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Consumer Privacy and Marketing Avoidance: A Static Model

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We introduce the concept of *marketing avoidance*—consumer efforts to conceal themselves and to deflect marketing. The setting is one in which sellers market some item through solicitations to potential consumers, who differ in their benefit from the item and suffer harm from receiving solicitations. Concealment by one consumer induces sellers to shift solicitations to other consumers, whereas deflection does not. Solicitations cause two externalities: direct harm on consumers and the (indirect) cost of consumer concealment and deflection. We find that in markets where the marginal cost of solicitation is sufficiently low, efforts by low-benefit consumers to conceal themselves will increase the cost-effectiveness of solicitations and lead sellers to market more. However, concealment by high-benefit consumers leads sellers to market less. Furthermore, concealment by low-benefit consumers increases direct privacy harm, and consumer welfare is higher with deflection than concealment. Finally, it is optimal to impose a charge on solicitations.

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1. Introduction

Privacy is a key concern for consumers (Westin 2001). Consumers use video recorders, TiVo, caller ID, spam filters, pop-up blockers, anonymous browsing, and other devices and techniques to avoid marketing and protect their privacy. In 2005, the U.S. industry spent $17.8 billion on consumer telemarketing (Direct Marketing Association 2006). However, over 100 million numbers were registered with the *do not call* list (Federal Trade Commission 2005).

Just as improvements in technology create new techniques of marketing, they provide fresh ways to avoid marketing and present new challenges to the marketing profession and for public policy. How should marketers respond to consumer avoidance of marketing? How does their strategic interaction affect consumer privacy? What is the appropriate public policy toward marketing activities that impose harm on consumers?

Prior analytical research has assumed that consumers passively accept promotions. In contrast, we introduce the concept of *marketing avoidance*, and analyze the endogenous trade-off between seller marketing and consumer privacy in a static setting. Consumers can get some item only through direct marketing, but the marketing directly imposes privacy harm on consumers and indirectly leads consumers to avoid marketing in two ways—*concealment* and *deflection*.

Concealment reduces the exposure of consumer addresses to sellers, whereas deflection turns away solicitations addressed to the consumer. From the consumer's viewpoint, both concealment and deflection reduce the likelihood of receiving solicitations. However, for sellers, they differ—concealment shifts solicitations to other consumers, whereas deflection causes solicitations to be discarded.

Our model includes two consumer segments—high- and low-benefit. When sellers decide expenditures on solicitations, they cannot distinguish the two

consumer segments and ignore the direct and indirect externalities that they cause.

We show that, in markets where the marginal cost of solicitation is sufficiently low, seller marketing is a strategic complement with concealment by low-benefit consumers. Efforts by low-benefit consumers to conceal themselves will increase the cost-effectiveness of marketing and lead sellers to increase solicitations. However, efforts by high-benefit consumers in concealment and deflection lead sellers to reduce solicitations.

Concealment by low-benefit consumers increases direct privacy harm—it shifts solicitations toward high-benefit consumers, who suffer more privacy harm as they spend less on deflection. Overall, consumer welfare is higher with deflection than concealment. Finally, solicitations are excessive, and so, it is optimal to impose a charge on them.

2. Motivation

A substantial literature in economics and marketing analyzes how sellers compete to acquire customers via advertising and price (Butters 1977, McAfee 1994, McGahan and Ghemawat 1994, Baye and Morgan 2001, Chen and Iyer 2002, Iyer and Pazgal 2003, Chioveanu 2008). Separately, analytical privacy research has considered how marketers use personal information to "screen" consumers and effect price discrimination (Chen et al. 2001, Taylor 2004, Acquisti and Varian 2005, Wathieu 2006, Hui and Png 2006).

However, previous analytical research has mostly ignored the harm that marketing imposes on consumers. Advertising and direct marketing (e.g., direct mail, telephone, and fax, and electronically) impose inconvenience and other harms on consumers. Marketers do not internalize these harms, and so they over-spend on advertising and direct marketing relative to the socially optimal level (Petty 2000, Drèze and Bonfrer 2005).

