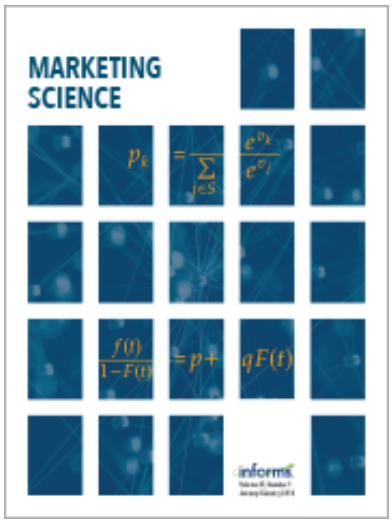

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Paul W. Dobson, Eitan Gerstner,

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For a Few Cents More: Why Supersize Unhealthy Food?

Paul W. Dobson
Norwich Business School, University of East Anglia, Norwich NR4 7TJ, United Kingdom,
p.w.dobson@gmail.com

Eitan Gerstner
Faculty of Industrial Engineering and Management, Technion–Israel Institute of Technology, Haifa 32000, Israel,
eitan.gerstner@gmail.com

Health-care experts believe that increases in portion sizes served by food vendors contribute to the obesity epidemic. This paper shows that food vendors can profit handsomely by using supersizing strategies where regular portion sizes are priced sufficiently high to discourage price-conscious consumers from selecting them, and the prices for enlarging food portions are set so low that these customers are tempted to order the larger portion sizes and overeat. Setting aside the impact of obesity on health-care costs, we show that using supersizing to steer customers toward consuming excessive amounts of food can destroy value from a social perspective; thus this social value destruction trap adds another justification for pressuring food vendors to reduce supersizing for unhealthy food. As a public policy response, we consider how "moderating policies" may counter these effects through measures designed specifically to encourage eating in moderation by applying supersizing bans, taxes, and warnings.

Key words: pricing; supersizing; overeating; obesity; self-control; temptation; social responsibility; public policy; moderating policies
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1. Introduction

What is common to all these offers: (a) supersize your french fries for 20 cents more; (b) get a free refill for a soda; (c) buy one pizza, get a second free; and (d) eat all you can for $7.99? They are obviously intended to tempt consumers to buy more food and drinks and thereby increase the sales of the vendor, but they also share a number of other common features. First, the prices for the incremental portions are incredibly low; typically, for a few cents more or even for free.[1] Second, they are most commonly used for unhealthy foods and drinks (NANA 2002). Third, they have been linked to the dramatic increase in portion sizes served to consumers over recent years (Young and Nestle 2002). Fourth, they are blamed for the alarming rise in obesity levels and resulting health-care costs to society (Rolls 2003, Wansink and Van Ittersum 2007).

[1] Portion upgrades at the time of writing include a 7-Eleven Coca-Cola ("Big Gulp" to "Super Big Gulp") for 10 cents more; McDonald's fries (medium to large) and Cinnabon (Minibon to Cinnabon) for 20 cents more; a Burger King value meal (large to king size), Starbucks Caffé Latte (grande to venti), and 7-Eleven Kit Kat/Snickers/Doritos (regular to king) for 30 cents more; McDonald's milk shake (large to king) for 40 cents more; and Regal Cinema popcorn (small to medium) for 50 cents more.

Since the mid-1990s, both food size portions and supersizing, a term coined by McDonald's for using bargain prices to entice consumers to enlarge food portions, have increased dramatically (Critser 2003). Fast-food vendors are criticized for supersizing unhealthy food such as french fries, popcorn, soda drinks, and cinnamon buns (Young and Nestle 2007), and they may even face litigations in the future (Werner et al. 2007). Why do fast-food restaurants offer bargain supersizing on unhealthy food? The simple answer is that unhealthy food loaded with salt, sugar, and fat tastes good, so hungry consumers are happy to buy more, and vendors can profit from satisfying their appetite. If this is so, however, why give more of it away at such ridiculously low prices? Moreover, it is conventionally argued that supersizing is profitable as long as the incremental price that can be charged for the additional quantity is larger than its incremental cost (e.g., McKenzie 2008). Can sellers profit from offering larger portions of unhealthy food at incremental prices that are below the incremental costs of providing it? Can supersizing be harmful from a social point of view even if the health-care costs associated with obesity are set aside? If so, should policy makers limit supersizing?

This paper contributes to the small literature that examines why portion sizes have increased dramatically in the last two decades. It shows that food vendors can profit handsomely by tempting some consumers to substantially enlarge the food portion they order using a supersizing strategy with bargain prices on supersized food portions. From a social point of view, this practice can destroy value because willingness to pay for enlarging the food portion can be below the incremental cost of supplying the extra amount. This result adds another justification for using public policies to reduce supersizing of unhealthy food. Our analysis suggests that such policies should be aimed at motivating eating in moderation. Such "moderating policies" can include supersizing bans, supersizing taxes, and supersizing warnings concerning overeating unhealthy food.

