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Abstract

I consider the shopping and consumption decision of an individual with a self-control problem. The consumer believes that restricting the consumption of a sinful product (such as chips) is in his long-run interest. But when facing the actual decision he is tempted to overeat. I ask how firms react to such self-control problems, and possibly exploit them, by offering different package sizes. In a competitive market, either one or three (small, medium and large) packages are offered. In contrast to common intuition, the large, and not the small package is a commitment device. The latter serves to exploit the naive consumer.

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1 Introduction

Many individuals face self-control problems: The pleasure of the moment seduces them to act against their own long run interests. For example, they are tempted to shirk on unpleasant tasks – such as dieting. And a poor diet contributes to the problem of overweight and obesity. The World Health Organization reports that more than 1.4 billion adults were overweight in 2008, and more than half a billion obese. It estimates that at least 2.8 million people die each year as a result of being overweight or obese. Moreover, globally, 44 percent of diabetes, 23 percent of ischaemic heart disease and 7-41 percent of certain cancers are attributable to overweight and obesity.[1] The associated health costs are large (cf., e.g., Finkelstein et al. 2009).

Chandon and Wansink (2010) discuss how firms influence food intake with their marketing strategies and thereby may contribute to the problem of overeating. Examples of such marketing strategies are food prices and promotion, the food's quality and quantity, marketing, the availability, salience and convenience of food, the type, size and shape of serving containers, or the atmospherics of the purchase and consumption environment.

In this paper, I want to focus on one particular marketing strategy – the packaging of sinful products such as chips. Wertenbroch (1998) argues that consumers engage in precommitment by rationing their purchase quantities, i.e., by buying, for example, small packages. Two questions arise from this. First, can the consumer indeed limit his consumption through such a strategy? And second, how do firms react to the consumer's self-control problem? The argument by Wertenbroch (1998) presumes that firms indeed offer small packages as commitment devices. But do they indeed do so or are they trying to counteract the consumer's wish for commitment?

To answer these questions, I consider the shopping and consumption decision of a vice, or sinful good (such as chips, cigarettes, or chocolate) of an individual that faces a self-control problem that arises due to time-inconsistent preferences. The individual judges that limiting the amount of, say, chips consumption is in his long-run interest. But once he sits in front of the TV and starts eating chips, the distant health benefits of a healthier life style suddenly do not seem worth the effort of restricting consumption.

The consumer goes shopping when he is not tempted to overeat. For example, when doing his weekly shopping trip, the consumer (self 0) has planned beforehand how much chips to buy and is not hungry. When sitting in front of the TV in the evening, however, the consumer (self 1) is tempted to overeat chips. The consumer can go shopping at this point, but, because

[1] See `http://www.who.int/features/factfiles/obesity/en/index.html` (last accessed January 2014).

of opportunity costs, the costs of such spontaneous shopping trips are higher than those of his weekly, planned shopping trip. I assume that the consumer is either sophisticated or naive, which means that the consumer, when doing his weekly shopping trip, is either fully aware or not at all aware that he faces a self-control problem.

Firms offer the consumer to buy a certain quantity (a "package") for a transfer. In the main model, I consider a competitive market. The sophisticated self 0 perfectly anticipates the shopping and consumption decision of his future self. Firms respond by offering self 0 either full or partial commitment. In contrast, the naive self 0 does not anticipate the decision of his future self. Hence, he goes shopping and buys the package that is optimal from his point of view. If the shopping costs of self 1 are large, then self 1 will not go shopping and the naive consumer receives full commitment. But if they are small, self 1 will go shopping and will buy a small "top-up" package.

Thus, in the competitive market, if the shopping costs of self 1 are large relative to those of self 0, one can observe either one package size, which is tailored to the interests of self 0; or, if these costs are relatively small, three package sizes (a small one, a medium one, and a large one) are offered. Consistent with this result Steenhuis et al. (2010) observe that firms offer different package sizes. In contrast to common intuition, the small package however is not a commitment device, but serves to exploit the naive consumer, while the large package offers commitment to the sophisticated consumer. The naive consumer initially buys the medium package believing that he will stick to this quantity. But later, when in the "hot state", he buys a small top-up. Thus, in a competitive market the naive consumer goes inefficiently often shopping. Indeed, Hinnosaar (2012) observes that time-inconsistent consumers go shopping more often than time-consistent consumer. And Vermeer et al. (2011) provide field evidence showing that people having a smaller portion in the lunch cafeteria later buy more other food.

