Marketing Self-Improvement Programs for Self-Signaling Consumers

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Abstract

How does a health club or credit counseling service market itself when its consumer becomes demotivated after a minor slip-up? To examine this issue, we utilize a self-signaling model that accounts for the complex process in which a resolution seeker manages his self-control perceptions. Specifically, we employ a model wherein a consumer oscillates between long-term resolution planning and short-term implementation: during each implementation juncture, the consumer must determine whether to lapse or follow through with prior resolution plans, a decision that affects his self-control perceptions in subsequent periods of long-term resolution planning. Using this framework, we derive many significant marketing insights for self-improvement programs, products which assist the pursuit of long-term resolutions. We first characterize a wide range of equilibrium pricing policies for self-improvement programs. We determine that the seller charges larger upfront fees whenever its consumer exerts high self-control in planning periods; however, we also demonstrate that the firm imposes higher per-usage rates when the consumer more easily implements prior plans. We also establish that self-signaling, as a process to manage self-control perceptions, leads to higher per-usage fees. In addition, we examine a scenario in which the seller simultaneously selects product and pricing strategies. We find that, under certain marginal cost conditions, the seller’s joint strategy reduces the likelihood of program use, impeding the consumer’s progress in reaching his resolution. Finally, we analyze the use of variable per-usage fees. We establish the conditions in which the seller implements introductory and loyalty discounts, as well as how each pricing policy influences self-control perceptions over time.

(Keywords: Self-Control, Pricing Strategy, Contracts, Game Theory, Behavioral Economics)
1 Background

Once an object of profound caution, instant gratification has turned unprecedentedly convenient as a consequence of modern innovation. Consider, for example, the evolution of food consumption and production. Refined sugar, a scarce commodity throughout much of history, prominently factors into current production of packaged foods, turning the act of eating into a source of dopamine release and instantaneous pleasure (Rada, et al. 2005; Gibson 2012). The supply chain expedites such pleasure, offering certain conveniences only feasible since industrialization. Producers employ vacuum packing, deep freezing, and preservatives so that buyers may forgo food preparation (Cutler, et al. 2003). Retailers facilitate purchase with strategies that include outlet proliferation, extended hours of operation, and same-day delivery for online orders (Muther 2013; Thau 2014).

The current ease of instant gratification presents a conundrum for self-improvement programs, products typically consumed to achieve long-term resolutions such as physical or financial health. These programs owe their demand to temptations that, in their ubiquity, have caused consumers to deviate from their desired long-term states. The same temptations, however, inevitably cause program participants to lapse or slip-up in self-improvement pursuit, a demotivating occurrence that makes subsequent effort formidable and ultimately contributes to enrollee turnover. Credit counseling and financial literacy programs, for instance, amass $1 billion in annual expenditures, yet about 50% of credit counseling participants quit or declare bankruptcy within the first year (Williams 2013; Weisbaum 2013). Similarly, annual health club expenditures exceed $21.4 billion but 50% of gym enrollees give up within the first six months (IHRSA 2012; Wilson and Brookfield 2009).

Our paper examines this conundrum. We determine how a self-improvement program develops marketing strategy to manage two key sources of program turnover—lapses and their demotivating effects. To do so, we construct a model wherein a consumer oscillates between being a long-term planner and a short-term implementer: during each implementation decision, the consumer may either lapse or follow through with his plans, a decision
that impacts his self-control perceptions the next time he plans long-term resolution effort.

Our model analysis illuminates many marketing decisions for products including health clubs, diet programs, and credit counseling services. We first explain the wide range of pricing strategies used for these products. We observe that the firm requires larger upfront fees if its consumer possesses greater restraint during periods of resolution planning; on the other hand, the seller charges a higher per-usage rate if its enrollee exerts better self-control while implementing his plans. Moreover, we indicate the pricing effects of self-signaling, a process wherein the consumer manages his self-control perceptions. We next analyze product strategy and reveal that a higher quality product may reduce program use likelihood without affecting enrollment; that is, higher quality may prevent the consumer from reaching his resolution, helping sustain the necessity of the program. Finally, we examine the use of variable pricing policies, determining the circumstances in which the seller employs both introductory discounts and loyalty rewards.

The remainder of the paper is organized as follows: In §2, we review the existing literature on self-control and explain our contribution to this area. In §3 and §4, we outline our baseline model and present key findings. We analyze strategic quality improvement and variable pricing in §5 and §6, respectively. We conclude in §7, discussing both contributions and limitations of our work.

2 Literature

Social scientists have broadly framed self-control as an ongoing conflict between analytic, forward-looking and instinctive, myopic reasoning processes (Freud 1922; Abelson 1963; Loewenstein 1996). With respect to this conflict, psychologists have demonstrated that instinctive processes dominate decision-making during emotional duress (Leith and Baumeister 1996; Tice, et al. 2001), in response to activating stimuli (Baumeister and Heatherton 1996), and under conditions of depleted self-regulatory resources (Baumeister, et al. 1994). Consumer behavior researchers have examined the implications of these findings with respect to
attribute valuation (Shiv and Fedorikhin 1999), impulse purchases (Rook 1987; Vohs and Faber 2007), and preference reversals (Hoch and Loewenstein 1991).

Adjacent to these papers, the economics and quantitative marketing literature has analyzed self-control, typically using non-exponential discounting models to express some “present-bias” or time inconsistency in the decision maker’s preferences (Strotz 1955; Phelps and Pollak 1968; O’Donoghue and Rabin 1999). Within this framework, researchers have explored the use of precommitment devices to restrict future choice (Laibson 1997; Wertebroch 1998; Jain 2012a). Other studies have also explored firm exploitation of present-bias, including the use of mail-in rebates (Gilpatric 2009), multiperiod quotas for salesforce compensation (Jain 2012b), and contract design (DellaVigna and Malmendier 2004).

In each of these models, the decision maker possesses an exogenous, static belief about his own self-control limitations. This approach, although reasonable in many contexts, does not suit the analysis of a long-term resolution. First, the consumer’s self-control beliefs change over the course of a resolution, where each success boosts and each setback deteriorates perceptions; moreover, self-control perceptions equally affect behavior, as the decision maker only exerts resolution effort if he senses his self-control as satisfactorily high (Bandura 1986; Latham and Locke 1991). These feedback processes cause a certain degree of fragility in resolution pursuit: where a slip-up sufficiently diminishes self-control perceptions, the consumer engages in lapse-activated misregulation, essentially ceasing effort as a result of his initial misstep (Marlatt 1985; Baumeister and Heatherton 1996). Recognizing this threat (Norcross and Vangarelli 1989), the consumer tries to avoid any slip-up as long as possible. He frequently thinks of any self-control lapse in catastrophic terms, compelling himself to rigidly pursue his resolution so that he maintains a high sense of self-control (Baumeister, et al. 1994; Baumeister and Heatherton 1996). The decision maker, in other words, strategically chooses effort so that he infers high self-restraint at a later time; more broadly, he acts to influence his future self-inferences by engaging in self-signaling (Prelec and Bodner 2003).

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2We use ‘decision maker’ and ‘consumer’ interchangeably. We also use ‘self-control’ and ‘self-restraint’ interchangeably.
Recent research has empirically documented the incidence of self-signaling in pay-what-you-want markets (Gneezy, et al. 2012) and charitable donations (Savary, et al. 2015). Most related to our paper, Dhar and Wertenbroch (2012) demonstrate the link between opportunity sets and self-signaling, finding that choice of a virtue (vice) creates a self-signal of high (low) self-control whenever the consumer faces both types of options. Complementing these studies, theoretical works have examined self-signaling in relation to heuristics (Bénabou and Tirole 2004) and peer effects (Battaglini et al. 2005). These analytical models employ a dual-state framework (Thaler and Shefrin 1981; Ali 2011) in which the consumer oscillates between long-term planning and short-term implementation states: the planning-state consumer observes his past implementation decisions to infer self-control limitations, implying that his implementation-state self can either strategically use or lapse to influence future self-control perceptions (Bénabou and Tirole 2004; Battaglini et al. 2005).

The present literature illustrates the impact of self-signaling on consumer decision making, but as far as we know, no existing work examines the strategic implications of this phenomenon. We accordingly incorporate a profit maximizing seller into a self-signaling consumer model. In doing so, we deduce how different contract pricing schemes influence self-signaling and, in turn, turnover in resolution pursuit. Accounting for these effects, our model explicates many empirically observed pricing strategies. We rationalize the use of low per-usage fees to contain the consumer’s risk of lapsing but also identify when the seller can require higher usage payments. Furthermore, we demonstrate the circumstances in which self-signaling, as a strategy to prevent lapse-activated misregulation, leads to greater per-usage fees and ultimately impedes resolution achievement. Our paper additionally explores the use of variable pricing policies. We establish that loyalty discounts encourage repeated use by creating a threat of lapse-activated misregulation, whereas introductory discounts minimize the risk of lapse-activated responses. Finally, we investigate self-control variation with respect to program quality. We demonstrate that certain program improvements, by way of corresponding price increases, heighten the probability of slip-ups.
To summarize, we contribute the following to the existing literature on self-control: (1.) we incorporate firm strategy into a dual-state consumer framework, determining how self-control perceptions relate to pricing and product policy; (2.) we investigate how seller strategy affects consumer self-signaling; (3.) we examine optimal contract pricing with respect to both planning and implementation stage self-control; (4.) we consider quality improvement as a technique to impact consumer slip-ups and program turnover; (5.) we examine variable pricing, outlining its implications for both self-control perceptions and resolution effort.

3 Model

We first introduce model preliminaries, explaining the rationale behind our assumptions as needed. Table 1 lists all symbols appearing in our model.

**General Framework:** A representative decision maker possesses some resolution. For instance, he may resolve to reduce his cholesterol level, intend to learn a programming language, or plan to increase his 401(k) savings. To achieve his resolution, the decision maker enrolls in a program that assists his self-improvement efforts: a health club, for physical fitness; a university, for professional training; a debt settlement program, for financial security.

In joining, the decision maker strategizes for his resolution by developing and regularly evaluating an ongoing program use schedule (Sayette, et al. 2008; Sniehotta, et al. 2005). He manages his schedule in *planning periods*, times in which he assesses whether to continue long-term effort toward his resolution. Such assessments depend, in part, on the consumer’s preference for instant gratification—during each planning period, he discounts all future transactions by quasi-hyperbolic factor $\gamma \in (0, 1)$.

Where $\gamma$ approaches 1, the consumer highly values the potential payoffs of continuing relative to the ease of quitting; that is, $\gamma$ roughly describes how much the consumer cares about or wants to progress toward his long-term resolution.

Where the decision maker possesses a high $\gamma$, he cares about his resolution enough to

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3 We employ a quasi-hyperbolic discounting model (Phelps and Pollak 1968) where the exponential factor $\delta = 1$ in all states. If we relax this assumption, our baseline model’s qualitative results do not change.
avoid quitting, continuing with an intention to use the program at scheduled *implementation periods*. When each implementation period arrives, the consumer must then confront the consequences of his prior ambition and determine whether to follow through with his planned schedule. Follow through may prove difficult, however, as each implementation decision begets some activating stimuli which exacerbates the decision maker’s desire for instant gratification (Baumeister and Heatherton 1996). For instance, a diet program participant encounters the unpleasant smell, and anticipated unpleasant taste, of the diet program’s prepared meal. Similarly, a worker intends to contribute to an IRA but confronts sales promotions which coincide with his paydays (Thompson 2012). Such stimuli, by exacerbating the desire for instant gratification, create an impulse, or sudden realization of duress, that the decision maker must endure to use the self-improvement program. The severity of the consumer’s duress corresponds to quasi-hyperbolic factor $\beta \in (0, \beta_{\text{max}})$ s.t. $\beta_{\text{max}} < \gamma$, the extent of his present-bias during implementation periods. In instances of greater present-bias, or where $\beta$ is closer to 0, the consumer suffers more severe impulses and encounters considerable obstacles in implementing his plans.