Supersizing leads to one explanation for the increase in the food portions observed. Food vendors could influence consumers to buy larger portion sizes by exploiting consumer behavior biases. For example, sellers can push larger sizes to consumers who underestimate the calorie intake that comes with larger portions of food (Chandon and Wansink 2007). Introducing "giant" sizes as an option can also increase sales of (smaller) "large" sizes because consumers tend to avoid choosing the extremes, and many would otherwise choose the "medium" size if only three sizes were available (small, medium, and large). The mere presence of the giant size as an option is likely to influence more consumers to select the large size (Sharpe et al. 2008). Whereas food vendors can adjust food portions to take advantage of such consumer behavior biases, previous research did not investigate whether supersizing practices can lead to socially inefficient outcomes.

The model we employ to explore the social welfare and policy implications of supersizing builds on existing theories of bundling, price discrimination, and quantity discounts. Typically, such models implicitly assume that consumers have control over what they buy and consume, and that consumers are not tempted to consume products that have undesirable delayed consequences, such as foods with high fat content. Recent theoretical models have incorporated temptations by assuming preferences that capture the trade-off between the pleasures of succumbing to temptation and the psychological costs associated with self-control to avoid the temptation. Specifically, this paper complements the recent research that explores optimal pricing under consumer temptation, notably Esteban et al. (2007) and Wertenbroch (1998), on costly self-control commitments for small sizes. In our case, it is the vendor's ability to segment customers, tempting some to upsize cheaply, that allows for raised prices on small sizes.

The model presented in §2 can lead to very deep quantity discounts to the extent that size upgrades on unhealthy foods are almost given away for free. Such discounts may be required to tempt consumers to eat larger portions of such food. In contrast, other than for loss-leader promotions, existing models of volume discounts are consistent with more moderate discounts (Dolan 1987, Kahn and Jain 2005) and can even lead to quantity premiums (Gerstner and Hess 1987, Sprott et al. 2003), as they typically focus on bundles of more-storable consumer products rather than individual meals and snacks consumed at the point of purchase.

Our model also builds on the theory of price discrimination under self-selection, where vendors provide menus of prespecified options open to all consumers but leave them to select the one that best suits their needs. This literature covers a wide range of applications, but the most relevant here is bundling and product line choice (Adams and Yellen 1976, Moorthy 1984, Stremersch and Tellis 2002, Kolay and Shaffer 2003, Hitt and Chen 2005, Thanassoulis 2007).

The rest of this paper is organized as follows. Section 2 outlines the model. Section 3 derives the optimal strategy. Section 4 examines the welfare implications of supersizing unhealthy food. Section 5 considers policies designed to moderate the undesirable consequences of supersizing. Section 6 presents the conclusion.

2. The Model

The purpose of the model is to explore the consequences of supersizing strategies that tempt customers to enlarge food portion sizes for bargain prices. In the model, a profit-maximizing food vendor serves a food item in a "regular" portion size that allows consumers to eat in moderation. The vendor can offer an enlarged portion and then decide on the price for the regular size and how much to charge for supersizing.[2]

The food vendor faces two types of consumers: α "disciplined" consumers denoted by D, and $1-\alpha$ "tempted" consumers denoted by T, where $0<\alpha<1$ so that the total number of consumers is normalized to unity. Customers of type i $(i=D,T)$ are willing to pay V_i for the regular portion size and value the extra amount from supersizing at U_i.

The characterization of consumer segments we employ fits with results from empirical studies showing that price-conscious consumers have a greater

[2] A supplemental appendix is available upon request from the authors that shows that all the key results of the present monopoly analysis are preserved in a Hotelling-based model of supersizing under competition that also allows for broader consumer heterogeneity (where consumers differ in their distances away from competing firms).

propensity to be overweight than less price-conscious consumers (Gandel and Shabelansky 2009) and that obesity and unhealthy food consumption rates tend to be higher among lower-income consumers (e.g., Drewnowski and Specter 2004). The segments can also be viewed in line with the "multi-self model" proposed in Thaler and Shefrin (1981) under which customers sometimes act as disciplined and other times as tempted. Generally speaking, the segmentation can be viewed as either person- or context-specific.[3] The preferences of the two consumer segments are characterized as follows.