Van Zandt (2004) and Anderson and de Palma (2006) consider heterogeneous sellers, which offer different products through direct marketing at fixed prices. Consumers can buy the items only through the sellers' messages, but must incur costs to "open" the messages. In this scenario, an increase in the sellers' marketing cost may raise welfare by screening out low-quality sellers. The average message quality would rise, and more consumers would open their messages (Gantman and Spiegel 2004, Loder et al. 2006).

In contrast, we emphasize heterogeneity among consumers and marketing avoidance—efforts by consumers to avoid advertising and solicitations. Motivated by the economics of security (Koo and Png 1994, Ayres and Levitt 1998), we distinguish two forms of marketing avoidance: concealment and deflection.[1] We do not take any a priori position on the merits of marketing or consumer privacy, but rather, address the endogenous trade-off among consumer surplus, privacy harms, consumers' avoidance costs, and sellers' marketing costs.

3. Setting

Like Van Zandt (2004), Anderson and de Palma (2006), and Loder et al. (2006), we consider competition among N sellers to market some item at a fixed price, p. 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, Van Zandt 2004, Anderson and de Palma 2006, Loder et al. 2006). They are of two types: H high types with individual demand $q_h(p)$ for the item, and L low types with individual demand $q_l(p) < q_h(p)$. Both types of consumers suffer the same harm w from each solicitation received and are risk neutral.

Consumers can invest effort to conceal their addresses from solicitations, for instance, by renting a post office box, registering with no-contact lists, and using an unlisted telephone number. Specifically, let the relative exposure of consumer j's address be

$$\varphi(k_j) = \frac{\alpha(k_j)}{\Lambda}, \tag{1}$$

where $k_j \geq 0$ represents her effort in concealment, $\alpha(k_j)$ satisfies

$$\alpha(0) = 1, \quad \frac{d}{dk_j}\alpha(k_j) < 0, \quad \text{and} \quad \frac{d^2}{dk_j^2}\alpha(k_j) > 0, \tag{2}$$

and the *total exposure* of consumer addresses is

$$\Lambda = \sum_{j=1}^{H} \alpha(k_j) + \sum_{i=1}^{L} \alpha(k_i), \tag{3}$$

where we use j to index high-type consumers and i to index low-type consumers. By (2), the total exposure has the reasonable property that, if all $k_j = 0$ and $k_i = 0$, then $\alpha(k_j) = 1$ and $\alpha(k_i) = 1$, and hence $\Lambda = H + L$, i.e., all consumer addresses are completely exposed. The consumer's cost of concealment is $C_K(k_j)$, where

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

and $dC_K/dk_j = 0$ at $k_j = 0$. This cost does not vary with the number of solicitations.

[1] This generalizes the concept of "ad avoidance" (Speck and Elliott 1997), which, in our framework, is a form of deflection.

Consumers can also invest effort to deflect solicitations, for instance, through call screening, pop-up blockers, and spam filters. Conditional on being addressed, a consumer would *receive* solicitations at rate $\rho(e_j)$, where $e_j \geq 0$ represents her effort in deflection and

$$\rho(0) = 1, \quad \frac{d}{de_j}\rho(e_j) < 0, \quad \text{and} \quad \frac{d^2}{de_j^2}\rho(e_j) > 0.^2 \tag{5}$$

The consumer's cost of deflection is $C_E(e_j)$, with the same properties as $C_K(k_j)$ in (4).[3]

On the seller side, given the total exposure of consumer addresses, Λ, the cost to seller m of soliciting S_m addresses is $C(S_m, \Lambda)$, where

$$C(0, \Lambda) = 0, \quad \frac{\partial}{\partial S_m}C(S_m, \Lambda) > 0, \quad \frac{\partial^2}{\partial S_m^2}C(S_m, \Lambda) > 0, \quad \frac{\partial}{\partial \Lambda}C(S_m, \Lambda) \leq 0, \quad \frac{\partial^2}{\partial \Lambda \partial S_m}C(S_m, \Lambda) \leq 0, \tag{6}$$

and $\partial C/\partial S_m = 0$ at $S_m = 0$. The cost $C(S_m, \Lambda)$ includes the cost of compiling customer addresses and the cost of sending the solicitations.[4] We assume that both $C(S_m, \Lambda)$ and $\partial C/\partial S_m$ decrease with Λ because it is easier for sellers to get addresses when the total exposure is larger.[5] For simplicity, we assume that the cost of producing the item is zero. To focus the analysis, we apply the following condition in this study:

Profitability Condition. *The marginal cost of solicitation, $\partial C(S_m, \Lambda)/\partial S_m$, is sufficiently low relative to the seller's incremental margin from high-type consumers, $pq_h(p)$.*

The sequence of events is as follows: (i) sellers set price; (ii) consumers choose efforts in concealment and deflection; while simultaneously, sellers send solicitations (at this time, they do not know the individual consumers' types, but only the distribution in the total exposure (Butters 1977, Grossman and Shapiro 1984, McAfee 1994)); (iii) if a high-benefit consumer receives a solicitation, she purchases $q_h(p)$ units and derives consumer surplus $V_h(p) > 0$; if she receives multiple solicitations, she purchases from one of the sellers at random.

We focus on a separating equilibrium in which sellers price the item such that low-benefit consumers would not buy the item even if solicited, that is, their surplus $V_l(p) \leq 0$.[6] To ensure that the analysis is tractable, we assume that consumers and sellers have rational expectations about the actions of each other and that they act symmetrically.[7]

4. Market Equilibrium

4.1. Consumer Concealment and Deflection

Consider a high-type consumer. She would receive a particular solicitation if it successfully addresses her and gets her attention. Given her efforts in concealment and deflection, k_j and e_j, this would occur with probability $\varphi(k_j)\rho(e_j)$, where $\varphi(k_j)$ is her probability of being drawn as defined in (1). Hence, given all sellers' solicitations, $S_1, \ldots, S_N$, her probability of receiving at least one solicitation is equal to one minus the

[2] In this paper "receiving" a solicitation means that the consumer actually receives the message, e.g., opens the junk mail, reads the e-mail, or listens to the telemarketing call.

[3] Both concealment and deflection encompass multiple methods with differing costs. For instance, methods of concealment from telemarketing include registering with the *do not call* list, using an unlisted telephone number, and disabling caller number display on outgoing calls. These methods should be ordered by increasing cost to conform with (4). Similarly, multiple methods of deflection can be ordered by increasing cost. We assume that the costs of concealment and deflection are convex. Realistically, once the consumer invests some effort in concealment or deflection, it becomes more difficult for her to further raise avoidance (e.g., a spam filter may screen out 95% of incoming spam, but to accurately filter the remaining 5% would require much more effort).

[4] A U.S. Federal Trade Commission (2002) experiment suggests that the marginal cost of compiling e-mail addresses varies with the source of addresses. Commission investigators seeded 250 e-mail addresses across the Internet and observed the following rates of spam: 86% of addresses posted to newsgroups, half of addresses posted on free personal Web pages, 27% of addresses posted to message boards, and 9% of addresses listed in e-mail membership directory. The different sources should be ordered to conform with the convex specification in (6). In a separate field experiment, Hann et al. (2006) found that spam was targeted rather than being randomly addressed, which suggests that the marginal cost of sending spam is not zero. We use "cost of solicitation" to refer to all costs incurred in compiling customer addresses and sending solicitations.

[5] In the context of the U.S. Federal Trade Commission experiment reported in Footnote 4, when consumers invest more effort to conceal their e-mail addresses and hence reduce their total exposure, the seller would have to visit more newsgroups, message boards, etc., to find e-mail addresses, and within each newsgroup or message board, it may have to spend more effort to traverse and process e-mail addresses (e.g., converting e-mail addresses that are stored as image to text, or concatenating the domain names that users deliberately break up).

[6] All we need is that the low-type consumer's individual demand curve be sufficiently low relative to that of the high-type consumer. Realistically, many people have low willingness to pay for directly marketed products, such as counterfeit software and discounted Viagra. Hence, it may not be profitable for sellers to slash prices to attract such low-type consumers. We discuss how purchases by low-type consumers affect our findings in §7. From this point onward, where it is not essential, we suppress the price argument in the quantities $q_h(p)$ and $q_l(p)$, and consumer surpluses, $V_h(p)$ and $V_l(p)$.

