# Consumer Privacy and Marketing Avoidance

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*Abstract*

We introduce the concept of "marketing avoidance" – consumer efforts to conceal themselves and to deflect marketing. The setting is one where sellers market some item through solicitations to potential consumers, the potential consumers differ in their value for the item, and the potential consumers suffer harm from receiving solicitations.

Seller marketing is a strategic complement with concealment by low-value consumers. Hence, efforts by low-value consumers to conceal themselves will increase the cost-effectiveness of marketing and lead sellers to market *more*. However, concealment by high-value consumers leads sellers to market *less*.

Owing to the externality from sellers to consumers, there is a clear need for public policy. A tax on solicitations should take account of both the expected harm to consumers and also the costs of consumer concealment and deflection induced by the seller solicitations.

From a consumer's viewpoint, concealment and deflection are substitutes: both reduce her likelihood of being solicited. But only concealment affects the "effective pool" of consumers that sellers address. Accordingly, from a social welfare perspective, deflection is preferable to concealment.

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## 1. Introduction

Privacy of personal information is a key concern for consumers:

> "There has been a well-documented transformation in consumer privacy attitudes over the past decade, moving concerns from a modest matter for a minority of consumers in the 1980s to an issue of high intensity expressed by more than three-fourth of American consumers in 2001" (Westin 2001).

Consumers use video-recorders, TiVo, caller-ID, spam filters, pop-up blockers, anonymous browsing, and other devices and techniques to protect their privacy and avoid marketing. In the U.S., over 50 million telephone numbers have been registered with the Federal Trade Commission "do not call" list (EPIC 2004). Such consumer actions to avoid marketing present critical challenges to marketers:

> "What's an advertiser to do when the most affluent customers aren't compelled to watch TV commercials and are, in fact, actively avoiding them?" (Barnes 2003).

Improvements in computing technologies are creating both new techniques of marketing and new ways to avoid marketing. These present new challenges to the marketing profession and public policy makers. How should marketers respond to consumer avoidance of marketing? How do marketers and consumers interact, and how does technology affect their interaction? What is the appropriate public policy towards marketing activities that impose harm on consumers?

Generally, prior analytical research in marketing has ignored the impact of marketing on consumer privacy and assumed that consumers would passively accept advertising and direct marketing. In this paper, we develop an analytical model that introduces the concept of "marketing avoidance" with which to address issues of marketing strategy and public policy. We focus on the endogenous trade-off between seller marketing and consumer privacy: consumers can only get the item through seller's marketing, but the marketing imposes costs on consumers and leads them to expend resources on avoidance.

The setting comprises multiple sellers who compete to market an identical product. There are two consumer segments: one segment has a higher valuation for the product than the other segment. Absent the sellers' marketing, consumers cannot buy the item. All consumers experience some harm from the sellers' marketing. A consumer may spend resources to avoid marketing in two ways – concealment or deflection. At the point of time that they incur marketing expenditures, sellers cannot distinguish the two types of consumer. Further, sellers ignore the harm caused by their marketing.

We show that seller marketing is a strategic complement with concealment by low-value consumers. Efforts by low-value consumers to conceal themselves will increase the cost-effectiveness of marketing and lead sellers to market more. However, concealment by high-value consumers leads sellers to market less.

Next, owing to the externality from sellers to consumers, there is a clear need for public policy. A tax on solicitations set equal to the expected harm caused to consumers would be insufficient. The tax should also take account of the costs to consumers of concealment and deflection induced by the seller solicitations.

Both concealment and deflection reduce a consumer's likelihood of being solicited. But only concealment shrinks the "effective pool" of consumers that sellers address, and so, further increases the expected harm. Accordingly, from a social welfare perspective, deflection is preferable to concealment.

The next section presents the background literature, and the following Section 3 introduces the analytical setting. Section 4 develops the consumer-seller equilibrium and Section 5 presents welfare and empirical implications. Section 6 concludes with limitations, extensions, and directions for future research.

## 2. Background Literature

A substantial literature in economics and marketing analyzes how sellers compete to acquire customers on dimensions of advertising and price (Butters 1977; McAfee 1994; McGahan and Ghemawat 1994; Chen and Iyer 2002; Baye and Morgan 2001 and 2004; Iyer and Pazgal 2003; Chioveanu 2003). Separately, analytical research into privacy has considered how marketers use personal information to effect price discrimination or screen out "bad" consumers (Chen et al. 2001; Chen and Iyer 2002; Taylor 2004; Acquisti and Varian 2005; Wathieu 2002).[1]

However, for the most part, previous analytical research ignored the harm that marketing imposes on consumers. Marketers use personal information to solicit new and existing customers, by direct mail, telephone, and fax, and electronically. Marketers also promote goods and services through advertising in the mass media. Advertising and unsolicited contacts impose inconvenience and other costs on consumers.[2] Marketers do not internalize these harms, and hence tend to over-spend on advertising and direct marketing relative to the socially optimal level (Petty 2000).

Anderson and de Palma (2005) analyze a direct marketing setting where sellers incur costs to send messages about some item to consumers, and consumers incur costs to "open" the messages. The item is available only through the sellers' messages. The sellers are heterogeneous and offer products of differing quality. In this scenario, an increase in the sellers' cost of communication can raise welfare by screening out lower-quality sellers. The average product quality would rise and more consumers would open messages addressed to them.[3]

By contrast with Anderson and de Palma (2005), we emphasize heterogeneity among consumers, and, the actions that consumers take to avoid

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[1] For a survey of the economics of privacy, see Hui and Png (2006).
[2] The costs imposed may differ with the advertising medium (Milne and Rohm 2000).
[3] Gantman and Spiegel (2004) consider the trade-off in software that incorporates advertising banners ("adware") between the benefit to consumers of receiving targeted information which improves their choice of product against the privacy cost.

advertising and solicitations, what we call "marketing avoidance". Motivated by the economics of security (Koo and Png 1994; Ayres and Levitt 1998), we distinguish two forms of marketing avoidance – concealment and deflection. This generalizes the concept of "ad avoidance", already recognized in the literature (Speck and Elliott 1997). In our framework, "ad avoidance" represents deflection.

Our analysis considers the interests of heterogeneous consumers who differ in their value for some item that is only available through seller marketing. All consumers suffer harm from marketing. We do not take an *a priori* position as to the merits of marketing, but rather, address the *endogenous* trade-off among the benefit of the item to consumers, the harm imposed on consumers by marketing, consumer costs of concealment and deflection, and sellers' marketing costs.[4]

## 3. Setting

We are motivated by the retail marketing of real estate brokerage, mobile telephone service, insurance, magazine subscriptions, cosmetics, and designer clothing – where the focus of competition is acquiring customers rather than price. In many markets, real estate brokerage commissions are fixed, hence brokers compete on service rather than price. T-Mobile, Verizon, and Sprint are represented by multiple outlets and independent retailers, all of which offer the same service plans. Likewise, in the insurance market, Prudential, State Farm, and AXA are represented by multiple agents and independent brokers who compete for customers in person and through telemarketing. Time and Newsweek subscriptions are marketed through multiple integrated and independent channels such as magazine inserts, Publishers Clearing House, and the Internet. Estee Lauder and Ralph Lauren are advertised by multiple department stores in the same city.[5]

[4] See, also, Chellappa and Shivendu (2003).
[5] Of 50 solicitations received in a Singapore mailbox between June and August 2005, the largest number (eight) were sent by real-estate brokers, none of which quoted price. On July

Accordingly, we assume that price, $p$, is fixed for some item and then $N$ sellers compete through solicitations to market it. The cost to seller $m$ of sending $S_m$ solicitations is $C(S_m)$, where

$$C(0) = 0, \frac{d}{dS_m}C(0) = 0, \frac{d}{dS_m}C(S_m) > 0, \text{ and } \frac{d^2}{dS_m^2}C(S_m) > 0. \qquad (1)$$

This sequence of actions is consistent with advertising and direct marketing solicitations that include the prices of the items. For simplicity, we assume that the cost of producing the item is zero.