1. *Disciplined consumers*: These health-conscious consumers try to eat in moderation and are prepared to pay a premium price, V_D, for rationing consumption in small portions (Wertenbroch 1998, 2003; Wansink and Huckabee 2005). They perceive an additional portion of product as an unhealthy portion because of major concerns about negative delayed consumption consequences, and thus their valuation of the additional portion U_D is minimal for unhealthy food and taken as less than the incremental cost of supplying the additional portion, c, such that $0 \leq U_D < c$. They are only prepared to supersize if the price of doing so is less than this valuation.[4]

2. *Tempted consumers*: These customers are more price conscious but also less resistant to the hedonic pleasure from eating food that is unhealthy but tasty compared with disciplined consumers (Raghunathan et al. 2006, Gandel and Shabelansky 2009). Tempted consumers are willing to pay only V_T for the regular size, where $V_T < V_D$, but value supersizing more than disciplined customers and are willing to pay a larger amount for the incremental portion, U_T, where $U_D < U_T < V_T$.

The vendor's problem is to maximize profits through pricing the regular size and the supersize upgrade (if offered) when knowing the proportions of each customer type and each type's valuations (i.e., known values of α, V_D, V_T, U_D, and U_T) but not individuals' preferences (thus ruling out direct price discrimination). In these circumstances, we show that the vendor can use pricing to entice customers to self-select by their type (i.e., reveal their nature through their purchasing decision), leading to an optimal supersizing strategy with the following properties.

(1) Regular-sized portions are priced sufficiently high to put off tempted consumers but still attract disciplined consumers, therefore enticing the tempted consumers through bargain supersizing.

(2) Supersizing may be used even if its added social value is negative ($U_i - c < 0$).

In the analysis that follows, we use the following notation. The price of the regular portion is P, and the incremental price of providing the additional portion is p, so the total price for the enlarged (supersized) portion is $P + p$. The supply cost of providing a regular portion is C, and with c as the incremental supply cost of providing the additional portion, the total cost of a supersized portion is $C + c$. As fixed costs for selling the product do not drive the analysis in this paper, we assume these to be zero.[5] Finally, for completeness, we assume $V_D > C$ and $V_T + U_T > C + c$ so that both regular and super sizes are feasible in the market.

3. Optimal Supersizing Strategy

In this section we refer to a strategy that maximizes profit among all the pricing options as optimal and seek to characterize the optimal supersizing strategy. The proofs to all propositions are given in the appendix.

3.1. Selling Without Supersizing

Without supersizing there are two pricing options to extract consumer surplus: (a) selling the regular size at a high price of V_D only to disciplined consumers, or (b) selling the regular size at a lower price of V_T to attract all consumers. The profit from each of these two nonsupersizing options is, respectively, $\alpha(V_D - C)$ and $V_T - C$, with the former greater (respectively, less) than the latter when $V_T - \alpha V_D <$ (respectively, $>$)$(1 - \alpha)C$, as shown in the first two rows of Table 1. Thus, option (a) is more (respectively, less) likely to be preferred over option (b) the greater (smaller) is the value of V_D, C, and α and the smaller (greater) is the value of V_T.

3.2. Supersizing

A supersizing option provides the opportunity for the vendor effectively to offer consumers two products: regular or super size. Supersizing is profitable to the

[3] Other categorizations exist in the psychology and consumer behavior literature, notably restrained versus unrestrained eaters (e.g., Herman and Polivy 1980), high versus low self-control individuals (e.g., Baumeister 2002), and prudent versus impulsive consumers (e.g., Ramanathan and Williams 2007). The categorization adopted here is intended to make clear the differences in willingness to pay for different portion sizes as the focus of interest lies with the vendor's perspective of how best to exploit these differences rather than the underlying causes of these consumer preferences.

[4] This tiebreaking rule avoids the notational complication of the vendor needing to add a fractional amount ε over and above U_D when it wants to prevent disciplined consumers supersizing as part of a segmentation strategy.

[5] Note that bargain prices for supersizing could exist because fixed costs dominate variable costs, so the incremental costs of upsizing are small. In this paper, supersizing can exist even when cost-based explanations are absent.

Table 1 Optimal Selling With and Without Supersizing

Selling option	Amount sold	Profit	Conditions for optimality
$P = V_D$ (no supersizing)	α regular size	$\alpha(V_D - C)$	$V_T - \alpha V_D < (1-\alpha)C$
$P = V_T$ (no supersizing)	1 regular size	$V_T - C$	$V_T - \alpha V_D > (1-\alpha)C$
$P = V_D$, $p = V_T + U_T - V_D$	α regular size	$\alpha V_D + (1-\alpha)(V_T + U_T)$	$V_T + U_T > C + c$
when $V_T + U_T \geq V_D + U_D$	$1-\alpha$ supersized	$-C - (1-\alpha)c$	$\alpha(V_D - V_T) + (1-\alpha)U_T > (1-\alpha)c$
$P = V_T + U_T - U_D$, $p = U_D$	α regular size	$V_T + U_T - \alpha U_D$	$V_T + U_T - \alpha(V_D + U_D) > (1-\alpha)(C+c)$
when $V_T + U_T < V_D + U_D$	$1-\alpha$ supersized	$-C - (1-\alpha)c$	$U_T - \alpha U_D > (1-\alpha)c$