Nonetheless, the consumer may withstand a particularly difficult impulse in order to positively influence future self-control perceptions. This occurs as a result of the consumer’s information about his own present-bias. He only retains full knowledge of $\gamma$, his long-term wants, across the entire timeline. In contrast, he merely possesses perfect information of $\beta$ during implementation periods: each impulse only creates fleeting duress, and this short-term anguish does not embed an enduring impression in the decision maker’s memory (Nordgren, et al. 2006; Burger and Huntzinger 1984). The decision maker, when planning, copes with uncertainty about $\beta$ and can only observe past implementation decisions to reduce this uncertainty. Accordingly, we model the decision maker’s planning state beliefs in two key ways. First, we model the consumer as holding a continuously differentiable, log-concave prior $f()$ in the first planning period. Second, we allow the consumer’s implementation decisions to signal information about his self-control limitations: program use suggests a
minimal impulse problem and results in an upward shift of \( f(\beta) \), improving the consumer’s perception that he can achieve his resolution; a lapse, or failure to use, implies a more pronounced impulse problem and adversely affects his self-control beliefs.

*Market Interaction:* A monopolistic seller markets its self-improvement program to the representative consumer. As part of its marketing strategy, the seller specifies a contract with the following terms: the consumer must pay 1.) upfront fee \( L \) to receive program access for two periods and 2.) per-usage fee \( p \) upon each incident of program use. The consumer’s utilization of this contract depends on his planning (subperiod 1) and implementation (subperiod 2) decisions each period.

We detail this timeline below, using the example of a physical fitness plan for illustrative purposes. Figure 1 depicts this sequence of events. Note that the decision maker does not discount transactions occurring in the current subperiod; however, he discounts all future transactions by \( \gamma \) when in a planning period and by \( \beta \) when in an implementation period.

*Period 1.1:* The consumer notices his recent weight gain and contemplates joining a health club. Faced with the program’s contract, he must determine whether to join the gym and attempt a workout at the beginning of each day. To make this decision, the consumer determines the discounted future benefits he expects from joining. Thus, he considers his discount factor \( \gamma \), the extent to which he wants the health benefits of long-term fitness. He also gauges his prospects for such benefits, determining the likelihood that he will actually follow through with a fitness plan; that is, he utilizes his prior \( f(\beta) \) to estimate whether he will push himself out of bed and to the gym each morning.\(^4\)

If the decision maker suspects he will skip his daily workouts, or if he cares little about improving his health, he rejects the gym contract and makes no effort toward his resolution. He instead treats himself to a daily supper of fried chicken: he immediately obtains \( a > 0 \) for the current night’s indulgence and again receives \( a \) when he eats leftovers the following evening. Otherwise, the decision maker immediately pays \( L \) to accept the contract and plans

\(^4\)In a heterogeneous agent framework, there may exist some degree of correlation between \( \gamma \) and \( \beta \). We do not explore such issues in the present paper, as we examine a representative agent model.
gym sessions for the following two mornings. He subsequently prepares for his first workout, eating a healthy dinner of quinoa and setting his alarm for sunrise.

**Period 1.2:** The shrill sound of an alarm beats against the consumer’s ear drums. The throbbing pain conjures up a similar agony in the consumer’s mind: the throbbing limbs to occur if he forces his atrophied muscles along a treadmill. He considers the burden of his fitness plan and feels an impulse to forgo his scheduled gym appointment.

If the decision maker gives into his impulse, he hits the snooze button and resumes sleep. He makes no attempt to implement his exercise plan and incurs no immediate costs, having attained immediate relief from his duress. This short-term relief, though, entails future costs. When the next period begins, the consumer only receives $a + 1 - r$ s.t. $r \in (0, 1)$: planning benefit $1 - r$, that earned above and beyond immediate gratification, merely reflects his cholesterol improvement from eating quinoa the evening before. The consumer, in other words, does not improve his long-term well-being on account of his early morning laziness. Moreover, his decision adversely affects his future self-control beliefs, risking future misregulation as a consequence of his initial lapse. Accordingly, the consumer only accepts these future consequences if he discounts them with a sufficiently low $\beta$; he only gives into his impulse to snooze if, upon hearing his alarm, he finds that leaving bed would prove far too taxing.

If the consumer can endure the duress of waking up, he continues along his self-improvement plan and immediately pays $p$ to use the gym for his morning workout. This effort pays off at the beginning of next period, when he receives $a + 1 - r + r = a + 1$: his program benefit $r$, that above and beyond $a + 1 - r$, represents calorie output directly attributable to his treadmill session. His program use also pays off as a self-signaling strategy, in that he will perceive a manageable impulse problem during his next planning decision.

**Period 2.1:** Evening falls and the consumer has long forgotten the piercing ring of his alarm. He can recall his morning activities, though, to estimate his level of self-control the following sunrise. He updates his prior belief $f(\beta)$ according to Bayes Rule and forms
posterior \( \mu (\beta) \), where only \( \beta \in (\beta', \beta_{\text{max}}) \) would have used the gym the first morning.

If the consumer exercised earlier that day, he surmises that he possesses relatively high self-restraint. He updates his self-control belief \( \mu (\beta) \) as follows:

\[
\frac{f (\beta)}{1 - F (\beta')} \quad \text{for } \beta_{\text{max}} > \beta > \beta' \\
0 \quad \text{for } \beta' > \beta > 0
\]  

(1a)  

(1b)

The consumer infers a more severe problem, however, if he hit the snooze button and fell back to sleep. He adjusts his belief \( \mu (\beta) \) downward in this instance:

\[
0 \quad \text{for } \beta_{\text{max}} > \beta > \beta' \\
\frac{f (\beta)}{F (\beta')} \quad \text{for } \beta' > \beta > 0
\]  

(2a)  

(2b)

Based on his updated information, the decision maker determines whether to set his alarm for tomorrow. He ceases all resolution effort if his self-control beliefs significantly worsen and he merely expects to snooze in the morning. In this instance, he tosses his alarm and health foods in the trash, seeking out a dinner of fried chicken and immediately receiving \( a \). Otherwise, the consumer perceives his self-control as satisfactory and continues his fitness plan, again eating quinoa and programming his clock for a morning treadmill session.

Period 2.2: If the consumer stuck to his fitness plan the prior evening, he confronts the same decision as in 1.2.\(^5\)

4 Profit Optimization

Before we derive the seller’s profit maximization problem, we must examine the consumer’s actions throughout the entire timeline. We note that the decision maker may earn one of three payoffs each period, depending on his planning and implementation decisions. If he does not plan to use the program, he exerts no effort and receives \( a \) at the beginning of the period. If he plans future use, he ultimately attains \( a + 1 \) if he follows through with

\(^5\)For brevity, we henceforth omit the label ‘period’. For instance, we refer to ‘period 2.2’ as ‘2.2’.
his plan or \( a + 1 - r \) if he later succumbs to his impulse. The timing of each payoff implies that the consumer discounts \( a + 1 \) and \( a + 1 - r \) by \( \gamma \) when he makes his planning decisions at the beginning of the period.

Thus, to fully characterize consumer behavior, we must evaluate \( a \) with respect to \( \gamma (a + 1) \) and \( \gamma (a + 1 - r) \). We first exclude the scenario where \( a > \gamma (a + 1) > \gamma (a + 1 - r) \).

This situation precludes the profitable sale of a contract, as the decision maker never attempts a long-term plan toward self-improvement. Conversely, \( \gamma (a + 1) > \gamma (a + 1 - r) > a \) implies that the consumer always schedules future effort, even if he definitively knows that he will not implement his plans. This contradicts the incidence of lapse-activated misregulation, so we exclude this scenario from our analyses. We thus assume that \( \gamma (a + 1) > a > \gamma (a + 1 - r) \):

during planning, the consumer requires moderate effort to delay gratification and continue toward his long-term resolution.\(^6\) The consumer only exerts planning effort if he believes he that he will likely follow through with his schedule; in other words, he abandons his resolution if he learns that he cannot manage his impulses during implementation junctures.

Using the assumption that \( \gamma (a + 1) > a > \gamma (a + 1 - r) \), we determine the incentive constraints for each \( \beta_{\text{max}} > \beta > 0 \) and derive three types of behavior in equilibrium. A finisher, a decision maker possessing \( \beta_{\text{max}} > \beta > r^{-1}p \), always utilizes the program and completes his self-improvement plan. A committer, characterized by \( r^{-1}p > \beta > p \), uses in 1.2 to commit himself to at least partial effort in 2.1. Finally, a quitter possesses \( p > \beta > 0 \); he does not use the program in 1.2 and subsequently abandons his plan in 2.1.

We formally derive these consumption patterns in the Technical Appendix and describe them in fuller detail below. We reemphasize that, during each planning period, the decision maker only observes past implementation decisions to infer \( \beta \). Thus, every consumer type possesses the same prior belief in 1.1 and accepts the program contract, provided that the seller sets sufficiently low prices; similarly, a finisher and a committer act upon the same information in 2.1 and make the same planning decision at that time.

\(^6\)Note that this restriction implies that \( \gamma < 1 \): lapse-activated misregulation occurs as a consequence of time-inconsistency in planning periods.
**Finisher:** The finisher possesses $\beta_{\text{max}} > \beta > r^{-1}p$, experiencing minimal present-bias variation between planning and implementation. He experiences rather weak impulses and encounters the least difficulty in his resolution pursuit.

His pursuit begins in 1.1, when he examines the seller’s contract. He does not know $\beta$ but uses $f(\beta)$ to estimate the likelihood that he implements in 1.2 and 2.2; based on this estimation, he expects a net benefit from accepting $\{L, p\}$. This action corresponds to (3a).

Having initiated his program, the finisher arrives at 1.2 and experiences the duress of his first impulse. He must determine whether to tolerate this duress and use the program, all while realizing that his perfect knowledge of $\beta$ will not extend to the next planning decision. He discerns that lapsing in 1.2 will signal a severe impulse problem in 2.1, thereby causing him to form low self-control perceptions and cease all effort. This sequence of actions corresponds to the RHS of (3b). The LHS, on the other hand, denotes the finisher’s ultimate payoffs from his preferred course of action—enduring his impulse as a self-signaling strategy. By using in 1.2, the finisher knows that he will perceive his self-control as high in 2.1, motivating him to continue his program schedule in 2.1 and allowing him to implement again in 2.2.

The finisher, having employed his willpower in 1.2, observes his earlier program use when he arrives in 2.1. He expects that his continued effort will justify delaying gratification, and he accordingly continues his self-improvement plan. This corresponds to (3c).

Finally, he enters 2.2 and regains perfect knowledge of $\beta$. He once again overcomes his impulse and completes his resolution pursuit, as expressed by (3d).

\[
1.1 : \gamma \left[ (a + 1 - p) (1 - F(p)) + (a + 1 - r) F(p) \right] + \\
\gamma \left[ (a + 1 - p) (1 - F(r^{-1}p)) + (a + 1 - r) \left( F(r^{-1}p) - F(p) \right) + a F(p) \right] \\
- L \geq \underbrace{a}_{\text{Period 1}} + \underbrace{\gamma a}_{\text{Period 2}} \quad (3a)
\]

\[
1.2 : \beta \underbrace{(a + 1) - p}_{\text{Period 1}} + \beta \underbrace{(a + 1 - p)}_{\text{Period 2}} \geq \beta \underbrace{(a + 1 - r)}_{\text{Period 1}} + \beta \underbrace{a}_{\text{Period 2}} \quad (3b)
\]
2.1 : $\gamma (a + 1 - p) \frac{1 - F(r^{-1}p)}{1 - F(p)} + \gamma (a + 1 - r) \frac{F(r^{-1}p) - F(p)}{1 - F(p)} \geq a \quad (3c)$

2.2 : $\beta (a + 1) - p \geq \beta (a + 1 - r) \quad (3d)$

**Committer:** The committer, characterized by $r^{-1}p > \beta > p$, confronts moderate present-bias variation between planning and implementation. To override his impulses, he must exert greater effort than that required of a finisher. However, he begins his resolution like a finisher, accepting the contract in 1.1.\footnote{To avoid redundancy, we omit the 1.1 preference constraint for both the committer and quitter.}

Arriving in 1.2, the committer chooses to overcome his first impulse and use the program. His action constitutes a form of precommitment, as he understands that his implementation in 1.2 will signal self-control efficacy in 2.1 and induce him to continue his plan. The committer effectively manipulates his period 2.1 beliefs by executing precommitment in 1.2, a notable strategy since the committer fully knows, at the time of precommitment, that he will ultimately lapse in 2.2. He chooses this course of action to stave off lapse-activated misregulation: his only alternative, lapsing in 1.2, will cause him to form low self-control perceptions in 2.1 and quit his efforts entirely. The course of lapse-activated misregulation corresponds to the RHS of (4a), whereas the LHS denotes the committer’s decision to use in 1.2 and delay his initial lapse.