Potential consumers can buy the item only if solicited, and in particular, they do not seek out sellers (Butters 1977; Grossman and Shapiro 1984; McAfee 1994; Anderson and de Palma 2005). They are of two types. There are $H$ high types who derive benefit $v$ from the item, and $L$ low types who derive benefit $\lambda v$, where $\lambda < 1$. Both types suffer the same harm $w$ from receiving a solicitation.[6]

Consumers can take action to *conceal* themselves from solicitations being addressed to them, for instance, by registering with the "no junk mail" list, subscribing to an unlisted telephone number, and using anonymous web browsing. Given that a seller has sent a solicitation, let the probability that a particular consumer $j$ is addressed be $\alpha(k_j)$, where $k_j$ represents the consumer's effort in concealment and the function $\alpha(k_j)$ is a probability, with

$$\alpha(0) = 1, \frac{d}{dk_j}\alpha(k_j) < 0, \frac{d^2}{dk_j^2}\alpha(k_j) > 0, \lim_{k_j \to \infty} \alpha(k_j) = \underline{\alpha} \qquad (2)$$

23, 2005, six different Singapore retailers advertised the Nokia 6020 at S$128 in conjunction with Singapore Telecom or StarHub service plans. On August 7, 2005, six different U.S. websites advertised one-year subscriptions as follows: *Cosmopolitan* (all six charged $18), *Newsweek* (five charged $31.97 and one, Amazon.com, charged $31.00), and *Forbes* (prices ranging from $29.95 to $29.99). During August 2005, three direct mail solicitations for Direct TV were received in a Los Angeles mailbox: all three retailers charged $29.99 a month for the first three months of a one-year subscription.

[6] Mr Orlando Soto of New York exemplifies a high-type consumer in the context of email marketing ("For Orlando Soto, No Day Is Complete Without Some Spam", *Wall Street Journal*, March 15, 2004). More generally, avoidance of mass advertising varies systematically with consumer demographics and the advertising medium (Speck and Elliott 1997).

and such that the function $1-\alpha(k_j)$ has a decreasing hazard rate,[7 8] i.e.,

$$\left[\frac{d\alpha}{dk_j}\right]^2 - \alpha(k_j)\frac{d^2\alpha}{dk_j^2} \le 0. \tag{3}$$

The cost of concealment is $C_K(k_j)$, where

$$C_K(0) = 0, \frac{d}{dk_j}C_K(k_j) > 0, \text{ and } \frac{d^2}{dk_j^2}C_K(k_j) > 0. \tag{4}$$

Further, given that the consumer has been addressed, she can invest effort to *deflect* solicitations, for instance, by using TiVo to skip advertisements, subscribing to a telephone call screening service, or using spam filters.[9] Let the (conditional) probability that she receives the solicitations be $\rho(e_j)$, where $e_j$ represents the consumer's effort in deflection and

$$\rho(0) = 1, \frac{d}{de_j}\rho(e_j) < 0, \frac{d^2}{de_j^2}\rho(e_j) > 0, \lim_{e_j \to \infty}\rho(e_j) = \underline{\rho}, \tag{5}$$

and such that the function $1-\rho(e_j)$ has a decreasing hazard rate, i.e.,

$$\left[\frac{d\rho}{de_j}\right]^2 - \rho(e_j)\frac{d^2\rho}{de_j^2} \le 0. \tag{6}$$

The cost of deflection is $C_E(e_j)$, which function has the same properties as detailed in (4) for $C_K(k_j)$.

The consumers decide on concealment and deflection at the same time as sellers decide on solicitations. In the next stage, consumers decide whether or not to buy. Figure 1 describes the timing of actions. If a high-type consumer receives solicitations from multiple sellers, she purchases from one of the sellers at random.

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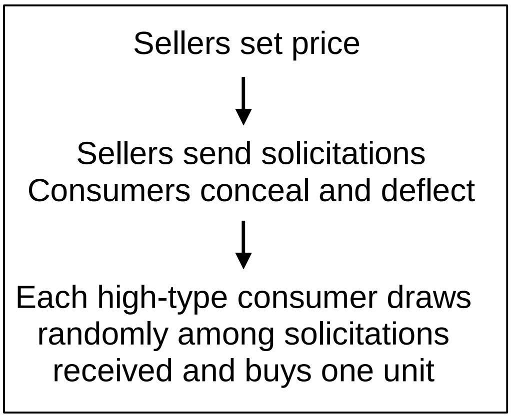
[7] Concealment is imperfect in the sense that the consumer cannot reduce the probability of being addressed below some minimum level, $\underline{\alpha}$. Similarly, deflection is imperfect. Realistically, so long as one has a postal address, telephone number, or email address, receiving some amount of solicitations seems inevitable.

[8] In other words, the marginal decrease in probability of being addressed is non-increasing as the level of concealment increases.

[9] In mid-2004, Microsoft Hotmail's SmartScreen was blocking almost 3 billion messages daily, which represented over 95 percent of all incoming spam (Gates 2004).

Figure 1




The price $p \in (\lambda v, v)$ is exogenous. Following Butters (1977), Grossman and Shapiro (1984), and McAfee (1994), we model the solicitations as draws with replacement from an "effective pool" of consumers. Each consumer's presence in the effective pool is reduced by the extent of her effort in concealment. Specifically, we assume that the effective pool is $H' + L'$, where

$$H' = \sum_{j=1}^{H} \alpha(k_j) \text{ and } L' = \sum_{j=1}^{L} \alpha(k_j). \qquad (7)$$

By (2), this specification has the reasonable properties that, if all $k_j = 0$, then, all $\alpha(k_j) = 1$, and so, $H' + L' = H + L$, and further, if all $k_j \to \infty$, then, all $\alpha(k_j) = \underline{\alpha}$, and hence, $H' + L' = [H + L]\underline{\alpha}$, which is the minimum "presence" of consumers in the effective pool.

To ensure that the analysis is tractable, we assume that consumers and sellers behave symmetrically.[10] To ensure that the market is sufficiently profitable, so that the setting is not trivial, we assume that

$$v - p \geq w. \qquad (8)$$

[10] The focus on symmetric equilibria is common to much research in advertising and direct marketing (Grossman and Shapiro 1984; McGahan and Ghemawat 1994; Meurer and Stahl 1994; Baye and Morgan 2001 and 2004; Iyer and Pazgal 2003).

## 4. Market Equilibrium

### Consumer Concealment and Deflection

Since sellers set $p \in (\lambda v, v)$, a high-type consumer who receives a solicitation will buy the item, while a low-type who receives a solicitation will not. Given that a seller has sent a solicitation, the probability that a particular consumer *j* receives the solicitation is

$$\alpha(k_j)\rho(e_j). \tag{9}$$

A high-type consumer's expected net utility is her expected net benefit from consuming the item (net of the price), less the expected harm from solicitations, and less the costs of concealment and deflection. Her probability of consuming the item is the probability of receiving *at least one* solicitation, which is equal to one minus the probability of receiving no solicitations, hence her expected net benefit from consumption is

$$\alpha(k_j)\rho(e_j)\left\{1-\prod_{i=1}^{N}\left[1-\frac{S_i}{H'+L'}\right]\right\}[v-p]. \tag{10}$$

The consumer incurs harm, $w$, from *every* solicitation received. Hence, her expected harm from solicitations received is

$$\alpha(k_j)\rho(e_j)\frac{\sum_i S_i}{H'+L'}w, \tag{11}$$

where $\sum_i S_i$ is the total solicitations by all sellers.

In symmetric equilibrium, all sellers send the same number of solicitations, $S_i = S$, all $i = 1,..,N$. Substituting in (10) and (11), and noting that $C_K(k_j)$ and $C_E(e_j)$ represent the costs of concealment and deflection respectively, the high-type consumer j's expected net utility is[11]

$$\begin{aligned} U_h(k_j, e_j) &= \alpha(k_j)\rho(e_j)\left\{\left\{1-\left[1-\frac{S}{H'+L'}\right]^N\right\}[v-p]-\frac{NS}{H'+L'}w\right\}-C_K(k_j)-C_E(e_j) \\ &= \alpha(k_j)\rho(e_j)B - C_K(k_j) - C_E(e_j), \end{aligned} \tag{12}$$

[11] We are grateful to a reviewer for observing that the high-type consumer benefits from the first solicitation received, and then suffers harm from every subsequent one.

where the conditional expected net benefit less harm (conditional on being addressed and receiving a solicitation),

$$B \equiv \left\{1-\left[1-\frac{S}{H'+L'}\right]^N\right\}[v-p]-\frac{NS}{H'+L'}w. \quad (13)$$

By (12), since concealment is costly, if the net benefit from the item is high enough, and the harm from solicitations is low enough that

$$B \geq 0, \quad (14)$$

then the high-type consumer will choose *zero* concealment.