My paper predicts that commitment is easier to achieve if self 1 faces large shopping costs. There is some evidence that supports this result. Hinnosaar (2012) predicts that Sunday sales restriction should decrease weekend consumption of alcohol. When looking at an actual policy change, Bernheim, Meer, and Novarro (2012) however observe no such effect. Currie, Della Vigna, Moretti, and Pathania (2010) observe that a close geographical proximity of a fast food restaurant is associated with higher rates of obesity (of children and pregnant women). Leung et al. (2011) show that the availability of convenience stores within a close distance of residence is correlated with a greater risk of girl's becoming overweight or obese. Lee (2012) however finds conflicting evidence regarding the association between distance and overweight.

In an extension, I contrast the competitive market with a monopolistic one. When facing a naive consumer, the monopolist tailors the package to the preferences of the self from whom he can extract the highest surplus. Thus, if the shopping costs of self 1 are large relative to the shopping costs of self 0, he caters to self 0 and perfect commitment is possible. If not, he caters to the interests of self 1 and offers a relatively large package. The sophisticated self 0 is willing to pay for a smaller commitment-package. The monopolist offers such (partial or full) commitment products to the sophisticated consumer – possibly at a higher price. Thus, in a monopolistic market, small packages are always commitment devices.

Comparing the monopolistic to the competitive market shows that for the sophisticated consumer only the distribution of rents differs, but the social surplus is the same in both markets. In contrast, the naive individual might be better or worse off in the competitive market. On the one hand, the competitive market provides more often full commitment to the naive consumer than the monopolistic market. However, if he does not receive full commitment, the social surplus in the competitive market can be lower than in the monopolistic market because the naive consumer goes shopping too often in the competitive market. Thus, competition can decrease the social surplus.

The paper is organized as follows. After discussing the related literature I introduce the model in section 2. The main analysis and results are presented in section 3. Section 4 concludes the paper.

Related literature The paper is most closely related to the literature on contracting with time-inconsistent agents. The theme that firms provide commitment to the sophisticated consumer, but exploit the naive consumer is well established in this literature. My paper is distinct by the application and the repeated setting it studies: package sizes in consumer markets with re-shopping possibilities have been underexplored – and some new features arise in such a setting. DellaVigna and Malmendier (2004) consider a model in which firms offer two-part tariffs consisting of a lump-sum payment and per-unit price to a time-inconsistent consumer. They establish that firms price investment goods below marginal costs, and leisure goods above. Gottlieb (2008) relaxes the assumption of DellaVigna and Malmendier (2004) that a consumer deals exclusively with one firm (for a similar model see also Kőszegi 2005). The assumption of a competitive spot market is more realistic in, e.g., markets for consumption goods such as sinful products. He shows that in this case marginal cost pricing of sinful products arises, i.e., commitment for the sophisticated consumers vanishes. Our paper demonstrates that the market may provide commitment under some circumstances – to both sophisticated and naive consumers. Gottlieb (2008) also shows that competition can decrease the social surplus. In our model, this is the case for the naive, but not for the sophisticated consumer. Heidhues and Kőszegi (2010) consider a competitive credit market.

They show that firms exploit naive consumers by offering a cheap baseline repayment, and specifying large penalties for late payments.[2]

A small literature strand in marketing asks about the package sizes firms provide when consumers face self-control problems. Dobson and Gerstner (2010) show why it can be profitable for firms to offer so-called "super-size" portions, i.e., very large portions which are not much more expensive than the normal sized portion. Firms employ such a strategy in order to price-discriminate between disciplined and tempted consumers. The former are willing to pay a premium for smaller sized portions. Jain (2012) considers, similar to my setting, the shopping decision of an individual with a present bias. The main difference is that in his framework only self 0 can go shopping, and consumption occurs on two days. The package size and number of package sizes are exogenous in his setting, while it is endogenous in mine. A small package thus is by assumption a commitment device in his model and its introduction increases the social surplus. Firms introduce small packages if the gain from doing so (attracting consumers who would otherwise not buy or buy less) outweighs the loss (some consumers buy less). Jain (2012) also briefly considers naive consumers, but as only self 0 can go shopping, exploitation by firms of naive consumers is not an issue.

Hinnosaar (2012) builds up a model of the behavior of a time-inconsistent consumer related to the one considered here. Her main aim is to identify time-consistent and time-inconsistent consumers from dynamic purchasing behavior, but she does not disentangle naive and sophisticated consumers. And she does not consider firm behavior as I do in this paper.

