Consumption Self-Control by Rationing Purchase Quantities of Virtue and Vice

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Abstract

Consumers' attempts to control their unwanted consumption impulses influence many everyday purchases with broad implications for marketers' pricing policies. Addressing theoreticians and practitioners alike, this paper uses multiple empirical methods to show that consumers voluntarily and strategically ration their purchase quantities of goods that are likely to be consumed on impulse and that therefore may pose self-control problems. For example, many regular smokers buy their cigarettes by the pack, although they could easily afford to buy 10-pack cartons. These smokers knowingly forgo sizable per-unit savings from quantity discounts, which they could realize if they bought cartons; by rationing their purchase quantities, they also self-impose additional transactions costs on marginal consumption, which makes excessive smoking overly difficult and costly.

Such strategic self-imposition of constraints is intuitively appealing yet theoretically problematic. The marketing literature lacks operationalizations and empirical tests of such consumption self-control strategies and of their managerial implications. This paper provides experimental evidence of the operation of consumer self-control and empirically illustrates its direct implications for the pricing of consumer goods. Moreover, the paper develops a conceptual framework for the design of empirical tests of such self-imposed constraints on consumption in consumer goods markets. Within matched pairs of products, we distinguish relative "virtue" and "vice" goods whose preference ordering changes with whether consumers evaluate immediate or delayed consumption consequences. For example, ignoring long-term health effects, many smokers prefer regular (relative vice) to light (relative virtue) cigarettes, because they prefer the taste of the former. However, ignoring these short-term taste differences, the same smokers prefer light to regular cigarettes when they consider the long-term health effects of smoking. These preference orders can lead to dynamically inconsistent consumption choices by consumers whose tradeoffs between the immediate and delayed consequences of consumption depend on the time lag between purchase and consumption. This creates a potential self-control problem, because these consumers will be tempted to overconsume the vices they have in stock at home. Purchase quantity rationing helps them solve the self-control problem by limiting their stock and hence their consumption opportunities. Such rationing implies that, per purchase oc-

casion, vice consumers will be less likely than virtue consumers to buy larger quantities in response to unit price reductions such as quantity discounts.

We first test this prediction in two laboratory experiments. We then examine the external validity of the results at the retail level with a field survey of quantity discounts and with a scanner data analysis of chain-wide store-level demand across a variety of different pairs of matched vice (regular) and virtue (reduced fat, calorie, or caffeine, etc.) product categories. The analyses of these experimental, field, and scanner data provide strong convergent evidence of a characteristic crossover in demand schedules for relative vices and virtues for categories as diverse as, among others, potato chips, chocolate chip cookies, cream cheese, beer, soft drinks, ice cream and frozen yogurt, chewing gum, coffee, and beef and turkey bologna. Vice consumers' demand increases less in response to price reductions than virtue consumers' demand, although their preferences are not generally weaker for vices than for virtues. Constraints on vice purchases are self-imposed and strategic rather than driven by simple preferences. We suggest that rationing their vice inventories at the point of purchase allows consumers to limit subsequent consumption. As a result of purchase quantity rationing, however, vice buyers forgo savings from price reductions through quantity discounts, effectively paying price premiums for the opportunity to engage in self-control. Thus, purchase quantity rationing vice consumers are relatively price insensitive.

From a managerial and public policy perspective, our findings should offer marketing practitioners in many consumer goods industries new opportunities to increase profits through segmentation and price discrimination based on consumer self-control. They can charge premium prices for small sizes of vices, relative to the corresponding quantity discounts for virtues. Virtue consumers, on the other hand, will buy larger amounts even when quantity discounts are relatively shallow. A key conceptual contribution of this paper lies in showing how marketing researchers can investigate a whole class of strategic self-constraining consumer behaviors empirically. Moreover, this research is the first to extend previous, theoretical work on impulse control by empirically demonstrating its broader implications for marketing decision making.

(*Intertemporal Choice*; *Pricing Policy*; *Product Policy*; *Segmentation*; *Self-Control*)

There are indeed some people not habitual drunkards, who cannot keep away from any alcohol they may have in the house: so they pay the retailer a very high wage for taking charge of their stock of it, and serving it out to them a little at a time. Alfred Marshall (1919, p. 814)

1. Introduction

Why do many regular smokers buy single packs of cigarettes instead of 10-pack cartons, even when they smoke a pack every day and do not normally face liquidity constraints? At, say, $2.75 a pack and $23 a carton, these consumers could save some $160 annually if they bought cartons. Many of them dispute that they behave irrationally when they regularly choose single packs over cartons and knowingly forgo sizable quantity discounts on cartons. They claim to control their smoking by having only a small stock of cigarettes available at any given time. This suggests that consumers may voluntarily ration their purchase quantities of certain coveted goods to control consumption by imposing transactions costs and perhaps associated feelings of guilt on additional consumption.

Such strategic self-imposition of constraints is intuitively appealing yet theoretically problematic. In particular, we lack operationalizations and empirical tests of consumption control strategies and of their implications for marketing decision making. This paper shows not only that consumers engage in purchase quantity rationing but also what the direct implications of this behavior are for the pricing of consumer goods. Moreover, this paper provides a conceptual framework for detecting self-control in consumer goods markets and for segmenting them accordingly. Note that we focus on consumption self-control via strategic purchase behavior, not on controlling purchase impulses or compulsive buying (O'Guinn and Faber 1989, Rook and Fisher 1995). We distinguish between relative vice and virtue goods whose preference ordering changes with whether one evaluates immediate or delayed consumption consequences. Two experiments manipulate these perceived intertemporal consequences to invoke and show self-control by purchase quantity rationing, and two subsequent field studies suggest manifestations of such rationing in real markets. In sum, we provide a conceptual definition of vices and virtues, and we show that demand is less price sensitive for vices than for virtues, suggesting that marketers can price discriminate on the basis of consumer self-control.

1.1. Virtue and Vice: The Causes of Consumption Self-Control Problems

Self-control problems arise from impulsive behavior—we often find ourselves making tempting choices against our own better judgment and self-interest. In these situations, maximizing the local, immediately realized utility of consumption conflicts with maximizing some higher-order, long-term, or life-time utility (Elster 1984, Freud 1911, Loewenstein 1996, Rachlin 1995, Thaler and Shefrin 1981). Consumers exercise self-control to forestall this temptation (Hoch and Loewenstein 1991).

Impulsive or time-inconsistent behavior and self-control have long been discussed in the context of intertemporal choice (Loewenstein and Elster 1992). In a classic paper, Strotz (1956) viewed impulsive behavior as reflecting dynamically inconsistent preferences due to nonconstant discounting. Thus, a dieter's choice (at time t) between chocolate cake or fresh fruit for dessert (at consumption time T), contributing to weight gain or continued weight reduction (realized at some future time $T + n$), may vary depending on whether s/he chooses before dinner at the time of purchase at the grocery store (at $t < T$) or during dinner at home when the cake and fruit are immediately available (at $t = T$). Hence, the rate at which the time interval $[T, T + n]$ is discounted is not constant and depends on the time lag between decision (at t) and consumption (at T).

Such dynamically inconsistent preferences typically characterize choices among goods and activities whose consumption consequences occur over multiple time periods, requiring consumers to make intertemporal tradeoffs between these consequences (Thaler 1980). To describe these goods and activities, let $X >_I Y$ denote a strict preference for good X over a comparable good Y when the consumer considers only concurrent, or immediate, consequences of consumption (e.g., taste at T) and ignores long-term, or delayed, consequences (e.g., health effects at $T + n$). Let $X >_D Y$ denote a strict preference for X over Y when s/he considers only delayed consequences and ignores immediate ones.

DEFINITION. Call X a vice relative to Y, and Y a virtue relative to X, if and only if, at the margin, $X >_I$

Y (maximizing immediate pleasure) and $Y >_D X$ (maximizing delayed utility).

If both $X >_I Y$ and $X >_D Y$, dynamic inconsistency between X and Y is impossible, because both immediate and delayed considerations prescribe the same choice, $X > Y$. Even if there is intertemporal conflict, however, a utility-maximizing consumer will also always prefer one good over the other, because his or her tradeoff between delayed (at $T + n$) and immediate consequences of consumption (at T) is constant no matter how long the time lag is between the choice and the onset of the immediate consequences ($T - t$). In contrast, Strotz (1956) showed that nonconstant discounting can lead to time-inconsistent preferences as described in the dessert example above. Thus, it is possible that $Y >_D X$ at $t < T$, when the consequences of one's choice are all delayed, but that $X >_I Y$ at $t = T$, when at least some of the consequences are immediate. Such nonconstant discounting and the ensuing time-inconsistent choices are well documented (e.g., Ainslie 1975, Benzion et al. 1989, Kirby 1997), suggesting that vices as defined here are relatively more likely to be consumed on impulse than comparable virtues. Hence, they impose a greater potential need for self-control.[1]

1.2. Testing for Self-Control by Purchase Quantity Rationing

According to the above definition, impulsive consumers' preferences between relative vices and virtues depend on the temporal perspective, which they take to choose between them. Without constant discounting, there is no simple, consistent preference relationship of the form $X > Y$ (Strotz 1956). Vices are both coveted and spurned. Self-control has typically been viewed as forestalling the impulsive preferences in deference to the long-term ones (e.g., Ainslie 1975, Schelling 1984). Consumers strategically forgo at least some of the preferred immediate benefits of vice consumption to maximize delayed utility. This can be achieved by altering one's incentives by restricting consumption opportunities through precommitment or otherwise raising the

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[1] We focus on nonconstant discounting as a well-established formal description of impulsive, time-inconsistent behavior. Other conceptualizations, e.g., in terms of visceral influences (Loewenstein 1996), would also predict that vices are more tempting yet subject to a greater need for self-control than virtues.

immediate cost of impulsive behavior (Rachlin 1995, Strotz 1956). Consumers can also reduce temptation through substitution and avoidance of, or distraction from, an impulse good (Hoch and Loewenstein 1991) and through mental accounting-based rules of behavior (Thaler 1985, Thaler and Shefrin 1981).

