period $\hat{t}$: $\beta^i \left(v - p^v + (T-1)a - k_{\hat{t}} - \sum_{t=2}^{\hat{t}-1} p_t^a\right)$ for some $\hat{t} \in \{2, \cdots, T-1\}$.

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 to both naive and time-consistent consumers. In this case, the firm sets $p^v + \sum_{t=2}^{T-1} p_t^a = v + k$.[20] The profits of the firm are $\pi = v - c^v + k$ and the long-run utility of each consumer is $u^N = u^{TC} = (T-1)a - k$.

Second, 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 $p_{T-1}^a = \frac{k}{\beta}$ as we showed in Lemma 1. Given this, in period $t \leq T-2$ naive consumers prefer to switch in the next period $t+1$ to switch in the current period t if and only if $p_t^a \leq \frac{(1-\beta)k}{\beta}$. As a result, the firm sets $p^v = v$, $p_{T-1}^a = \frac{k}{\beta}$, and $p_t^a = \frac{(1-\beta)k}{\beta}$ for all $t \in \{2, \cdots, T-2\}$. Naive consumers do not switch, whereas time-consistent consumers switch in period 1. The profits of the firm are $\pi = v - c^v + \frac{\alpha}{\beta}[(T-3)(1-\beta)k + k]$ and the long-run utility of each type of consumer is $u^N = (T-1)a - \frac{1}{\beta}[(T-3)(1-\beta)k + k]$ and $u^{TC} = (T-1)a - k$.

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

Proof of Corollary 1.

Immediate from Lemma 4. □

Proof of Lemma 5.

[20] There are actually multiple equilibria for charging higher p^v and lower p^a. We can eliminate other equilibria by assuming that a tiny fraction of consumers exits the market after $t = 1$.

(i) Notice that time-consistent consumers do not switch in period 1 if and only if $\sum_{t=2}^{T-1} p_t^a \leq \underline{k}$. Naive consumers do not switch in period 1 because switching in period 2 is always preferable: $-\underline{k} \leq -\beta\overline{k}$.

First, suppose that the firm sells the add-on to both naive and time-consistent consumers. In this case, the firm sets $p^v + \sum_{t=2}^{T-1} p_t^a = v + \underline{k}$.[21] The profits of the firm are $\pi = v - c^v + \underline{k}$ and the long-run utility of each consumer is $u^N = u^{TC} = (T-1)a - \underline{k}$.

Second, suppose that the firm sells the add-on only to naive consumers. In this case, the firm sets $p^v = v$, $p_{T-1}^a = \frac{\overline{k}}{\beta}$, and $p_t^a = \frac{(1-\beta)\overline{k}}{\beta}$ for all $t \in \{2, \cdots, T-2\}$ as in Lemma 4. Naive consumers do not switch, whereas time-consistent consumers switch in period 1. The profits of the firm are $\pi = v - c^v + \frac{\alpha}{\beta}[(T-3)(1-\beta)\overline{k} + \overline{k}]$ and the long-run utility of each type of consumer is $u^N = (T-1)a - \frac{1}{\beta}[(T-3)(1-\beta)\overline{k} + \overline{k}]$ and $u^{TC} = (T-1)a - \underline{k}$.

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 $\sum_{t=2}^{T-1} p_t^a \leq \underline{k}$. Naive consumers do not switch in period 1 if and only if $\beta \sum_{t=2}^{T-1} p_t^a \leq \underline{k}$ because naive consumers always prefer to switch in period 1 rather than to switch in any subsequent period.

First, suppose that the firm sells the add-on to both naive and time-consistent consumers. In this case, the firm sets $p^v + \sum_{t=2}^{T-1} p_t^a = v + \underline{k}$.[22] The profits of the firm are $\pi = v - c^v + \underline{k}$ and the long-run utility of each consumer is $u^N = u^{TC} = (T-1)a - \underline{k}$.

Second, suppose that the firm sells the add-on only to naive consumers. In this case, the firm sets $p^v = v$ and $\sum_{t=2}^{T-1} p_t^a = \frac{\underline{k}}{\beta}$. Naive consumers do not switch, whereas time-consistent consumers switch in period 1. The profits of the firm are $\pi = v - c^v + \alpha\frac{\underline{k}}{\beta}$ and the long-run utility of each type of consumer is $u^N = (T-1)a - \frac{\underline{k}}{\beta}$ and $u^{TC} = (T-1)a - \underline{k}$.

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

Proof of Lemma 6. Again, we divide the analysis into two cases.

First, suppose that the firm sells the add-on to both naive and time-consistent consumers on the equilibrium path. In this case, the firm sets $p^v + \sum_{t=2}^{T-1} p_t^a = v + \underline{k}$.[23] The profits of the firm are $\pi = v - c^v + \underline{k}$ and the long-run utility of each consumer is $u^N = u^{TC} = (T-1)a - \underline{k}$.