Having used in 1.2 as a self-signaling strategy, the committer observes his earlier behavior and infers relatively high self-control in 2.1. He continues his resolution, as reflected by (4b).

He then enters 2.2 and encounters his final implementation decision during the contract’s effective period. With the contract terminating, the committer’s decision to lapse does not affect future decisions to utilize the self-improvement program. Accordingly, the committer forgoes the effort required to withstand his impulse, as expressed by (4c).

\[
1.2 : \left( \beta (a + 1) - p \right)_{\text{Period 1}} + \beta (a + 1 - r)_{\text{Period 2}} \geq \beta (a + 1 - r)_{\text{Period 1}} + \beta a_{\text{Period 2}} \quad (4a)
\]
2.1: \( \gamma (a + 1 - p) \frac{1 - F(r^{-1}p)}{1 - F(p)} + \gamma (a + 1 - r) \frac{F(r^{-1}p) - F(p)}{1 - F(p)} \geq a \) (4b)

2.2: \( \beta (a + 1) - p < \beta (a + 1 - r) \) (4c)

**Quitter:** The quitter possesses \( p > \beta > 0 \) and faces the greatest difficulty in his resolution pursuit. Before he encounters these obstacles, though, he accepts the seller’s self-improvement contract.

The quitter then approaches his first implementation decision in 1.2. At this time, he suffers such an aversive impulse that he must surrender to temptation and decline program use. The quitter subsequently enters 2.1 and observes his prior failure to use the program. Based on this observation, he surmises severe self-control limitations and quits his resolution as a result of his initial lapse. Equation (5a) captures his self-control lapse in 1.2, whereas (5b) denotes the decision to quit in 2.1.

\[
1.2: \underbrace{\beta (a + 1) - p}_{\text{Period 1}} + \underbrace{\beta (a + 1 - r)}_{\text{Period 2}} < \underbrace{\beta (a + 1 - r)}_{\text{Period 1}} + \underbrace{\beta a}_{\text{Period 2}} \quad (5a)
\]

\[
2.1: \gamma (a + 1 - r) < a \quad (5b)
\]

We summarize these results in Lemma 1 below:

**Lemma 1.** For any \( p \in (0, r\beta_{\text{max}}) \), the producer expects demand \( 1 - F(p) \) in 1.2 and \( 1 - F(r^{-1}p) \) in 2.2.

The present framework captures the wide range of usage behaviors observed in self-improvement programs, illustrating when a decision maker finishes his resolution and when he quits immediately. Most importantly, though, this framework rationalizes the incidence of lapse-activated misregulation, whereby an initial lapse deteriorates the consumer’s self-control perceptions and causes him to cease all effort. This phenomenon characterizes resolution progress across a wide range of self-improvement domains. For instance, dieters often binge following a small slip-up (Marlatt 1985; Polivy and Herman 1985). Similarly, savers engage in unrestrained spending following a setback in their financial goals, whether a credit card balance (Wilcox, et al 2011) or a broken monetary budget (Soman and Cheema 2004).
The above lemma also provides the probability of program use in each period, permitting us to state the seller’s optimization problem:

\[
\{L^*, p^*\} = \text{arg max}_{\{L,p\}} \ L + (p - c) \left( 2 - F(p) - F(r^{-1}p) \right)
\]

\[\text{s.t. } \gamma \left[ (a + 1 - p) (1 - F(p)) + (a + 1 - r) F(p) \right] + \gamma \left[ (a + 1 - p) (1 - F(r^{-1}p)) + (a + 1 - r) (F(r^{-1}p) - F(p)) + aF(p) \right] - L \geq a + \gamma a \tag{6b} \]

\[\text{s.t. } \gamma (a + 1 - p) \frac{1 - F(r^{-1}p)}{1 - F(p)} + \gamma (a + 1 - r) \frac{F(r^{-1}p) - F(p)}{1 - F(p)} \geq a \tag{6c} \]

where the aforementioned pricing scheme, the consumer’s planning and implementation decisions, and self-control beliefs constitute a Perfect Bayesian Equilibrium. Here, \(c > 0\) equals the firm’s marginal cost of providing the self-improvement program.

Equation (6b) corresponds to the consumer’s planning decision during 1.1. The RHS denotes the total payoff from contract rejection; in this instance, the consumer attempts no self-control and receives \(a\) at the beginning of each period. Conversely, the LHS represents his expected payoff if he accepts the contract and undertakes a self-improvement plan. He determines, based on \(f(\beta)\), that the following will transpire if he pursues his resolution: he becomes a finisher with probability \(1 - F(r^{-1}p)\), earning \(a + 1 - p\) in both 1.2 and 2.2; a committer with probability \(F(r^{-1}p) - F(p)\), receiving \(a + 1 - p\) in 1.2 and \(a + 1 - r\) in 2.2; a quitter with probability \(F(p)\), obtaining \(a + 1 - r\) in 1.2 and \(a\) in 2.1.

Equation (6c) corresponds to the consumer’s planning decision in 2.1, assuming that he utilized the program in 1.2. In this instance, he infers that he incurs moderate impulses, expecting to become a finisher with probability \(\frac{1 - F(r^{-1}p)}{1 - F(p)}\) and a committer with probability \(\frac{F(r^{-1}p) - F(p)}{1 - F(p)}\). This discounted expected benefit must exceed \(a\), the benefit of immediate gratification, in order for the consumer to continue his self-improvement plan in 2.1. If this constraint is not met, the consumer does not accept the proposed contract in 1.1, as we demonstrate in Lemma 1 in the Technical Appendix.
Constraint (6b) binds in equilibrium, implying that we may restate (6a)-(6c):

\[ p^* = \arg \max_{p} \quad -a (1 - \gamma) + \gamma (1 - r) F (r^{-1}p) + (\gamma + p (1 - \gamma) - c) (2 - F (p) - F (r^{-1}p)) \]

\[ \text{s.t.} \quad \gamma (a + 1 - p) \frac{1 - F (r^{-1}p)}{1 - F (p)} + \gamma (a + 1 - r) \frac{F (r^{-1}p) - F (p)}{1 - F (p)} \geq a \]  

For the parameter space in which an interior solution exists, we derive the FOC of Equation (7a) to characterize \( p^* \):

\[ (1 - \gamma) (2 - F (p^*) - F (r^{-1}p^*)) - \gamma (f (p^*) + f (r^{-1}p^*)) - (p^* (1 - \gamma) - c) (f (p^*) + r^{-1} f (r^{-1}p^*)) = 0 \]  

We assume that \( 2 (1 - \gamma) - 2 \gamma f (0) + c (1 + r^{-1}) f (0) > 0 \) to restrict our analysis to interior equilibria. To ensure a unique equilibrium, we also require strict concavity of the firm’s objective function. This corresponds to the following SOC of (7a):

\[ -2 (1 - \gamma) (f (p) + r^{-1} f (r^{-1}p)) - \gamma (f' (p) + r^{-1} f' (r^{-1}p)) - (p (1 - \gamma) - c) (f' (p) + r^{-2} f' (r^{-1}p)) < 0 \]

**Pricing Impact of Present-Bias**

The decision maker’s willingness to create and maintain a self-improvement schedule depends on his planning state preferences. Where present-bias \( \gamma \) approaches 1, the consumer increasingly values the future benefits of self-improvement and exhibits higher willingness to pay (WTP) during contract examination. In this instance, however, he also discounts future costs less sharply, implying that per-usage fee \( p \) renders more influence during contract examination. The decision maker, when in possession of a high \( \gamma \), thus requires a considerably lower \( L \) to tolerate any incremental hike in the per-usage rate. Per-usage fees net marginal returns at higher levels of \( \gamma \), necessitating that the seller shift its revenue collection toward its upfront fee. In other words, as \( \gamma \) increases, the firm charges a lower \( p \) and a higher \( L \) to
optimally respond to the consumer’s planning state preferences.

The consumer’s present-bias during implementation, though, determines whether he follows through his plan to use the self-improvement program. He benefits from a greater probability of use when his distribution of $\beta$ approaches $\beta_{\text{max}}$, as this implies that severe impulses transpire with smaller likelihood. This minimal impulse problem, in turn, allows the seller to set its per-usage fees with greater flexibility. Consequently, the seller charges per-usage fees closer to, if not in excess of, marginal cost $c$; that is, as $f(\beta)$ converges toward $\beta_{\text{max}}$, the firm assesses a higher $p$.

We formally present these insights in Propositions 2 and 3 below:

**Proposition 2.** As self-control increases in planning states, the seller decreases $p^*$ and increases $L^*$. That is, $\frac{\partial p^*}{\partial \gamma} < 0$ and $\frac{\partial L^*}{\partial \gamma} > 0$.

**Proposition 3.** As implementation state self-control approaches $\beta_{\text{max}}$, the seller increases $p^*$. That is, $p^*_g > p^*_f$ for any $f(\beta)$ and $g(\beta)$ such that $\frac{\partial g(p)}{\partial f(p)} > 0$ and $\frac{\partial g(p)+r^{-1}g(r^{-1}p)}{\partial f(p)+r^{-1}f(r^{-1}p)} > 0$.

The above framework permits the consumer’s time-inconsistency to vary between his planning and implementation decisions. This, in turn, separates the consumer’s contract decision into two factors relevant to firm strategy: the consumer’s 1.) ability and 2.) desire to achieve his resolution.

If the consumer possesses a high $\gamma$, he exhibits little present-bias during planning decisions. He greatly values his long-term well-being, desperately wanting to progress in his resolution and become a finisher. This objective necessitates that the consumer avoid lapse-activated misregulation, and the seller can only facilitate this avoidance by setting a low per-usage fee that minimizes the risk of initial lapse. In minimizing this risk, however, the seller greatly increases the consumer’s overall WTP. Accordingly, the seller commands a substantial upfront fee in its contract terms—having abetted resolution progress, the seller capitalizes on the consumer’s wish to achieve his resolution.

The decision maker’s want of finishing, although important, does not entirely determine contract pricing; rather, the seller also sets strategy with respect to the decision maker’s
abilities. Consider a consumer with \( f(\beta) \) approaching \( \beta_{\text{max}} \), implying minimal present-bias during implementation decisions. A fitness enthusiast, for instance, effortlessly sticks to an exercise plan and faces only a remote chance of lapse-activated misregulation. Unlikely to become a quitter, this type of consumer provides the seller with considerable flexibility in its per-usage pricing; in fact, the seller can even set this price in excess of marginal costs under certain circumstances. This finding elucidates pricing strategies previously overlooked by the existing self-control literature. Observe, for example, the evidence in the boutique fitness sector. Such studios, which include emerging brands SoulCycle and CorePower Yoga, target those with fitness experience and highly defined exercise preferences. These establishments typically set rates differently than most full-service clubs; instead of annual contracts, boutique studios price their services per session, per month, or offer multiple session packages (Dussault 2012; Hilmantel 2013). A similar evidence exists in the meal delivery industry. Firms such as Farm Fresh to You, My Fit Foods, and Home Bistro prominently advertise individual shipment options, a notable contrast to programs which primarily target dieters.

**Pricing Impact of Self-Signaling**

In our first two propositions, we observe how present-bias compounds consumer self-signaling in resolution pursuit; however, these results do not examine the direct strategic impact of self-signaling. We determine this direct effect in the following analysis, and to do so, we devise a comparative model in which self-signaling does not transpire.