2 Model

Firms There is one consumer and a continuum of firms who operate in a competitive market. In each period $\tau \in \{0, 1\}$, firms offer the consumer a schedule, i.e., a quantity-transfer pair (x_τ, t_τ) that specifies for every quantity, a (possibly negative) transfer from the consumer to the firm. Firms make these offers in a given period simultaneously. In each period, firms observe which contracts have been offered previously. A firm's cost of producing x units is $c\,x$.

[2] A number of papers focuses on the question how to screen agents who differ in their degree of sophistication, or in their degree of time-inconsistency (see, e.g., Eliaz and Spiegler 2006, Eliaz and Spiegler 2008, Esteban and Miyagawa 2006, Esteban, Miyagawa, and Shum 2007, Galperti 2012). The theme that relatively sophisticated types receive full commitment, while relatively naive types are exploited re-appears when firms screen agents who differ in their degree of sophistication (see, e.g., Eliaz and Spiegler 2006, Eliaz and Spiegler 2008).

Consumer In period 0, the consumer goes shopping. In period 1, the consumer possibly goes shopping again and consumption takes place. Shopping trips are costly. The consumer incurs a monetary cost k_τ for a shopping trip in period τ. I assume that $k_1 \geq k_0 = 0$.

The consumer faces a self-control problem, i.e., the consumer's preferences regarding consumption change between periods 0 and 1. When confronted with the consumption and shopping decision in period 1, the consumer's instantaneous utility is $v(x) - t_1$, where x is the total quantity available at this date and $v(x)$ is a strictly increasing and concave function. Let $x_1^* = \arg\max_x v(x) - c\,x$. In period 0, the consumer evaluates the consumption of x units of the good in period 1 with the utility function $u(x)$, where $u(x)$ is a strictly increasing and concave function. Let $x_0^* = \arg\max_x u(x) - c\,x$. If the consumer does not consume, he receives the reservation utility $\bar{u} = 0$.[3][4]

I am interested in the case where the good is a harmful vice good, such as chips, or cigarettes. The date 0 incarnation of the individual, which I call self 0, prefers a lower consumption than the date 1 incarnation of the individual, self 1. Assuming $v(x) > u(x)\,\forall x$ and $v'(x) > u'(x)\,\forall x$ implies $x_1^* > x_0^*$, i.e., there is a conflict of interest between self 0 and self 1.

I consider the case where the consumer is either naive or sophisticated about his future preferences. The consumer believes that his future preferences are captured by the utility function $\hat{v}(x)$. If $\hat{v}(x) = v(x)$ the consumer is fully sophisticated and if $\hat{v}(x) = u(x)$ he is fully naive.

I assume that firms know $v(x)$ and $\hat{v}(x)$. Relaxing the assumption that firms know the degree of sophistication does not change my results as I discuss at the end of section 3.2.[5] Furthermore, I assume that gains from trade are positive, i.e., $v(x_1^*) - c\,x_1^* - k_1 > 0$ and $u(x_0^*) - c\,x_0^* > 0$.

The setup captures the idea that in period 0 the individual does his (weekly) shopping trip. At this date, he is in a cold state and not tempted to overeat the harmful product (such as chips). In period 1, when sitting in front of the TV, he is in a hot state, and prefers to eat more chips than is optimal from the long run perspective. He can go shopping at this date, but at this point in time the opportunity costs of a shopping trip are higher than for the

[3]Allowing for $\bar{u} > 0$, or $k_0 > 0$ does not change results. What matters is the difference between $\bar{u} + k_1$ and $\bar{u} + k_0$.

[4]These preferences capture in a stylized way present biased preferences (Laibson 1997, O'Donoghue and Rabin 1999). For example, the consumption of x units of the good causes immediate benefits of $b(x)$ and delayed costs of $h(x)$. Self 0 weighs these costs equally, i.e., $u(x) = b(x) - h(x)$. Self 1 attaches, due to his present bias, $\beta \in (0, 1)$, a larger relative weight to the current benefits than to the delayed costs, i.e., $v(x) = b(x) - \beta\,h(x)$.