However, if (14) is not satisfied, then she will choose the level of concealment that *minimizes* the sum of harm and concealment cost less expected net benefit,

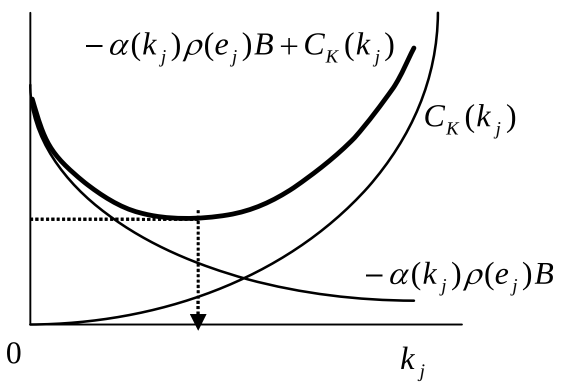
$$-\alpha(k_j)\rho(e_j)B + C_K(k_j). \quad (15)$$

The first-order condition is

$$-\rho(e_j)B\frac{d\alpha}{dk_j}+\frac{d}{dk_j}C_K(k_j)=0, \quad (16)$$

where, for simplicity, we ignore the impact of concealment on $B(k_j)$ through $H'$.[12] Figure 2 illustrates the high-type consumer's net utility when (14) does not hold.

Figure 2




[12] Intuitively, when the effective pool of consumers is large, each individual consumer's concealment would have a minimal impact on her presence in the effective pool.

The high-type consumer's choice of deflection is similar. Under condition (14), she will choose zero deflection. Otherwise, she will choose according to the first-order condition,

$$-\alpha(k_j)B\frac{d\rho}{de_j}+\frac{d}{de_j}C_E(e_j)=0. \tag{17}$$

The analysis for low-type consumers is similar except that, since $\lambda v < p$, they would not buy the item, hence a low-type consumer *j*'s expected net utility is simply

$$U_l(k_j,e_j)=-\alpha(k_j)\rho(e_j)\frac{NS}{H'+L'}w-C_K(k_j)-C_E(e_j). \tag{18}$$

Evidently, the low-type consumer will choose positive levels of concealment and deflection, which are characterized by the first-order conditions

$$\frac{NS}{H'+L'}w\rho(e_j)\frac{d\alpha}{dk_j}+\frac{d}{dk_j}C_K(k_j)=0, \tag{19}$$

$$\frac{NS}{H'+L'}w\alpha(k_j)\frac{d\rho}{de_j}+\frac{d}{de_j}C_E(e_j)=0. \tag{20}$$

**Proposition 1**. Consumers' concealment and deflection are strategic complements (Bulow et al. 1985) with the sellers' solicitations.[13]

Intuitively, if sellers increase solicitations, this means more harm for low-type consumers, so they definitely will increase concealment and deflection. The response of high-type consumers depends on their conditional expected net benefit less harm, $B$. If $B \geq 0$, they do nothing, while if $B < 0$, they, like low-type consumers, will increase concealment and deflection.

Finally, in symmetric equilibrium, $k_j = k_h$ for all high-type consumers, and $k_j = k_l$ for all low-type consumers. Hence, with regard to the effective pool,

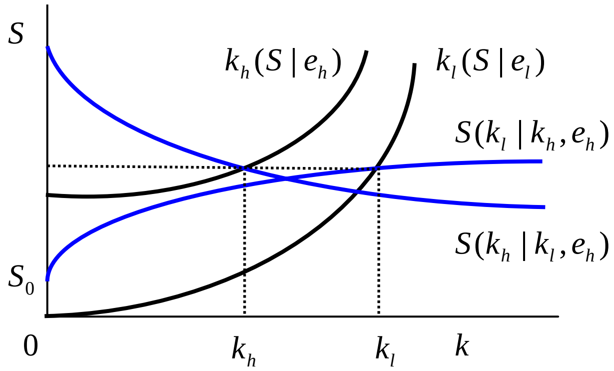
$$H' = H\alpha(k_h) \text{ and } L' = L\alpha(k_l). \tag{21}$$

Figure 3 shows the high- and low-type consumer concealment as a function of seller solicitations. By Proposition 1, consumer concealment is increasing in seller solicitation. Further, by comparing (16) and (19), it is

[13] For brevity, the proofs of this and all other results are provided in the Appendix.

obvious that, for all $S$, the concealment function of the low-type consumer always lies to the right of that of the high-type consumer (since the high-type consumer gets positive benefit from the item, she spends less in concealment).[14] The consumers' deflection strategy is similar.

Figure 3




**Seller Solicitation**

Refer to Figure 1, which depicts the steps involved in making a sale. Suppose that sellers $i \neq m$ choose $S_i = S$, while seller *m* chooses $S_m$. Consider a high-type consumer who has received a solicitation from seller *m*. If she receives no other solicitation, she will buy from seller *m* with certainty. However, if she receives solicitations from *j* other sellers, she will buy with probability $1/[j+1]$ from seller *m*, since all sellers charge the same price, $p$. Taking account of the number of ways in which the *j* sellers can be selected, then, conditional on the consumer having been addressed and received a solicitation, the probability that she will buy from seller *m* is,

$$\frac{1}{j+1}\binom{N-1}{j}\left[\frac{S}{H'+L'}\right]^{j}\left[1-\frac{S}{H'+L'}\right]^{N-1-j}.$$

To calculate seller *m*'s expected revenue, we must sum over all the various possibilities, $j = 0,..,N-1$, take account of the probability that the consumer is

[14] The shapes of the consumer concealment reaction functions depend on the functional form of $C_K(k_j)$, but for our purposes, they are not important. We introduce the blue curves later: they are seller solicitations as a function of low-type (high-type) consumer concealment, holding deflection and high-type (low-type) consumer concealment unchanged.

high-type and the consumer's effort in concealment and deflection, and multiply by seller *m*'s number of solicitations and the price. Accordingly, seller *m*'s expected revenue is

$$R(S_m) = \sum_{j=0}^{N-1} \frac{1}{j+1} \binom{N-1}{j} \left[ \frac{S}{H'+L'} \right]^j \left[ 1 - \frac{S}{H'+L'} \right]^{N-1-j} \frac{H'}{H'+L'} \alpha(k_h) \rho(e_h) p S_m . \quad (22)$$

The next result provides a useful simplification.

**Lemma 1**.

$$\sum_{j=0}^{N-1} \frac{1}{j+1} \binom{N-1}{j} \left[ \frac{S}{H'+L'} \right]^j \left[ 1 - \frac{S}{H'+L'} \right]^{N-1-j} = \left\{ 1 - \left[ 1 - \frac{S}{H'+L'} \right]^N \right\} \frac{H'+L'}{NS} .$$

Applying Lemma 1 to (22), seller *m*'s profit is

$$\Pi(S_m) = \left\{ 1 - \left[ 1 - \frac{S}{H'+L'} \right]^N \right\} \frac{H'}{NS} \alpha(k_h) \rho(e_h) p S_m - C(S_m) . \quad (23)$$

The first-order condition is

$$\left\{ 1 - \left[ 1 - \frac{S}{H'+L'} \right]^N \right\} \frac{H'}{NS} \alpha(k_h) \rho(e_h) p = \frac{dC}{dS_m} .$$

Substituting from (21), this becomes

$$\left\{ 1 - \left[ 1 - \frac{S}{H\alpha(k_h) + L\alpha(k_l)} \right]^N \right\} \frac{H}{NS} [\alpha(k_h)]^2 \rho(e_h) p = \frac{dC}{dS_m} . \quad (24)$$

**Proposition 2**. Sellers' solicitation is a strategic complement to concealment by low-type consumers, and a strategic substitute to concealment and deflection by high-type consumers.