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

probability of not receiving any solicitation. Accordingly, her expected surplus from the item is

$$\left\{1-\prod_{m=1}^{N}[1-\varphi(k_j)\rho(e_j)]^{S_m}\right\}V_h = \{1-[1-\varphi(k_j)\rho(e_j)]^{S_1+\cdots+S_N}\}V_h.^{8} \quad (7)$$

She incurs harm, w, from every solicitation received, and so, her expected harm is

$$[S_1+\cdots+S_N]\varphi(k_j)\rho(e_j)w.^{9} \quad (8)$$

Recall that $C_K(k_j)$ and $C_E(e_j)$ represent the costs of concealment and deflection. Hence, by (7) and (8), the expected utility of the high-type consumer j is

$$U_h(k_j,e_j) = \{1-[1-\varphi(k_j)\rho(e_j)]^{S_1+\cdots+S_N}\}V_h - [S_1+\cdots+S_N]\varphi(k_j)\rho(e_j)w - C_K(k_j)-C_E(e_j). \quad (9)$$

If $U_h(k_j,e_j)$ is maximized at $k_j=0$ or $e_j=0$, then the high-type consumer would choose zero effort in concealment or deflection. Otherwise, she would choose positive efforts in concealment and deflection according to the first-order conditions,

$$\frac{\partial U_h}{\partial k_j} = [S_1+\cdots+S_N]\rho(e_j)\frac{d\varphi}{dk_j}\{[1-\varphi(k_j)\rho(e_j)]^{S_1+\cdots+S_N-1}V_h-w\} - \frac{d}{dk_j}C_K(k_j)=0, \quad (10)$$

$$\frac{\partial U_h}{\partial e_j} = [S_1+\cdots+S_N]\varphi(k_j)\frac{d\rho}{de_j}\{[1-\varphi(k_j)\rho(e_j)]^{S_1+\cdots+S_N-1}V_h-w\} - \frac{d}{de_j}C_E(e_j)=0. \quad (11)$$

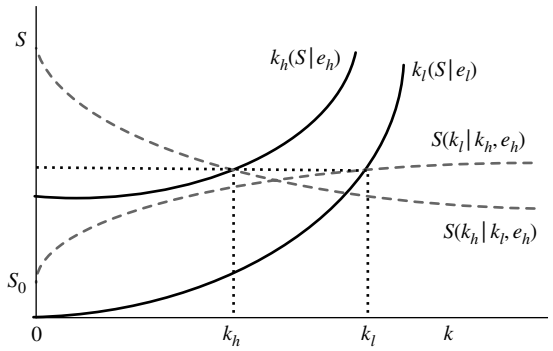
For low-type consumers, $V_l(p)<0$, and so they would not buy the item. Hence, the expected utility of a low-type consumer i is simply

$$U_l(k_i,e_i) = -[S_1+\cdots+S_N]\varphi(k_i)\rho(e_i)w - C_K(k_i)-C_E(e_i). \quad (12)$$

[8] We assume that it is possible for a consumer to receive multiple solicitations from the same seller because the seller may have compiled addresses from different sources that contain duplicate entries, and also, the consumer may have multiple addresses (e-mail accounts, telephone numbers, etc.) and hence may get the same solicitations in each of these addresses.

[9] The privacy harm, w, can be interpreted as annoyance or the resources needed to dispose of solicitations, and hence we assume it applies to every solicitation. We are grateful to a reviewer for observing that each high-type consumer benefits only from the first solicitation received, but suffers harm from all solicitations. From the demand for state-level *do not call* registries, Png (2007) estimated the harm from telemarketing to range between \$13.19 and \$98.33 per household.

Figure 1 Consumer Concealment and Seller Solicitation



The low-type consumer would choose positive levels of efforts in concealment and deflection according to the first-order conditions,

$$\frac{\partial U_l}{\partial k_i} = -[S_1+\cdots+S_N]\rho(e_i)w\frac{d\varphi}{dk_i}-\frac{d}{dk_i}C_K(k_i)=0, \quad (13)$$

$$\frac{\partial U_l}{\partial e_i} = -[S_1+\cdots+S_N]\varphi(k_i)w\frac{d\rho}{de_i}-\frac{d}{de_i}C_E(e_i)=0. \quad (14)$$

Our first result shows that consumers' efforts in concealment and deflection are strategic *complements* (Bulow et al. 1985) with sellers' solicitations. Intuitively, an increase in seller solicitation increases harm to consumers, and so consumers will raise concealment and deflection.