vendor if it allows it to increase its revenue by extracting greater consumer surplus sufficient to outweigh the additional costs compared to selling only the regular size. This will be the case if the costs of the two sizes are sufficiently low relative to willingness to pay for them. The precise form the supersizing offer then takes depends on whether or not the total willingness to pay of the tempted consumers, for a supersized portion, $V_T + U_T$, is larger or smaller than that of the disciplined consumers, $V_D + U_D$.

Proposition 1. *The optimal supersizing strategy is uniquely characterized as follows*:

(a) $P = V_D$ *with* $p = V_T + U_T - V_D$ *when* $V_T + U_T \geq V_D + U_D$ *with a profit greater than selling without supersizing if* $V_T + U_T > C + c$ *and* $\alpha(V_D - V_T) + (1-\alpha)U_T > (1-\alpha)c$.

(b) $P = V_T + U_T - U_D$ *with* $p = U_D$ *when* $V_T + U_T < V_D + U_D$ *with a profit greater than selling without supersizing if* $V_T + U_T - \alpha(V_D + U_D) > (1-\alpha)(C+c)$ *and* $U_T - \alpha U_D > (1-\alpha)c$.

The third and fourth rows of Table 1 show the outcomes for the respective optimal supersizing strategy. The intention in both cases is to segment the consumer types into buying different portion sizes through the prices offered.

Proposition 2. *Under optimal supersizing the regular portion is priced sufficiently high to make it attractive only to disciplined consumers. The supersized portion is offered at a bargain price to attract the tempted consumers and yet put off the disciplined consumers.*

In the absence of being able to target offers to individuals, the vendor offers a menu of prices to practice indirect price discrimination. The valuation of disciplined consumers for supersizing is small, and given $U_D < c$, the vendor has no incentive to tempt them into supersizing (because this would then entail both segments supersizing, resulting in incremental cost exceeding incremental revenue), so the vendor always ensures that $p \geq U_D$ to put them off from supersizing. Instead, the vendor's interest in supersizing lies solely with targeting tempted consumers, who are willing to consider supersizing but only if $p \leq U_T$. Clearly, the vendor could extract the full incremental surplus by setting $p = U_T$. However, it is never in the vendor's interest to do this. Specifically, if the vendor is prepared to offer supersizing, then it will always do so with the offer of bargain supersizing entailing $p < U_T$, as doing so allows the vendor to extract more consumer surplus either by setting a higher price on the regular portion or increasing total sales.

As Proposition 1 shows, there are two different situations, differing in how much surplus the vendor can extract and how cheap supersizing is. When $V_T + U_T \geq V_D + U_D$, the vendor can extract all the surplus from disciplined consumers purchasing the regular size by setting $P = V_D$ while extracting all the surplus from tempted consumers through supersizing for $p = V_T + U_T - V_D \leq U_D$, so that the total price they pay is $P + p = V_T + U_T$. In contrast, when $V_T + U_T < V_D + U_D$, the most tempted consumers are prepared to pay for the supersize portion is $P + p = V_T + U_T$, but to prevent disciplined consumers from supersizing, the lowest the vendor can charge for supersizing is $p = U_D < U_T$, meaning the highest price it can set for the regular size is $P = V_T + U_T - U_D < V_D$. Thus, respectively, the greater is V_D and the lower is U_D, then the lower the price of supersizing. In the limit where disciplined customers place absolutely no value on supersizing, i.e., $U_D = 0$, then the vendor may even offer supersizing for free.

4. Supersizing and Economic Inefficiency

The results in the previous section provide a rationale for why food vendors can sell regular portion sizes at very high profit margins while enlarging portion sizes at low or even negative margins. In this section, we examine the economic welfare aspects of such bargain supersizing. We show that when supersizing is optimal from a vendor perspective, its added value to society, defined as willingness to pay for supersizing less the incremental cost of supplying it, can be negative (i.e., $U_T - c < 0$). This means that total welfare could, in these circumstances, be increased if supersizing were eliminated.