We suggest a hybrid mechanism. Consumers self-impose a constraint on their vice consumption by rationing their purchase quantities (relative to virtues). The rationing rule says "Never buy more of a vice than r_X units at a time." This precommits them to consume vices at no more than rate r_X during an interpurchase interval. Consumption at higher rates can only occur at the expense of incurring additional transactions costs. In the extreme, r_X is the rate that maximizes the delayed utility of current consumption. At the same time, the rationing rule allows consumers to partially give in to temptation to get some immediate utility as well (for all $r_X > 0$). This is both a strength and weakness of purchase quantity rationing—if $r_X > 0$, consumers can bend the rule by accelerating their interpurchase intervals and simply buying vices more often. In contrast, if $r_X = 0$, consumers don't ration but constrain themselves so severely that they don't buy the vice at all. This corner solution technically constitutes the most stringent form of self-control, renunciation.

More formally, let the utility of consuming k units of a relative vice X or of a relative virtue Y per interpurchase interval be a function of the immediate utility [$u_{X,I}(\cdot)$ or $u_{Y,I}(\cdot)$] and the delayed utility [$u_{X,D}(\cdot)$ or $u_{Y,D}(\cdot)$] of consumption. Immediate marginal utility is greater for vices than for virtues [$u'_{X,I}(k) > u'_{Y,I}(k)$], while delayed marginal utility is greater for virtues than for vices [$u'_{Y,D}(k) > u'_{X,D}(k)$]. We also assume that at least $u'_{X,I}(k)$ and $u'_{Y,D}(k)$ are positive; otherwise, there would be no reason at all to consume X or Y. Consumers ration their purchase quantities of relative vices at r_X subject to the rule-based constraint $k^*_{X,D} \leq r_X < k^*_{X,I}$ where $k^*_{X,D}$ and $k^*_{X,I}$ are the consumption rates that maximize $u_{X,D}(\cdot)$ and $u_{X,I}(\cdot)$. This limits vice consumption at rate $k \leq r_X$. Relative virtues are rationed less or not at all.

The self-imposed purchase quantity rationing constraint keeps vice consumers from increasing their demand in response to price reductions. They simply

can't buy a larger amount of vices without violating their self-imposed rule. Rule violations are possible (Thaler 1985) but psychologically costly (e.g., Hoch and Loewenstein 1991), imposing a tax on purchase quantity increases which, in turn, mitigates the positive impact of any given price cut. Thus, our central hypothesis throughout the empirical work to follow is:

Hypothesis 1. *All else equal (e.g., consumers' inventory holding costs), consumers are less price sensitive for vices than for virtues.*

That is, demand for vices is increasingly constrained when the price constraint is relaxed. Notice, though, that a smaller increase in consumers' demand for vices than for matched virtues in response to a price reduction might also imply that consumers simply prefer virtues to vices. To rule out this alternative explanation, we simultaneously predict the following:

Hypothesis 2. *Consumers do not prefer virtues over vices at all prices.*

Thus, there should be at least a crossover in demand schedules rather than an upward shift for virtues (cf. Boulding et al. 1994).

We test these predictions in two experiments and examine their external validity in two field studies. Experiment 1 shows that demand for a relative vice accelerates less in response to an increase in quantity discounts than demand for a relative virtue. Yet, overall preferences are stronger for the vice than for the virtue. Experiment 2 shows that the predicted crossover in demand schedules for a relative vice and a relative virtue depends on how impulsive consumers are, that is, on whether they have a heightened need for self-control. The experimental results imply that impulsive consumers do not prefer the virtue to the vice, yet their marginal valuations at each quantity are nevertheless lower for the vice. Field Study 1 illustrates this implication by showing that retail quantity discounts are deeper for relative vices than virtues, assuming that retailers set prices equal to these marginal valuations. Field Study 2 employs scanner data to show that store-level aggregate demand for regular (relative vice) products is less price sensitive than for light (relative virtue) products.

2. Experiment 1: Do We Forgo Quantity Discounts to Ration Our Vice Purchases?

Using an experimental market approach, we test whether (relative) vice consumers are less price sensitive than (relative) virtue consumers by examining buyers' demand for potato chips at two different quantity discount depths offered for a large purchase quantity. We manipulate the conditions of intertemporal preference inconsistency and potential need for self-control by framing the chips as either 25% fat (relative vice) or 75% fat-free (relative virtue).

Quantity discounts provide an interesting and relevant experimental context, because marketers often use them to induce consumers to accelerate purchase quantities (Wansink 1996). In addition, they allow marketers to price discriminate against homogeneous consumers by setting the unit price at each purchase quantity equal to consumers' marginal valuations at that quantity (Dolan 1987). Larger quantities carry lower unit prices because these marginal valuations are diminishing.

If vice consumers self-impose constraints on their purchase quantities, their marginal valuations of larger purchase quantities should be less than virtue consumers' marginal valuations. Hence, vice buyers should be less likely to accelerate purchase quantities than virtue buyers in response to a given increase in quantity discount depth, that is, when the exogenous price constraint is relaxed. One needs to rule out, however, that forgoing a quantity discount and choosing a smaller quantity of the vice merely indicates weaker preferences for vices. So buyers' demand for virtues should not exceed that for vices at both discount depths.

2.1. Method

Subjects and Procedure. Subjects were MBA students ($N = 304$) who participated in this experiment as part of a class requirement. They were first shown a 6-oz. bag of an existing brand of potato chips as a reference package size. A questionnaire then offered them the opportunity to buy zero, one, or three 6-oz. bags of a new brand of potato chips at different prices per bag. The new brand was described as having an innovative mix of ingredients and as currently being test marketed. We used potato chips because they are a prototypical impulse product as illustrated by,

for instance, Frito Lay's slogan "No One Can Eat Just One!" Subjects were informed that approximately one in 10 of those who completed their questionnaires would be randomly selected in a lottery to receive $10 as compensation.[2] So that subjects would accurately reveal their demand for the chips, they learned that the lottery winners would have to buy that amount of potato chips at the given price that they had chosen in the questionnaire. This procedure is incentive compatible because a subject who understates her true demand at a given price will forgo some potato chips that she would prefer to buy at this price, if she is selected. Similarly, if a subject overstates her true demand at a given price, she will have to buy potato chips that she would prefer not to have at that price. The lottery winners ultimately bought chips of a popular existing brand.

Design. The design was a 2 × 2 between-subjects full factorial in which a new brand of potato chips was described as 25% fat to one group of subjects and as 75% fat-free to another (FRAME). This framing manipulation was adopted from Levin and Gaeth (1988) to

vary the perceived intertemporal consequences of consumption while holding the objective stimulus information fixed. Chips that are 25% fat should appear more preferable when considering only immediate consequences of consumption, while 75% fat-free chips should appear more preferable when considering only delayed consequences.

The other between-subjects factor was the depth of the quantity discount offered (DISCOUNT). All subjects were offered a choice between a small purchase quantity of one 6-oz. bag of potato chips for $1 or a large purchase quantity of three 6-oz. bags of chips, which were separately sealed to maintain freshness. This large size was offered to one group at a shallow quantity discount at $2.80 and to the other group at a deep discount at $1.80. Alternatively, subjects could choose not to buy any potato chips and keep the $10, if they were among the lottery winners.

As manipulation checks, subjects rated on 9-point scales how good they predicted the new brand of potato chips would taste when eating 6 ounces and when eating 18 ounces (both from 1 = *bad tasting* to 9 = *good tasting*), how much of this new brand was safe to eat (from 1 = *a little* to 9 = *a lot*), how concerned they would be about eating too much of the new brand (from 1 = *not at all concerned* to 9 = *very much concerned*), and how the large size was priced relative to the small one (from 1 = *inexpensive* to 9 = *expensive*).

[2]The $10 were provided to eliminate budget constraints. While Thaler and Johnson (1990) suggest that consumers may be less reluctant to risk spending windfall gains than existing assets, this $10 windfall should not affect subjects in the 25% fat and the 75% fat-free conditions differently depending on discount depth.

Table 1 ANOVA Least-Square Means of Manipulation Check Variables in Experiment 1

Quantity Discount	Vice Frame		Virtue Frame		*F* Value	*p* <
	Deep	Shallow	Deep	Shallow		
Expensive	2.03	4.06	2.36	3.89	108.19[a]	0.0001
Safety	3.23	3.22	4.07	4.13	15.63[b]	0.0001
Concern	6.12	6.15	5.42	5.28	8.92[b]	0.01
Taste after eating 6 oz.[d]	4.67	4.58	4.16	4.05	4.02[c]	0.05
Taste after eating 18 oz.[d]	2.82	2.85	2.81	2.50		

[a]Main effect of quantity DISCOUNT, *N* = 291.

[b]Main effect of FRAME, *N* = 291.

[c]Between-subjects main effect of FRAME in repeated-measures ANOVA of taste ratings across both package sizes (6 and 18 oz.), *N* = 290.

[d]Within-subjects main effect of 6- versus 18-oz. package size in repeated-measures ANOVA of taste ratings, *F* = 216.46, *p* < 0.0001; interaction with FRAME: *F* = 2.40, *p* < 1; *N* = 290.

Finally, the dependent measure was subjects' choice of zero, one, or three bags of potato chips.