Proposition 1. *Consumers' efforts in concealment and deflection are strategic complements with sellers' solicitations.*[10]

Figure 1 shows the consumers' efforts in concealment as functions of seller solicitations. By Proposition 1, the consumer effort in concealment is increasing in seller solicitation. Furthermore, by comparing (10) with (13), the high-type consumer derives more surplus, and so she invests less effort in concealment. Hence, the high-type consumers' concealment function lies to the left of the low-type consumers'. The consumers' deflection strategies are similar.[11]

[10] For brevity, the proofs of all results are presented in the online appendix, which is provided in the e-companion that can be found at http://mansci.journal.informs.org/. For other supplementary materials, please refer to http://www.comp.nus.edu.sg/~ipng/research/.

[11] The shapes of the consumer concealment functions depend on the functional forms of $C_K(k_j)$ and $\alpha(k_j)$, but, for our purpose, they are not important. We introduce the broken curves later: they are sellers' solicitations as a function of low-type (high-type) consumers' concealment, holding deflection and high-type (low-type) consumers' concealment constant. In principle, Figure 1 should have $H+L+N$ dimensions, but, for ease of presentation and without loss of generality, we draw the reaction functions of only one high-type consumer, k_h, one low-type consumer, k_l, and one seller, S.

4.2. Seller Solicitation

Consider a high-type consumer j who has received a solicitation from seller m. If she also receives z other solicitations (whether from seller m or other sellers), she will buy with probability $1/[z+1]$ from each of the received solicitations. Hence, she will buy from *that* solicitation by seller m with probability

$$\frac{1}{z+1}\binom{S_{\sim m}+S_m-1}{z}[\varphi(k_j)\rho(e_j)]^z[1-\varphi(k_j)\rho(e_j)]^{S_{\sim m}+S_m-1-z}, \quad (15)$$

where $S_{\sim m} \equiv S_1 + \cdots + S_{m-1} + S_{m+1} + \cdots + S_N$ denotes solicitations by all other sellers.[12]

To calculate seller m's expected revenue from marketing to that high-type consumer, we must sum over all the various possibilities, $z = 0, 1, \ldots, S_{\sim m} + S_m - 1$, and take account of the probability that one of the solicitations from seller m is *that* solicitation, which equals the product of the probability that the high-type consumer's address is drawn, $\varphi(k_j)$, her effort in deflection, $\rho(e_j)$, and seller m's number of solicitations, S_m. Accordingly, taking into account the incremental margin from each high-type consumer, pq_h, seller m's expected revenue from that high-type consumer alone is

$$\begin{aligned}\sum_{z=0}^{S_{\sim m}+S_m-1}&\left\{\frac{1}{z+1}\binom{S_{\sim m}+S_m-1}{z}[\varphi(k_j)\rho(e_j)]^z\right.\\&\left.\cdot[1-\varphi(k_j)\rho(e_j)]^{S_{\sim m}+S_m-1-z}\right\}\varphi(k_j)\rho(e_j)S_m pq_h\\&=\{1-[1-\varphi(k_j)\rho(e_j)]^{S_{\sim m}+S_m}\}\frac{S_m}{S_{\sim m}+S_m}pq_h, \quad (16)\end{aligned}$$

by Lemma 1 (presented in the online appendix).

In symmetric equilibrium, all $k_j = k_h$ and $e_j = e_h$. Seller m's expected profit is its expected revenue from all consumers less the cost of solicitations. Seller m's expected revenue from all consumers is simply H times (16).[13] Hence, substituting from (6), seller m's expected profit is

$$\begin{aligned}\Pi(S_m) = H\{1-[1-\varphi(k_h)\rho(e_h)]^{S_{\sim m}+S_m}\}&\\\cdot\frac{S_m}{S_{\sim m}+S_m}pq_h - C(S_m, \Lambda).& \quad (17)\end{aligned}$$

[12] The bases for (15) are that (i) sellers collectively sent $S_{\sim m} + S_m$ solicitations; (ii) the high-type consumer has received one solicitation from seller m; and (iii) the high-type consumer receives z other solicitations, which are drawn binomially from the remaining $S_{\sim m} + S_m - 1$ solicitations.