[5]Later, I also consider the problem of a monopolist. For the monopolistic market, I discuss the robustness of the results to the assumption that firms know the degree of sophistication in the appendix.

weekly shopping trip. For example, buying chips in the shop around the corner just before the movie starts causes higher costs than buying them along with other goods on a planned, weekly shopping trip.[6]

Competitive equilibrium As usual in the literature, I define the competitive equilibrium in terms of the contracts that survive competitive pressure. A contract is a quantity-transfer pair. Consumers apply for at most one contract and if their participation constraint is satisfied, they choose the contract that yields the highest utility to them (if indifferent they randomize 50-50). In each period, they can choose a different contract from a different firm. Each equilibrium contract earns zero expected profits, and there exists no profitable deviation in any period that is accepted by a consumer and that yields strictly positive expected profits. Each contract offered is purchased by some consumers. I assume that firms produce on the spot. Thus, firms can react to a deviation of a firm in the current period in later periods. At the end of section 3.2, I discuss the robustness of the results to this assumption.[7]

3 Analysis

I start by analyzing the behavior of the consumer by specifying his participation constraints, before I turn to firm behavior in the competitive market. In an extension, I consider the problem of a monopolist and contrast it to the competitive market.

3.1 Consumer behavior

Suppose self 0 bought some quantity x_0. Self 1 has to decide whether he is satisfied with this quantity, or whether he wants to incur the costs of an additional shopping trip and pay the transfer to get the additional quantity x_1. So he goes shopping whenever the following participation constraint is satisfied

$$v(x_0 + x_1) - k_1 - t_1 \geq v(x_0). \tag{1}$$

The naive self 0 believes that his consumption plan coincides with the one of self 1. This means that self 0 does not anticipate that self 1 will possibly go shopping. Hence, the naive self 0 goes shopping whenever the following participation constraint is satisfied:

$$u(x_0) - t_0 \geq 0. \tag{2}$$

[6]The assumption that costs are higher in period 1 than in period 0 could also reflect psychological costs, such as a bad conscience for an additional shopping trip.

[7]For the monopolistic market, I discuss the robustness of my results to this assumption in the appendix.

In contrast to the naive, the sophisticated self 0 perfectly anticipates the consumption and shopping decision of his future self. Suppose he does not go shopping in period 0. Then self 1 would accept (x_1, t_1) if $v(x_1) - k_1 - t_1 \geq 0$. This yields utility $u(x_1) - t_1 - k_1$ to self 0. Hence, the sophisticated self 0 accepts contracts which satisfy the following participation constraint

$$u(x_0) - t_0 \geq u(x_1) - t_1 - k_1, \tag{3}$$

where (x_1, t_1) must be such that the participation constraint of self 1, inequality (1), holds and where x_0 must be such that self 1 does not go shopping. This means that for any profitable (x_1', t_1') it must hold that

$$v(x_0) \geq v(x_0 + x_1') - k_1 - t_1'.$$

3.2 Competition

Contract for self 1 In period 1, the competitive equilibrium contract solves:

$$\max_{t_1, x_1} \quad t_1 - c\, x_1 \quad \text{s.t.} \quad v(x_0 + x_1) - k_1 - t_1 \geq \max\{v(x_0), \bar{v}^*\}. \tag{4}$$

Utility level $\bar{v}^*$ is the perceived utility from the (equilibrium) contract. This level must be such that the profits from the maximized contract are zero. The solution to this problem is to sell $x_1 = x_1^* - x_0$ at $t_1 = c\,(x_1^* - x_0)$, whenever $v(x_1^*) - c\, x_1^* - k_1 \geq v(x_0) - c\, x_0$, and 0 else.

Contract for the naive self 0 I first argue that in any competitive equilibrium the naive self 0 goes shopping. If this were not the case, a firm had an incentive to deviate and offer self 0, say, x_0^* defined by $u'(x_0^*) = c$ for a transfer $t_0 = u(x_0^*)$. The naive self 0, who is not aware that self 1 shall possibly go shopping, accepts such an offer and the offer yields strictly positive profits for a firm. Thus, in a competitive equilibrium, the participation constraint of the naive self 0 cannot be violated and the period-0 contract for the naive consumer solves

$$\max_{t_0, x_0} \quad t_0 - c\, x_0 \quad \text{s.t.} \quad u(x_0) - t_0 \geq \bar{u}^*. \tag{5}$$

Again, utility level $\bar{u}^*$ is the perceived utility from the equilibrium contract. The solution is to offer $(x_0^*, c\, x_0^*)$ in period 0. The naive self 0 accepts this offer.