Intuitively, if low-type consumers increase concealment, they reduce their presence and hence enrich the proportion of high types in the effective pool of consumers. Hence, sellers would increase solicitations. By contrast, if high-type consumers increase concealment and deflection, they dilute the effective pool of consumers. Accordingly, sellers would reduce solicitations.

Referring to Figure 3, the upward-sloping blue curve depicts seller solicitation as a function of low-type consumer concealment, holding deflections and high-type consumer concealment constant, while the downward-sloping blue curve depicts seller solicitation as a function of high-type consumer concealment, holding deflections and low-type consumer concealment constant.[15] [16]

**Consumer-Seller Equilibrium**

To ensure that the setting is not trivial, we must prove the existence of equilibrium, and in particular, that sellers will want to send solicitations. We state this formally in Lemma 2.

**Lemma 2.** There exists a non-trivial equilibrium.

Referring to (13), if $B \geq 0$, the equilibrium is defined by the sellers and low-type consumers, i.e., conditions (24), (19), and (20), while if $B \geq 0$, the equilibrium is defined by the sellers and both consumer types, i.e., conditions (24), (16), (17), (19), and (20).

Generally, we cannot rule out the possibility of multiple equilibria. The reaction functions of the sellers and low-type consumers both slope upward, hence it is possible that they will intersect more than once. To ensure that the equilibrium is unique, we need to specify the third derivatives of the concealment, deflection, and cost functions.

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15 The blue curves correspond to cross-sections of the seller solicitation reaction function (which is a surface) with respect to consumer concealment and deflection. As with the consumer reaction functions, the shape of the seller solicitation function is not essential.

16 In the Appendix, specifically, the proof of Lemma 1, we show that $de_h / dk_h > 0$. Similarly, it can be shown that $de_h / dk_h > 0$. Hence, the diagram for consumer deflection is essentially the same as Figure 3.

## 5. Welfare and Empirical Implications

Welfare is the expected benefit that the item provides to high-type consumers less the sellers' solicitation cost, the harm caused by solicitations to both consumer types, and the costs of concealment and deflection to both consumer types. From (23), the expected benefit from the item to high-type consumers is $N$ times the benefit conveyed by one seller, i.e.,

$$N \cdot \left\{1 - \left[1 - \frac{S}{H\alpha(k_h) + L\alpha(k_l)}\right]^N\right\} \frac{H}{NS}[\alpha(k_h)]^2 \rho(e_h) Sv$$

$$= \left\{1 - \left[1 - \frac{S}{H\alpha(k_h) + L\alpha(k_l)}\right]^N\right\} Hv[\alpha(k_h)]^2 \rho(e_h).$$

Hence, welfare is

$$\begin{aligned} W = &\left\{1 - \left[1 - \frac{S}{H\alpha(k_h) + L\alpha(k_l)}\right]^N\right\} Hv[\alpha(k_h)]^2 \rho(e_h) - NC(S) \\ &- H\alpha(k_h)\rho(e_h)w\frac{NS}{H\alpha(k_h) + L\alpha(k_l)} - HC_K(k_h) - HC_E(e_h) \qquad (25) \\ &- L\alpha(k_l)\rho(e_l)w\frac{NS}{H\alpha(k_h) + L\alpha(k_l)} - LC_K(k_l) - LC_E(e_l). \end{aligned}$$

Comparing a typical seller's profit and social welfare (equations (23) and (25)), there are two essential differences:

- Sellers ignore the harm caused by solicitations and consumers' efforts in concealment and detection. These externalities cause sellers' solicitations to *exceed* the socially optimal level.
- Sellers charge less than $v$ for the item, hence leaving high-type consumers with some surplus. To this extent, sellers' solicitations *fall short* of the socially optimal level. This effect is a standard result of any analysis of imperfect competition.

Our first welfare result follows immediately. It addresses the policy question of how to induce sellers to internalize the externalities that they impose on consumers. A "postage" charge or tax on email has been widely advocated as a way to resolve the problem of spam, most famously by Microsoft cofounder, Bill Gates (CNN.com 2004). How should the charge be set? It might seem intuitive to set the charge equal to the expected harm caused by solicitations. However, our analysis implies such a charge would be *too low* because it overlooks consumers' concealment and deflection costs. Comparing a typical seller's profit and social welfare (equations (23) and (25)), the following charge would align seller's profit with social welfare:

**Proposition 3**. The optimal charge per unit of seller solicitations is

$$\tau = -\left\{1-\left[1-\frac{S}{H\alpha(k_h)+L\alpha(k_l)}\right]^N\right\}H[\alpha(k_h)]^2\rho(e_h)[v-p]$$
$$+\frac{H\alpha(k_h)\rho(e_h)+L\alpha(k_l)\rho(e_l)}{H\alpha(k_h)+L\alpha(k_l)}w$$
$$+H\left[C_K(k_h)\frac{dk_h}{dS}+C_E(e_h)\frac{de_h}{dS}\right]+L\left[C_K(k_l)\frac{dk_l}{dS}+C_E(e_l)\frac{de_l}{dS}\right].$$

Intuitively, the charge is *decreasing* in the expected surplus of high-type consumers, and *increasing* with the expected harm caused by solicitations and consumers' concealment and deflection costs.

Our next welfare result focuses on the relative social value of concealment and deflection. Governments promote both concealment ("do not contact" lists) and deflection (educating consumers to use spam filters). Which should they emphasize?

**Proposition 4**. If the number of sellers, $N$, is sufficiently large, deflection is socially preferable to concealment.

Intuitively, deflection works by reducing the probability of receiving a solicitation that has been addressed to the consumer, and so, reduces the expected harm and, for a high-type consumer, also reduces the expected net benefit from consuming the item.

By contrast, concealment has *two* effects. One is to reduce the consumer's probability of being addressed – an effect which is similar to that of deflection. The other effect of concealment is quite subtle. It shrinks the "effective pool" of consumers. Superficially, this might seem to be inconsequential, as it simply causes the same number of seller solicitations to be spread over fewer consumers. However, it does matter, because for high-type consumers, one solicitation is valuable, while additional solicitations cause harm. The smaller the pool over which the solicitations are spread, the higher will be the probability that high-type consumers receive more than one solicitation. Accordingly, the other effect of concealment also reduces social welfare.

Proposition 4 implies that, in markets which are more competitive in the sense of having more sellers, policy-makers should pay more attention to deflection than concealment. For instance, to the extent that entry barriers into email marketing are lower than barriers into other forms of direct marketing, there will be relatively more online retailers. Accordingly, policy-makers should emphasize deflection of spam relatively more than concealment of email addresses.[17]

Given the seller-consumer equilibrium, we can compute the effects of changes in the demand, cost, and competition parameters. Generally, parameter changes have direct effects through the sellers' profit and the consumers' expected net benefit, harm, and costs. They also have indirect effects, as the direct effect on one party causes its reaction function to shift, thus moving the equilibrium.

In order to ensure that the equilibrium is unique, and hence that the comparative statics are meaningful, we assume specific functional forms for concealment, deflection, and the costs of solicitation, concealment, and deflection, viz.,

$$\alpha(k_j) = \underline{\alpha} + \frac{1-\underline{\alpha}}{1+k_j} \text{ and } \rho(e_j) = \underline{\rho} + \frac{1-\underline{\rho}}{1+e_j}, \tag{26}$$

and

$$C(S_m) = cS_m^2,\ C_K(k_j) = c_k k_j^2, \text{ and } C_E(e_j) = c_e e_j^2, \tag{27}$$

which we call the "reciprocal-quadratic" specification.

[17] Conjecture: One more proposition – Increase in competition (higher N) will lead to lower welfare. Direct effect: increase in expected benefit outweighed by increase in expected harm. But what about effects through changes in S, k, e?

With the "reciprocal-quadratic" specification, we computed the comparative statics as reported in the following Table in the case of $B \geq 0$, i.e., where the high-type consumers prefer to receive solicitations.

**Table**

| On variable | Effect of an increase in | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | $v$ | $H$ | $L$ | $C_K$ | $C_E$ | $w$ | $C$ | $N$ |
| $S$ | Nil | ? | - | - | + | + | - | ? |
| $k_h, k_l$ | Nil | ? | - | - | + | + | - | ? |
| $e_h, e_l$ | Nil | ? | - | + | - | + | - | ? |

However, in the case of $B < 0$, most of comparative statics had ambiguous sign as the direct and indirect effects were in opposite directions.