In this alternate setup, the decision maker obtains perfect knowledge of \( \beta \) in 1.2 and retains perfect knowledge for the remainder of the model. The consumer’s retention of \( \beta \) nullifies self-signaling in two key ways. First, the consumer does not endure any uncertainty in 2.1 because he recalls \( \beta \) at that time. Second, because the consumer remembers \( \beta \) in 2.1, his implementation decision in 1.2 does not influence his future self-control perceptions; that is, the consumer faces the same information set in 2.1 irrespective of his actions in the prior period.

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8We note that both full-service gyms and boutique fitness studios face capacity constraints—capacity constraints cannot explain the difference in pricing between the two types of services.
Accordingly, the consumer’s first implementation decision does not impact his future strategy—his entire self-improvement effort collapses into a sequence of static one-period optimization problems. Here, the consumer either prefers to use the program in both periods or in neither period.\footnote{Like the baseline model, we determine the preference constraints for both the user and non-user. These constraints appear in our Online Appendix.}

In this setup, the seller maximizes profits as follows:

$$\begin{align*}
\{L^*, p^*_r\} = & \arg \max_{\{L, p\}} L + (p - c) \left(2 - 2F \left( r^{-1}p \right) \right) \\
\text{s.t.} & \quad \gamma \left[ (a + 1 - p) \left(1 - F \left( r^{-1}p \right) \right) + (a + 1 - r) F \left( r^{-1}p \right) \right] + \\
& \quad \gamma \left[ (a + 1 - p) \left(1 - F \left( r^{-1}p \right) \right) + aF \left( r^{-1}p \right) \right] - L \geq a + \gamma a \\
\text{s.t.} & \quad \gamma (a + 1 - p) \geq a
\end{align*}$$

Here, (10b) binds, allowing us to restate the optimization problem and derive the following FOC:

$$2 \left(1 - \gamma \right) \left(1 - F \left( r^{-1}p^*_r \right) \right) - \gamma \left(1 + r^{-1} \right) f \left( r^{-1}p^*_r \right)$$

$$- 2 \left(p^*_r (1 - \gamma) - c \right) r^{-1} f \left( r^{-1}p^*_r \right) = 0$$

To ensure a unique interior equilibrium, we assume that $$2 \left(1 - \gamma \right) - \gamma \left(1 + r^{-1} \right) f \left(0 \right) + 2cr^{-1} f \left(0 \right) > 0$$ and that the below SOC holds:

$$- 2 \left(p (1 - \gamma) - c \right) r^{-2} f' \left( r^{-1}p \right) < 0$$

In the absence of self-signaling, the decision maker cannot affect future self-control perceptions nor delay future misregulation. His initial implementation decision carries no implications, and he possesses fairly little incentive to withstand his first impulse. Accordingly, a more narrow range of consumer types use the program in 1.2, relative to an identically priced market where self-signaling exists. In the present comparative framework, the seller
expects a smaller probability of implementation and responds by setting a suitably lower per-usage fee. Stated differently, the firm assesses higher per-usage rates when self-signaling impacts consumer behavior.

**Proposition 4.** Where implementation state self-control is sufficiently high, self-signaling inflates $p^*$. That is, $p^* > p^*_e$ for any $f(\beta)$ such that $1 - F(r^{-1}p^*_e) > r(1 - F(p^*))$.

By requiring greater per-usage fees, the seller exploits the self-signaling consumer and his eagerness to remain optimistic in resolution pursuit. This eagerness, however, only pertains to the initial period of implementation. The decision maker faces no future decisions once he enters 2.2—during this final period, he faces the same tradeoff irrespective of his information set in 2.1. Self-signaling, in other words, does not impact the final probability of use for any given per-usage fee. Moreover, because $p^* > p^*_e$, fewer consumer types actually achieve their resolution when self-signaling influences self-improvement pursuit.

The decision maker emerges as worse off for only temporarily recalling $\beta$, although this temporary recall does not affect consumer welfare per se; rather, the consumer, in trying to stave off lapse-activated misregulation, initially accepts prices that he would not otherwise tolerate. Accordingly, policymakers must circumvent this aspect of pricing strategy in order to successfully bolster resolution pursuit. Policymakers can achieve this end by minimizing the threat of lapse-activated responses; one possible policy intervention, for instance, may incentivize service providers to follow up and motivate consumers that have slipped in their resolution efforts.

### 5 Quality Improvement

In the model outlined so far, the seller withstands limited pricing latitude, owing to an inability to affect WTP. However, firms often influence WTP by strategically selecting or altering the quality of their self-improvement programs. For instance, Jenny Craig has historically relied upon in-person consultations for its dieting participants, but eventually introduced telephone counseling as a convenient alternative (Callahan 2008). Their competi-
tor Nutrisystem recently expanded its menu of weight-loss meals, in addition to improving the taste of its existing selections (Farnham 2011). Health clubs such as LA Fitness and Gold’s Gym have started to offer small-group training for customers seeking a sense of community; similarly, these chains have widened their scope of fitness classes to include options like spinning, yoga, and martial arts (Masihy 2014).

We examine these issues in the following analysis, where the seller can select any quality level \( s \geq 1 \) at marginal cost \( s^2c \). If the seller incurs greater costs, its higher quality selection increases the consumer’s preference for exercising self-control during implementation; that is, for any \( s \geq 1 \), the consumer receives \( rs \) each time he endures his impulse and uses the program. This direct program benefit, in turn, impacts the decision maker’s willingness to delay gratification between implementation decisions— he exhibits greater motivation to undertake a self-improvement plan if he ultimately earns higher payoffs from program use. In other words, for any \( s \geq 1 \), the decision maker earns benefit \((1 - r)s\) when he exercises self-restraint during planning periods.

The seller thus evaluates the increase in expected demand against the increase in costs from improving quality: for some moderate range of baseline cost \( c \), the seller improves its quality but not to the extent that \( \gamma(a + (1 - r)s) \geq a \). In this instance, the consumer may quit upon forming a negative posterior, implying that self-signaling remains consequential. We accordingly focus on this setting below.\(^{10} \)

In this scenario, the sellers employs a product and pricing strategy as follows\(^{11} \):

\[
\{\hat{L}, \hat{p}, \hat{s}\} = \arg \max_{\{L, p, s\}} L + (p - s^2c)(2 - F(s^{-1}p) - F(r^{-1}s^{-1}p))
\]

\[
s.t. \ \gamma[(a + s - p)(1 - F(s^{-1}p)) + (a + (1 - r)s)F(s^{-1}p)] + \\
\gamma[(a + s - p)(1 - F(r^{-1}s^{-1}p))] + \\
\gamma[(a + (1 - r)s)(F(r^{-1}s^{-1}p) - F(s^{-1}p)) + aF(s^{-1}p)] - L \geq a + \gamma a
\]

\(^{10}\)If \( c \) is sufficiently low, the seller selects \( s > 1 \) \( s.t. \ \gamma(a + (1 - r)s) \geq a \), which implies that the consumer never quits his self-improvement plan.

\(^{11}\)We formally denote the constraints for each consumption pattern in our Online Appendix.
Using Equation (13b) to solve for \( \hat{L} \), we characterize the interior equilibrium in \( \{ \hat{p}, \hat{s} \} \):\(^{12}\)

\[
(1 - \gamma) \left( 2 - F(\hat{s}^{-1}\hat{p}) - F\left( r^{-1}\hat{s}^{-1}\hat{p} \right) \right) - \gamma \left( f(\hat{s}^{-1}\hat{p}) + f\left( r^{-1}\hat{s}^{-1}\hat{p} \right) \right) \\
- \hat{s}^{-1}(\hat{p}(1 - \gamma) - \hat{s}^2c) \left( f(\hat{s}^{-1}\hat{p}) + r^{-1}f\left( r^{-1}\hat{s}^{-1}\hat{p} \right) \right) = 0 \quad (14a) \\
(\gamma - 2\hat{s}c) \left( 2 - F(\hat{s}^{-1}\hat{p}) - F\left( r^{-1}\hat{s}^{-1}\hat{p} \right) \right) + \gamma \hat{s}^{-1}\hat{p} \left( f(\hat{s}^{-1}\hat{p}) + f\left( r^{-1}\hat{s}^{-1}\hat{p} \right) \right) + \\
\hat{s}^{-2}\hat{p}(\hat{p}(1 - \gamma) - \hat{s}^2c) \left( f(\hat{s}^{-1}\hat{p}) + r^{-1}f\left( r^{-1}\hat{s}^{-1}\hat{p} \right) \right) + \gamma (1 - r) F\left( r^{-1}\hat{s}^{-1}\hat{p} \right) = 0 \quad (14b)
\]

**Consumption Effects of Quality Improvement**

In order to provide improved quality, the seller must incur higher costs on each occasion of program use. The seller can only recover such costs by increasing its per-usage fees, a strategy further incentivized by two facets of the consumer’s implementation decisions. First, and more obvious, the decision maker exhibits greater WTP during implementation because he receives a larger benefit from program use. This first effect, in turn, suggests that the consumer possesses particular incentive to continue his self-improvement plan in 2.1 and preempt lapse-activated misregulation in 1.2. Accordingly, the seller assesses a substantial hike in per-usage fees for a comparatively small quality improvement, all the while sustaining a rather modest decrease in program use likelihood relative to the baseline model.

While modestly affecting implementation, the seller’s product and pricing strategies render even less impact on self-improvement planning. During each planning state, the decision maker acknowledges his slightly lower prospect of implementation, but this decreased probability does not deteriorate the overall expected benefit from continuing. The firm, by offering a larger payoff from program use, profitably sells a contract where the consumer becomes a quitter with greater probability.

These findings are formally presented in Propositions 5 and 6 below:

**Proposition 5.** When the seller improves program quality, its corresponding pricing strategy

\[^{12}\]We have omitted the SOCs for brevity.
reduces the likelihood of program use relative to the baseline model. That is, for any \( \hat{s} > 1 \), 
\( \hat{p} > p^* \hat{s} \) and 
\[ 2 - F (\hat{s}^{-1} \hat{p}) - F (r^{-1} \hat{s}^{-1} \hat{p}) < 2 - F (p^*) - F (r^{-1} p^*). \]

**Proposition 6.** Where implementation state self-control is sufficiently high, self-signaling inflates \( \hat{p} \) and/or deflates \( \hat{s} \). That is, 
\( \hat{p} > \hat{p}_- \) and/or \( \hat{s} < \hat{s}_- \) for any \( f (\beta) \) such that
\[ 1 - F (r^{-1} \hat{s}_-^{-1} \hat{p}_-) > r (1 - F (\hat{s}^{-1} \hat{p}_-)). \]

The seller’s joint strategy capitalizes on present-bias variation, essentially deterring plan implementation but not planning itself. This approach corresponds to evidence from the fitness and health club industry, where full-service gyms procure countless machines requiring routine upkeep. Relative to low-maintenance free weights, workout machines typically possess limited efficacy; however, these machines appeal to casual gym users that often suspend attendance mid-contract (McMurray 1998). This type of tactic, in which the seller impedes resolution achievement, also sustains program demand when consumers lack perfect knowledge of their self-control limitations. Weight Watcher’s largest online support group, for instance, targets those reattempting the diet (Weight Watchers 2014). Similarly, over 50% of Jenny Craig enrollees have formerly participated in its weight-loss program (Dunlevy 2009).

6 Variable Pricing

In both §4 and §5, we assume that the firm charges the same per-usage fee during every incident of program utilization. Nevertheless, marketers do not always price self-improvement programs in this manner. 24 Hour Fitness, for example, provides loyalty discounts after one year of membership, ostensibly helping the gym prevent exercise apathy and enrollee attrition. Walgreens offers its Balance Rewards program, where customers redeem store credit earned from wellness activities such as exercise and health screenings. Conversely, the weight-loss provider Nutrisystem regularly offers promotional trials to convert its prospects into customers.