To find conditions where supersizing is optimal from the seller's perspective but not from a social welfare perspective, we computed the total welfare as the sum of profit and consumer surplus for each selling option—see Table 2. The first point to note

Table 2 Welfare With and Without Supersizing

Selling option	Profit	Surplus of disciplined	Surplus of tempted	Total welfare
$P = V_D$ (no supersizing)	$\alpha(V_D - C)$	0	0	$\alpha(V_D - C)$
$P = V_T$ (no supersizing)	$V_T - C$	$\alpha(V_D - V_T)$	0	$\alpha V_D + (1-\alpha)V_T - C$
$P = V_D, p = V_T + U_T - V_D$	$\alpha V_D + (1-\alpha)(V_T + U_T)$			$\alpha V_D + (1-\alpha)(V_T + U_T)$
when $V_T + U_T \geq V_D + U_D$	$-C - (1-\alpha)c$	0	0	$-C + (1-\alpha)c$
$P = V_T + U_T - U_D, p = U_D$	$V_T + U_T - \alpha U_D$			$\alpha V_D + (1-\alpha)(V_T + U_T)$
when $V_T + U_T < V_D + U_D$	$-C - (1-\alpha)c$	$\alpha(V_D - V_T - U_T + U_D)$	0	$-C - (1-\alpha)c$

in this setting is that the amount sold determines the level of total welfare. Thus in both supersizing cases, with α units of regular size and $1-\alpha$ supersized units sold, the same level of total welfare is achieved at $\alpha V_D + (1-\alpha)(V_T + U_T) - C + (1-\alpha)c$, even though the profit levels are different (because when $V_T + U_T \leq V_D + U_D$ the vendor cannot fully extract all the surplus from disciplined consumers). However, in the absence of supersizing, the level of total welfare depends on whether the vendor sells just to disciplined consumers or to both consumer segments.

When it is optimal in the absence of supersizing for the vendor to set price at $P = V_D$, and thus sell only to disciplined consumers, then total welfare is $\alpha(V_D - C)$. The added welfare from supersizing under self-selection is thus $(1-\alpha)(V_T + U_T - C - c)$, which is positive by the assumption made that $V_T + U_T > C + c$ (to ensure that the supersize portion is feasible in the market). In contrast, when it is optimal in the absence of supersizing to set $P = V_T$ and sell to both segments, then total welfare is higher (because of the extra $1-\alpha$ units of regular size sold) at $\alpha V_D + (1-\alpha)V_T - C$. Then, the difference in welfare compared to the supersizing cases is $(1-\alpha)(U_T - c)$, so that supersizing only adds value from a social perspective if $U_T > c$.

Comparing these conditions for supersizing to add to social welfare with the conditions required for supersizing to be optimal for the vendor (shown in the final column of Table 1) shows that the private interests of the vendor can conflict with societal interests.

Proposition 3. *A food vendor may find it optimal to supersize even when its added social value is negative* $(U_T - c < 0)$.

Proposition 3 implies that supersizing could destroy social value because the resources for providing the additional quantity can cost more than the amount consumers are willing to pay for it. From the vendor's perspective, supersizing can still add to profits in such circumstances either when it allows for a higher price to be charged on the regular size to extract a greater amount of surplus from the disciplined consumers sufficient to cover the costs of supersizing, or when it involves selling to tempted consumers that would otherwise not be as profitable so long as the additional surplus extracted covers the combined additional costs. Society, though, would be better off if the vendor avoided using welfare-destroying supersizing and instead sold only the regular size to all consumers. The absence of a private incentive to do this results in a social value destruction trap, suggesting a role for public policy intervention.

5. Moderating Policies to Reduce Overeating

McDonald's coined the term *supersizing* in the mid-1990s but stopped using the term in the wake of the 2004 documentary *Super Size Me*, which communicated the evils of the practice. However, the practice as such remains ubiquitous in the fast-food sector. Consumers are everywhere encouraged to "go large," "upsize," or "upgrade" to ever-larger portion sizes for only a few cents more. Huge servings abound, like the quadruple-patty Quad Stacker sandwich at Burger King or the Big Gulp soda at 7-Eleven. Moreover, negative publicity over supersizing has been no deterrent to the promotion of giant sizes, as illustrated in 2007 by McDonald's introduction of its "Hugo" soda, a 42-ounce drink containing 410 calories for just 89 cents, with advertisements seemingly targeted at minorities disproportionately affected by the obesity epidemic.[6]

For susceptible consumers, supersizing may appear as a bargain. It does not when account is taken of all the additional costs from putting on the extra weight from eating enlarged food portions. These costs include not only the future health costs and work days lost, but additional living costs such as higher-energy needs to support increased body weight, including higher gasoline consumption. Close and Schoeller (2006) estimated that supersizing a meal on average brings consumers 73% more calories for only an additional 17% in price, but these hidden financial costs substantially outweigh the initial supersizing cost, driving up the total meal price by up to 191% for men and up to 131% for women, depending on their body type. Moreover, these calculations

[6] See Martin (2007).

do not take into account the social costs of obesity arising from discrimination, stigma, and loss of self-esteem (Puhl and Brownell 2001, Crandall 1994).