[13] Note that low-type consumers do not buy the item, and hence the expected revenue from all consumers equals the expected revenue from all high-type consumers.

Accordingly, the first-order condition is

$$\begin{aligned}\frac{\partial\Pi}{\partial S_m} = H\left\{\right.&-[1-\varphi(k_h)\rho(e_h)]^{S_{\sim m}+S_m}\ln(1-\varphi(k_h)\rho(e_h))\\&\cdot\frac{S_m}{S_{\sim m}+S_m}+\{1-[1-\varphi(k_h)\rho(e_h)]^{S_{\sim m}+S_m}\}\\&\left.\cdot\frac{S_{\sim m}}{[S_{\sim m}+S_m]^2}\right\}pq_h-\frac{\partial}{\partial S_m}C(S_m, \Lambda)=0. \quad (18)\end{aligned}$$

Proposition 2. *Sellers' solicitation is a strategic substitute with high-type consumers' efforts in deflection and concealment. Sellers' solicitation is independent of low-type consumers' effort in deflection, and, if and only if the marginal cost of solicitation does not increase too fast with consumer concealment, then sellers' solicitation is a strategic complement with low-type consumers' effort in concealment.*

A consumer's effort in concealment has two effects. First, it changes the *mix* of consumers in the total exposure, Λ. Implicitly, by changing the mix, concealment performs a "screening" function for sellers. If low-type consumers increase effort in concealment, they reduce their exposure and hence enrich the proportion of high types. By contrast, if high-type consumers increase effort in concealment, they reduce their proportion in the total exposure.

The other effect of concealment is to reduce the total exposure of all consumers, Λ, which raises the seller's marginal cost of solicitation. If the marginal cost of solicitation is not too sensitive to consumer concealment, the screening effect outweighs the marginal cost effect, and so, concealment by low-type consumers is good for sellers.

The implication for direct marketers is obvious: deflection is bad, although concealment can be good. Indeed, the UK Direct Marketing Association supports consumer efforts to opt out of direct mail, telemarketing, and fax marketing; the U.S. Direct Marketing Association also supports opt out of direct mail, telemarketing, and e-mail marketing.

Note that the converse of Proposition 2 also holds—sellers' solicitation is a strategic substitute with all consumers' concealment effort if the marginal cost of solicitation increases too fast with consumer concealment. Hence, marketers should pay close attention to changes in technology and cost differences. For any medium whose marginal cost of solicitation is sufficiently sensitive, consumer concealment is bad for sellers.

Referring to Figure 1, the upward-sloping (downward-sloping) broken curve depicts seller solicitation as a function of low-type (high-type) consumer concealment effort, holding deflection efforts and

high-type (low-type) consumer concealment effort constant.[14]

4.3. Consumer-Seller Equilibrium

Our setting is not trivial. Specifically, as proved in Lemma 2 (presented in the online appendix), there exists an equilibrium in which sellers do send solicitations, and consumers do invest efforts in concealment and deflection. If high-type consumers maximize utility by choosing $k_j = 0$ and $e_j = 0$, then the equilibrium is defined only by sellers and low-type consumers, i.e., (18), (13), and (14). Otherwise, the equilibrium is defined by sellers and both types of consumers, i.e., (18), (10), (11), (13), and (14).

Generally, we cannot rule out multiple equilibria—it is possible that the reaction functions of sellers and low-type consumers intersect more than once. To ensure a unique equilibrium, we need to specify the third derivatives of the cost functions, $C_K(k_j)$, $C_E(e_j)$, and $C(S_m, \Lambda)$, the concealment function, $\alpha(k_j)$, and the deflection function, $\rho(e_j)$.