Contract for the sophisticated self 0 Self 0 anticipates that if self 1 went shopping, he would consume x_1^* in total. Selling self 0 such a low quantity that self 1 goes shopping could not, however, be a competitive equilibrium. As the shopping costs of self 0 are lower than those of self 1, firms could increase profits by selling the desired quantity to self 0 rather than to self 1. Thus, in any competitive equilibrium, only the sophisticated self 0, not self 1 goes shopping. So the competitive equilibrium is characterized by the solution to the following optimization problem:

$$\begin{aligned} \max_{t_0,x_0} \quad & t_0 - c\,x_0 \\ \text{s.t.} \quad & u(x_0) - t_0 \geq \bar{u}^*, \\ \text{s.t.} \quad & v(x_0) \geq v(x_1^*) - c\,(x_1^* - x_0) - k_1. \end{aligned} \tag{6}$$

Utility level $\bar{u}^*$ is the perceived utility from the equilibrium contract. Suppose first that $v(x_0^*) - c\,x_0^* \geq v(x_1^*) - c\,x_1^* - k_1$. Then self 1 would never go shopping when self 0 bought x_0^*, and hence the solution to the above problem is x_0^*, defined by $u'(x_0^*) = c$, $t_0 = c\,x_0^*$. Suppose next that self 1 would go shopping if self 0 bought only x_0^*. Then the "no-shopping" constraint has to be binding. Otherwise a firm had an incentive to deviate and lower x_0 by an ε. The lower offer is more attractive for self 0, and self 1 would, for ε small, still not go shopping. Hence, the optimal solution x_0^S is defined by $v(x_0^S) - c\,x_0^S = v(x_1^*) - c\,x_1^* - k_1$, and $t_0 = c\,x_0^S$. So overall, firms offer (partial) commitment to the sophisticated self 0. Specifically, selling self 0 the quantity desired by self 1, x_1^* for $t_1 = c\,x_1^*$, cannot be a competitive equilibrium. Suppose it were. Then a firm could deviate and offer self 0 some quantity $x_0 \in [x_0^*, x_1^*)$ and a transfer t_0, such that $u(x_0) - t_0 \geq u(x_1^*) - c\,x_1^*$. Such an offer raises the utility of self 0 if the quantity is such that self 1 would not go shopping in period 1. Consider, e.g., $x_0 = x_1^* - \varepsilon$ and note that $v(x_1^*) > v(x_1^*) - t_1 - k_1$. Offering $x_0 = x_1^* - \varepsilon$ implies that, by continuity, $v(x_1^* - \varepsilon) > v(x_1^*) - t_1 - k_1$.

Proposition 1

1. *The competitive equilibrium contract for the naive individual is $(x_0^*, c\,x_0^*)$, which he buys in period 0. If, in addition, $v(x_1^*) - c\,x_1^* - k_1 \geq v(x_0^*) - c\,x_0^*$, then firms offer contract $(x_1^* - x_0^*, c\,(x_1^* - x_0^*))$, which self 1 buys in period 1.*

2. *The competitive equilibrium contract for the sophisticated individual is $(x_0^S, c\,x_0^S)$, where $x_0^S \in [x_0^*, x_1^*)$ is defined by $v(x_0^S) - c\,x_0^S = v(x_1^*) - c\,x_1^* - k_1$, which he buys in period 0. If $v(x_0^*) - c\,x_0^* \geq v(x_1^*) - c\,x_1^* - k_1$, then $x_0^S = x_0^*$.*

In the competitive market, either 1 or 3 different package sizes are offered. If $v(x_0^*) - c\,x_0^* \geq v(x_1^*) - c\,x_1^* - k_1$, then both the naive and the sophisticated consumers receive full commitment and only a package of size x_0^* is offered. If this does not hold, then 3 packages are offered: a large package (x_0^S), a medium package (x_0^*) and a small package ($x_1^* - x_0^*$). In contrast to common intuition, the large package, x_1^S offers commitment to the sophisticated consumer. The small package is not a commitment device, but serves to exploit the naive consumer.

The naive consumer initially buys the medium package x_0^* believing that he will stick to this quantity. But later, when in the "hot state" he buys a top-up. This results in inefficiently high shopping costs.

Knowing the degree of sophistication The assumption that firms can distinguish between the naive and the sophisticated consumer is not crucial. Suppose three packages are offered. The commitment quantity x_0^S at the given transfer is not attractive for the naive consumer as he does not demand commitment. And $x_1^* - x_0^*$ and x_0^* are not attractive for the sophisticated consumer as they would induce overconsumption. If one package size (x_0^*) is offered, then it is offered at the same transfer to the sophisticated and naive consumer.