2.2. Results and Discussion

Thirteen subjects were eliminated from the analyses because they had indicated that they never ate potato chips and hence had no relevant consumption experience.

Manipulation Checks. Least-square cell means for the manipulation check variables are displayed in Table 1. As predicted, analyses of variance (ANOVAs) revealed that subjects saw the large package as more expensive under the shallow ($M = 3.97$) than under the deep ($M = 2.20$) quantity discount ($F(1, 287) = 108.19, p < 0.0001$), and that they rated the potato chips under the 25% frame as less safe to eat ($M = 3.23$) than under the 75% fat-free frame ($M = 4.10, F(1, 287) = 15.63, p < 0.0001$). Similarly, subjects were also more concerned about eating too many chips under the 25% fat frame ($M = 6.14$) than under the 75% fat-free frame ($M = 5.35, F(1, 287) = 8.92, p < 0.01$]. A repeated-measures ANOVA showed that they also regarded the chips as better tasting under the 25% fat frame, independent of package size ($M = 4.63$ for 6 oz. and $M = 2.84$ for 18 oz. under the vice frame, compared to $M = 4.11$ and $M = 2.66$ under the virtue frame; $F(1, 286) = 4.02, p < 0.05$), and that taste was rated worse after eating 18 ounces of chips ($M = 2.75$) than after eating 6 ounces ($M = 4.36$) across frames ($F(1, 286) = 216.46, p < 0.0001$). No other main effects or interactions approached statistical significance. These results indicate that subjects preferred the 25% fat chips over the 75% fat-free chips when considering only the immediate consequences of consumption (taste), but that their preferences reversed when considering only delayed consequences (concern and safety). Thus, the potato chips were successfully framed as a relative vice and a relative virtue.

Purchase Quantity Choices. To detect rationing effects, we excluded nonbuyers from the analysis of purchase quantities because one cannot distinguish whether those subjects exercised self-control or simply didn't like potato chips. Thus, we focus on the purchase quantity decision, given that a (probabilistic) purchase occurred, and not on the decision of whether

or not to buy. We ran the following logistic regression model to predict purchase quantity probabilities for the 151 subjects who bought one or three bags of potato chips (see Maddala 1983):

$$\Pr(3 \text{ bags}) = \frac{e^{x'\beta}}{1 + e^{x'\beta}} \quad \text{and}$$

$$\Pr(1 \text{ bag}) = 1 - \frac{e^{x'\beta}}{1 + e^{x'\beta}} = \frac{1}{1 + e^{x'\beta}}, \quad (1)$$

where x' is a row vector with 1 as the first element and FRAME (coded as $0 = 75\%$ fat-free virtue frame, $1 = 25\%$ fat vice frame), DISCOUNT ($0 =$ shallow quantity discount, $1 =$ deep quantity discount), and FRAME × DISCOUNT as the remaining elements, and where β is a vector of parameters to be estimated. Figure 1 shows the observed probabilities of choosing three bags, given that a purchase occurred, and Table 2 shows the results of the logistic regression.[3]

Overall, subjects who bought potato chips were more likely to prefer the large size when the chips were framed as 25% fat (Pr = 0.49) than as 75% fat-free (Pr = 0.42; $\beta_{\text{FRAME}} = 1.07, p < 0.10$). Buyers also showed a stronger preference for the large package size when the quantity discount was deep (Pr = 0.59) rather than shallow (Pr = 0.28; $\beta_{\text{DISCOUNT}} = 2.00, p < 0.0001$). As predicted, this effect of quantity discount depth was mitigated under the 25% fat vice frame ($\beta_{\text{FRAME} \times \text{DISCOUNT}} = -1.57, p < 0.05$). The probability of buying the large size under the virtue frame increased from Pr = 0.20 under the shallow discount to Pr = 0.65 under the deep discount, an increase of 225%, while under the vice frame the corresponding increase was from Pr = 0.41 to Pr = 0.53, or merely 29% (see Figure 1).

As predicted, these findings show that buyers'

[3]To contrast rationing effects among buyers with the impact of the experimental variables on overall demand by both buyers and non-buyers, we also jointly analyzed subjects' decisions of whether and how much to buy. Both a three-category (0, 1, or 3 bags bought) ordered logit model (Maddala 1983) and a two-part model, combining a logit analysis of whether or not subjects bought with an ordinary least squares (OLS) regression of buyers' logged purchase quantities (Manning et al. 1987), failed to reveal an interaction of FRAME and DISCOUNT. The OLS regression of buyers' logged purchase quantities in the two-part model, however, showed the same effects as the logistic regression reported in Table 2, also confirming the rationing hypothesis.

Figure 1   Observed Probability of Choosing Large Purchase Quantity (Three Bags of Potato Chips), Given a Purchase, in Experiment 1
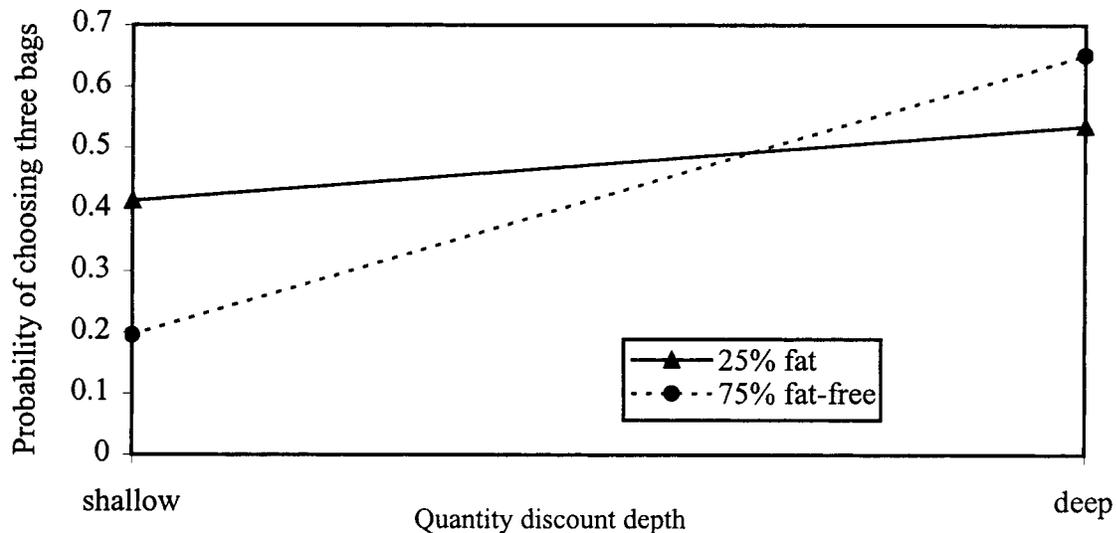

Table 2   Effects of FRAME and DISCOUNT on Purchase Quantities of Potato Chips in Experiment 1

	Logistic Regression Parameter Estimates	SE
Intercept	−1.45***	0.39
FRAME (25% fat)	1.07*	0.55
DISCOUNT (deep)	2.00****	0.51
FRAME × DISCOUNT	−1.57**	0.71
log likelihood	−94.03	
Chi square	18.87***	
df	3	
N	151	

Note. SE = standard error.

*$p < 0.10$, **$p < 0.05$, ***$p < 0.001$, ****$p < 0.0001$.

slower acceleration of purchase quantities under the vice frame was not due to weaker overall preferences for the potato chips under that frame. To the contrary, subjects had a slight overall preference for the 25% fat chips as indicated by their greater likelihood of buying the large purchase quantity. Yet, increasing the depth of the quantity discount was less effective in enticing vice buyers to increase their purchase quantities, suggesting that they self-imposed a rationing constraint as

external price constraints were relaxed. Nonetheless, the vice-virtue manipulation merely created conditions for impulsive behavior without measuring the resulting need for self-control directly. Thus, vice buyers may have capped their purchase quantities not to control their temptation to consume but simply because they actually preferred to consume at lower rates as consumption at higher rates causes increasingly negative delayed consequences. Consumption at lower rates allows vice buyers to enjoy the taste without having to worry about these delayed consequences. Moreover, vice consumption may have a bigger impact than virtue consumption on some nonprice dimension (e.g., health) so that price is relatively less important in choosing purchase quantities of vices, leading to less price-sensitive demand. These rivals are ruled out next.

3.   Experiment 2: Do Purchase Quantity Preferences Depend on Need for Self-Control?

Experiment 1 showed that a deep quantity discount is less effective in inducing buyers to purchase large quantities of a relative vice than of a relative virtue, even though the virtue is not preferred over the vice.

Experiment 2 replicates this finding and shows that it is the result of purchase quantity rationing, not of differences in consumption rates or relative importance of price. Experiments 1 and 2 differ in that we now examine purchase quantity preferences in another product category. Second, purchase quantity and unit price are orthogonal; both small and large quantities are available to all subjects at all unit prices. Third, we include a measure of the need for self-control, subjects' scores on Puri's (1996) Consumer Impulsiveness Scale (CIS). In several experiments, Puri (1996) found that consumers with high impulsiveness scores (hedonics) were more likely to behave impulsively than consumers with low impulsiveness scores (prudents). Hedonics are thus faced with a greater potential need than prudents to self-impose external constraints on their vice consumption because they are more likely to give in to temptation when they have an opportunity to do so. Prudents, in contrast, are intrinsically controlled. Unlike purchase quantity rationing, neither of the rivals raised above predicts that hedonics require deeper quantity discounts as an incentive to buy larger quantities than the farsighted, highly controlled prudents.