However, consumers appear oblivious to these long-term costs from overeating, and obesity levels continue to rise at an alarming rate. In the face of mounting public health concerns, policy makers are now reviewing different measures to completely ban or reduce sales and consumption of unhealthy food. These measures tend to be quite broad in nature, seeking to reduce general consumption of unhealthy food, such as banning junk food from schools, warning customers about high levels of trans fats, limiting advertising and sales of sodas, and taxing "fattening food of little nutritional value" (Fried and Nestle 2002; Seiders and Petty 2004; Chandon and Wansink 2007; Ubel 2009; *Economist* 2008, 2009).

Our analysis suggests that measures specifically aimed at reducing supersizing have their own merit as they could help put restraints on marketing efforts that tempt customers to supersize and overeat. Such efforts entice customers to buy and eat more food on the margin, i.e., increasing the quantity they consume even when they are not very hungry, and thus exceed the recommended daily allowances of sugar and fat instead of eating in moderation. Moreover, as we have demonstrated by Proposition 3, selling these incremental quantities can occur at prices below their marginal cost. Therefore, policies designed to discourage supersizing and to remind customers about the benefits of eating in moderation are likely to be useful in the fight against the obesity epidemic. Thus, our focus here is on what we term moderating policies, referring to measures designed to combat supersizing and overeating unhealthy food. We consider three alternative measures: restricting the availability of large portions, using monetary incentives through taxation, or alerting consumers to the dangers of supersizing. We discuss the merits of these three different measures in turn. Table 3 provides a summary.

Table 3 Moderating Policies to Control Supersizing of Unhealthy Food

Type of policy	Purpose	Impacts and unintended consequences
Supersizing bans	Limit supersizing offers and supersize portions	Stops supersizing. May be circumvented through multiple portion deals.
Supersizing taxes	Sales tax (t) on large portions to raise cost of supersizing ($\uparrow c$)	Reduces profit incentive for supersizing. May be circumvented through multiple portion deals.
Supersizing warnings	Reduce willingness to pay for supersizing ($\downarrow U_T, \downarrow U_D, \uparrow \alpha$)	Decreases demand for supersizing. Vendor may respond with even more generous supersizing deals.

5.1. Supersizing Bans

A direct, if extreme, way to fight supersizing of unhealthy food is to ban the practice. In the context of our model, this would be socially beneficial if it forces the vendor to focus on selling the regular size to all consumers (i.e., set $P = V_T$). However, such a beneficial outcome from banning or restricting supersizing is by no means certain. First, the vendor, on giving up supersizing, might simply opt to raise prices on regular sizes to exclude some consumers (i.e., $P = V_D$), but in the context of curtailing unhealthy food consumption, this might still be viewed as socially beneficial. Second, the vendor might seek to circumvent such a restriction by instead offering multiple portion deals (like "buy one regular size, get a second at half price"). However, such deals may not be as popular as supersizing if individuals would be embarrassed to take up such offers (as suggested by Critser 2003). Also, the vendor may lose revenue if families and friends take advantage of such deals to save on buying multiple regular sizes.

There are also practical difficulties with implementing a ban on supersizing. For example, directly restricting portion size would require policy makers to define and distinguish between allowed and prohibited sizes for all products for which the ban were to be applied. Similarly, restricting pricing inducements for supersizing would also require defining and distinguishing between different product sizes. A blanket ban on quantity discounts would remove such definitional requirements, with vendors obliged to apply a constant unit price to their different portion sizes. However, such a move would result in inefficiency if prices were unable to fully reflect costs (e.g., when larger sizes have lower unit costs than smaller sizes) or if pricing competition were reduced (where quantity discounts could be a means of competing vigorously for different consumer segments). Under these conditions, alternative policies to discourage eating large portions of unhealthy food should be considered.

5.2. Supersizing Taxes

Levying supersizing taxes on unhealthy food could provide monetary incentives for consumers and vendors to discourage supersizing. There is evidence that taxing calories, in general, can have a gradual effect on decreasing people's weight (e.g., Goldman et al. 2009). However, the context here suggests a deliberately targeted tax to discourage the purchase of enlarged portions of unhealthy food. Specifically, as the vendor uses nonlinear pricing with a quantity discount, the corrective incentive measure would be through a nonlinear tax to remove the quantity discount in order to entice consumers to eat in moderation. Accordingly, the tax should be discrete in nature,

targeting food portions exceeding a critical level of unhealthy components such as calories or fat.