Relaxing the assumption of on-the-spot-production The assumption that firms produce on the spot and can thus react to a period-0-deviation in period 1 neither drives the results for the sophisticated consumer if perfect commitment is feasible, nor for the naive consumer. In all these cases, no firm had an incentive to deviate – independent of what will happen in period 1. If however the sophisticated consumer receives only partial commitment, i.e., x_0^S, the assumption matters. Self 0 would prefer to buy a lower quantity than x_0^S – but only if he knew that self 1 would not go shopping. In the model with on-the-spot-production, firms can, in reaction to a period-0-deviation of some firm to say some lower quantity than x_0^S, offer self 1 a quantity that makes a shopping trip attractive. Anticipating this, self 0 would not buy the lower quantity and a deviation would not pay off.

If however firms could not react in period 1, the threat to sell self 1 some quantity might not be credible anymore. And if self 0 knew that self 1 would not go shopping, then he would buy the lower quantity from the deviating firm. But even if firms could not react to the deviation by tailoring a package for self 1, self 1 might still go shopping and buy one of the other available packages ($x_1^* - x_0^*, x_0^*$, or x_0^S). Anticipating this self 0 would not buy from the deviating firm. So if there exists no $x_0^* \leq x_0 < x_0^S$, such that $v(x_0) > \max\{v(x_0 + x_0^*) - c\,x_0^*, v(x_0 + x_0^S) - c\,x_0^S, v(x_0 + x_1^* - x_0^*) - c\,(x_1^* - x_0^*)\} - k_1$, offering package x_0^S is still a competitive equilibrium. If this condition fails to hold, a firm has an incentive to deviate, and no competitive equilibrium exists.

3.3 Monopolist

The monopolist maximizes his profits, $t_0 + t_1 - c\,(x_0 + x_1)$ subject to the respective participation constraints. For the sophisticated consumer, optimization problem (6) is unchanged, except for the reservation utility of self 0. Thus, as in the competitive market, self 0 receives either full or partial commitment. What changes is the transfer, which is given by

$t_0 = u(x_0) - [k_1 + u(x_1^*) - v(x_1^*)] \equiv u(x_0) - \bar{u}^S$, $x_0 \in \{x_0^*, x_0^S\}$.[8]

Consider next the naive consumer. Unlike firms in the competitive market, the monopolist can commit to sell to only one of the selves. He maximizes profits subject to the participation constraint of self 0 and/or self 1. As I show in the appendix, the monopolist never finds it optimal to sell a positive quantity to both selves. That is, he either caters self 0 (by selling x_0^*), or self 1 (by selling x_1^*). Whether it is optimal to cater the interest of self 0 or self 1 depends on whether $v(x_1^*) - c\,x_1^* - k_1$ is smaller or larger than $u(x_0^*) - c\,x_0^*$. While the sophisticated self 0 always does all the shopping, the naive self 0 never buys x_1^* and self 1 does the shopping. This results in inefficiently high shopping costs.

Proposition 2

1. *If $v(x_1^*) - c\,x_1^* - k_1 \geq u(x_0^*) - c\,x_0^*$ the monopolist offers contract (x_1^*, t_1^*), with $t_1^* = v(x_1^*) - k_1$ to the naive consumer, who goes shopping in period 1. If $u(x_0^*) - c\,x_0^* \geq v(x_1^*) - c\,x_1^* - k_1$ the monopolist offers contract (x_0^*, t_0^*), $t_0^* = u(x_0^*)$ to the naive consumer, who goes shopping in period 0.*

2. *If $v(x_0^*) - c\,x_0^* \geq v(x_1^*) - c\,x_1^* - k_1$ the monopolist offers contract (x_0^*, t_0^S), $t_0^S = \max\{u(x_0^*) - \bar{u}^S, u(x_0^*)\}$ to the sophisticated consumer. Otherwise he offers (x_0^S, t_0^S), $t_0^S = \max\{u(x_0^S) - \bar{u}^S, u(x_0^S)\}$ and x_0^S defined by $v(x_0^S) - c\,x_0^S = v(x_1^*) - c\,x_1^* - k_1$.*

Hence, the monopolist either offers one package size (x_0^*), which provides perfect commitment to both types of consumers. Such perfect commitment is possible if the shopping costs of self 1 are large. Or he offers a small and a large package (either the pair (x_0^*, x_1^*) or the pair (x_0^S, x_1^*) depending on whether or not perfect commitment for the sophisticated consumer is possible). Thus, in a monopolistic market, small packages are always commitment devices for sophisticated consumers.