Specifically, participants in an experimental market state how many packages of Oreo chocolate chip cookies they want to buy at each of 20 different package prices. If subjects use purchase quantity rationing as a self-control mechanism, then hedonics (i.e., those with a high need for self-control) will be more likely than prudents (i.e., those with a low need for self-control) to ration their purchase quantities of vices. Accordingly, we predict that individual demand is less price sensitive for regular-fat Oreos (i.e., the relative vice) than for reduced-fat Oreos (i.e., the relative virtue) for hedonic subjects but not for prudent subjects. Further, hedonics do not generally prefer reduced-fat Oreos, that is, their virtue demand does not exceed their vice demand at all prices.

3.1. Method

Subjects and Procedure. Subjects were MBA students ($N = 310$) who completed a brief questionnaire during an orientation session before beginning their coursework. They stated how many packages of Oreos they wanted to buy at each of 20 different package prices. Subjects were told that, after filling out the

questionnaire, 10% of them would be selected at random to receive $10 as compensation. The experimenter would also randomly pick one of the 20 package prices in the questionnaire, and the lottery winners would have to buy as many Oreo packages at that price as indicated by their questionnaire responses. Like Experiment 1, this procedure is incentive compatible because a subject who overstates her true demand at a given package price will end up having to buy more packages of Oreos than she wants to if she is selected to buy at that price. Similarly, if she understates her true demand, she will receive fewer packages than she would like for her money.

Design. The design included three independent variables. First, in a two-level between-subjects manipulation, one group of subjects was shown a 1 lb. 4 oz. package of regular-fat Nabisco Oreo chocolate chip cookies, while another group saw a package of 25% reduced-fat cookies of the same brand and size (FAT). Subjects were asked to predict how much they "would like the taste" (from 1 = *would not at all like the taste* to 9 = *would like the taste very much*) and to "evaluate any delayed consequences" (from 1 = *bad delayed consequences* to 9 = *good delayed consequences*) of eating one and two packages of these Oreos during the week after the experiment. These measures tested whether the factor FAT successfully manipulated the perceived intertemporal consequences of consumption.

Second, we measured subjects' chronic tendencies to act impulsively as a continuous between-subjects variable, using the 12-item Consumer Impulsiveness Scale developed and validated by Puri (1996). The CIS consists of two independent subscales. One measures subjects' hedonic orientation, while the other reflects a more cognitive dimension called prudence. Puri (1996) scored the items such that lower scores reflected higher impulsiveness. She then classified respondents with impulsiveness scores below the median on both dimensions as impulsive or hedonic. Those with scores above the median on both dimensions were classified as nonimpulsive or prudent. In contrast, for ease of interpretability, we scored the items such that higher scores reflected greater impulsiveness. That is, we reverse scored the five items that make up the hedonic subscale (impulsive, careless, extravagant, easily

tempted, enjoy spending) and used subjects' actual ratings of the seven items that make up the prudent subscale (self-controlled, farsighted, responsible, restrained, rational, methodical, a planner). Then, we added subjects' scores on both subscales, characterizing each subject by a continuous impulsiveness score (IMPULSE). Applying Puri's (1996) original categorical classification scheme did not affect the results.

Third, subjects stated for each of 20 package prices (ranging from \$5 to \$0.25 in steps of \$0.25) whether they wanted to buy zero, one, or two packages of the particular Oreos they were being shown at that price. This was counterbalanced with the elicitation of CIS scores. Subjects' responses yielded the lowest per-unit price at which they would buy one pack of Oreos and the lowest per-unit price at which they would buy two packs, that is, their reservation prices for buying one pack and two packs, respectively. This served as a two-level within-subjects factor (QUANTITY). The reservation prices at these two levels were the dependent variable.

3.2. Results and Discussion

Manipulation Checks.   The effect of the FAT manipulation was tested in a repeated-measures ANOVA of the manipulation check variables. Least-square cell means are given in Table 3. As predicted, subjects rated the regular-fat Oreos as tasting better ($M = 5.31$ across both quantities) than the reduced-fat Oreos ($M = 4.76$; $F(1, 308) = 5.02$, $p < 0.05$), and they evaluated the delayed consequences of consuming regular-fat Oreos as worse ($M = 3.08$) than those of consuming reduced-fat Oreos ($M = 3.55$; $F(1, 308) = 6.22$, $p < 0.05$). Subjects thus preferred regular-fat Oreos to reduced-fat Oreos when they considered the immediate consequences of consumption (i.e., taste), but they preferred the reduced-fat Oreos with respect to delayed consequences. That is, they regarded regular-fat Oreos as a vice relative to reduced-fat Oreos.

Subjects rated the regular-fat Oreos as better tasting only when eating one pack but not two in one week (Table 3). While this result suggests that the taste of regular-fat Oreos satiates when they are consumed in large amounts, subjects should stockpile regular-fat Oreos at least as much as reduced-fat Oreos, simply to

Table 3 Repeated-Measures ANOVA Least-Square Means of Manipulation Check Variables in Experiment 2

| | | FAT | | | |
	QUANTITY	Regular	Reduced	F Value[a]	p <
Taste[b]	One pack	6.13	5.19	5.02	0.05
	Two packs	4.49	4.33		
Delayed consequences[c]	One pack	3.75	4.14	6.22	0.05
	Two packs	2.41	2.96		

Note. $N = 310$.

[a]Between-subjects main effect of FAT across both Quantities.

[b]Within-subjects main effect of QUANTITY: $F = 174.37$, $p < 0.0001$; interaction with FAT: $F = 16.95$, $p < 0.0001$.

[c]Within-subjects main effect of QUANTITY: $F = 302.65$, $p < 0.0001$; interaction with FAT: $F = 1.31$, $p < 1$.

take advantage of a low price, as they are free to delay consumption of the second pack by one week (given sealed packaging and assuming negligible inventory and opportunity costs). After one week, the regular-fat Oreos would again taste better than the reduced-fat Oreos. Satiation, therefore, cannot explain any differences in purchase quantity preferences.

Reservation Prices.   For descriptive purposes, we first conducted a median split of IMPULSE (median = 35, mean = 36.32, standard deviation = 8.01, minimum = 19, maximum = 62). Adopting Puri's (1996) terminology, we refer to the 161 respondents with high impulsiveness scores (>35) as hedonics and to the 146 respondents with low impulsiveness scores (≤35) as prudents. The key result is as predicted and shown in Figure 2. Hedonics' mean reservation prices showed a steeper decline for regular Oreos, dropping from \$1.95 for one pack to \$0.90 per unit for two packs, than for reduced-fat Oreos, for which they dropped from \$1.86 for one pack to \$0.92 per unit for two packs. For prudents, the pattern was reversed. Their mean reservation prices per unit dropped from \$1.77 for one pack to \$0.86 for two packs of regular Oreos but showed a steeper decline from \$1.81 to \$0.77 for reduced-fat Oreos. A repeated-measures ANOVA of these reservation prices with QUANTITY (within subjects), FAT, and IMPULSE (median split into hedonics and prudents) as independent variables supported our hy-

Figure 2   Mean Willingness to Pay for Oreo Cookies in Experiment 2 (Based on Median Split of IMPULSE into "Hedonics" and "Prudents")
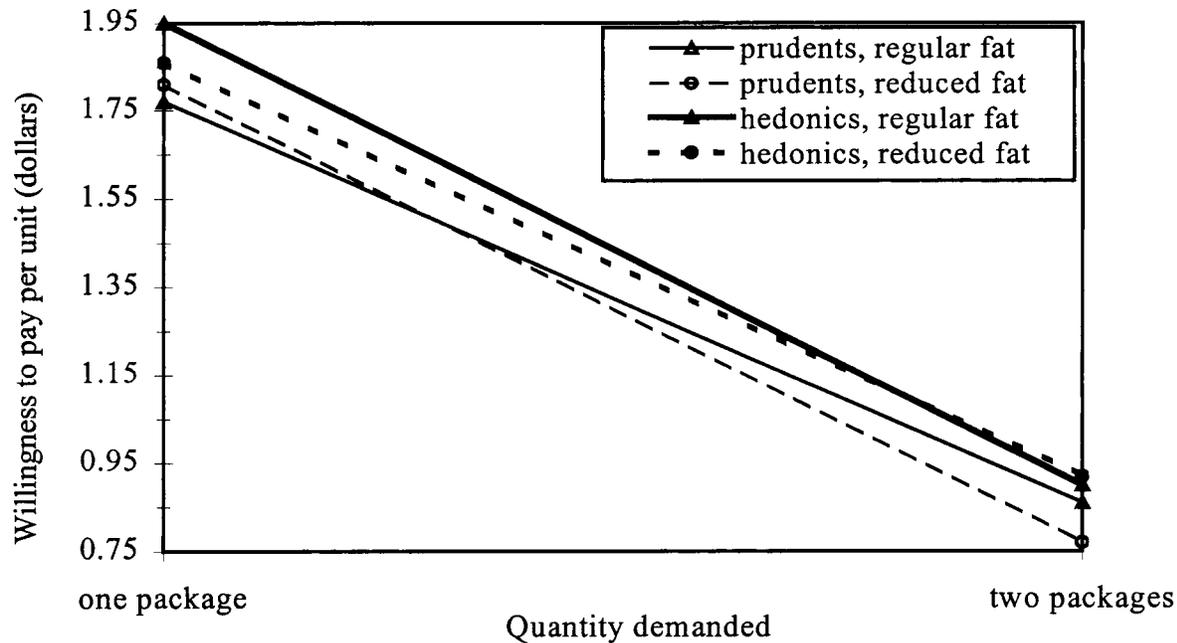
pothesis. Due to missing values, only 307 observations could be considered. The order of CIS score and purchase quantity preference elicitation had no effect and was dropped from the analysis. The ANOVA confirmed that hedonics required a deeper quantity discount for the regular-fat Oreos than for the reduced-fat Oreos to induce them to buy a larger quantity. Prudents showed the opposite pattern ($F_{QUANTITY \times FAT \times IMPULSE}$ (1, 303) = 3.02; $p < 0.10$). Nevertheless, hedonics were not willing to pay more for the relative virtue than the relative vice ($F_{FAT \times IMPULSE}$ (1, 303) = 0.00; $p < 1$). Not surprisingly, subjects' per-unit reservation prices were generally lower for buying two packs than for buying one ($F_{QUANTITY}$ (1, 303) = 735.36; $p < 0.0001$). No other effects approached statistical significance.