We address these issues in the following analysis, allowing the seller to set a per-usage
fee specific to each implementation decision. That is, the firm tenders contract \( \{L, p_1, p_2\} \): 
\( L \) represents an upfront fee, as in §4 and §5; \( p_1 \) and \( p_2 \), however, denote the per-usage rates charged on the first and second incidents of program use. Note that \( p_1 \) and \( p_2 \) do not necessarily correspond to the period of time; that is, the decision maker only pays \( p_2 \) in 2.2 if he utilized the program in 1.2.

A variable pricing scheme permits a wider range of consumption patterns in equilibrium. In particular, pricing strategy impacts self-improvement planning in 2.1, when the consumer monitors his progress toward his resolution. At this point, \( p_1 \) and \( p_2 \) determine whether he continues his resolution plan (1.) conditional on having used in 1.2 or (2.) irrespective of his prior implementation decision.\(^{13}\)

**Loyalty Discount:** The first scenario, bearing resemblance to §4 and §5, occurs when the seller sets \( p_2 \) sufficiently low. This loyalty discount strategy incentivizes repeated program use, as the consumer only receives access to \( p_2 \) if he first uses at rate \( p_1 \) in 1.2. Here, the consumer tolerates \( p_1 \), in part, due to a threat of lapse-activated misregulation: if he lapses in 1.2, he effectively forfeits loyalty discount \( p_2 \) and, upon entering 2.1, attributes his forfeiture to a severe impulse problem. Thus, in this scenario, the consumer’s willingness to continue in 2.1 entirely hinges on his prior implementation decision.

This scenario, like §4 and §5, presents three consumption types: finisher, committer, and quitter. We detail these consumption patterns below. In the descriptions that follow, \( D_{1,2} \) denotes the unconditional probability that the decision maker uses in both 1.2 and 2.2. Similarly, \( D_{1,0}, D_{0,1}, \) and \( D_{0,0} \) respectively represent the unconditional probabilities of using only in 1.2, only in 2.2, and in neither period.

**Finisher:** Only knowing \( f(\beta) \) in 1.1, the finisher investigates the seller’s contract and expects a net benefit from joining the self-improvement program. He accepts the contract, as indicated by (15a). Following his contract acceptance, the finisher enters 1.2 and attains complete information about \( \beta \). He pays \( p_1 \) and uses the program at this time, knowing that

\(^{13}\)The consumer may also abandon his plan in 2.1, regardless of his actions in 1.2. However, our simulations did not uncover any equilibrium consistent with this possibility.
his resultant beliefs in 2.1 will induce him to continue his plan. This decision corresponds to (15b).

Once the finisher enters 2.1 and recalls his prior implementation decision, he infers a minimal self-control problem and sustains his resolution efforts. This corresponds to (15c). Finally, he enters 2.2 and regains perfect knowledge of $\beta$. He pays loyalty rate $p_2$ and uses the program again, as reflected by (15d).

$$1.1 : \gamma [(a + 1 - p_1) (D_{1,2} + D_{1,0}) + (a + 1 - r) D_{0,0}] +$$  
$$\gamma [(a + 1 - p_2) D_{1,2} + (a + 1 - r) D_{1,0} + a D_{0,0}] +$$  
$$- L \geq a_{\text{Period 1}} + \gamma a_{\text{Period 2}} \quad (15a)$$

$$1.2 : \beta (a + 1) - p_1 + \beta (a + 1 - p_2) \geq \beta (a + 1 - r) + \beta a \quad (15b)$$

$$2.1 : \gamma (a + 1 - p_2) \frac{D_{1,2}}{D_{1,2} + D_{1,0}} + \gamma (a + 1 - r) \frac{D_{1,0}}{D_{1,2} + D_{1,0}} \geq a \quad (15c)$$

$$2.2 : \beta (a + 1) - p_2 \geq \beta (a + 1 - r) \quad (15d)$$

**Committer:** Like the finisher, the committer maintains his plan in 2.1; the committer, however, does not pay $p_2$ to use the program in 2.2.

$$1.2 : \beta (a + 1) - p_1 + \beta (a + 1 - r) \geq \beta (a + 1 - r) + \beta a \quad (16a)$$

$$2.1 : \gamma (a + 1 - p_2) \frac{D_{1,2}}{D_{1,2} + D_{1,0}} + \gamma (a + 1 - r) \frac{D_{1,0}}{D_{1,2} + D_{1,0}} \geq a \quad (16b)$$

$$2.2 : \beta (a + 1) - p_2 < \beta (a + 1 - r) \quad (16c)$$

Note that, per (16a) and (16c), this consumption pattern only transpires if $p_2 \geq r p_1$; otherwise, any consumer type that used in 1.2 will do so again in 2.2.

**Quitter:** The quitter succumbs to his impulse in 1.2, knowing that he will form negative self-control perceptions and quit all efforts in 2.1. This sequence of actions corresponds to
the LHS of (17a). The RHS, on the other hand, represents the quitter’s ultimate payoffs if he uses the program in 1.2: conditional on use in 1.2, quitter types that satisfy $\beta \geq r^{-1}p_2$ prefer to pay $p_2$ in 2.2.

\[
1.2 : \beta(a + 1 - r) + \beta a \geq \beta(a + 1) - p_1 + \beta(a + 1 - p_2) + (1 - \beta \geq r^{-1}p_2) \beta(a + 1 - r) \quad (17a)
\]

\[
2.1 : \gamma(a + 1 - r) < a \quad (17b)
\]

**Introductory Discount:** Whereas the above scenario requires a discounted $p_2$, the second planning scenario transpires when the seller sets $p_1$ low, both in absolute value and relative to $p_2$. This pricing strategy, instead of impelling repeated use, reduces initial implementation barriers and coaxes the consumer to try out the program. In turn, the decision maker remains optimistic toward his resolution irrespective of his self-control perceptions. That is, the decision maker continues his resolution in 2.1 even if he recalls past implementation failure—he deduces that he will only pay $p_1$ to use the program and that he purposefully postponed this consumption until 2.2. In this scenario, the seller essentially averts lapse-activated misregulation through its use of an introductory discount strategy.

This planning scenario contains three consumption types: finisher, postponer, and optimist. We describe these below.

**Finisher:** The finisher first accepts the seller’s contract in 1.1, as shown by (18a). He then enters 1.2 and pays $p_1$ to utilize the program, realizing that he will ultimately pay $p_2$ to use again in 2.2. This corresponds to the LHS of (18b). The RHS, on the other hand, denotes the finisher’s total payoff from non-use in 1.2, where he prefers to pay $p_1$ in 2.2 if $\beta \geq r^{-1}p_1$. The finisher then arrives in 2.1 and, observing his past implementation decision, surmises that he will ultimately execute his plan in 2.2. He continues his resolution efforts, as indicated by (18c). Finally, he enters 2.2 and uses the program at rate $p_2$, as reflected by (18d).
1.1 : $\gamma [(a + 1 - p_1) D_{1,2} + (a + 1 - r) (D_{0,1} + D_{0,0})] +$

$\gamma [(a + 1 - p_2) D_{1,2} + (a + 1 - p_1) D_{0,1} + (a + 1 - r) D_{0,0}]$

$- L \geq a \gamma \alpha + \gamma a \quad (18a)$

$$1.2 : \beta (a + 1) - p_1 + \beta (a + 1 - p_2) \geq \beta (a + 1 - r) +$$

$$\beta (a + 1 - p_2) + (1 - \beta_{2 r - 1}) \beta (a + 1 - r) \quad (18b)$$

2.1 : $\gamma (a + 1 - p_2) \geq a \quad (18c)$

2.2 : $\beta (a + 1) - p_2 \geq \beta (a + 1 - r) \quad (18d)$

Postponer: The postponer forgoes utilization in 1.2 with the knowledge that he will use in 2.2. This decision corresponds to (19a).

Upon entering 2.1, the postponer no longer possesses complete information about his impulse problem and must estimate whether he will pay $p_1$ in 2.2. He holds relatively optimistic expectations and determines that he should continue his resolution plan, as reflected by (19b).

$$1.2 : \beta (a + 1 - r) + \beta (a + 1 - p_1) \geq \beta (a + 1 - p_1) +$$

$$\beta (a + 1 - p_1) + (1 - \beta_{2 r - 1}) \beta (a + 1 - r) \quad (19a)$$

$$2.1 : \gamma (a + 1 - p_1) + \frac{D_{0,1}}{D_{0,1} + D_{0,0}} + \gamma (a + 1 - r) \frac{D_{0,0}}{D_{0,1} + D_{0,0}} \geq a \quad (19b)$$

2.2 : $\beta (a + 1) - p_1 \geq \beta (a + 1 - r) \quad (19c)$

Optimist: Like the postponer, the optimist decides to continue in 2.1 despite his prior implementation failure. The optimist, however, ultimately gives into his impulse again in 2.2. This final decision corresponds to (20c).
1.2 : $\beta (a + 1 - r) + \beta (a + 1 - r) \geq \beta (a + 1) - p_1 +$

Period 1

Period 2

Period 1

Period 2

$\beta (a + 1 - p_2) + (1 - \beta \geq r - 1 \beta p_2) \beta (a + 1 - r) \geq a$

(20a)

2.1 : $\gamma (a + 1 - p_1) \frac{D_{0,1}}{D_{0,1} + D_{0,0}} + \gamma (a + 1 - r) \frac{D_{0,0}}{D_{0,1} + D_{0,0}} \geq a$

(20b)

2.2 : $\beta (a + 1) - p_1 < \beta (a + 1 - r)$

(20c)

Having illustrated each possible incidence of planning and implementation, we may formulate the seller’s profit maximization problem:

$$\{\bar{L}, \bar{p}_1, \bar{p}_2\} = \arg \max_{\{L, p_1, p_2\}} L + (p_1 - c) (1 - D_{0,0}) + (p_2 - c) D_{1,2}$$

(21a)

\[ s.t. \gamma [(a + 1 - p_1) (D_{1,2} + D_{1,0}) + (a + 1 - r) D_{0,0}] + \]

\[ \gamma [(a + 1 - p_2) D_{1,2} + (a + 1 - r) D_{0,0} + aD_{0,0}] - L \geq a + \gamma a \]

If $p_1$ and $p_2$ satisfy (15a) through (17b)

(21b)

\[ s.t. \gamma [(a + 1 - p_1) D_{1,2} + (a + 1 - r) (D_{0,1} + D_{0,0})] + \]

\[ \gamma [(a + 1 - p_2) D_{1,2} + (a + 1 - p_1) D_{0,1} + (a + 1 - r) D_{0,0}] - L \geq a + \gamma a \]

If $p_1$ and $p_2$ satisfy (18a) through (20c)

(21c)

**Variable Pricing Strategies and Consumer Learning**

The seller influences resolution pursuit through its selection of a pricing strategy. A loyalty pricing scheme encourages repeated use via a discounted $\bar{p}_2$; this strategy incentivizes initial use, though, by creating a threat of lapse-activated misregulation. Accordingly, a loyalty strategy only yields its intended results when the consumer incurs a relatively moderate impulse problem. Where the decision maker suffers more severe impulses, the firm must devise a pricing strategy that minimizes the effects of an initial lapse. The firm, for instance, can help prevent the occurrence of an initial slip-up if it sets $\bar{p}_1 = \bar{p}_2 = 0$, but this strategy generates no per-usage revenues and expects that the firm encounters relatively low marginal
costs. In the event of higher per-usage costs, the seller may only limit the consequences of an initial lapse by using an introductory discount scheme with $\bar{p}_1 > 0$ significantly below $\bar{p}_2$.

We address these insights in Result 7 below. In the following analysis, we do not characterize a general set of equilibria for (21a)-(21c), as the shape of the demand curve depends upon $\{L, p_1, p_2\}$. We thus numerically examine a scenario where $\beta$ follows a truncated beta distribution.$^{15}$

**Result 7.** Suppose that $f(\beta) \sim \text{Truncated Beta}(\alpha_1, \alpha_2; 0, \beta_{\text{max}})$, where $\alpha_1$ and $\alpha_2$ are shape parameters and $\beta$ is defined on $(0, \beta_{\text{max}})$. If the ratio $\alpha_1/\alpha_2$ is sufficiently high, then the seller sets $\bar{p}_1 > \bar{p}_2$. Conversely, the seller sets $\bar{p}_2 > \bar{p}_1$ if $\alpha_1/\alpha_2$ is sufficiently low and $c$ is sufficiently high.