The solution for the sophisticated consumer is identical in the monopolistic and competitive market. Only the distribution of rents differs. Thus, the social surplus is the same. What about the naive consumer? He receives full commitment more often in the competitive market than in the monopolistic market. If, however, $v(x_1^*) - c\,x_1^* - k_1 \geq v(x_0^*) - c\,x_0^*$, so that not only self 0, but also self 1 goes shopping in the competitive market, then the total quantity consumed is equal in the monopolistic and the competitive market, but total shopping costs are higher in the competitive market. Thus, the social surplus is lower in the

[8] Consider the subgame following a rejection of self 0 in period 0. In this subgame, the monopolist maximizes his profits by offering quantity x_1^* at transfer $t_1 = v(x_1^*) - k_1$. Self 1 accepts such an offer. This yields utility $k_1 + u(x_1^*) - v(x_1^*)$ to self 0. Thus, self 0 accepts contracts with $u(x_0) - t_0 \geq k_1 + u(x_1^*) - v(x_1^*) \Leftrightarrow u(x_0) - [k_1 + u(x_1^*) - v(x_1^*)] \geq t_0$ given that $v(x_0) \geq v(x_1^*) - c\,(x_1^* - x_0) - k_1$.

competitive than in the monopolistic market as the naive consumer goes shopping too often in the competitive market.[9]

4 Conclusion

The paper considers the shopping and consumption decision of an individual who faces a self-control problem and asks how firms react to consumers' self-control problems, and possibly exploit them, by offering different package sizes. In a monopolistic market, small packages are commitment devices. In a competitive market, small packages are not commitment devices, but, quite to the contrary, serve to exploit naive consumers, who go (unexpectedly) frequently shopping. Further, the paper shows that while the sophisticated consumer receives the same commitment in the monopolistic and competitive market, the social surplus from the naive consumer can be lower in the competitive market because the naive consumer goes shopping more often in competitive markets.

Our model is consistent with recent results in the literature that suggest positive welfare effects of restricting sales times or locations of sinful products (see, e.g., Beshears, Choi, Laibson, and Madrian 2006, Hinnosaar 2012). Such policies increase k_1 and therefore make commitment easier to achieve, i.e., firms are less likely to offer products that cater the interests of the short-run self. Care should however be taken when restricting package sizes or subsidizing small packages. Depending on the market environment, a large package can either be a commitment device or can serve the interests of the short-run self. Thus, a careful market analysis would be needed to decide which one is the case.

[9] Comparing the sophisticated and the naive consumer in the monopolistic market shows that the social surplus generated from the sophisticated consumer is larger than the one for the naive self 0. The monopolist offers full commitment to the sophisticated self 0 whenever $v(x_0^*) - c\,x_0^* \geq v(x_1^*) - c\,x_1^* - k_1$ and partial commitment otherwise. In contrast, the naive individual receives full commitment whenever $u(x_0^*) - c\,x_0^* \geq v(x_1^*) - c\,x_1^* - k_1$, i.e., as $v(x_0^*) - c\,x_0^* > u(x_0^*) - c\,x_0^*$, less often than the sophisticated individual.

Appendix

Knowing the degree of sophistication (monopolistic case)