To take into account the full variance of subjects' CIS responses, we conducted a second ANOVA with the original impulsiveness scores as a continuous independent variable. The results confirmed the predicted three-way interaction ($F_{QUANTITY \times FAT \times IMPULSE}$ (1, 303) = 5.86; $p < 0.05$). With increasing impulsiveness scores, the decline in subjects' per-unit reservation

prices for two packs relative to one pack became significantly steeper for regular-fat Oreos than for reduced-fat Oreos. In spite of this, more impulsive subjects did not value reduced-fat Oreos more than regular-fat Oreos ($F_{FAT \times IMPULSE}$ (1, 303) = 0.43; $p < 1$). Again, subjects' reservation prices were generally lower for two packs than for one pack ($F_{QUANTITY}$ (1, 303) = 28.88; $p < 0.0001$). Controlling for impulsiveness, this decline was less steep for regular-fat than for reduced-fat Oreos ($F_{QUANTITY \times FAT}$ (1, 303) = 5.83; $p < 0.05$). No other effects approached significance.

In summary, these results show that impulsive consumers, or hedonics, are less price sensitive and require a deeper quantity discount for a relative vice than for a relative virtue to induce them to buy a larger quantity. The reluctance to buy larger quantities is not due to weaker preferences for the vice because hedonics do not generally prefer the virtue over the vice. Instead, they impose purchase quantity constraints on themselves when buying vices. Prudents, in contrast, do not need to self-impose such constraints because they are less impulsive and hence less likely to give in to a temptation to consume a larger quantity of the vice

when an opportunity arises. They buy a larger quantity even at a relatively shallow quantity discount, displaying greater price sensitivity. In sum, consumers with a need for self-control require deeper price cuts as an incentive to overcome self-imposed purchase quantity constraints.

4. Field Study 1: Are Retail Quantity Discounts Consistent with Purchase Quantity Rationing?

Experiments 1 and 2 have provided evidence of purchase quantity rationing by examining purchase quantity preferences under different quantity discounts and impulsive consumers' per-unit reservation prices for different quantities of relative vices and virtues. In contrast to these experiments, however, consumers in real markets may not only ration purchase quantities of vices to control their consumption, but they may also buy relative virtues (e.g., low fat) instead of vices (e.g., regular fat; Hoch and Loewenstein 1991). Such substitution of relative virtues reduces the need to ration purchase quantities because virtue consumption entails fewer delayed costs. We now search for suggestive evidence of purchase quantity rationing in real markets where demand for vices and virtues may be subject to such substitution effects as well as many other influences that were controlled in the experiments.

We assume that firms set retail prices in response to the demand they observe, as a function of revealed consumer preferences for different purchase quantities. The experiments have shown that vices require deeper price reductions than virtues to induce impulsive consumers to purchase larger amounts. Purchase quantity rationing would thus manifest itself by deeper quantity discounts for vices than for relative virtues at the retail level. To test this prediction, we created a set of matched pairs of (mostly nonaddictive) product categories for which consumers should differ in their need for self-control. If consumers engage in purchase quantity rationing, one should detect corresponding firm pricing behavior for those pairs of categories within which they express conflicting temporal preference orders (i.e., for pairs of relative vices and

virtues) but not for pairs with consistent temporal preference orders. We first conducted a consumer survey of temporal preference orders to classify the product categories as vices and virtues and then tested our prediction with field data on retail-level quantity discounts for these categories.

4.1. Procedure

Design. To control supply- and demand-based effects on retail prices that are unrelated to self-control, we created 30 pairs of consumer product categories that were approximately matched within each pair with respect to production technology, retailer and consumer inventory holding and handling costs, and frequency and expandability of consumption. To vary the relative need for self-control, the categories were selected to be ordered substitutes within each pair (Table 4). One category (the relative vice) was hypothesized to be preferable to the other category (the relative virtue) if the delayed consequences of consumption were assumed to be identical for both categories ($X >_I Y$), while the relative virtue was hypothesized to be preferable to the relative vice if the immediate consequences were assumed to be identical ($Y >_D X$).

Data Collection. Two sets of data were collected. To test the pairwise temporal preference ordering between the categories, the pairs and the categories within them were put in random order and then presented to a group of 136 MBA students naive to the hypothesis. These subjects rated for each pair which category they preferred to consume, first considering for all pairs only the immediate consequences of consumption (assuming identical delayed consequences), and second considering only the delayed consequences (assuming identical immediate consequences). Specifically, when evaluating the immediate consequences (*i*), subjects were asked: "If you were a consumer of each of the following products and consumption of these products entailed identical long-term consequences (such as long-term health or social effects or any other long-term costs and benefits), which of the two products in each pair would you rather consume? To evaluate these short-term effects, think about taste, ease of use, fun, temptation, or anything else that would make consuming the products

Table 4   Relative Vice and Virtue Product Categories in Field Study 1 (as hypothesized)

Relative Vices	Relative Virtues	Mean Temporal Reversal Score	N
Regular salad dressing	Light salad dressing	2.95***	130
Regular fat cream cheese	Light cream cheese	2.93****	122
Regular processed cheese	Light processed cheese	2.77****	125
Regular mayonnaise	Light mayonnaise	2.74****	125
Ice cream	Frozen yogurt	2.69****	134
Regular yogurt	Light yogurt	2.37****	125
Alcoholic beer	Nonalcoholic beer	2.20****	107
Regular ice tea	Low-calorie ice tea	1.71****	105
Sugared cereal	Low-sugar cereal	1.64****	134
Regular chewing gum	Sugarless chewing gum	1.50****	131
Dunkin' Donuts munchkins	Dunkin' Donuts muffins	1.44****	115
Regular soft drinks	Diet soft drinks	1.35****	127
Regular coffee	Decaffeinated coffee	1.34****	98
Whole milk	Low-fat milk	1.18****	133
Butter	Margarine	1.17****	133
Beef bologna	Turkey bologna	0.96***	95
Regular tea	Decaffeinated tea	0.91***	116
Regular cigarettes	Light cigarettes	0.68	28
Hair spray (aerosol)	Hair spray (pump)	0.53	75
Dexatrim	Slimfast	0.53	30
Snacks with preservatives	Snacks without preservatives	0.51**	136
White rice	Brown rice	0.43****	134
Sugared fruit drinks	Fruit juice	0.40**	134
Bleached flour	Whole wheat flour	0.23	128
Pornographic magazines	News magazines	0.22*	128
White bread	Whole grain bread	0.17	128
Deodorant (aerosol spray)	Deodorant (roll-on)	0.16	123
Seltzer water	Natural spring water	0.14	125
Sugar	Brown sugar	0.11	133
Vegetable shortening	Vegetable oil	−0.15†	126

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$, ****$p < 0.0001$ in two-sided t test.

†Mean difference score was counter to hypothesis ($p < 1$);

enjoyable." When evaluating the delayed consequences (d), they were asked: "If you were a consumer of each of the following products and consumption of these products entailed identical short-term effects (such as taste, ease of use, fun, temptation, or anything else that would affect how much you enjoy consumption in the short run), which of the two products in each pair would you rather consume? To evaluate these long-term effects, think about health or social effects of consumption, etc." The ratings for each pair were given on a 9-point scale anchored at 1 and 9 by

the two categories such that the midpoint represented indifference. This procedure served to identify conditions for time-inconsistent preferences, i.e., which, if any, of the categories in a pair was perceived as the relative vice and which as the relative virtue.

The second set of data was a convenience sample of regular (nonpromotion) retail package prices and package sizes for the 30 pairs. These data were collected in five stores of two major supermarket chains, two stores of a major drug store chain, one store of a major bookstore chain, a Dunkin' Donuts outlet, and a

high-volume liquor store in the Chicago metropolitan area. Up to five different package sizes and 15 different brands per product category were available in those stores and included in our convenience sample.

4.2. Results and Discussion

Category Classifications. As a prerequisite for the quantity discount analysis, the categories in each pair were first classified depending on whether or not subjects perceived them as relative vices and virtues. Note that we had randomized whether the lower or upper anchors of the i and d preference scales marked the category that was hypothesized to be the relative virtue in each pair. Therefore, we first rescaled subjects' i and d ratings from -4 to $+4$, such that a preference for the hypothesized virtue (vice) in a pair would always be indicated by a positive (negative) rating. We then sorted responses depending on whether a respondent at least weakly preferred the same category in a pair from both temporal perspectives (i.e., $d \geq 0$ and $i \geq 0$, or $d \leq 0$ and $i \leq 0$) or whether a respondent preferred one category in a pair to the other from one temporal perspective (e.g., $d > 0$) but expressed a reverse preference from the other temporal perspective (e.g., $i < 0$).

