

Consumption self-control by rationing purchase quantities of virtue and vice

1. Abstract

Consumers voluntarily and strategically ration their purchase quantities of goods that are likely to be consumed on impulse and may therefore pose self-control problems.

A smoker buys cigarettes per pack and not a full 10 pack carton

This paper provides experimental evidence of the operation of **consumer self-control** and empirically illustrates its direct implications for the **pricing of consumer goods**. In this paper we distinguish relative “Virtue” and “Vice” goods whose preference ordering changes whether consumers evaluate immediate or delayed consumption consequences

(1)When a smoker ignores long term health issues he prefers regular (vice) to light (virtue) cigarettes because of its taste. (2) However when a smoker ignores short term taste issue he prefers light to regular cigarettes

The **preference orders** can lead to inconsistent consumption choices (1) by consumers whose tradeoffs between the immediate and delayed consequences of consumption depend on the time lag between purchase and consumption. This can create a **self-control problem** because the consumer will be tempted to consume the vice they have in stock. **Purchase quantity rationing** helps them to solve the self control problem by limiting their stock and therefore their consumption opportunities. Such rationing implies that vice consumers will be less likely than virtue consumers to buy larger quantities in response to unit price reductions such as quantity discounts. This means that **vice consumers’ demand increases less in response to price reductions than virtue consumers’ demand**. As a result, vice buyers effectively pay price premiums for the opportunity to engage in self control.

These findings offer marketing practitioners new opportunities to increase profits through segmentation and price discrimination based on consumer self-control

On the one hand you can charge a premium prices for small sizes of vice (relative to the corresponding quantity discounts for virtues.)

On the other hand, virtue consumers will buy larger amounts even when quantity discounts are relatively trivial

2. Introduction

Even though smokers can realize noticeable savings when they buy 10 pack cartons rather than pack per pack, a large majority of them keep on buying small packs. 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 transaction costs and perhaps associated feelings of guilt. It is important to notice that this paper focuses on **consumption self-control via strategic purchase behavior**, not controlling purchase impulses.

Self-control problems arise from impulsive behavior. This means that the will to maximize immediately realized utility of consumption conflicts with maximizing some long-term utility. According

to Strotz (1956), impulsive behavior reflects dynamically inconsistent preferences due to non-constant discounting.

First approach of the model

$X >_I Y \rightarrow$ Preference for good X over a comparable good Y when considering **Immediate** consequences of consumption

$X >_D Y \rightarrow$ Preference for good X over a comparable good Y when considering the **Delayed** consequences of consumption

X is a vice relative to Y and Y a virtue to X if and only if at the margin:

- $X >_I Y$ (maximizing immediate pleasure)
- $Y >_D X$ (maximizing delayed utility)

If $X >_I Y$ and $X >_D Y$, it is impossible to have a dynamic inconsistency because immediate and delayed considerations prescribe the same choice.

In presence of **non-constant discounting** there is no simple consistent preference relation of the form $X > Y$. Therefore a consumer can end up with time-inconsistent preferences

- $Y >_D X$ at $t < T$ and $X >_I Y$ at $t = T$ (*cigarette example abstract*)

Under self-control, consumers strategically forgo at least some of the preferred immediate benefits of vice consumption to maximize delayed utility. This can be achieved by **restricting consumption opportunities, raising the immediate cost of impulsive behavior, substitution, avoidance or distraction**. The rationing rule says “Never buy more of a vice than r_x units at a time”. In this model, r_x is the rate that maximizes the delayed utility of current consumption, but this law allows consumers to partially give in to temptation to get some immediate utility as well for all $r_x > 0$.

- If $r_x > 0$ a consumer can bend the rule by simply buying vices more often.
- If $r_x = 0$ a consumer constrain himself severely because he doesn't buy the vice at all.

More formally

Let the **utility of consuming k units** of a relative vice X or of a relative virtue Y be a function of the immediate utility [$u_{X,I}(k)$ or $u_{Y,I}(k)$] and the delayed utility [$u_{X,D}(k)$ or $u_{Y,D}(k)$]

Immediate marginal utility is greater for vice than for virtues and vice-versa.

$\rightarrow [u'_{X,I}(k) > u'_{Y,I}(K)] \text{ and } [u'_{X,D}(k) < u'_{Y,D}(K)]$

We also assume that $u'_{X,I}(k)$ and $u'_{Y,D}(k)$ are positive otherwise there would be no reason at all to consume X and Y.

Consumer 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 $k^*_{...}$ are the consumption rates that maximize $u_{X,D}(\cdot)$ and $u_{X,I}(\cdot)$. This limits vice consumption at rate $K \leq r_x$.