In the main text, I assumed that the monopolist can distinguish between the naive and the sophisticated consumer. I now discuss what happens if I relax this assumption. Suppose first that the monopolist caters to the naive self 1 by offering (x_1^*, t_1^*). Then $v(x_1^*) - c\,x_1^* - k_1 \geq u(x_0^*) - c\,x_0^*$. Further note that $\max\{u(x_0^*) - u(x_1^*) + [v(x_1^*) - k_1], u(x_0^*)\} = u(x_0^*)$ if and only if $u(x_1^*) > v(x_1^*) - k_1$. So if the monopolist caters to the naive self 1, then the sophisticated consumer pays transfer $u(x_0^*) - u(x_1^*) + [v(x_1^*) - k_1]$ for x_0^*. Similarly, he would pay $u(x_0^S) - u(x_1^*) + [v(x_1^*) - k_1]$ for x_0^S. The naive consumer has no willingness to pay for commitment. Thus, the naive self 0 would not choose x_0^* or x_0^S as the associated transfer (which extracts the sophisticated consumer's willingness to pay for commitment) is too high. The sophisticated consumer is indifferent between the commitment contract and (x_1^*, t_1^*). Thus, no type had an incentive to choose the contract designed for the other type. Suppose next the monopolist caters to the naive self 0. Then $u(x_0^*) - c\,x_0^* \geq v(x_1^*) - c\,x_1^* - k_1$. Note that then $v(x_0^*) - c\,x_0^* \geq v(x_1^*) - c\,x_1^* - k_1$ also holds. Hence, the sophisticated consumer also receives x_0^*. If $t_0^S = \max\{u(x_0^*) - u(x_1^*) + [v(x_1^*) - k_1], u(x_0^*)\} = u(x_0^*) - u(x_1^*) + [v(x_1^*) - k_1]$, then the monopolist prefers to offer x_0^* at a higher transfer to the sophisticated consumer than to the naive consumer. But then the sophisticated consumer would choose the contract for the naive consumer. Hence, the monopolist either offers only (x_0^*, t_0^S) and serves only the sophisticated consumers or offers (x_0^*, t_0^*) and serves both types. What is optimal depends on the share of naive and sophisticated consumers. If, for example, the share of sophisticated consumers is large, he prefers to offer x_0^* at the higher transfer and not serve the naive consumers.

Proposition 3 *Suppose the monopolist cannot distinguish naive and sophisticated consumers.*

1. *Suppose* $v(x_1^*) - c\,x_1^* - k_1 \geq u(x_0^*) - c\,x_0^*$, *or* $u(x_0^*) - c\,x_0^* \geq v(x_1^*) - c\,x_1^* - k_1$ *and* $t_0^S = \max\{u(x_0^*) - u(x_1^*) + [v(x_1^*) - k_1], u(x_0^*)\} = u(x_0^*)$. *Then the contracts for the naive and the sophisticated consumers are as described in Proposition 2.*

2. *Suppose* $u(x_0^*) - c\,x_0^* \geq v(x_1^*) - c\,x_1^* - k_1$ *and* $t_0^S = \max\{u(x_0^*) - u(x_1^*) + [v(x_1^*) - k_1], u(x_0^*)\} = u(x_0^*) - u(x_1^*) + [v(x_1^*)]$. *Then the monopolist either offers only contract* (x_0^*, t_0^S), *i.e., serves only the sophisticated consumers or he offers* (x_0^*, t_0^*) *and serves both the naive and the sophisticated consumer.*

Relaxing the assumption of on-the-spot-production (monopolistic case)

The solution for the naive consumer in the monopolistic market does not rely on the assumption that on-the-spot-production is feasible. So consider the sophisticated consumer. If the monopolist cannot produce on the spot, then, when facing a sophisticated consumer, he maximizes his profits subject to the participation constraint of self 0 and/or self 1. The solution coincides with the solution for the naive consumer. So the monopolist does not offer partial commitment to self 0 any longer.

Proof Proposition 2

The proof for the sophisticated consumer is in the text. So consider the naive consumer. Suppose it is optimal to sell some quantity $x_0 > 0$ to self 0 and $x_1 > 0$ to self 1. Then it follows from the participation constraint of self 0 that $t_0 = u(x_0)$. And from the participation constraint of self 1 it follows that $t_1 = v(x_0+x_1)-k_1-v(x_0)$. Thus, the monopolist maximizes $v(x_0 + x_1) - v(x_0) + u(x_0) - c\,(x_0 + x_1)$. The first order conditions are:

$$
\begin{aligned}
x_0 : &\quad v'(x_0 + x_1) - v'(x_0) + u'(x_0) \leq c \quad \text{with equality if } x_0 > 0, \\
x_1 : &\quad v'(x_0 + x_1) \leq c \quad \text{with equality if } x_1 > 0.
\end{aligned}
$$

The two first order conditions cannot hold with equality at the same time. Hence, either $x_0 > 0$ and $x_1 = 0$, or $x_0 = 0$ and $x_1 > 0$. In the former case the optimal transfer and quantity are determined by:

$$
u'(x_0^*) = c \quad \text{and} \quad t_0^* = u(x_0^*).
$$

In the latter case, the optimal transfer and quantity are determined by:

$$
v'(x_1^*) = c \quad \text{and} \quad t_1^* = v(x_1^*) - k_1
$$

Whether it is optimal to cater to the interest of self 0 or self 1 depends on whether $v(x_1^*) - c\,x_1^* - k_1$ is smaller or larger than $u(x_0^*) - c\,x_0^*$.

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