5. Welfare and Policy Implications

We now analyze the endogenous trade-off between direct marketing and consumer privacy. Summing (9), (12), and (17) over the H high-type consumers, L low-type consumers, and N sellers, in symmetric equilibrium, social welfare simplifies to

$$\begin{aligned} W = {} & H\{1-[1-\varphi(k_h)\rho(e_h)]^{S_1+\cdots+S_N}\}[V_h + pq_h] \\ & - \sum_{m=1}^{N} C(S_m, \Lambda) - [S_1+\cdots+S_N]H\varphi(k_h)\rho(e_h)w \\ & - HC_K(k_h) - HC_E(e_h) - [S_1+\cdots+S_N]L\varphi(k_l)\rho(e_l)w \\ & - LC_K(k_l) - LC_E(e_l). \end{aligned} \tag{19}$$

In Proposition 3, we characterize the impact of concealment and deflection on the direct privacy harm caused by solicitations. Surprisingly, concealment efforts by low-type consumers increase direct privacy harm. They reduce their own harm, but shift solicitations toward high-type consumers, who invest less effort in deflection, and so suffer relatively more privacy harm.[15] Overall, the total direct privacy harm would increase. In contrast, deflection efforts and high-type consumers' concealment effort unequivocally reduce the direct privacy harm.

Proposition 3. *The direct privacy harm caused by seller solicitations is decreasing in both consumer types' deflection efforts and high-type consumers' concealment effort, but increasing in low-type consumers' concealment effort.*

Besides directly imposing privacy harm, seller solicitations also indirectly induce consumers to incur costs of concealment and deflection. Comparing (17) with (19), there are three differences between a seller's profit and social welfare:

- Because we assumed elastic demand, high-type consumers enjoy some surplus, which is ignored by sellers. This causes sellers to send *too few* solicitations.
- Sellers ignore the direct privacy harm caused by solicitations and concealment and deflection costs, and hence tend to send *too many* solicitations.
- Sellers ignore the demand that they take away from other sellers, and hence tend to send *too many* solicitations.

How then should sellers be induced to internalize the externalities that they impose on consumers and other sellers? Microsoft's cofounder, Bill Gates, famously advocated a postage charge on e-mail to control spam (CNN.com 2004).[16] Our next result addresses how the charge should be set, and whether telemarketing and direct mail should also be taxed.

Proposition 4. *The optimal charge per unit of seller solicitation is positive. Furthermore, it is decreasing in the expected surplus of high-type consumers, and increasing in the direct privacy harm caused by solicitations and the demand that sellers take from each other.*

By contrast with a simple Pigouvian solution, the optimal charge depends on the *actions of the victims* of the externality (i.e., consumers). Proposition 3 shows that the direct privacy harm from solicitations is decreasing in both consumer types' deflection efforts. By Proposition 2, deflection by high-type consumers reduces sellers' solicitations too. Hence, deflection reduces the optimal charge.

The impact of concealment is not obvious—by Proposition 3, concealment efforts by high- and low-type consumers have different effects on the direct privacy harm, and by Proposition 2, they also shift sellers' solicitations in opposite directions. Hence, the net effect of consumer efforts in concealment on the optimal charge depends on the balance between high- and low-type consumers.

[14] The broken curves correspond to cross-sections of the seller solicitation function (which is a surface) with respect to consumer concealment and deflection. As with the consumer concealment functions, the shape of the seller solicitation function is not essential. The figure with seller solicitation and consumer deflection functions has only one (downward-sloping) solicitation curve because, by Proposition 2, seller solicitations are independent of low-type consumers' effort in deflection.

[15] It is worth noting that as high-type consumers receive more solicitations, they also have a higher probability of getting the item and enjoying a positive surplus, and so, the net benefit of low-type consumers' concealment effort on the welfare of high-type consumers is ambiguous.

[16] This suggestion is in line with Van Zandt (2004) and Anderson and de Palma (2006), who advocated raising communication costs to curb unsolicited promotions by low-quality sellers.

It is surprising that the optimal charge is positive even when high-type consumers benefit from solicitations. The essential reason is that the marginal cost of solicitation is so low relative to the seller's incremental margin (the profitability condition) that solicitations are excessive. Spam very likely satisfies this condition, and hence Proposition 4 implies that it should be subject to a tax. Whether telemarketing and direct mail should also be taxed depends on whether these methods of direct marketing satisfy the profitability condition.