If preferences reversed (i.e., $d > 0$ and $i < 0$, or $d < 0$ and $i > 0$), the rating of the immediate consequences was subtracted from the rating of the delayed consequences ($d - i$). Positive temporal reversal scores ($d - i > 0$) meant that $d > 0$ and $i < 0$, while negative reversal scores ($d - i < 0$) meant that $d < 0$ and $i > 0$. Thus, positive temporal reversal scores implied that the category that was preferred from the delayed perspective ($Y >_D X$) was not preferred from the immediate perspective ($Y <_I X$), making it a relative virtue and the other category in the pair a relative vice as hypothesized. Negative temporal reversal scores implied that the category not preferred from the delayed perspective ($X <_D Y$) was preferred from the immediate perspective ($X >_I Y$), making it a relative vice and the other category a relative virtue. For instance, consider light and regular cigarettes. If a subject marked a 2 on the immediate scale (indicating a preference for one anchor, e.g., regular cigarettes) and a 9 on the delayed scale (indicating a preference for the other anchor, e.g., light cigarettes), these values were rescaled

to -3 (immediate) and $+4$ (delayed). The temporal reversal score (delayed minus immediate) would then be $+7$, so that light cigarettes would be classified as a relative virtue and regular cigarettes as a relative vice.

Pairs in which one category was at least weakly preferred over another from both the immediate and the delayed perspectives (so that after rescaling both ratings were either nonnegative or nonpositive) received a zero temporal reversal score, indicating that they did not induce time-inconsistent preferences. Thus, for every respondent, each pair was characterized by a temporal reversal score that identified which category, if any, was the relative vice and which the virtue.

The mean temporal reversal score for each pair was then taken across all subjects who had stated that they had consumption experience with both categories in the pair, including those who at least weakly preferred the same category in a pair from both temporal perspectives (i.e., $d \geq 0$ and $i \geq 0$, or $d \leq 0$ and $i \leq 0$) and who had therefore been assigned a temporal reversal score of $d - i = 0$. Table 4 lists the mean temporal reversal scores for each pair as well as the number of subjects with consumption experience. These mean scores differed from zero for 21 pairs (at $p < 0.05$ or less), indicating that the product categories in these pairs created intertemporal conflict between preferences and can thus be characterized as relative vices and virtues.

Quantity Discount Analysis. Several separate OLS regressions were run to determine quantity discount depths for subsets of m category pairs for which package price and size data had been collected. All regressions were log-log models of the form

$$\ln(p) = \alpha + \alpha_{\text{Diff}}R + \beta \ln(q)$$
$$+ \beta_{\text{Diff}}R \ln(q) + \Sigma\gamma_i C_i + \epsilon, \quad (2)$$

where
p = unit price,
R = indicator variable for perceived vice categories (1 = vice, 0 = virtue),
q = number of units per package (between 1 and 360; 10th percentile = 6 units, 90th percentile = 64 units),
C_i = indicator variables for $m - 1$ category pairs to control for pair-specific differences in unit price levels,
ϵ = error term (iid $N \sim 0, \sigma^2$).

The first analysis included the $m = 21$ pairs of relative vices and virtues with mean temporal reversal scores greater than zero at $p < 0.05$. Figure 3 and the first column of Table 5 show the results (ignoring the pair-specific intercept terms γ_i). Due to the logarithmic transformation of the data, the slope parameter $\beta = -0.451$ ($p < 0.0001$) is a constant elasticity. It shows that doubling package sizes for the virtues in these 21 pairs results in a 45% decrease in unit price. As predicted, unit prices drop even more rapidly, by 12% more, for vices when package size doubles—vices carry deeper quantity discounts than matched virtues ($\beta_{\text{Diff}} = -0.120$; $p < 0.01$). At the same time, small package sizes of relative vices carry higher unit prices than small sizes of relative virtues ($\alpha_{\text{Diff}} = 0.232$; $p < 0.05$).[4]

[4]As an approximation, we assume that consumers' underlying utility functions are defined with respect to the measure of package size q that is used by the manufacturer of the product. For example, package sizes are measured in ounces for most grocery categories in our sample but in number of items for cigarettes, muffins, and magazines. As a result, the package size scale varies across product categories. However, matching relative vices and virtues ensures that

Table 5 also shows the results of an additional set of analyses, performed separately for each third of $m = 10$ pairs of the categories in Table 4. The 10 categories with the highest mean temporal reversal scores exhibit the predicted pattern of deeper quantity discounts for vices than for matched virtues ($\beta_{\text{Diff}} = -0.225$; $p < 0.01$) and higher unit prices for small package sizes of relative vices than for small sizes of relative virtues ($\alpha_{\text{Diff}} = 0.424$; $p < 0.05$). Also consistent with our theory, this difference in the signs of α_{Diff} and β_{Diff} disappears as temporal reversal scores decrease and the categories within pairs cannot be characterized as relative vices and virtues anymore (see the four right-most columns of Table 5 for the estimates for the middle and bottom thirds of pairs in Table 4).

The pricing structure of the product categories in this convenience sample is consistent with the premise that firms behave as if vice consumers are less price sensitive than virtue consumers: Relative vices are

the scale is the same within each category pair so that any remaining specification error affects all observations within a pair equally.

Figure 3   Predicted Unit Price as a Function of Package Size for the 21 Pairs of Relative Vices and Virtues ($p < 0.05$) in Field Study 1
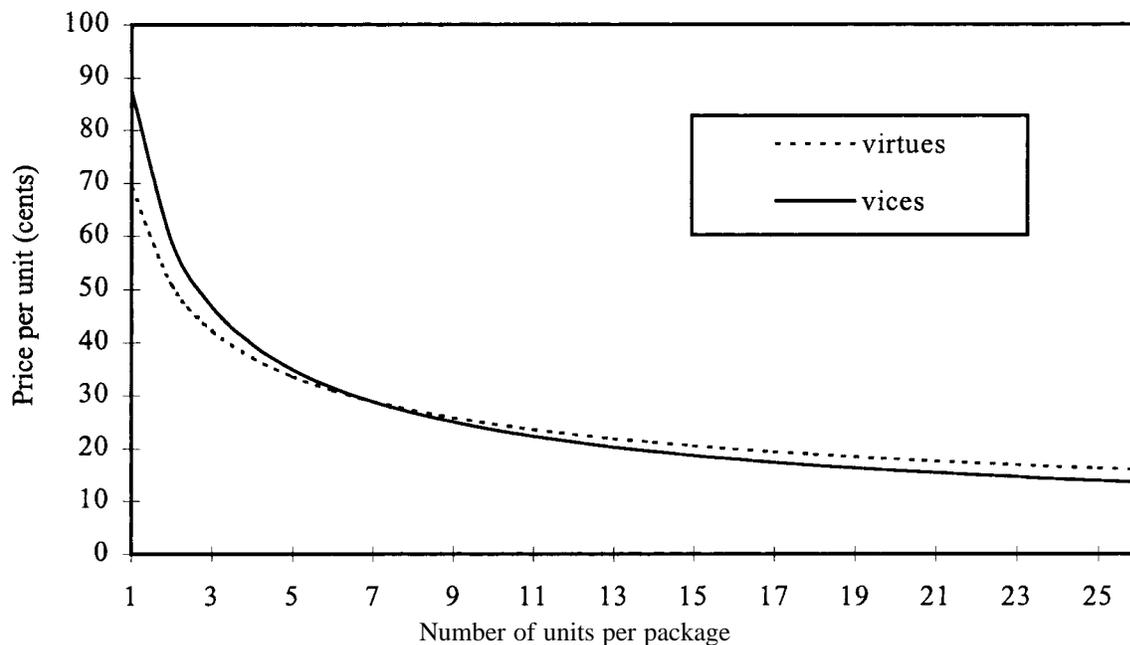
Table 5 Unit Price Estimation as a Function of Package Size (Number of Units per Pack) for Pairs of Relative Vices and Relative Virtues in Field Study 1

21 Pairs With Vice-Virtue Distinction at $p < 0.05$	SE	Top Third (10 Pairs)	SE	Middle Third (10 Pairs)	SE	Bottom Third (10 Pairs)	SE
α (virtue intercept)	4.238***	0.131	4.291***	0.238	4.217***	0.148	4.729***	0.223
α_{Diff} (intercept difference for vices)	0.232*	0.113	0.424*	0.206	−0.013	0.180	−0.046	0.209
β (virtue slope)	−0.451***	0.033	−0.428***	0.088	−0.411***	0.048	−0.691***	0.052
β_{Diff} (slope difference for vices)	−0.120**	0.038	−0.225**	0.077	−0.056	0.060	0.019	0.069
R^2	0.92***		0.89***		0.93***		0.91***	
df	23		12		12		12	
n	307	135	124		108			

$*p < 0.05, **p < 0.01, ***p < 0.0001.$

more expensive than relative virtues when bought in small packages, but they also carry deeper quantity discounts. That is, sellers have to offer deeper discounts to induce consumers to increase their vice purchases. This result, however, does not imply awareness among retailers of consumer self-control processes. It merely illustrates a market-level pricing structure that is consistent with our experimental results.

This pricing structure cannot be explained by differences in overall preferences for vices and virtues. For example, if consumers had stronger preferences for the vices in this sample, perhaps due to more differentiated competition among vices, one would observe an outward shift in the pricing schedule instead of a crossover (cf. Boulding et al. 1994). That is, vices should be more expensive for all package sizes ($\alpha_{\text{Diff}} > 0$) and should exhibit equal or shallower quantity discounts ($\beta_{\text{Diff}} \geq 0$), contrary to our findings. Put differently, if vices simply carried greater utility, consumers would tend to buy them in large quantities even when these are not heavily discounted. The different quantity discount depths observed here are also not just a function of how health-oriented the categories are, because the difference in discount depth disappears in pairs for which subjects expressed weaker, if any, intertemporal preference inconsistencies, although these pairs show similar differences in health orientation (see the middle and bottom thirds of category pairs in Table 4). Finally, one might expect more educated and wealthier consumers to prefer the relative virtues and less educated and poorer consumers to prefer the relative vices, perhaps leading to deeper quantity discounts for vices. If

that were true, however, relative vices should be cheaper in general—again in contrast to the findings.