Without complete knowledge of the consumer’s impulse severity, the seller must use $f(\beta)$ to determine its pricing policy.

For instance, when $\alpha_1$ is sufficiently greater than $\alpha_2$, $f(\beta)$ possesses significant mass near $\beta_{\text{max}}$ and the decision maker suffers strong impulses with little probability. This scenario provides the firm sufficient latitude to utilize a loyalty pricing strategy. Notably, in our simulations, the seller employs a sizeable loyalty discount in its pricing scheme, ultimately with the aim of converting all would-be committers into finishers. An example of this retention method, many small fitness chains utilize the loyalty program Perkville, a software that tallies gym use and then allows earned reward points to be applied to membership costs (Miles 2012). Similar to this strategy, many firms utilize financial rewards as incentivization. Cambridge Credit Counseling, for instance, offers a cash back reward to customers after six consecutive payments, helping the company attain a particularly high retention rate for its industry (Cambridge Credit Counseling 2002; Williams 2013). Employers also reward employees that persevere through fitness programs; for example, King County, WA incentivized

---

$^{14}$We have not discussed off-equilibrium beliefs as of yet, as no prior results have included off-equilibrium actions. A pooling equilibrium where $p_1 = p_2 = 0$ permits any off-equilibrium belief for all $\beta \in (0, \beta_{\text{max}})$.

$^{15}$We use a Beta Distribution for its ability to assume many different shapes. We require a truncated distribution because we assume that $\beta \in (0, \beta_{\text{max}})$. Our result arises from an extensive simulation analysis. We plot $\bar{p}_1$ and $\bar{p}_2$ for different values of $f(\beta)$ in our Online Appendix.
2,000 workers to lose at least 5% body fat (Noguchi 2013).

On the other hand, $f(\beta)$ is sufficiently skewed away from $\beta_{\max}$ when $\alpha_1/\alpha_2$ is relatively low. The consumer, in this instance, incurs severe impulses with considerable likelihood, forcing the seller to sustain optimistic consumer expectations with an introductory discount strategy. Jenny Craig, for instance, frequently offers reduced membership fees for the first month (Jenny Craig 2014). Additionally, many credit cards offer teaser rates for an initial period, an effective method to gain customers seeking to transfer existing debt (Warnick 2014). Firms may utilize such introductory discounts so that consumers do not realize their limitations during an initial "cooling-off period", a window in which remorseful buyers can exit an otherwise binding contract (GSA 2014). This particular use of introductory discounts contextualizes consumer complaints in self-improvement industries; most complaints within the health club sector, for instance, center around gyms offering introductory terms and aggressive sells tactics (Smith Maguire 2008).

7 Concluding Remarks

Our present model examines self-signaling, a method to stave off resolution abandonment, and its implications for self-improvement program strategy. We establish that self-signaling, as a strategy to avert lapse-activated misregulation, causes the decision maker to endure higher per-usage rates during resolution pursuit. We also ascertain that the consumer faces higher per-usage fees when in little risk of lapsing during implementation. However, we determine that the decision maker confronts higher upfront fees and lower per-usage fees when he possesses high self-control during planning decisions.

Our paper further examines self-signaling in regards to product quality. We indicate that self-signaling allows a firm to greatly increase its per-usage fees when improving product quality, a joint strategy that ultimately impedes resolution achievement and sustains program necessity when consumers possess imperfect self-control perceptions. Finally, we explore self-control perceptions and its relation to variable pricing policies. We find that
introductory discounts circumvent lapse-activated misregulation, sustaining the enrollee’s optimism toward his resolution; a loyalty discount strategy, however, incentivizes precommitment by yielding negative perceptions after an initial lapse.

Many of our results suggest potential policy intervention as a method to improve consumer well-being. Such intervention may induce the seller to employ strategies which better enable resolution achievement. For instance, an incentive program can offset fixed costs associated with technological investment, allowing the firm to improve quality without raising its per-usage fees. Policymakers can also subsidize loyalty discounts, so that pricing incentivizes repeated program use. Alternatively, policy intervention may directly target consumers; financial rewards, particularly those linked to resolution progress, encourage long-term use in a manner similar to that of a loyalty discount program.

These policy and strategy prescriptions present future research opportunities. For example, self-improvement participants typically rely on peer interaction, both as a source of emotional support and of competitive inspiration. Accordingly, future work may explore social influences and their implications for program pricing. Additional research may analyze competition and its effect on both enrollee segmentation and targeting. Finally, future work can explore pricing issues outside the domain of contract design. For instance, research may determine whether a firm should time its promotional policies in order to induce impulsive behavior.
Table 1: Model Notation

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\gamma$</td>
<td>Consumer’s present-bias during planning</td>
</tr>
<tr>
<td>$\beta$</td>
<td>Consumer’s present-bias during implementation</td>
</tr>
<tr>
<td>$f(\beta)$</td>
<td>Prior distribution of $\beta$</td>
</tr>
<tr>
<td>$\mu(\beta)$</td>
<td>Posterior distribution of $\beta$</td>
</tr>
<tr>
<td>$a$</td>
<td>Benefit to immediate gratification</td>
</tr>
<tr>
<td>$1 - r$</td>
<td>Payoff from self-control during planning</td>
</tr>
<tr>
<td>$r$</td>
<td>Payoff from self-control during implementation</td>
</tr>
<tr>
<td>$L^*$</td>
<td>Optimal upfront fee in §4</td>
</tr>
<tr>
<td>$p^*$</td>
<td>Optimal per-usage fee in §4</td>
</tr>
<tr>
<td>$s$</td>
<td>Optimal quality level in §5</td>
</tr>
<tr>
<td>${L, \hat{p}}$</td>
<td>Optimal contract in §5</td>
</tr>
<tr>
<td>${L, \hat{p}_1, \hat{p}_2}$</td>
<td>Optimal contract in §6</td>
</tr>
</tbody>
</table>

Figure 1: Consumer Decision Tree
REFERENCES


Lemma 1. Proof

Suppose that every consumer type abandons his plan in 2.1, regardless of whether he used the program in 1.2. In 2.1, the consumer faces the below trade-offs:

\[ \gamma (a + 1 - p) \frac{1 - F(\max(\beta_1, \beta_2))}{1 - F(\beta_1)} + \gamma (a + 1 - r) \frac{F(\max(\beta_1, \beta_2)) - F(\beta_1)}{1 - F(\beta_1)} < a \]  
(22a)

\[ \gamma (a + 1 - p) \frac{F(\beta_1) - F(\min(\beta_1, \beta_2))}{F(\beta_1)} + \gamma (a + 1 - r) \frac{F(\min(\beta_1, \beta_2))}{F(\beta_1)} < a \]  
(22b)

where \( \beta_{\max} > \beta \geq \beta_1 \) utilized the program in 1.2 and \( \beta_{\max} > \beta \geq \beta_2 \) would ultimately use in 2.2, conditional on not quitting in 2.1. Here, the first inequality characterizes the decision to quit after having used in 1.2; the consumer, despite knowing that \( \beta_{\max} > \beta \geq \beta_1 \), does not expect a payoff to justify delaying gratification. Similarly, the second inequality applies to a consumer that did not use in 1.2.

The decision maker would ultimately utilize the program in 2.2 if \( \beta (a + 1) - p \geq \beta (a + 1 - r) \), or if \( \beta \geq \beta_2 = r^{-1}p \). Furthermore, if all types quit in 2.1, the consumer only uses the product in 1.2 if \( \beta (a + 1) - p + \beta a \geq \beta (a + 1 - r) + \beta a \). That is, \( \beta_1 = \beta_2 = r^{-1}p \), requiring that \( \gamma (a + 1 - p) < a \) and \( \gamma (a + 1 - r) < a \). These inequalities imply that \( \gamma (a + 1 - p) (1 - F(\beta_1)) + \gamma (a + 1 - r) F(\beta_1) + \gamma a - L < a + \gamma a \) for any \( L \geq 0 \). Thus, in 1.1, the consumer does not accept any contract, and this scenario cannot occur in equilibrium.

Next, suppose that every consumer type continues his plan in 2.1, irrespective of whether he used in 1.2. This implies the below trade-offs in 2.1:

\[ \gamma (a + 1 - p) \frac{1 - F(\max(\beta_1, \beta_2))}{1 - F(\beta_1)} + \gamma (a + 1 - r) \frac{F(\max(\beta_1, \beta_2)) - F(\beta_1)}{1 - F(\beta_1)} \geq a \]  
(23a)

\[ \gamma (a + 1 - p) \frac{F(\beta_1) - F(\min(\beta_1, \beta_2))}{F(\beta_1)} + \gamma (a + 1 - r) \frac{F(\min(\beta_1, \beta_2))}{F(\beta_1)} \geq a \]  
(23b)

The consumer uses the program in 2.2 if \( \beta (a + 1) - p \geq \beta (a + 1 - r) \), or if \( \beta \geq \beta_2 = r^{-1}p \). For any \( \beta \geq r^{-1}p \), the consumer also utilizes the product in 1.2 since \( \beta (a + 1) - p + \beta (a + 1 - p) \geq \beta (a + 1 - r) + \beta (a + 1 - p) \). Conversely, no decision maker uses the program in 1.2 if he does not ultimately consume in 2.2. This follows from
the fact that $\beta (a + 1) - p + \beta (a + 1 - r) < \beta (a + 1 - r) + \beta (a + 1 - r)$ $\forall r^{-1}p > \beta > 0$. Thus, $\beta_1 = \beta_2 = r^{-1}p$, requiring that $\gamma (a + 1 - p) \geq a$ and $\gamma (a + 1 - r) \geq a$. This latter inequality, however, violates the assumption that $\gamma (a + 1 - r) < a$. Hence, this scenario does not transpire in equilibrium.

Finally, suppose that the consumer quits in 2.1 only if he did not use the program in 1.2. This implies the following in 2.1:

$$\gamma (a + 1 - p) \frac{1 - F(\max\{\beta_1, \beta_2\})}{1 - F(\beta_1)} + \gamma (a + 1 - r) \frac{F(\max\{\beta_1, \beta_2\}) - F(\beta_1)}{1 - F(\beta_1)} \geq a$$  \tag{24a}$$
$$\gamma (a + 1 - p) \frac{F(\beta_1) - F(\min\{\beta_1, \beta_2\})}{F(\beta_1)} + \gamma (a + 1 - r) \frac{F(\min\{\beta_1, \beta_2\})}{F(\beta_1)} < a$$  \tag{24b}$$

Any consumer satisfying $\beta_{\max} > \beta \geq \beta_2 = r^{-1}p$ utilizes the program in 2.2 so long as he does not quit in 2.1. He factors this knowledge into his implementation decision in 1.2: if he uses in 1.2, he ultimately earns $\beta (a + 1) - p + \beta (a + 1 - p)$; if not, he will quit in 2.1 and receive a total payoff of $\beta (a + 1 - r) + \beta a$. It follows that $\beta (a + 1) - p + \beta (a + 1 - p) \geq \beta (a + 1 - r) + \beta a$ $\forall \beta_{\max} > \beta \geq r^{-1}p$, implying that $\beta_2 \geq \beta_1$.

On the other hand, a consumer with type $\beta_2 = r^{-1}p > \beta > 0$ will not use in 2.2. To determine whether to utilize the product in 1.2, he compares ultimate payoffs $\beta (a + 1) - p + \beta (a + 1 - r)$ and $\beta (a + 1 - r) + \beta a$, where $\beta (a + 1) - p + \beta (a + 1 - r) \geq \beta (a + 1 - r) + \beta a$ $\forall r^{-1}p > \beta \geq \beta_1 = p$.