The effectiveness of a supersizing tax may work through reducing the incentives of the vendor to offer supersizing when the tax hits its profits. Take the case of a unit sales tax operating at the rate t on supersizing, i.e., a tax paid by the vendor applicable only to portions above some defined regular size. In our model, this would have the effect of raising the vendor's unit cost of supersizing from c to $c+t$, thereby reducing the profitability of supersizing relative to selling only the regular size. If the intention were then to eliminate the vendor's desire to operate the practice, the optimal tax would be to raise t until the profit from supersizing was just below the profit from not supersizing.

As an illustration drawing on Table 1, consider the case where $V_T + U_T \geq V_D + U_D$ with the supersizing pricing strategy of $P = V_D$ and $p = V_T + U_T - V_D$; then the profit from supersizing under the tax would be $\alpha V_D + (1-\alpha)(V_T + U_T) - C - (1-\alpha)(c+t)$. If it were optimal in the absence of supersizing for the vendor to sell the regular size to all consumers, i.e., set $P = V_T$ leading to a profit of $V_T - C$, then the optimal tax level is obtained by setting these two profit expressions to be equal and solving for t, which gives $t = \alpha(V_D - V_T)/(1-\alpha) + U_T - c$. Analogously, in the case where $V_T + U_T < V_D + U_D$, the optimal tax level is $t = (U_T - \alpha U_D)/(1-\alpha) - c$. Observe that in both cases the optimal tax level is increasing in U_T, as the more the tempted consumers desire supersizing the greater is the required off-setting penalty for providing it, as well as increasing in α, because the greater the proportion of disciplined consumers the greater the tax needed to counter the vendor's incentive for using supersizing as a profitable segmentation device.

Setting the tax just above these respective optimal thresholds would effectively eliminate supersizing. Again, the vendor might seek to circumvent such a restriction on its ability to profitably segment customers by offering multiple portion deals involving regular sizes. However, as with a supersizing ban, this may not prove so effective when it appeals to groups (e.g., families or friends) willing to share meals and so results in the vendor losing revenue. More positively from a social perspective, the vendor might seek to avoid the supersizing tax by shifting from *upselling* unhealthy food towards *cross-selling* more healthy food, such as offering a combination of healthy and tasty-but-less-healthy food, e.g., offering a deep discount when ordering both french fries and a salad instead of only enlarging the former.

5.3. Supersizing Warnings

The third alternative to fight supersizing is to provide information to counter susceptible consumers' desire to supersize by requiring vendors to alert consumers about the dangers of supersizing unhealthy food. For instance, vendors that supersize could be required to post signs that warn consumers about the dangers of overeating unhealthy food (Wansink and Huckabee 2005) or to emphasize the benefits from eating in moderation. Vendors can also be pressured to bring back the small size portions they used to carry.[7] This by itself may motivate customers to select regular-sized portions instead of supersizing because some customers prefer to avoid extreme choices (Sharpe et al. 2008). However, as consumers become more accustomed to large portions they may become more resistant to downsizing, perhaps explaining why restaurants have not been successful in reintroducing small portion sizes.

In the context of our model, such information provision could serve to reduce consumers' willingness to pay for supersizing (i.e., reduce U_T and U_D) or even convert tempted into disciplined consumers, highly averse to supersizing (i.e., increase α). This may discourage the vendor from offering supersizing when demand is cut back. However, it might lead to the vendor offering even larger-quantity discounts and seemingly more generous bargain supersizing to counter the reduced demand. If this happens, the problem persists.

Mandating information provision does not mean that consumers will take notice, especially if it is delivered in the form of dry statistics rather than evocative images that create aversion to large portions of unhealthy food (Russo et al. 1986, Ubel 2009). Moreover, vendors may use tactics to deliberately mislead consumers about optimal portion size selection. For example, seeking to alter consumers' views of "normal" size portions, vendors could introduce gigantic portions to make their other portion sizes, including large, look healthier by comparison. Accordingly, supersizing warnings should be focused around creating communications to grab the attention of consumers, perhaps by using scaring techniques to warn them about the high health risks associated with supersizing. This is not an easy task given vendors' incentive to undermine any such campaign and given the difficulty of monitoring their behavior.

6. Conclusion

The obesity epidemic and the associated health-care problems motivated research to identify causes and cures to this global problem. Researchers believe that the increase in portion sizes of unhealthy food sold to

[7] For example, the UK's Food Standards Agency (FSA) is pressuring snack producers to reduce portion sizes along with reducing fat and sugar content (see FSA 2009).

consumers combined with bargain pricing for enlarging food portions have played a key role. We demonstrated that food vendors could profit handsomely by offering regular portion sizes at prices sufficiently high to put off price-conscious consumers and instead tempting them through bargain prices on supersizing, thus encouraging them to order larger portions and overeat. This profit advantage of supersizing unhealthy food provides one explanation for why the serving sizes and the overeating of fast food have increased so much since fast-food chains started using supersizing more than two decades ago.