5. Field Study 2: Is Store-Level Demand Consistent with Purchase Quantity Rationing?

Aggregate demand does not allow for an experimental test of rationing. Nonetheless, price-discriminating retailers need to determine the net effect of purchase quantity rationing on the specific aggregate demand schedules they are facing. Hence, we now illustrate the implications of the experimental results further by using store-level scanner data to estimate the price elasticity of aggregate demand in retail markets for a subset of the categories that were characterized as relative vices and virtues in the previous study. Less price-sensitive demand for vices than for virtues represents suggestive evidence of the presence of purchase quantity rationing. Since the operation of self-control in shaping aggregate demand is not directly observable, we control for the effects of several other, normative variables on demand.

5.1. Procedure

Data. The data came from Dominick's Finer Foods, a major supermarket chain with 86 stores and a 20% market share in metropolitan Chicago. The database contains store-specific, weekly retail unit sales volume and unit price data as well as descriptive data for all brands and UPCs sold throughout the chain during an

entire calendar year, plus demographic information about the store trading areas (from 1990 Census data provided by Market Metrics). Price was exogenous to the extent that the retailer did not adjust prices every week according to elasticity estimates derived from previous observations. Vice (regular) and virtue (light) UPCs were matched by brand, store, week, package size, unit price, by whether they were offered on deal, and whether they were featured in newspaper inserts or in-store displays (based on IRI InfoScan data on chain-wide promotional activity). Thus, every light UPC specified by these variables was matched by at least one corresponding regular UPC to ensure that the elasticity comparison would be over identical ranges of variation in price, packaging, promotional support, and store demographics.

Cream cheese, processed cheese, soft drinks, and beer were the only available categories for which UPCs could unambiguously be classified as regular or light, for which the previous study had empirically verified the perceived vice-virtue characterization, and for which enough regular and light UPCs were offered to meet the matching criterion. Due to a lack of observations for nonalcoholic beer, we contrasted regular beer jointly with light and nonalcoholic beer (available for 70 stores). The resulting data set had 574,217 observations across the four categories.

Model Specification. We estimated the demand for regular and light UPCs with the following OLS regression model:

$$\ln(q) = \alpha + \alpha_{\text{Diff}}R + \beta \ln(p) + \beta_{\text{Diff}}R \ln(p)$$

$$+ \Sigma\gamma_j C_j \ln(s) + \theta_1 \ln(v) + \theta_2 \ln(c)$$

$$+ \theta_3 \ln(w) + \theta_4 D + \theta_5 F + \epsilon, \qquad (3)$$

where, for each UPC,

q = unit sales per store and week in ounces,
R = indicator for the regular subcategory (1 = regular, 0 = light),
p = price per ounce per store and week,
C_j = category indicator,
s = percent unit volume market share of each UPC i within category j across stores and weeks ($100 \cdot q_i / \Sigma q_i$,
v = total unit volume sold per store and category across weeks,

c = total number of UPCs available per store, week, and regular or light subcategory,
w = proportion of homes in individual store trading area with property values > \$150,000,
D = deal indicator for sale, bonus buy, or coupon price promotion per week,
F = indicator for newspaper feature insert and/or in-store display per week, and
ϵ = error term (iid $N \sim 0, \sigma^2$).

The intercept of the logged demand schedule for light products is α, while α_{Diff} is the difference in intercepts between the regular and light subcategories. Due to the conventional log-log demand specification, β represents the constant own-price elasticity of the light subcategory, while β_{Diff} is the price elasticity differential between regular and light, the parameter of interest. These parameters are adjusted for the effects of several control variables C_j, s, v, c, w, D, and F that capture normative influences on demand. These may co-vary with prices and create differential demand for light and regular UPCs independently of self-control. Some of the control variables measure consumer and market characteristics ($C_j \cdot s$, v, w); others control for manufacturer and/or retailer merchandising and promotion policies (c, D, F). Thus, γ_1 to θ_5 are scaling parameters that convert a given value of these variables into a specific level of demand.

First, differences in demand may be category- and UPC-dependent due to variations in taste and other product characteristics. We captured these demand idiosyncrasies through the interaction of a category indicator with UPC volume market shares per category across stores and weeks ($C_j \cdot s$). This measured the impact of consumers' strength of preference for each UPC (as an annual baseline relative to the other UPCs in the category), conditional on overall category demand and independently of whether a UPC was light or regular. We used this measure instead of including separate UPC-specific intercept terms, which caused multicollinearity. Second, effects of store-specific demand for each category were controlled by including store volume, computed as the total number of ounces sold per category and store over the 52 weeks (v). Third, differences in price elasticity should arise if there were differences in the numbers of perceived substitutes for light and regular UPCs. Hence, we included the total

number of UPCs on the shelf in each regular or light subcategory per store and week as a measure of the effect of competitive intensity and level of substitutability on demand (*c*). Fourth, consumers' strength of preference for light and regular may vary with their education and wealth. Therefore, we used the proportion of homes in each store trading area whose property values exceeded $150,000 as a proxy for aggregate wealth in the store trading area (*w*). Finally, marketing and promotional support may create differential demand for light and regular products. So we controlled for the effects of weekly sale, bonus buy, and coupon price promotions (*D*) and of newspaper inserts and in-store displays (*F*) on demand by allowing the intercept to vary with changes in these promotional activities.

5.2. Results and Discussion

Descriptive statistics are shown in Table 6, while the OLS parameter estimates are in Table 7. There was no multicollinearity between the variables. Tolerances, i.e., the proportion of variance in an independent variable that cannot be accounted for by a linear combination of the other independent variables in the OLS model ($1 - R^2$), ranged from 12.2% for store volume to 99.0% for store trading area wealth. The control variables have normatively correct and expected signs. UPC-level demand was an increasing function of market share (γ_1 to γ_4), store volume (θ_1), customer wealth (θ_3), promotional activity (θ_4), and newspaper or in-store display advertising (θ_5), and a decreasing function of competitive intensity (θ_2). For example, on average and conditional on all other variables equaling

zero, a 1% increase (decrease) in within-category UPC market share, or relative preference, led to an increase (decrease) in demand of $\gamma_1 = .6\%$ for beer.

Figure 4 and the top of Table 7 show the key result. Demand for regular products (relative vices) was weaker than demand for light products (relative virtues) only at low unit prices ($\alpha_{\text{Diff}} = -0.0871$). As predicted, demand for regular products was also less price sensitive ($\beta_{\text{Diff}} = 0.0996$), resulting in a crossover of demand as unit price rises. In other words, demand for regular products was increasingly constrained when price constraints were relaxed, although neither subcategory was preferred over the other across the entire price range as there was no outward shift of demand (see Boulding et al. 1994). The constraint on vice demand appears to be self-imposed, since several key normative effects on demand were directly controlled as described above. Excluding beer from the analysis (because light and nonalcoholic beer were jointly classified as a relative virtue, in contrast to the empirical classification in Field Study 1) led to comparable results.

The price elasticity differential between light and regular products is consistent with our hypothesis of self-control through purchase quantity rationing, given that the model adjusted aggregate demand for the effects of these key control variables and light and regular UPCs were carefully matched. For example, because light and regular UPCs were matched in package size, inventory requirements were identical for both subcategories. Hence, the elasticity differential

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Table 6   Descriptive Statistics of Database in Field Study 2

|	Mean	*SD*	Minimum	Maximum
Number of ounces sold per week and store	1,226	4,054	5	770,544
Indicator for regular subcategory	0.54	0.50	0	1
Price per ounce in cents	6.74	7.11	1.24	37.80
Volume market share in category (%)	2.05	3.85	7.85×10^{-4}	55.12
Total unit volume sold per store and category (in ounces)	4,108,574	2,591,980	19,916	10,015,848
Number of competing UPCs (per store, week, and regular or light)	13.33	7.92	1	37
Proportion of homes worth more than $150,000	0.35	0.24	2.51×10^{-3}	0.92
Deal (sale, bonus buy, or coupon)	0.26	0.44	0	1
Feature and/or in-store display	0.12	0.32	0	1

Note. N = 574,217

Table 7   Demand Estimation for Light and Regular Products in Field Study 2

	OLS Parameter Estimates (Includes Beer)	SE
α(intercept)	− 2.3791	0.0358
α_{Diff}(Indicator for regular subcategory)	− 0.0871	0.0049
β[ln(price)]	− 0.3408	0.0039
β_{Diff}[Indicator for regular subcategory $\times$ ln(price)]	0.0996	0.0029
γ_1 [beer indicator $\times$ ln(share)]	0.6000	0.0012
γ_2 [cream cheese indicator $\times$ ln(share)]	0.5723	0.0027
γ_3 [processed cheese indicator $\times$ ln(share)]	0.5621	0.0022
γ_4 [soft drinks indicator $\times$ ln(share)]	0.7270	0.0013
θ_1 [ln(store volume)]	0.6139	0.0021
θ_2 [ln(number of competing UPCs)]	− 0.1377	0.0016
θ_3 [ln(proportion of housing value $>$ \$150K)]	0.0276	0.0008
θ_4 (deal indicator)	0.6806	0.0028
θ_5 (feature indicator)	0.4680	0.0036
R^2	0.69	
df	12	
N	568,487	

Note. All estimates significant at $p < 0.0001$.