Thus, $\beta_{\max} > \beta \geq \beta_1 = p$ implement in 1.2 and continue in 2.1; of these, however, only $\beta_{\max} > \beta \geq \beta_2 = r^{-1}p$ utilize the program in 2.2. Finally, $\beta_1 = p > \beta > 0$ do not use in 1.2 and quit in 2.1. This demand pattern occurs for any $p$ that satisfies:

$$\gamma (a + 1 - p) \frac{1 - F(r^{-1}p)}{1 - F(p)} + \gamma (a + 1 - r) \frac{F(r^{-1}p) - F(p)}{1 - F(p)} \geq a$$  \tag{25a}$$
$$\gamma (a + 1 - r) < a$$  \tag{25b}$$

**Proposition 2. Proof**

To determine $\frac{\partial p^*}{\partial \gamma}$, we first apply the implicit function theorem to Equation (8a). This
yields:
\[
\frac{\partial p^*}{\partial \gamma} = \frac{(2 - F(p^*) - F(r^{-1}p^*)) + (1 - p^*) f(p^*) + (1 - r^{-1}p^*) f(r^{-1}p^*)}{-2(1 - \gamma)(f(p^*) + r^{-1}F(r^{-1}p^*)) - \gamma(f(p^*) + r^{-1}F(r^{-1}p^*)) - \gamma f(p^*) + (1 - \gamma)(f(p^*) + r^{-2}F(r^{-1}p^*))}
\]  

(26a)

The equilibrium price \( p^* \) must satisfy \( 0 < r^{-1}p^* < \beta_{\text{max}} < 1 \) in order for some range of \( \beta \) to satisfy (3a)-(3d). Accordingly, we conclude that the above numerator is positive. We also determine that the denominator is negative, per Equation (9a). These two findings imply that \( \frac{\partial p^*}{\partial \gamma} < 0 \).

Next, we note \( L^* = -a (1 - \gamma) + \gamma (2 - F(p^*) - r F(r^{-1}p^*)) - p^* \gamma (2 - F(p^*) - F(r^{-1}p^*)) \).

We differentiate this figure with respect to \( \gamma \):

\[
\frac{\partial L^*}{\partial \gamma} = a + (2 - F(p^*) - r F(r^{-1}p^*)) - p^* (2 - F(p^*) - F(r^{-1}p^*))
\]

\[- \frac{\partial p^*}{\partial \gamma} \gamma [(2 - F(p^*) - F(r^{-1}p^*)) + (1 - p^*) f(p^*) + (1 - r^{-1}p^*) f(r^{-1}p^*)]
\]  

(27a)

We know that \( 0 < r^{-1}p^* < \beta_{\text{max}} < 1 \) and \( 1 > r > 0 \), meaning that \( (2 - F(p^*) - r F(r^{-1}p^*)) - p^* (2 - F(p^*) - F(r^{-1}p^*)) > (1 - p^*) (2 - F(p^*) - F(r^{-1}p^*)) > 0 \). Since \( \frac{\partial p^*}{\partial \gamma} < 0 \), it follows that \( \frac{\partial L^*}{\partial \gamma} > 0 \).

**Proposition 3. Proof**

Before we show that \( p^*_y > p^*_f \), we deduce relevant properties of the strict monotone likelihood ratio property (MLRP).

We first note that, where \( \frac{\partial}{\partial p} \frac{g(p)}{f(p)} > 0 \) \( \forall \beta_{\text{max}} > p > 0 \), \( \frac{g(p)}{f(p)} > \frac{g(p')}{f(p')} \) for any \( \beta_{\text{max}} > p' > p > 0 \). This implies \( \frac{g(r^{-1}p)}{f(r^{-1}p)} > \frac{g(p)}{f(p)} \) since \( r^{-1}p > p \) for any \( 1 > r > 0 \) and \( \beta_{\text{max}} > p > 0 \). It also follows that

\[
\frac{g(p) + r^{-1}g(r^{-1}p)}{f(p) + r^{-1}f(r^{-1}p)} > \frac{g(p) + g(r^{-1}p)}{f(p) + f(r^{-1}p)}
\]  

(28a)

Next, we indicate that \( \frac{\partial}{\partial p} \frac{g(p) + r^{-1}g(r^{-1}p)}{f(p) + r^{-1}f(r^{-1}p)} > 0 \) is equivalent to \( \frac{g(p'') + r^{-1}g(r^{-1}p'')}{f(p'') + r^{-1}f(r^{-1}p'')} > \frac{g(p) + r^{-1}g(r^{-1}p)}{f(p) + r^{-1}f(r^{-1}p)} \) \( \forall \beta_{\text{max}} > p'' > p > 0 \). We rearrange this to \( (f(p) + r^{-1}f(r^{-1}p)) (g(p'') + r^{-1}g(r^{-1}p'')) > (f(p'') + r^{-1}f(r^{-1}p'')) (g(p) + r^{-1}g(r^{-1}p)) \). Integrating both sides with respect to \( p'' \), we
demonstrate that:
\[
\frac{2-G(p)-G(r^{-1}p)}{2-F(p)-F(r^{-1}p)} > \frac{g(p)+r^{-1}g(r^{-1}p)}{f(p)+r^{-1}f(r^{-1}p)}
\]
(29a)

We now utilize equations (28a) and (29a) to establish that \( p_g^* > p_f^* \), where \( p_f^* \) and \( p_g^* \) denote the respective optimal prices when \( \beta \sim f() \) and \( \beta \sim g() \). To demonstrate that \( p_g^* > p_f^* \), assume the opposite (i.e. \( p_g^* \leq p_f^* \)). We know that, by definition, \( p_f^* \) and \( p_g^* \) satisfy the below FOCs:

\[
(1-\gamma) \left( 2 - F(p_f^*) - F(r^{-1}p_f^*) \right) - \gamma \left( f(p_f^*) + f(r^{-1}p_f^*) \right) - \left( p_f^* (1-\gamma) - c \right) (f(p_f^*) + r^{-1}f(r^{-1}p_f^*)) = 0 \tag{30a}
\]
\[
(1-\gamma) \left( 2 - G(p_g^*) - G(r^{-1}p_g^*) \right) - \gamma \left( g(p_g^*) + g(r^{-1}p_g^*) \right) - \left( p_g^* (1-\gamma) - c \right) (g(p_g^*) + r^{-1}g(r^{-1}p_g^*)) = 0 \tag{30b}
\]

This, along with the SOC, suggests that \( (1-\gamma) \left( 2 - G(p_f^*) - G(r^{-1}p_f^*) \right) - \gamma \left( g(p_f^*) + g(r^{-1}p_f^*) \right) \) \( - (p_f^* (1-\gamma) - c) (g(p_f^*) + r^{-1}g(r^{-1}p_f^*)) \leq 0 \) if \( p_g^* \leq p_f^* \). However, (28a) and (29a) imply
\[
-\gamma \left( g(p_f^*) + g(r^{-1}p_f^*) \right) > -\gamma \left( f(p_f^*) + f(r^{-1}p_f^*) \right) \frac{g(p_f^*)+r^{-1}g(r^{-1}p_f^*)}{f(p_f^*)+r^{-1}f(r^{-1}p_f^*)}
\]
and
\[
(1-\gamma) \left( 2 - G(p_f^*) - G(r^{-1}p_f^*) \right) > (1-\gamma) \left( 2 - F(p_f^*) - F(r^{-1}p_f^*) \right) \frac{g(p_f^*)+r^{-1}g(r^{-1}p_f^*)}{f(p_f^*)+r^{-1}f(r^{-1}p_f^*)}
\]

It follows that:

\[
(1-\gamma) \left( 2 - G(p_f^*) - G(r^{-1}p_f^*) \right) - \gamma \left( g(p_f^*) + g(r^{-1}p_f^*) \right) - \left( p_f^* (1-\gamma) - c \right) (g(p_f^*) + r^{-1}g(r^{-1}p_f^*)) > 0 \tag{31a}
\]

Contradiction.

**Consumption Patterns w/o Self-Signaling in §4.**

**User:** The user employs \( f(\beta) \) to estimate \( \beta \) and decides to purchase the seller’s contract in 1.1. The user then arrives in 1.2 and gains complete information about \( \beta \). Aware that he will retain knowledge of \( \beta \), the user understands that he will both maintain his plan in 2.1 and use the program in 2.2 whether or not he implements in 1.2. Thus, the user’s decision in 1.2 reduces to a one-shot decision; here, the user decides to implement his plan, as he will
ultimately do again in 2.2.

\[
1.1 : \gamma \left[ (a + 1 - p) \left( 1 - F \left( r^{-1}p \right) \right) + (a + 1 - r) F \left( r^{-1}p \right) \right] + \left[ (a + 1 - p) \left( 1 - F \left( r^{-1}p \right) \right) + a F \left( r^{-1}p \right) \right] - L \geq a + a \tag{32a}
\]

\[
1.2 : \beta (a + 1) - p + \beta (a + 1 - p) \geq \beta (a + 1 - r) + \beta (a + 1 - p) \tag{32b}
\]

\[
2.1 : \gamma (a + 1 - p) \geq a \tag{32c}
\]

\[
2.2 : \beta (a + 1) - p \geq \beta (a + 1 - r) \tag{32d}
\]

**Non-User:** Upon learning \( \beta \), the non-user realizes that his impulse problem precludes program use in 2.2. Also knowing that he will possess this information in 2.1, the non-user understands that he will quit his plan entirely at that time.

\[
1.1 : \gamma \left[ (a + 1 - p) \left( 1 - F \left( r^{-1}p \right) \right) + (a + 1 - r) F \left( r^{-1}p \right) \right] + \left[ (a + 1 - p) \left( 1 - F \left( r^{-1}p \right) \right) + a F \left( r^{-1}p \right) \right] - L \geq a + a \tag{33a}
\]

\[
1.2 : \beta (a + 1) - p + \beta a < \beta (a + 1 - r) + \beta a \tag{33b}
\]

\[
2.1 : \gamma (a + 1 - r) < a \tag{33c}
\]

**Proposition 4. Proof**

Before we illustrate the strategic effects of self-signaling, we specify relevant properties of log-concavity.

We first indicate that log-concavity of \( f(\beta) \) necessitates a monotonically increasing failure rate, implying that \( \frac{f(p')}{1 - F(p')} \geq \frac{f(p)}{1 - F(p)} \) for any \( \beta_{\text{max}} > p > p' > 0 \). Thus, \( \frac{f(r^{-1}p)}{1 - F(r^{-1}p)} \geq \frac{f(p)}{1 - F(p)} \) since \( r^{-1}p > p \) for any \( 1 > r > 0 \) and \( \beta_{\text{max}} > p > 0 \). Where \( f(r^{-1}p) > 0 \) and
\( f(p) > 0 \), this also means that

\[
\frac{r^{-1} f(r^{-1}p)}{1 - F(r^{-1}p)} > \frac{f(p)}{1 - F(p)} \tag{34a}
\]

Next, we derive a consequence of log-concavity when \( f(\beta) \) contains sufficient mass near \( \gamma \). Specifically, if \( 1 - F(r^{-1}p) > r(1 - F(p)) \), then log concavity implies that

\[
1 > \frac{f(p)}{r^{-1} f(r^{-1}p)} \quad \text{for} \quad 1 - F(r^{-1}p) > r(1 - F(p)) \tag{35a}
\]

We now utilize equations (34a) and (35a) to compare \( p^* \), the optimal per-usage fee in the baseline model, and \( p^*_c \), the optimal fee where self-signaling does not occur. We wish to establish that \( p^* > p^*_c \) wherever \( 1 - F(r^{-1}p^*_c) > r(1 - F(p^*_c)) \). To demonstrate this, assume instead that \( p^* \leq p^*_c \).

Using (8a) and (11a), we know that \( p^* \) and \( p^*_c \) are as follows:

\[
(1 - \gamma) (2 - F(p^*) - F(r^{-1}p^*)) - \gamma (f(p^*) + f(r^{-1}p^*)) - (p^*(1 - \gamma) - c) (f(p^*) + r^{-1} f(r^{-1}p^*)) = 0 \tag{36a}
\]

\[
2(1 - \gamma) (1 - F(r^{-1}p^*_c)) - \gamma (1 + r^{-1}) f(r^{-1}p^*_c) - 2(p^*_c(1 - \gamma) - c) r^{-1} f(r^{-1}p^*_c) = 0 \tag{36b}
\]

The above equations, along with the SOC, suggest that \( (1 - \gamma) (2 - F(p^*_c) - F(r^{-1}p^*_c)) - \gamma (f(p^*_c) + f(r^{-1}p^*_c)) - (p^*_c(1 - \gamma) - c) (f(p^*_c) + r^{-1} f(r^{-1}p^*_c)) \leq 0 \) if \( p^* \leq p^*_c \).