The self-imposed purchase quantity rationing constraint keeps vice consumers from increasing their demand in response to price reductions because they can't buy a larger amount of vices without violating their self imposed rule.

3. Experiment 1: Do we forgo quantity discounts to ration our vice purchases?

In experiment 1 we test whether *relative vice consumers are less price sensitive than relative virtue* consumers by examining buyers' demand at two different quantity discount depths for a large purchase quantity. Intertemporal preference inconsistency is manipulated with the tag on the potato chips bag. The tags were either 25% fat (vice) or 75% fat free (virtue). Quantity discount offers an interesting experimental context because they accelerate encourage to purchase higher quantities.

If consumers self-impose constraints on their purchase quantities, their marginal valuations of larger purchase quantities should be less than the virtue consumers' marginal valuations.

The participants to the survey were first confronted with an existing brand of potato chips as a reference package size. The questionnaire offered them the opportunity to buy 0,1 or 3 bags of a new brand at different prices per bag. The participants were also informed that 10% of them would win 10\$ that they were obliged to spend on this potato chips. By doing so the experimenter created an incentive for the participant to give his true demand at a given price.

Therefore, this experiment is a 2^(25% fat or 75% fat free) x 2^(Deep or Shallow quantity discount) full factorial between subjects.

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		

^aMain effect of quantity DISCOUNT, *N* = 291.

^bMain effect of FRAME, *N* = 291.

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

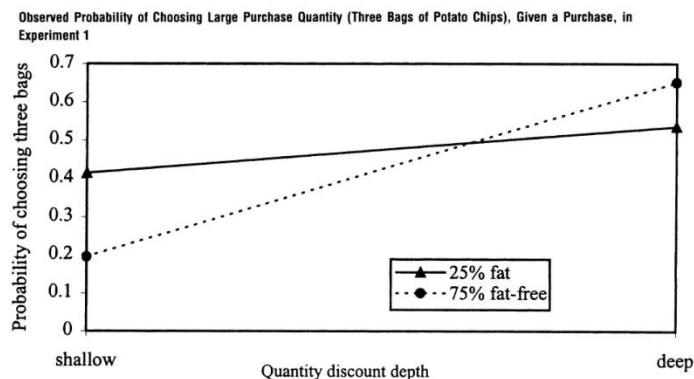
^dWithin-subjects main effect of 6- versus 18-oz. package size in repeated-measures ANOVA of taste ratings, *F* = 216.46, *p* < 0.0001; interaction with FRAME: *F* = 2.40, *p* < 1; *N* = 290.

Conclusions:

- Subjects saw the package as more expensive under the shallow than deep (3,97>2,20)
- Subjects rated the 25% fat as less safe to eat compared to the 75% fat free (3,23<4,10)
- Subjects were more concerned about eating too many chips under the 25% fat tag compared to the 75% fat free one (6,14>5,35)
- Subjects thought the potato chips would be better under the 25% fat rather than the 75% fat free (4,63;2,84>4,11;2,66) and taste was rated worse after eating 18 ounces of chips than after 6 ounces (2,75<4,36)

These results indicate that subjects preferred the 25% fat when they considered only the immediate consequences of the consumption (taste) and that their preference reversed when they were more concerned about the delayed consequences (concern and safety).

The author ran a logistic regression model to predict purchase quantity probabilities. Overall the subject who bought potato chips were more likely to prefer the large size when the chips were tagged as 25% fat. Buyers also showed a stronger preference for the larger package size when the quantity discount was deep. It is important to notice that the effect of quantity discount depth was mitigated under the 25% fat tag.



It is clear that increasing the depth of the quantity discount was less effective in enticing vice buyers to increase their purchase quantities → Self imposed rationing constraint.

Limitation: This experiment did merely create conditions for impulsive behavior. Vice buyers may have capped their purchase quantities, but not to control their temptation. Indeed they preferred to consume at a lower level as consumption at higher rates causes increasingly negative delayed consequences. More-over, vice consumption may have a bigger impact than virtue consumption on some non-price dimension.

4. Experiment 2: Do purchase quantity preferences depend on need for self-control?

In experiment 2 will replicate try to replicate the findings of experiment 1 and shows ***that it is the result of purchase quantity rationing.*** Experiment 2 differs from experiment 1 in 3 ways:

- First, for the purpose of this study the author uses another product category. Regular Oreos (vice) or Reduced-fat Oreos(virtue)
- Second, purchase quantity and unit price are orthogonal; small and large quantities are available to all subjects.
- Third, the author include a measure of the need for self-control → ***Consumer impulsiveness Scale*** (Puri 1996)

In several experiments Puri found that people with a high impulsiveness score (Hedonic) were more likely to behave impulsively. Therefore they face a greater potential need to self-impose external constraints on their vice consumption. Consumers with low impulsiveness scores (Prudent) are intrinsically controlled.