In 2003, the U.S. Federal Trade Commission established a national "do not call" registry. This would have reduced the cost of concealment from telemarketing. According to the Table, sellers would respond by increasing solicitations, as the effective pool of consumers becomes richer in high-type consumers. The Direct Marketing Association (2004), provides some supportive empirical evidence: "For those direct marketers whose primary objective was to solicit direct order sales, telephone marketing again produced the highest response rate (5.78%), … Telephone also led the pack in terms of overall efficiency for direct order marketers ... Perhaps this was due to the institution of Do-Not-Call laws, leaving a smaller, but more productive base to promote to" (page 29).

By (13), the function $B$ is decreasing in $N$, hence the smaller is $N$, the more likely is $B \geq 0$. Refer to DMA report, for types of direct marketing that are relatively less used, then $N$ would be relatively lower, and hence, $B \geq 0$ is more likely. Accordingly, to the extent that telemarketing involves fewer competitors than email marketing, $B \geq 0$ is more likely and hence the Table is more likely to apply.

## 6. Concluding Remarks

Consumers widely use VCRs, TiVo, caller-ID, spam filters, anonymous browsing, and many other devices – all to avoid marketing, and so, protect their privacy. Our contribution is to introduce consideration of "marketing avoidance" into analytical research. This fits into the broader context of market reactions to the 4Ps of marketing, with the three others being cannibalization of product offerings, conflict in distribution channels, competition in pricing.

While we set the analysis in terms of direct marketing, it also applies to broadcast advertising with the following limitation. Since broadcast advertising is not targeted, consumers can only avoid by deflection and not by concealment. Accordingly, all of our results with respect to deflection apply to broadcast advertising.

We assumed that the price of the item was exogenous. It is fairly straightforward to allow the upstream manufacturer or service provider to determine the price of the item. Clearly, it would set the price at either $\lambda v$ or $v$, depending on whether it is relatively more profitable to set a lower price and sell to both consumer types or set a high price and sell only to the high-type consumers. The price would affect seller solicitation and consumer concealment and deflection in fairly obvious ways.

We assumed that solicitations caused the same harm $w$ to both high- and low-type consumers. Realistically, the harm caused by solicitations might differ between the segments. For instance, people with higher income would have higher opportunity cost of time, and hence both benefit more from the item being marketed and suffer more from solicitations. What we need for the key results is that for the high segment, the benefit net of harm exceeds that for the low segment. Formally, suppose that low-type consumers suffer harm $\mu w$, where $\mu < 1$, then what we need is that $v - p - w > \lambda v - p - \mu w$.[18]

We assumed a general function for the sellers' cost of solicitations. Butters (1977), Grossman and Shapiro (1984), and McAfee (1994) suggest the

[18] To confirm.

following specification of the solicitation cost:

$$C(S_m) = -c\ln\left(1 - \frac{S_m}{H' + L'}\right),$$

where $c$ is the unit cost of each draw from the effective pool of consumers. As explained by McAfee, this formulation exhibits constant returns to scale in the sense that if a given quantity of solicitations is divided into two batches, the total cost of solicitation would remain the same. Taking this as a benchmark, we could explore the implications of increasing and decreasing returns to scale in solicitation.

## References


Acquisti, Alessandro, and Hal R. Varian, "Conditioning Prices on Purchase History," *Marketing Science*, Vol. 24 No. 3, Summer 2005.

Anderson, Simon P., and André de Palma, "A Theory of Information Overload", Working Paper, Dept of Economics, University of Virginia, January 2005.

Ayres, Ian, and Steven D. Levitt, "Measuring the Positive Externalities from Unobservable Victim Precaution: An Empirical Analysis of Lojack," *Quarterly Journal of Economics*, Vol. 113 No. 1, 1998, 43–77.

Barnes, Tom, "Tackling TiVo", marketingprofs.com, April 24, 2003.

Baye, Michael R., and John Morgan, "Information Gatekeepers on the Internet and the Competitiveness of Homogeneous Product Markets," *American Economic Review*, Vol. 91, No. 3, June 2001, 454-474.

Baye, Michael R., and John Morgan, "Brand Awareness and Price Competition in Online Markets," Indiana University and University of California, Berkeley, February 2004.

Butters, Gerard R., "Equilibrium Distributions of Sales and Advertising Prices," *Review of Economic Studies*, Vol. 44 No. 3, 1977, 465-91.

Bulow, Jeremy, John Geanakoplos, and Paul Klemperer, "Multimarket Oligopoly: Strategic Substitutes and Complements," *Journal of Political Economy*, Vol. 93 No. 3, June 1985, 488-511.

Calzolari, Giacomo, and Alessandro Pavan, "Optimal Design of Privacy Policies," Department of Economics, Northwestern University, May 2002.

Chellappa, Ram, and S. Shivendu, "Online Personalization and Privacy: Bargaining for Customer Information," Working Paper, USC Marshall School of Business, 2003.

Chen, Yuxin, and Ganesh Iyer, "Consumer Addressability and Customized Pricing," *Marketing Science*, Vol. 23, No. 2, Spring 2002, 197-208.

Chen, Yuxin, Chakravarthi Narasimhan, and Z. John Zhang, "Individual Marketing with Imperfect Targetability," *Marketing Science*, Vol. 20 No. 1, Winter 2001, 23-41.

Chioveanu, Ioana, "Advertising, Brand Loyalty and Pricing," IDEA, Barcelona, Spain, August 2003.

CNN.com, "Gates: Buy stamps to send e-mail", March 5, 2004.

Direct Marketing Association, *The DMA 2004 Response Rate Report*, New York, October 2004.

EPIC (Electronic Privacy Information Center), "Do-Not-Call Registry", http://www.epic.org/privacy/telemarketing/dnc/, Accessed August 6, 2005.

Gantman, Nataly, and Yossi Spiegel, "Adware, Shareware, and Consumer Privacy", Working Paper No. 04-02, NET Institute, October 2004 http://ssrn.com/abstract=618741

Gates, Bill, "Preserving and Enhancing the Benefits of Email — A Progress Report", Microsoft Executive E-mail, June 28, 2004.

Grossman, Gene M., and Carl Shapiro, "Informative Advertising with Differentiated Products," *Review of Economic Studies*, Vol. 51, No. 1, January 1984, 63-81.

Hann, Il Horn, Sang-Yong T. Lee, Kai-lung Hui, Ivan P. Png, "Sales and Promotion: A More General Model," Manuscript, National University of Singapore, 2004.

Koo, Hui-wen, and I.P.L. Png, "Private Security: Deterrent or Diversion?" *International Review of Law and Economics*, Vol. 14, March 1994, 87-101.

McAfee, R. Preston, "Endogenous Availability, Cartels, and Merger in an Equilibrium Price Dispersion," *Journal of Economic Theory*, Vol. 62, 1994, 24-47.

McGahan, A. M., and Pankaj Ghemawat, "Competition to Retain Customers," *Marketing Science*, Vol. 13, No. 2, Spring 1994, 165-176.

Milne, George R., and Andrew J. Rohm, "Consumer Privacy and Name Removal Across Direct Marketing Channels, Exploring Opt-In and Opt-Out Alternatives," *Journal of Public Policy and Marketing*, Vol. 19, No. 2, Fall 2000, 238-249.

Petty, Ross D. "Marketing Without Consent: Consumer Choice and Costs, Privacy, and Public Policy," *Journal of Public Policy and Marketing*, Vol. 19, No. 1, Spring 2000, pp. 42-53.

Speck, Paul Surgi, and Michael T. Elliott, "Predictors of advertising avoidance in print and broadcast media", *Journal of Advertising*, Vol. 26 No. 3, Fall 1997, 61-76.

Taylor, Curtis R., "Consumer Privacy and the Market for Customer Information," *RAND Journal of Economics*, Vol. 35 No. 4, Winter 2004, 631-650.

U.S. Federal Trade Commission, "Email Address Harvesting: How Spammers Reap What You Sow," *FTC Consumer Alert*, November 2002.

Varian, Hal R., "A Model of Sales," *American Economic Review*, Vol. 16 No. 4, September 1980, 651-659.