Figure 4   Predicted Store-Level Demand in Ounces for Regular and Light UPCs in Field Study 2
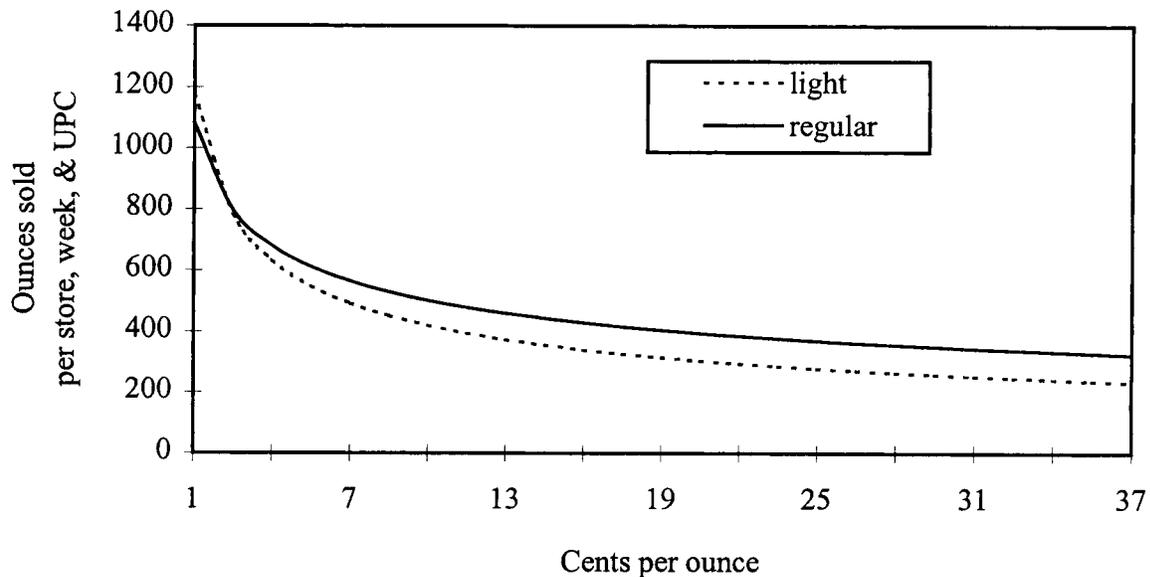
cannot be explained as a result of differences in inventory constraints, unless regular consumers had less inventory space available than light consumers. This might have been the case if light consumers were wealthier and lived in larger homes, but this was controlled in the model by including housing value as a covariate. Overall, the results suggest the presence of purchase quantity rationing in actual retail markets

334

and are useful to retailers for segmentation purposes. We interpret these results in light of the convergent experimental evidence provided above. Without such evidence, it would be difficult to draw inferences about individual consumer behavior from a demand model that is based on aggregate store-level data because construct operationalizations are necessarily imprecise and one can never rule out the presence of other, unobserved effects on demand.

6. General Discussion: Scope, Limitations, Future Research, and Managerial Implications

Consumers' attempts to control their impulsive consumption influence many everyday purchase decisions. This research is the first to extend previous, theoretical work on impulse control by empirically showing its broader implications for marketing decision making. The consistent finding across multiple methods and data sources is a characteristic crossover in demand schedules for vices and virtues. Vice demand increases less in response to price reductions than virtue demand, although consumers do not generally prefer virtues over vices. Hence, inventory constraints on vices appear self-imposed and strategic rather than driven by simple preferences. By restricting their inventory of vices at the time of purchase, consumers can limit subsequent consumption. As a result of purchase quantity rationing, vice buyers forgo savings from price reductions through quantity discounts, effectively paying price premiums in order to engage in self-control.

Consumers may reason that purchase quantity rationing imposes transactions costs on additional consumption once their inventory is depleted or they may try to avoid feelings of guilt that may be associated with buying large amounts of vices. From a behavioral perspective, the reasoning on which the rationing decision is based is not relevant (Rachlin 1995). Thus, Experiment 1 induces purchase quantity rationing by varying need for self-control indirectly, merely manipulating subjects' perceptions of the intertemporal consequences of consumption without examining the cognitive processes underlying their behavior. Experiment 2 shows that the relationship between these perceptions and rationing depends directly on subjects' impulsiveness and consequently on their need for self-control. Both experiments utilize real products and real choices to assess subjects' demand under controlled laboratory conditions, but are limited to two single, nonaddictive product categories.

Field Studies 1 and 2, in turn, rely on statistical instead of experimental control to examine ecological validity and managerial implications through aggregate market data from multiple categories. Field Study 1 shows the implications of Experiment 1 by reversing the dependent (quantity) and independent (price) variables. Quantity discounts as a function of actual package sizes offered by manufacturers are deeper for vices than for matched virtues. Field Study 2 builds on Experiment 2 by tracing out actual demand schedules for regular and light products faced by a large retailer. Consistent with the findings in Experiments 1 and 2, regular (vice) demand is less price sensitive than, and crosses with, light (virtue) demand when other, normative effects on demand are controlled. Neither field study allows for experimental control in a test of purchase quantity rationing. Both have to be interpreted in conjunction with the preceding experiments. However, the consistent pattern of results across all studies suggests strong convergent evidence of purchase quantity rationing in consumer markets.

The findings raise interesting follow-up questions. For example, does purchase quantity rationing indeed affect consumption rates? The transactions costs of additional shopping trips, which rationing imposes on marginal consumption, as well as recent findings on inventory effects on consumption suggest that rationing should reduce consumption rates (Folkes et al. 1993; Wansink 1996). If it does, vice manufacturers may want to counteract it. Second, how else do we control our consumption? For example, can we resolve dynamic inconsistencies by manipulating our tastes (Gibbs 1998)? Some smokers seem to acquire a taste for light cigarettes, perhaps to reduce an otherwise continued temptation to smoke regular cigarettes. How can marketers support this change in tastes? Third, how do marketing mix variables affect purchase quantity rationing? Building on Experiment 1, research could examine ways to influence rationing through different

advertising message appeals or different promotional vehicles. Perhaps the mere provision of a quantity discount makes the need for self-control more salient to consumers because they can only obtain the cheaper price if they buy more. So couponing and other forms of price promotion that are not explicitly directed at package size may be more effective in accelerating vice purchases and consumption.

More generally, this research on purchase quantity rationing opens a whole class of strategic self-constraining behaviors to empirical investigation by marketing researchers (cf. Wertenbroch and Carmon 1997). The crossover of demand schedules for relative vices and virtues shown here provides a conceptual basis for a test of self-control in any domain. For example, we can apply the analysis to consumer responses to different pricing schedules and payment vehicles. Thus, self-controlling consumers may prefer to pay for video rentals on a per-unit basis to make excessive watching costly. In contrast, health clubs should charge fixed up-front fees to minimize the cost of the marginal workout. If fixed-fee video club or pay-as-you-go health club memberships became available at cheaper average prices, hedonics might be less likely than prudents to switch to these. Easily tempted hedonic shoppers may prefer carrying cash instead of credit cards (see Prelec and Loewenstein 1998), even when they can pay off credit card debt in full at the end of the month. Constraining liquidity by carrying less cash than their available credit line may allow these consumers to curb spending. Increasing their credit line or lowering interest rates may not raise their demand for credit card usage as much as it might raise more prudent shoppers' demand. They willingly forgo interest earnings from credit card use (which they could realize by paying off the balance at the end of the grace period), paying the price of self-control.

Our findings suggest that marketers can segment and price discriminate based on consumer self-control. By offering a variety of package sizes, including rather small ones (e.g., M&Ms sold in vending machines), vice manufacturers can best appeal to both rationing and nonrationing consumers. For example, Michelob beer is sold not only in 6 packs of 12-oz. bottles but also of 7-oz. bottles. Similarly, cigarettes may well be

sold in packs of 10 in addition to packs of 20 and cartons.[5] Purchase quantity rationing allows marketers to charge premium prices for small sizes of vices relative to the corresponding quantity discounts for virtues. On the other hand, firms that want consumers to pantry-load vices to increase consumption (Wansink 1996) or preempt competitors will find this costly. To move consumers beyond the self-imposed constraint on consumption and to induce them to build up larger inventories of vices, firms will have to offer deep quantity discounts. In contrast, consumers should find even relatively shallow quantity discounts sufficient to stock up on virtues. Field Study 1 shows that, at least to some degree, some sellers follow these pricing strategies already. For example, for the top 10 pairs with the strongest vice-virtue distinction shown in Table 4, consumers receive an average quantity discount of only 25.7% for doubling the purchase quantity of the virtue, compared to a much deeper 36.4% quantity discount for doubling that of a corresponding vice. The price elasticity estimates in Field Study 2 provide additional evidence that smaller sizes of regular products can be priced relatively higher per unit than those of light products. Thus, the experimental- and market-level results show that consumers' attempts to control their consumption have important segmentation and pricing implications for many packaged goods sellers. If a firm can successfully price discriminate, it will be better off than if it cannot (Pigou 1948). Purchase quantity rationing provides an opportunity for doing just that, although public policy makers may, or perhaps should, show concern about firms charging consumers

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[5]Note again that the formal vice-virtue distinction is not absolute and denotes merely which in a pair of goods is preferable when one considers the immediate and delayed consumption consequences separately. As a managerial heuristic, however, it seems plausible to categorize known impulsive or addictive goods such as cigarettes, alcohol, or candy and so forth as vices. More generally, Brian Gibbs (personal communication) suggests the following definition of absolute vices and virtues: Call W at price p_W a vice if and only if $w_I > p_W$ and $p_W > w_D$, where w_I is the immediately realized value of W and w_D is the delayed value. Call W at p_W a virtue if and only if $p_W > w_I$ and $w_D > p_W$. This suggests that an effective retail tactic may be to promote virtues by redressing their deficiency in immediate benefits, e.g., by attaching small indulgences (a small of piece of chocolate) to healthy but less tempting products (fat-free cheese) to increase w_I.

a premium for "virtuous," or self-constrained, consumption behavior.[6]

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