However, we utilize (36b) and (34a) to demonstrate that

\[
(1 - \gamma) ((1 - F(p^*_c)) - (1 - F(r^{-1}p^*_c))) - (\gamma + p^*_c(1 - \gamma) - c) (f(p^*_c) - r^{-1} f(r^{-1}p^*_c)) >
\]

\[
\left(\frac{f(p^*_c)}{r^{-1} f(r^{-1}p^*_c)} - 1\right) [(1 - \gamma) (1 - F(r^{-1}p^*_c)) - (\gamma + p^*_c(1 - \gamma) - c) r^{-1} f(r^{-1}p^*_c)].
\]

We indicate, per (35a), that \( \frac{f(p^*_c)}{r^{-1} f(r^{-1}p^*_c)} - 1 < 0 \) whenever \( 1 - F(r^{-1}p^*_c) > r(1 - F(p^*_c)) \). Next, we employ (36b) to show

\[
(1 - \gamma) (1 - F(r^{-1}p^*_c)) - \gamma f(r^{-1}p^*_c) - (p^*_c(1 - \gamma) - c) r^{-1} f(r^{-1}p^*_c) >
\]
\[ 0 > (1 - \gamma) (1 - F (r^{-1} p^*_s)) - \gamma r^{-1} f (r^{-1} p^*_s) - (p^*_s (1 - \gamma) - c) r^{-1} f (r^{-1} p^*_s). \] It follows that:

\[
(1 - \gamma) (2 - F (p^*_s) - F (r^{-1} p^*_s)) - \gamma (f (p^*_s) + f (r^{-1} p^*_s)) - (p^*_s (1 - \gamma) - c) (f (p^*_s) + r^{-1} f (r^{-1} p^*_s)) > 0 \quad (37a)
\]

Contradiction.

**Consumption Patterns in §5.**

A consumer with \( \beta_{\text{max}} > \beta > r^{-1} s^{-1} p \) finishes the program, using in both 1.2 and 2.2:

\[
\beta (a + s) - p + \beta (a + s - p) \geq \beta (a + (1 - r) s) + \beta a \quad (38a)
\]

\[
\beta (a + s) - p \geq \beta (a + (1 - r) s) \quad (38b)
\]

A consumer with \( r^{-1} s^{-1} p > \beta > s^{-1} p \) becomes a committer, only enduring his impulse in 1.2:

\[
\beta (a + s) - p + \beta (a + (1 - r) s) \geq \beta (a + (1 - r) s) + \beta a \quad (39a)
\]

\[
\beta (a + s) - p < \beta (a + (1 - r) s) \quad (39b)
\]

Finally, a quitter satisfies \( s^{-1} p > \beta > 0 \):

\[
\beta (a + s) - p + \beta (a + (1 - r) s) < \beta (a + (1 - r) s) + \beta a \quad (40a)
\]

**Proposition 5. Proof**

In order to show that \( \hat{\beta} > p^* \hat{s} \), consider the reverse as true (i.e., \( \hat{\beta} \leq p^* \hat{s} \)). This suggests that, at \( \hat{\beta} = p^* \hat{s}, (1 - \gamma) (2 - F (\hat{s}^{-1} p^* \hat{s}) - F (r^{-1} \hat{s}^{-1} p^* \hat{s})) - \gamma (f (\hat{s}^{-1} p^* \hat{s}) + f (r^{-1} \hat{s}^{-1} p^* \hat{s})) - \hat{s}^{-1} (p^* \hat{s} (1 - \gamma) - \hat{s}^2 c) (f (\hat{s}^{-1} p^* \hat{s}) + r^{-1} f (r^{-1} \hat{s}^{-1} p^* \hat{s})) \leq 0. \) Utilizing Equations (8a) and (14a), we simplify the above expression to \( (\hat{s} - 1) c (f (p^*) + r^{-1} f (r^{-1} p^*)) \leq 0 \), which requires that \( \hat{s} < 1 \).

Contradiction.

Since \( \hat{\beta} > p^* \hat{s} \), it immediately follows that \( 2 - F (\hat{s}^{-1} \hat{p}) - F (r^{-1} \hat{s}^{-1} \hat{p}) < 2 - F (p^*) - F (r^{-1} p^*) \).
Proposition 6. Proof

To begin, we know that \{\hat{\beta}, \hat{s}\} and \{\hat{\beta}_-, \hat{s}_-\} are defined as follows:

\[
(1 - \gamma) \left( 2 - F(\hat{s}_{-1} \hat{\beta}) - F(r^{-1} \hat{s}_{-1} \hat{\beta}_-) \right) - \gamma \left( f(\hat{s}_{-1} \hat{\beta}) + f(r^{-1} \hat{s}_{-1} \hat{\beta}_-) \right) - \hat{s}_{-1} (\hat{\beta}_-(1 - \gamma) - \hat{s}_-^2 \gamma) \left( f(\hat{s}_{-1} \hat{\beta}) + r^{-1} f(r^{-1} \hat{s}_{-1} \hat{\beta}_-) \right) = 0 \quad (41a)
\]

\[
(\gamma - 2\hat{s}_- c) \left( 2 - F(\hat{s}_{-1} \hat{\beta}) - F(r^{-1} \hat{s}_{-1} \hat{\beta}_-) \right) + \gamma \hat{s}_{-1} \hat{\beta}_-(f(\hat{s}_{-1} \hat{\beta}) + f(r^{-1} \hat{s}_{-1} \hat{\beta}_-)) + \hat{s}_{-1}^2 \hat{\beta}_-(\hat{\beta}_-(1 - \gamma) - \hat{s}_-^2 \gamma) \left( f(\hat{s}_{-1} \hat{\beta}) + r^{-1} f(r^{-1} \hat{s}_{-1} \hat{\beta}_-) \right) + \gamma (1 - r) F(r^{-1} \hat{s}_{-1} \hat{\beta}_-) = 0 \quad (41b)
\]

\[
2(1 - \gamma) \left( 1 - F(r^{-1} \hat{s}_{-1} \hat{\beta}_-) \right) - \gamma (1 + r^{-1}) f(r^{-1} \hat{s}_{-1} \hat{\beta}_-) - 2\hat{s}_{-1} (\hat{\beta}_-(1 - \gamma) - \hat{s}_-^2 \gamma) r^{-1} f(r^{-1} \hat{s}_{-1} \hat{\beta}_-) = 0 \quad (41c)
\]

\[
2(\gamma - 2\hat{s}_- c) \left( 1 - F(r^{-1} \hat{s}_{-1} \hat{\beta}_-) \right) + \gamma \hat{s}_{-1} \hat{\beta}_-(1 + r^{-1}) f(r^{-1} \hat{s}_{-1} \hat{\beta}_-) + 2\hat{s}_{-1}^2 \hat{\beta}_-(\hat{\beta}_-(1 - \gamma) - \hat{s}_-^2 \gamma) r^{-1} f(r^{-1} \hat{s}_{-1} \hat{\beta}_-) + \gamma (1 - r) F(r^{-1} \hat{s}_{-1} \hat{\beta}_-) = 0 \quad (41d)
\]

Using a similar proof to Proposition 4, we can first show that

\[
(1 - \gamma) \left( 2 - F(\hat{s}_{-1} \hat{\beta}_-) - F(r^{-1} \hat{s}_{-1} \hat{\beta}_-) \right) - \gamma \left( f(\hat{s}_{-1} \hat{\beta}_-) + f(r^{-1} \hat{s}_{-1} \hat{\beta}_-) \right) - \hat{s}_{-1} (\hat{\beta}_-(1 - \gamma) - \hat{s}_-^2 \gamma) \left( f(\hat{s}_{-1} \hat{\beta}_-) + r^{-1} f(r^{-1} \hat{s}_{-1} \hat{\beta}_-) \right) > 0 \quad (42a)
\]

for a log-concave \( f(\beta) \) that satisfies \( 1 - F(r^{-1} \hat{s}_{-1} \hat{\beta}_-) > r (1 - F(\hat{s}_{-1} \hat{\beta}_-)) \).

Next, we need to show that

\[
(\gamma - 2\hat{s}_- c) \left( 2 - F(\hat{s}_{-1} \hat{\beta}_-) - F(r^{-1} \hat{s}_{-1} \hat{\beta}_-) \right) + \gamma \hat{s}_{-1} \hat{\beta}_-(f(\hat{s}_{-1} \hat{\beta}_-) + f(r^{-1} \hat{s}_{-1} \hat{\beta}_-)) + \hat{s}_{-1}^2 \hat{\beta}_-(\hat{\beta}_-(1 - \gamma) - \hat{s}_-^2 \gamma) \left( f(\hat{s}_{-1} \hat{\beta}_-) + r^{-1} f(r^{-1} \hat{s}_{-1} \hat{\beta}_-) \right) + \gamma (1 - r) F(r^{-1} \hat{s}_{-1} \hat{\beta}_-) < 0 \quad (43a)
\]

We multiply (41c) by \( \hat{s}_{-1} \hat{\beta}_- \) and subsequently add this figure to (41d). In doing so, we find that \( \gamma (1 - r) F(r^{-1} \hat{s}_{-1} \hat{\beta}_-) + 2 (\gamma + (1 - \gamma) \hat{s}_{-1} \hat{\beta}_- - 2\hat{s}_- c) (1 - F(r^{-1} \hat{s}_{-1} \hat{\beta}_-)) = 0 \), implying

\[
(\gamma + (1 - \gamma) \hat{s}_{-1} \hat{\beta}_- - 2\hat{s}_- c) < 0.
\]

Similarly, we multiply (42a) by \( \hat{s}_{-1} \hat{\beta}_- \) and then add this to (43a). This yields \( \gamma (1 - r) F(r^{-1} \hat{s}_{-1} \hat{\beta}_-) + (\gamma + (1 - \gamma) \hat{s}_{-1} \hat{\beta}_- - 2\hat{s}_- c) (2 - F(\hat{s}_{-1} \hat{\beta}_-) - F(r^{-1} \hat{s}_{-1} \hat{\beta}_-)) < 0 \) where \( (\gamma + (1 - \gamma) \hat{s}_{-1} \hat{\beta}_- - 2\hat{s}_- c) < 0 \).
0. This result, in conjunction with (42a), means that (43a) must hold.

Finally, we need to show that $\hat{s}$ cannot exceed $\hat{s}_-$ when $\hat{p} < \hat{p}_-$. Suppose otherwise, i.e. that $\hat{s} > \hat{s}_-$ and $\hat{p} < \hat{p}_-$. We know that, given $\hat{s}_-$, a decrease in $p$ from $\hat{p}_-$ to $\hat{p}$ would make (42a) more positive. For $\{\hat{p}, \hat{s}\}$ to satisfy (41a), (42a) must decrease as $s$ increases from $\hat{s}_-$ to $\hat{s}$.

However, in solving the second-order derivatives associated with (41a) and (41b), it can be shown that the mixed partial derivative is positive. Thus, (42a) increases further as $s$ is raised from $\hat{s}_-$ to $\hat{s}$, meaning that (41a) cannot hold where $\hat{s} > \hat{s}_-$ and $\hat{p} < \hat{p}_-$. 

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Note that $\bar{p}_1 = \bar{p}_2 = 0$ in subfigures (b), (c), and (f). In subfigure (e), $\bar{p}_1 = \bar{p}_2 = 0$ when $\gamma$ is approximately greater than .72.
Figure 3: Result 7 Variable Pricing Simulations

Note that \( \bar{p}_1 = \bar{p}_2 = 0 \) in subfigure (c). In subfigure (b), \( \bar{p}_1 = \bar{p}_2 = 0 \) when \( \gamma \) is approximately greater than .44.