Wathieu, Luc, "Privacy, Exposure and Price Discrimination," Harvard Business School Marketing Research Paper 02-03, October 2002.

Westin, Alan F., Testimony before U.S. House of Representatives, Committee on Energy and Commerce, Subcommittee on Commerce, Trade, and Consumer Protection, Hearing on "Opinion Surveys: What Consumers Have To Say About Information Privacy," May 8, 2001.

## Appendix

**Proof of Proposition 1**: Consider a high-type consumer. If (14) holds, she chooses zero concealment, hence an increase in sellers' solicitations does not affect her concealment. If (14) does not hold, then, by (13),

$$\frac{w}{v-p} > \frac{H'+L'}{NS}\left\{1-\left[1-\frac{S}{H'+L'}\right]^N\right\}, \tag{A1}$$

and her choice of concealment is given by (16).

Before considering (16), some preliminary analysis is useful.
By (13), differentiating $-B$ with respect to $S$,

$$-\frac{dB}{dS} = \frac{N}{H'+L'}\left\{w-[v-p]\left[1-\frac{S}{H'+L'}\right]^{N-1}\right\}. \tag{A2}$$

By (A1) and Lemma 1,

$$\begin{aligned}\frac{w}{v-p} &> \frac{H'+L'}{NS}\left\{1-\left[1-\frac{S}{H'+L'}\right]^N\right\} \\ &= \sum_{j=0}^{N-1}\frac{1}{j+1}\binom{N-1}{j}\left[1-\frac{S}{H'+L'}\right]^{N-1-j}\left[\frac{S}{H'+L'}\right]^j > \left[1-\frac{S}{H'+L'}\right]^{N-1},\end{aligned} \tag{A3}$$

since the last expression is just the first term in the summation on the left-hand side of the inequality. Substituting from (A3) in (A2), we have

$$-\frac{dB}{dS} = \frac{N}{H'+L'}\left\{w-[v-p]\left[1-\frac{S}{H'+L'}\right]^{N-1}\right\} > 0. \tag{A4}$$

Next, we claim that $de_j / dk_j \geq 0$. Totally differentiating (16) and (17),

$$-B\frac{d\alpha}{dk_j}\frac{d\rho}{de_j}\Delta e_j - \rho(e_j)B\frac{d^2\alpha}{dk_j^2}\Delta k_j - \rho(e_j)\frac{d\alpha}{dk_j}\left[\frac{dB}{dS}\Delta S\right] + \frac{d^2C_K}{dk_j^2}\Delta k_j = 0, \tag{A5}$$

$$-B\frac{d\rho}{de_j}\frac{d\alpha}{dk_j}\Delta k_j - \alpha(k_j)B\frac{d^2\rho}{de_j^2}\Delta e_j - \alpha(k_j)\frac{d\rho}{de_j}\left[\frac{dB}{dS}\Delta S\right] + \frac{d^2C_E}{de_j^2}\Delta e_j = 0, \tag{A6}$$

where we ignore the impact of $\Delta k_j$ and $\Delta e_j$ on $B$. Equating (A5) with (A6),

$$\frac{B\frac{d\alpha}{dk_j}\frac{d\rho}{de_j}\Delta e_j + \rho(e_j)B\frac{d^2\alpha}{dk_j^2}\Delta k_j - \frac{d^2C_K}{dk_j^2}\Delta k_j}{\rho(e_j)\frac{d\alpha}{dk_j}} = -\frac{dB}{dS}\Delta S$$

$$= \frac{B\frac{d\rho}{de_j}\frac{d\alpha}{dk_j}\Delta k_j + \alpha(k_j)B\frac{d^2\rho}{de_j^2}\Delta e_j - \frac{d^2C_E}{de_j^2}\Delta e_j}{\alpha(k_j)\frac{d\rho}{de_j}}, \tag{A7}$$

which simplifies to

$$\alpha(k_j)\frac{d\rho}{de_j}\left[B\frac{d\alpha}{dk_j}\frac{d\rho}{de_j}\Delta e_j + \rho(e_j)B\frac{d^2\alpha}{dk_j^2}\Delta k_j - \frac{d^2C_K}{dk_j^2}\Delta k_j\right]$$

$$= \rho(e_j)\frac{d\alpha}{dk_j}\left[B\frac{d\rho}{de_j}\frac{d\alpha}{dk_j}\Delta k_j + \alpha(k_j)B\frac{d^2\rho}{de_j^2}\Delta e_j - \frac{d^2C_E}{de_j^2}\Delta e_j\right],$$

and hence,

$$\Delta e_j = \frac{\rho(e_j)B\left\{\left[\frac{d\alpha}{dk_j}\right]^2 - \alpha(k_j)\frac{d^2\alpha}{dk_j^2}\right\} + \alpha(k_j)\frac{d^2C_K}{dk_j^2}}{\alpha(k_j)B\left\{\left[\frac{d\rho}{de_j}\right]^2 - \rho(e_j)\frac{d^2\rho}{de_j^2}\right\} + \rho(e_j)\frac{d^2C_E}{de_j^2}}\left[\frac{\frac{d\rho}{de_j}}{\frac{d\alpha}{dk_j}}\right]\Delta k_j. \tag{A8}$$

Since (14) does not hold, $B < 0$. By (2) and (4), $d\alpha / dk_j < 0$, $d\rho / de_j < 0$, $d^2C_K / dk_j^2 > 0$, and $d^2C_E / de_j^2 > 0$. Further, by (3) and (6),

$$\left[\frac{d\alpha}{dk_j}\right]^2 - \alpha(k_j)\frac{d^2\alpha}{dk_j^2} \le 0 \text{ and } \left[\frac{d\rho}{de_j}\right]^2 - \rho(e_j)\frac{d^2\rho}{de_j^2} \le 0.$$

Hence, the coefficient of $\Delta k_j$ on the right hand side of (A8) is positive, and,

$$\frac{de_j}{dk_j} = \lim_{\Delta k_j = 0}\frac{\Delta e_j}{\Delta k_j} > 0. \tag{A9}$$

Substituting $\Delta e_j = [de_j / dk_j]\Delta k_j$ in (A7),

$$-\frac{dB}{dS}\Delta S = \frac{B\frac{d\alpha}{dk_j}\frac{d\rho}{de_j}\frac{de_j}{dk_j} + \rho(e_j)B\frac{d^2\alpha}{dk_j^2} - \frac{d^2C_K}{dk_j^2}}{\rho(e_j)\frac{d\alpha}{dk_j}}\Delta k_j,$$

By (A9) and the same observations as following (A8), the coefficient of $\Delta k_j$ on the right hand side of (A8) is positive. Thus, by (A4),

$$\frac{dk_j}{dS} = \lim_{\Delta S = 0} \frac{\Delta k_j}{\Delta S} > 0\,, \tag{A10}$$

which is the result.

The proof for deflection is similar, as is the proof for the low-type consumers. [ ]

**Proof of Lemma 1:** Note that

$$\frac{1}{j+1}\binom{N-1}{j} = \frac{1}{j+1}\frac{(N-1)!}{j!(N-1-j)!} = \frac{(N-1)!}{(j+1)!(N-1-j)!} = \frac{1}{N}\frac{N!}{(j+1)!(N-1-j)!} = \frac{1}{N}\binom{N}{j+1}$$

and hence,

$$\begin{aligned} &\sum_{j=0}^{N-1} \frac{1}{j+1}\binom{N-1}{j}\left[1-\frac{S}{H'+L'}\right]^{N-1-j}\left[\frac{S}{H'+L'}\right]^{j} \\ &\qquad = \frac{1}{N}\sum_{j=0}^{N-1}\binom{N}{j+1}\left[1-\frac{S}{H'+L'}\right]^{N-1-j}\left[\frac{S}{H'+L'}\right]^{j} \\ &\qquad = \frac{H'+L'}{NS}\sum_{j=0}^{N-1}\binom{N}{j+1}\left[1-\frac{S}{H'+L'}\right]^{N-1-j}\left[\frac{S}{H'+L'}\right]^{j+1}. \end{aligned} \tag{A11}$$

Now

$$\begin{aligned} &\sum_{j=0}^{N-1}\binom{N}{j+1}\left[1-\frac{S}{H'+L'}\right]^{N-1-j}\left[\frac{S}{H'+L'}\right]^{j+1} \\ &\qquad = \sum_{j=1}^{N}\binom{N}{j}\left[1-\frac{S}{H'+L'}\right]^{N-j}\left[\frac{S}{H'+L'}\right]^{j} \\ &\qquad = \sum_{j=0}^{N}\binom{N}{j}\left[1-\frac{S}{H'+L'}\right]^{N-j}\left[\frac{S}{H'+L'}\right]^{j} - \left[1-\frac{S}{H'+L'}\right]^{N} \\ &\qquad = 1-\left[1-\frac{S}{H'+L'}\right]^{N}\,, \end{aligned} \tag{A12}$$

where the first step changes the index of summation, the second step uses

$$\binom{N}{0} = 1,$$

and the third step applies the binomial theorem. Substituting from (A12) in (A11) yields the result. [ ]

**Proof of Proposition 2:** Consider the left-hand side of (24). Clearly, it is increasing in $k_l$ and decreasing in $e_h$, which proves that the seller's solicitation is a strategic complement with the low-type consumer's concealment, and a strategic substitute with the high-type consumer's deflection.