[21] Again, there are multiple equilibria for charging higher p^v and lower p^a.

[22] Again, there are multiple equilibria for charging higher p^v and lower p^a.

[23] Note: p_2^a should not be too high here and elsewhere. Again, there are multiple equilibria for charging higher p^v and lower p^a.

Second, suppose that the firm sells the add-on only to naive consumers. In this case, the firm sets $p^v = v$ and $p^a_{T-1} = \frac{\underline{k}}{\beta}$, and $p^a_t = \frac{(1-\beta)\underline{k}}{\beta}$ for all $t \in \{2, \cdots, T-2\}$. The firm increases its add-on price in $t = 2$, and then keeps the add-on prices constant with setting a low k. Note that the firm voluntarily reduces the switching cost to $\underline{k}$ in any period after the firm is forced to do so by the policy; on the one hand, this makes naive consumers more likely to believe that they will switch in future, and hence makes them more likely to procrastinate their switching decision, as it relaxes the constraint $\underline{k} \geq \beta(p^a_t + k_{t+1})$. On the other hand, it tightens the constraint $k_{t+1} \geq \beta(p^a_{t+1} + k_{t+2})$. However, this does not decrease profits as the firm could only increase its profits potentially by charging a higher price in a future period. Suppose that a firm didn't decrease the switching cost voluntarily. To make use of the relaxed constraint $k_{t+1} \geq \beta(p^a_{t+1} + k_{t+2})$, the firm would have to increase the price. By doing so, the firm would be forced to reduce k in that future period. Hence, in any future period, the firm faces the same trade-off and therefore leaves the switching cost at $\underline{k}$. Naive consumers do not switch, whereas time-consistent consumers switch in period 1. The profits of the firm are $\pi = v - c^v + \frac{\alpha}{\beta}[(T-3)(1-\beta)\underline{k} + \underline{k}]$ and the long-run utility of each type of consumer is $u^N = (T-1)a - \frac{1}{\beta}[(T-3)(1-\beta)\underline{k} + \underline{k}]$ and $u^{TC} = (T-1)a - \underline{k}$.

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

Proof of Proposition 4. Immediate from Lemma 4, Lemma 5, and Lemma 6. □

Proof of Proposition 5. Immediate from Lemma 4 with $k_t = \underline{k}$ for all t and Lemma 6. □

Proof of Proposition 6. Note first that time-consistent consumers' utility is not affected by the policy and is always $u^{TC} = (T-1)a - \overline{k}$.

Denote $\underline{t}$ the first period of a sequence of periods such that $k_t = \infty$ for all $t \in \{\underline{t}, \cdots, \overline{t}\}$ where $\underline{t} \leq \overline{t} \leq T-1$. Then, naive consumers do not switch in period $\underline{t}-1$ if and only if $k_{\underline{t}-1} \geq \beta\left(\sum_{t=\underline{t}-1}^{\tau} p^a_t + k_{\tau+1}\right)$ for some $\tau \in \{\underline{t}+1, \cdots, T-1\}$ or $k_{\underline{t}-1} \geq \beta\left(\sum_{t=\underline{t}-1}^{T-1} p^a_t\right)$. So the maximum sum of prices a firm can charge (weakly) decreases as increasing the number of periods in which consumers cannot switch. Charging lower prices potentially benefits naive consumers and potentially increases social welfare when time-consistent consumers do not switch any more.

Analogous to Lemma 1, if $t = 2$ is the last period in which a consumer can cancel the contract and if $\alpha \geq \beta$, then the firm sets $p^v = v$ and $\sum_{t=2}^{T-1} p^a_t = \frac{\overline{k}}{\beta}$. Naive consumers do not switch, whereas time-consistent consumers switch either in period 1 or period 2. The profits of the firm are $\pi = v - c^v + \alpha\frac{\overline{k}}{\beta}$ and the long-run utility of each type of consumer is $u^N = (T-1)a - \frac{\overline{k}}{\beta}$ and $u^{TC} = (T-1)a - \overline{k}$. If $t = 2$ is the last period in which a consumer can cancel the contract and if $\alpha < \beta$, then the firm sets $p^v + \sum_{t=2}^{T-1} p_t^a = v + \overline{k}$. The profits of the firm are $\pi = v - c^v + \overline{k}$ and the long-run utility of each consumer is $u^N = u^{TC} = (T-1)a - \overline{k}$. Note also that adding period $t = 2$ to $\mathfrak{T}$ does not make a difference in any of these cases.

Comparing this to Lemma 4 delivers the result. □

Proof of Corollary 2. Immediate from Lemma 4 and Proposition 6. □

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