Steering customers toward unhealthy supersized food portions, however, can destroy value from a social perspective, even leaving aside the impact of obesity on health-care costs. This can occur because under supersizing, the costs in resources used to provide the enlarged food portion can exceed consumers' willingness to pay for it. Therefore our analysis suggests that appropriate policies to fight supersizing should be aimed at countering vendor's rewards from using the practice and also at reducing consumers' desire to supersize unhealthy food for a few cents more. Such moderating polices can include supersizing bans, supersizing taxes, and supersizing warnings.

We recognize that these measures are likely to be contentious, not least because vendors are likely to see these regulatory moves as working against their profits. These measures also could involve significant enforcement and compliance costs, yet they target the root problem: not of eating unhealthy food in general, but rather of *overeating* such food, which is helping to fuel the obesity epidemic. As well as encouraging vendors to decrease portion sizes of unhealthy food, moderating policies may also lead vendors to intensify promotions of healthier food, which may provide further help in reducing the consumption of unhealthy food.

The focus of this paper has been on pricing strategies that tempt customers to substantially enlarge portions of unhealthy food. However, the model employed is applicable to other "vice products" such as cigarettes, drugs, and alcohol. For example, deep quantity discounts are commonly observed for alcoholic drinks served in bars in the form of "two-for-one" offers, "all-you-can-drink" offers for a fixed price, and "women-drink-for-free" offers that encourage binge drinking. In the wake of increasing health and social problems associated with excessive drinking, some countries, including France and the United Kingdom, have recently moved to curb such practices to encourage drinking in moderation.

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Appendix

Proof of Proposition 1. (a) When $V_T + U_T \geq V_D + U_D$, the vendor can segment consumers to extract all the surplus from tempted consumers by selling them $1-\alpha$ supersize portions at $P + p = V_T + U_T$ and all the surplus from disciplined customers on the regular size by selling them α portions at $P = V_D$, so $p = V_T + U_T - V_D \geq U_D$, and the resulting profit is $\alpha V_D + (1-\alpha)(V_T + U_T) - C - (1-\alpha)c$. Selling these portions at lower prices would result in lower revenue with no change in costs, and therefore lower profit. Selling supersize portions to both types of consumers would require $P + p < V_D + U_D$ with $p < U_D$, yielding profit lower than $V_D + U_D - C - c$, which is less than the profit under the optimal segmented supersizing strategy above. Finally, the two stated profit conditions are derived directly by contrasting the profit from the optimal segmented supersizing strategy with, respectively, the profit of αV_D from selling only the regular size at $P = V_D$ and the profit of V_T from selling only the regular size at $P = V_T$.

(b) When $V_T + U_T < V_D + U_D$, the vendor can extract all the surplus from tempted consumers by selling them $1-\alpha$ supersize portions at $P + p = V_T + U_T$ but the minimum supersize upgrade price it can set to prevent supersizing by disciplined consumers is $p = U_D$, implying that the maximum price it can set for the regular size to extract as much surplus as possible from disciplined customers is selling them α units at $P = V_T + U_T - U_D < V_D$, resulting in profit of $V_T + U_T - \alpha U_D - C - (1-\alpha)c$. Setting $p < U_D$ with still $P + p = V_T + U_T$ would motivate both consumer segments to supersize but would lead to lower profit because $U_D < c$ by assumption. Contrasting the profit from the optimal segmented supersizing strategy with that from the two nonsupersizing options yields the two stated profit conditions. □

Proof of Proposition 2. The proposition follows directly from the optimal pricing shown in Proposition 1, where in both supersizing cases we find $V_T < P \leq V_D$ and $U_D \leq p < U_T$, together with $P + p = V_T + U_T$. □

Proof of Proposition 3. All four optimality conditions covering the two supersizing cases shown in Proposition 1 (and the final column of Table 1) allow $U_T - c < 0$ for a range of permissible values of the other parameters. First, when $V_T + U_T \geq V_D + U_D$, the optimality condition $V_T + U_T > C + c$ holds as long as $U_T - c > -(V_T - C) < 0$, and the optimality condition $\alpha(V_D - V_T) + (1-\alpha)U_T > (1-\alpha)c$ holds as long as $U_T - c > -\alpha(V_D - V_T)/(1-\alpha) < 0$. Second, when $V_T + U_T < V_D + U_D$, the optimality condition $U_T - \alpha U_D > (1-\alpha)c$ holds as long as $U_T - c > -\alpha(U_T - U_D)/(1-\alpha) < 0$ and the optimality condition $V_T + U_T - \alpha(V_D + U_D) > (1-\alpha)(C + c)$ can hold with $U_T - c < 0$ as long as $V_T - C > \alpha(V_T + U_T - V_D - U_D)/(1-\alpha)$. □

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