Totally differentiating (24),

$$\left\{1-\left[1-\frac{S}{H\alpha(k_h)+L\alpha(k_l)}\right]^N\right\}\frac{H}{NS}\left\{2\alpha(k_h)\rho(e_h)\frac{d\alpha}{dk_h}p\,\Delta k_h+[\alpha(k_h)]^2\frac{d\rho}{de_h}p\,\Delta e_h\right\}$$

$$+\left\{N\left[1-\frac{S}{H\alpha(k_h)+L\alpha(k_l)}\right]^{N-1}\left[\frac{1}{H\alpha(k_h)+L\alpha(k_l)}\right]\frac{H}{NS}\right.$$

$$\left.-\left\{1-\left[1-\frac{S}{H\alpha(k_h)+L\alpha(k_l)}\right]^N\right\}\frac{H}{NS^2}\right\}[\alpha(k_h)]^2\rho(e_h)p\,\Delta S$$

$$-N\left[1-\frac{S}{H\alpha(k_h)+L\alpha(k_l)}\right]^{N-1}\frac{S}{[H\alpha(k_h)+L\alpha(k_l)]^2}\left[H\frac{d\alpha}{dk_h}\right]\frac{H}{NS}[\alpha(k_h)]^2\rho(e_h)p\,\Delta k_h$$

$$-N\left[1-\frac{S}{H\alpha(k_h)+L\alpha(k_l)}\right]^{N-1}\frac{S}{[H\alpha(k_h)+L\alpha(k_l)]^2}\left[L\frac{d\alpha}{dk_l}\right]\frac{H}{NS}[\alpha(k_h)]^2\rho(e_h)p\Delta k_l$$

$$=\frac{d^2C}{dS_m^2}\Delta S_m. \qquad \text{(A13)}$$

Suppose $\Delta S=0$, $\Delta k_l=0$, $\Delta e_h=0$, and let

$$\Phi\equiv\left\{1-\left[1-\frac{S}{H\alpha(k_h)+L\alpha(k_l)}\right]^N\right\}$$
$$-\left[\frac{NS}{H\alpha(k_h)+L\alpha(k_l)}\right]\left[1-\frac{S}{H\alpha(k_h)+L\alpha(k_l)}\right]^{N-1}\left[\frac{H\alpha(k_h)}{H\alpha(k_h)+L\alpha(k_l)}\right]. \qquad \text{(A14)}$$

Then (A13) simplifies to

$$\frac{d^2C}{dS_m^2}\Delta S_m=\left\{1-\left[1-\frac{S}{H\alpha(k_h)+L\alpha(k_l)}\right]^N+\Phi\right\}\frac{H}{NS}\alpha(k_h)\rho(e_h)\frac{d\alpha}{dk_h}p\,\Delta k_h, \qquad \text{(A15)}$$

However, by (A11) and (A12),

$$\left\{1-\left[1-\frac{S}{H\alpha(k_h)+L\alpha(k_l)}\right]^N\right\}$$

$$\equiv \frac{NS}{H\alpha(k_h)+L\alpha(k_l)}\sum_{j=0}^{N-1}\frac{1}{j+1}\binom{N-1}{j}\left[1-\frac{S}{H\alpha(k_h)+L\alpha(k_l)}\right]^{N-1-j}\left[\frac{S}{H\alpha(k_h)+L\alpha(k_l)}\right]^j$$

$$> \frac{NS}{H\alpha(k_h)+L\alpha(k_l)}\left[1-\frac{S}{H\alpha(k_h)+L\alpha(k_l)}\right]^{N-1}, \qquad \text{(A16)}$$

since the last expression is just the first term in the summation on the left-hand side of the inequality. Substituting (A16) into (A14), $\Phi > 0$. Now, by (2), $d\alpha / dk_h < 0$, hence the coefficient of $\Delta k_h$ on the right-hand side of (A15) is negative. By (1), $d^2C / dS_m^2 > 0$ and hence, by (A15), $\Delta S_m / \Delta k_h < 0$, which implies that the seller's solicitation is a strategic substitute with the high-type consumer's concealment. [ ]

**Proof of Lemma 2:** Differentiating (13) with respect to $S$,

$$\frac{dB}{dS} \equiv \left[1-\frac{S}{H'+L'}\right]^{N-1}\frac{N}{H'+L'}[v-p]-\frac{N}{H'+L'}w. \qquad \text{(A17)}$$

Differentiating again,

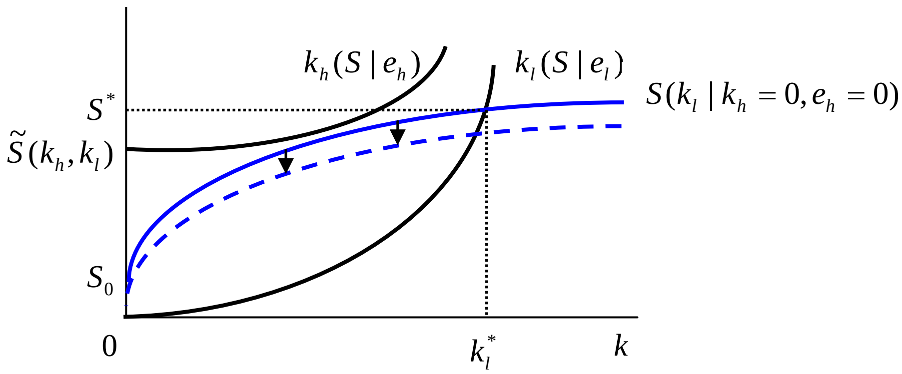
$$\frac{d^2B}{dS^2} \equiv -\left[1-\frac{S}{H'+L'}\right]^{N-2}\frac{N[N-1]}{H'+L'}[v-p]<0.$$

At $S=0$, $B=0$ and $dB/dS>0$, since $v-p>w$. By (A17), for sufficiently large $S$, $dB/dS<0$. Note that $B$ depends on $k_h$ and $k_l$ through $H'$ and $L'$. Accordingly, there exists $\tilde{S}(k_h,k_l)>0$ defined by

$$B(\tilde{S}(k_h,k_l))=0, \qquad \text{(A18)}$$

and such that, for $S\in(0,\tilde{S}(k_h,k_l))$, then $B(S)>0$.

<u>Figure 4</u>




Refer to Figure 4. Suppose that the high-type consumers choose zero concealment and deflection, $k_h = e_h = 0$. We first show that the seller solicitation function, $S(k_l \mid k_h, e_h)$, with $k_h = e_h = 0$, intersects the $S$-axis at a level $S_0 > 0$. By (2) and (5), $\alpha(k_h) \geq \underline{\alpha} > 0$ and $\rho(e_h) \geq \underline{\rho} > 0$. So, the left-hand side of (24) is positive. Now, by (1), $dC / dS_m = 0$ at $S_m = 0$. Hence, by (24), $S_m > 0$ when $k_l = 0$, i.e., $S_0 > 0$.

Next, by Proposition 2, the solicitation function is decreasing in $k_h$, while by (2), if $k_h \to \infty$, then $d\alpha / dk_h \to 0$, and so, the right-hand side of (A15) converges to zero, which implies that $\Delta S_m / \Delta k_h \to 0$, i.e., that seller solicitations tend towards an asymptote as $k_h \to \infty$.