Hedonics do not generally prefer reduced-fat Oreos → Their virtue demand does not exceed their vice demand at all prices.

Design included three independent variables:

- Two level between subject manipulation (Regular-fat Oreo; 25% reduced-fat Oreo).
- Chronic tendencies to act impulsively. This is a continuous between subjects variable.
- Quantity (0,1 or 2) a subject is likely to buy for 20 different package prices (0,25\$->5\$)

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

	QUANTITY	FAT		F Value ^a	p <
		Regular	Reduced		
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.

^aBetween-subjects main effect of FAT across both Quantities.

^bWithin-subjects main effect of QUANTITY: $F = 174.37$, $p < 0.0001$; interaction with FAT: $F = 16.95$, $p < 0.0001$.

^cWithin-subjects main effect of QUANTITY: $F = 302.65$, $p < 0.0001$; interaction with FAT: $F = 1.31$, $p < 1$.

Subjects rated the regular-fat Oreos as tasting better (5,31>4,76). They also evaluated the delayed consequences of consuming regular fat Oreo as worse (3,08<3,55). Therefore, subjects preferred Oreo with regular fat when they considered the immediate consequences (vice)of consumption and Oreo reduced fat when considering the delayed consequences (virtue).

Furthermore, subjects rated the regular fat Oreos as better tasting only when eating one pack but not two in one week. Subject can stockpile

regular fat Oreo to avoid the satiation effect. By doing so, after one week the regular fat Oreo tastes better again. Therefore satiation cannot explain any difference in purchase quantity preference.

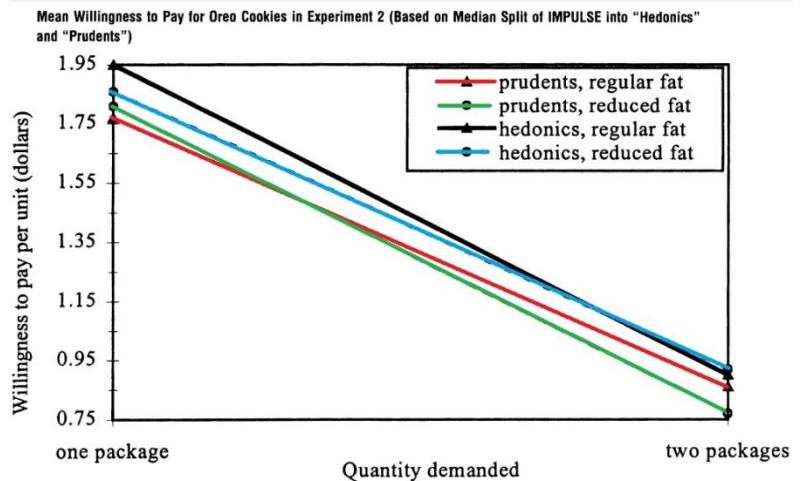
Hedonics' mean willingness to pay (WTP) showed a steeper decline for **regular cookies** than for **reduced fat**. The pattern was reversed for the prudent ones.

The ANOVA confirmed that hedonics required a deeper quantity discount for regular fat Oreos than for reduced fat to induce them to buy larger quantities. Again, prudent showed the opposite pattern.

Hedonics were not willing to pay more for the relative virtue than the relative vice. And the WTP were generally lower for buying two packs than one pack.

The results also confirmed the predicted 3 way interaction. With increasing impulsiveness scores, the decline in subjects per unit WTP for two packs relative to one pack became significantly steeper for regular fat Oreos than for reduced-fat Oreos.

In summary : Hedonics are less price sensitive and require a deeper quantity discount for a relative vice than for a relative virtue. Hedonics impose purchase quantity constraints on themselves when buying vices. Prundents are different, they are less likely to give in to a temptation.



5. Field study 1: Are retail quantity discounts consistent with purchase quantity rationing?

In this part the author search for suggestive evidence of purchase quantity rationing in real markets where demand for vice and virtues may be subject to **substitution effects** as well as many other influences. Indeed in real markets, consumers may not only ration purchase quantities of vices to control their consumption. They may also **substitute the vice by the virtue** to reduce the delayed costs generated by the vice. The author assumes that firms set retail prices as a function of revealed consumer preferences for different purchase quantities. This assumption combined to the findings in the former experiments means that purchase quantity rationing would manifest itself by deeper quantity discounts for vices than for relative virtues at a retail level.