Further, by Proposition 1, the low-type consumers' concealment function $k_l(S \mid e_l)$ is increasing, while by (19), $k_l = 0$ if $S = 0$ and $k_l \to \infty$ as $S \to \infty$. Accordingly, the seller solicitation and low-type consumer concealment functions will intersect at some $(S^*, k_l^*)$, where $S^* > 0$ and $k_l^* > 0$.

If $S^* \leq \tilde{S}(k_h = 0, k_l^*)$, then, by (A18), the high-type consumers would choose zero concealment and deflection, which is consistent with the initial supposition. Accordingly, $(S^*, k_h, e_h, k_l^*, e_l^*)$, with $k_h = e_h = 0$ and where $e_l^*$ solves (20), constitutes the seller-consumer equilibrium.

However, if $S^* > \tilde{S}(k_h = 0, k_l^*)$, the high-type consumers would choose positive levels of concealment and deflection, $k_h > 0$ and $e_h > 0$, which is not consistent with the original supposition. Then, let $k_h = \Delta k$ and $e_h = \Delta e$, and now re-compute the seller solicitation function, $S(k_l \mid k_h, e_h)$, illustrated by the broken curve in Figure 4. By Proposition 2, the increase in $k_h$ and $e_h$ would shift the sellers' solicitation function downwards, and so, shift its intersection with the low-type consumer concealment function to some $(S^* - \Delta S, k_l^* - \Delta k^*)$.

Referring to the high-type consumer concealment and deflection, if

$$k_h(S^* - \Delta S^* \mid e_h) = \Delta k \text{ and } e_h(S^* - \Delta S^* \mid e_h) = \Delta e, \tag{A19}$$

then $(S^* - \Delta S, \Delta k, \Delta e, k_l^* - \Delta k^*, e_l^* - \Delta e^*)$, where $e_l^* - \Delta e^*$ solves (20), constitutes the seller-consumer equilibrium. However, if $k_h(S^* - \Delta S^* \mid e_h) > \Delta k$ or $e_h(S^* - \Delta S^* \mid e_h) > \Delta e$, then continue to raise $k_h$ and $e_h$ by small increments and repeat the above procedure until the intersection of the seller solicitation and low-type concealment curves satisfies the equivalent of condition (A19). Figure 3 illustrates the equilibrium. [ ]

**Proof of Proposition 4:** The direct effect of high-type consumer concealment on welfare (ignoring consequential effects on consumer deflection and seller solicitation)

$$\begin{aligned}\frac{dW}{dk_h} = &-N\left[1-\frac{S}{H\alpha(k_h)+L\alpha(k_l)}\right]^{N-1}\frac{S}{[H\alpha(k_h)+L\alpha(k_l)]^2}H^2v[\alpha(k_h)]^2\rho(e_h)\frac{d\alpha}{dk_h}\\ &+\left\{1-\left[1-\frac{S}{H\alpha(k_h)+L\alpha(k_l)}\right]^{N}\right\}Hv\cdot 2\alpha(k_h)\rho(e_h)\frac{d\alpha}{dk_h}\\ &+\frac{NS}{[H\alpha(k_h)+L\alpha(k_l)]^2}[H\alpha(k_h)\rho(e_h)+L\alpha(k_l)\rho(e_l)]Hw\frac{d\alpha}{dk_h}\\ &-\frac{NS}{H\alpha(k_h)+L\alpha(k_l)}Hw\rho(e_h)\frac{d\alpha}{dk_h}-H\frac{dC_K}{dk_h},\end{aligned} \tag{A20}$$

Similarly, the direct effect of high-type consumer deflection on welfare,

$$\begin{aligned}\frac{dW}{de_h} = &\left\{1-\left[1-\frac{S}{H\alpha(k_h)+L\alpha(k_l)}\right]^{N}\right\}Hv[\alpha(k_h)]^2\frac{d\rho}{de_h}\\ &-\frac{NS}{H\alpha(k_h)+L\alpha(k_l)}Hw\alpha(k_h)\frac{d\rho}{de_h}-H\frac{dC_E}{de_h}.\end{aligned} \tag{A23}$$

Suppose that $\alpha(.) = \rho(.), C_K(.) = C_E(.), k_h = e_h$, then, subtracting (A23) from (A20),

$$\frac{dW}{dk_h}-\frac{dW}{de_h}=-\left[1-\frac{S}{H\alpha(k_h)+L\alpha(k_l)}\right]^{N-1}\frac{NSH\alpha(k_h)}{[H\alpha(k_h)+L\alpha(k_l)]^2}Hv[\alpha(k_h)]^2\frac{d\alpha}{dk_h}$$
$$+\left\{1-\left[1-\frac{S}{H\alpha(k_h)+L\alpha(k_l)}\right]^{N}\right\}Hv[\alpha(k_h)]^2\frac{d\alpha}{dk_h} \qquad \text{(A24)}$$
$$+\frac{NS}{[H\alpha(k_h)+L\alpha(k_l)]^2}H[H+L]w[\alpha(k_h)]^2\frac{d\alpha}{dk_h}<0,$$

by (A16) and since $d\alpha/dk_h<0$. Accordingly,

$$\frac{dW}{dk_h}<\frac{dW}{de_h}, \qquad \text{(A23)}$$

which proves the result for high-type consumers.

Likewise, the direct effect of the low-type consumers' concealment

$$\frac{dW}{dk_l}=-N\left[1-\frac{S}{H\alpha(k_h)+L\alpha(k_l)}\right]^{N-1}\frac{S}{[H\alpha(k_h)+L\alpha(k_l)]^2}HLv[\alpha(k_h)]^2\rho(e_h)\frac{d\alpha}{dk_l}$$
$$+\frac{NS}{[H\alpha(k_h)+L\alpha(k_l)]^2}[H\alpha(k_h)\rho(e_h)+L\alpha(k_l)\rho(e_l)]Lw\frac{d\alpha}{dk_l} \qquad \text{(A24)}$$
$$-\frac{NS}{H\alpha(k_h)+L\alpha(k_l)}Lw\alpha(k_l)\frac{d\rho}{de_l}-L\frac{dC_K}{dk_l},$$

and direct effect of low-type consumer deflection on welfare,

$$\frac{dW}{de_l}=-\frac{NS}{H\alpha(k_h)+L\alpha(k_l)}Lw\alpha(k_l)\frac{d\rho}{de_l}-L\frac{dC_E}{de_l}. \qquad \text{(A25)}$$

Suppose that $\alpha(.)=\rho(.),C_K(.)=C_E(.),e_h=e_l$, then, subtracting (A25) from (A24),

$$\frac{dW}{dk_l}-\frac{dW}{de_l}$$
$$=-N\left[1-\frac{S}{H\alpha(k_h)+L\alpha(k_l)}\right]^{N-1}\frac{S}{[H\alpha(k_h)+L\alpha(k_l)]^2}HLv[\alpha(k_h)]^2\rho(e_h)\frac{d\alpha}{dk_l} \qquad \text{(A26)}$$
$$+\frac{NS}{[H\alpha(k_h)+L\alpha(k_l)]^2}[H\alpha(k_h)\rho(e_h)+L\alpha(k_l)\rho(e_l)]Lw\frac{d\alpha}{dk_l}.$$

Since $d\alpha/dk_l<0$, the sign of (A26) is that of

$$\left[1-\frac{S}{H\alpha(k_h)+L\alpha(k_l)}\right]^{N-1}Hv[\alpha(k_h)]^2\rho(e_h)-[H\alpha(k_h)\rho(e_h)+L\alpha(k_l)\rho(e_l)]w. \qquad \text{(A27)}$$

By (2), $1\geq\alpha(k_j)\geq\underline{\alpha}>0$, hence, for sufficiently large $N$,

$$\left[1-\frac{S}{H\alpha(k_h)+L\alpha(k_l)}\right]^{N-1}v\alpha(k_h)-w<0,$$

and, hence by (A26) and (A27),

$$\frac{dW}{dk_l} < \frac{dW}{de_l}, \tag{A28}$$

since $d\alpha / dk_l < 0$. This proves the result for low-type consumers. [ ]