In order to analyze the price setting behavior of firms, the author first had to develop a list of relative vice and virtue product categories. To do so the author developed a procedure to identify which of the categories in pair was perceived as the relative vice and which was perceived as the relative virtue (based on time-inconsistent preferences). The second set of data was a convenience sample of regular retail package prices and package sizes for the 30 pairs. Once all the information was collected the category pairs were classified in function of their mean temporal reversal score; Table 4. (for very interested people the method is based on the introduction part above. Cf. page 329 “Category classification”).

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 $p < 0.05$		Top Third (10 Pairs)		Middle Third (10 Pairs)		Bottom Third (10 Pairs)	
		SE		SE		SE		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		

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

Results:

- Doubling package sizes for the virtues results in a **45% decrease** in unit price
- Doubling package sizes for vices drop the unit price **12% faster** compared to virtues
Therefore, vices carry deeper quantity discounts than matched virtues.
- Small package size or relative vice carry **higher unit prices** than small sizes of relative virtues.

Furthermore the 10 categories with the highest mean temporal reversal score exhibit:

- **Deeper quantity discounts** for vices than for matched virtues
- **Higher unit prices** for small package sizes of relative vices

The pricing structure of the product categories is consistent with the premise that firms behave as if vice consumers are less price sensitive than virtue consumers. This however does not imply awareness among retailers of consumer self-control processes.

This pricing structure cannot be explained by differences in overall preferences for vices and virtues. If consumers had stronger preferences for the vices, these should be more expensive for all packages and should exhibit equal or shallower quantity discount. Additionally, the different quantity discounts are not just a function of how health-oriented the categories are. Indeed the discount depth disappears in pairs with weaker intertemporal preference inconsistencies, even though these pairs show similar differences in health orientation.

6. Field study 2: Is store-level demand consistent with purchase quantity rationing?

In the second field study, the author uses 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. (Again the “Procedure” and the “Model specification” are not included → Only for interested people cf. page 332).

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

	OLS Parameter Estimates (Includes Beer)	SE
$\alpha(\text{intercept})$	-2.3791	0.0358
$\alpha_{\text{DM}}(\text{Indicator for regular subcategory})$	-0.0871	0.0049
$\beta[\ln(\text{price})]$	-0.3408	0.0039
$\beta_{\text{DM}}[\text{Indicator for regular subcategory} \times \ln(\text{price})]$	0.0996	0.0029
$\gamma_1 [\text{beer indicator} \times \ln(\text{share})]$	0.6000	0.0012
$\gamma_2 [\text{cream cheese indicator} \times \ln(\text{share})]$	0.5723	0.0027
$\gamma_3 [\text{processed cheese indicator} \times \ln(\text{share})]$	0.5621	0.0022
$\gamma_4 [\text{soft drinks indicator} \times \ln(\text{share})]$	0.7270	0.0013
$\theta_1 [\ln(\text{store volume})]$	0.6139	0.0021
$\theta_2 [\ln(\text{number of competing UPCs})]$	-0.1377	0.0016
$\theta_3 [\ln(\text{proportion of housing value} > \$150\text{K})]$	0.0276	0.0008
$\theta_4 (\text{deal indicator})$	0.6806	0.0028
$\theta_5 (\text{feature indicator})$	0.4680	0.0036
R^2	0.69	
df	12	
N	568,487	

In order to determine whether the constraint on vice demand is self imposed, the author controlled directly the effects of **several key normative effects** to rule out other hypotheses. These control variables had the expected signs. Indeed, UPC level demand was an **increasing function** of market share, promotion activity... and it was a **decreasing function** of competition.

Results:

- Demand for regular products (vice) was weaker than demand for light products (virtue)
- Demand for regular products is less price sensitive → Crossover of demand as unit price rises.
This means that demand for regular products was increasingly constrained when price constraints were relaxed.

The price elasticity differential between light and regular products is consistent with our hypothesis of self control through purchase quantity rationing. Consequently, the **results suggest the presence of purchase quantity rationing in actual retail markets.**

7. Conclusion

- Vice demand increases less in response to price reductions than virtue demand, although consumers do not generally prefer virtues over vices.
- Purchase quantity rationings on vices appear self-imposed and strategic rather than driven by simple preferences.
- As a result, vice buyers forgo savings from price reductions through quantity discounts. They accept to pay a price premium in order to engage in self-control.
- To build up larger inventories of vices, firms will have to offer deep quantity discounts. In contrast, virtue consumers should find even relatively shallow quantity discounts sufficient to stock up on this kind of product.
- Marketers can segment and price discriminate based on consumer self-control. By offering a variety of package sizes, vice manufacturers can best appeal to both rationing and non rationing consumers.
- Field study 1 shows that at some degree, sellers follow these pricing strategies already
- Field study 2 provide additional evidence that smaller sizes of regular products can be priced relatively higher per unit than those of light products.