The optimal charge also increases with the demand that sellers take from competitors. A seller's solicitations may reach new customers, and so expand the primary demand. However, they might also reach customers who have already received solicitations from other sellers and so "steal" the other sellers' customers, which does not raise welfare.

Finally, governments promote both concealment, such as "no contact" registries, and deflection, such as spam filters (see, e.g., the U.S. Senate Judiciary Committee 2002). Which should they emphasize? Proposition 5 shows that, for consumer welfare, concealment is worse than deflection.

Proposition 5. *Effort in deflection raises consumer welfare more than effort in concealment*.

Proposition 5 is intuitive. Both concealment and deflection reduce the likelihood of solicitations reaching a consumer. The key distinction is that concealment causes solicitations to be *diverted* to other consumers, whereas deflection causes solicitations to be *discarded*. When the marginal cost of solicitation is sufficiently low, sellers send excessive solicitations; hence, the marginal benefit of solicitations to high-type consumers is low. Accordingly, consumers are better off with solicitations being discarded than diverted.

Note that Proposition 5 considers only consumer welfare. Any effort in concealment by low-type consumers raises seller profit as well, because it increases the effectiveness of solicitation. Essentially, the social choice between concealment vis-à-vis deflection resolves to a trade-off between the change in the expected utility of all consumers and gain in sellers' profit. With the profitability condition, the sellers' additional profit is outweighed by the direct and indirect externalities on consumers (even accounting for any increase in surplus), and so, deflection is preferable.

Supposing that spam satisfies the profitability condition, Proposition 5 implies that policy-makers should emphasize deflection (installing spam filters and marking commercial e-mails with the "ADV" tag) over concealment (using unlisted addresses and *do not contact* registries). Even in markets that do not satisfy the profitability condition, consumers still prefer deflection to concealment if the direct privacy harm is so large that high-type consumers choose positive effort in concealment.

6. Empirical Implications

Generally, parameter changes have complex equilibrium effects—directly affecting one side of the market and indirectly affecting the other side. Owing to the difficulty of equilibrium analysis in the general model, we focus on the "reciprocal-quadratic" parameterization,

$$\alpha(k_j) = \frac{1}{1+k_j} \quad \text{and} \quad \rho(e_j) = \frac{1}{1+e_j}, \quad \text{and} \tag{20}$$

$$C(S_m, \Lambda) = \left\{1 + \left[1 - \frac{\Lambda}{H+L}\right]\right\} c S_m^2,$$

$$C_K(k_j) = c_K k_j^2, \quad \text{and} \quad C_E(e_j) = c_E e_j^2. \tag{21}$$

Table 1 presents empirical implications in the case where only low-type consumers invest in concealment and deflection. We present the other case—where all consumers invest in concealment and deflection—in the online appendix.

In 2003, the U.S. Federal Trade Commission established a national *do not call* list. This reduced consumers' cost of concealment from telemarketing. According to Table 1, sellers would respond by increasing solicitations, as the total exposure of addresses became richer in high-type consumers. Indeed, the Direct Marketing Association (2004, p. 29) reported:

> For those direct marketers whose primary objective was to solicit direct order sales, telephone marketing again produced the highest response rate (5.78%)... Perhaps this was due to the institution of Do-Not-Call laws, leaving a *smaller, but more productive base to promote to*. [italics added]

Varian et al. (2005) found that households with higher income were more likely to sign up with the U.S. Do Not Call Registry. To the extent that the benefit from direct sales and direct privacy harm increase with household size and income, these findings are consistent with the predictions in Table 1.

Table 1 Empirical Implications

	Effect of an increase in							
On variable	pq_h	H	L	c_K	c_E	w	c	N
S	+	?	−	−	+	+	−	?
k_l	+	?	−	−	+	+	−	?
e_l	+	?	−	?	?	+	−	?

7. Extensions

Our model can be extended in several meaningful ways:

(i) *Multiple items*. We assumed that sellers market only one item. It is straightforward to extend our analysis to marketing of multiple items, with each being marketed by a distinct group of sellers. The key is that consumers (endogenously) divide into multiple segments that can be ordered by the aggregate surpluses from consuming the items. Then, the analysis of consumer net utility and seller profit extend in an obvious way.[17]

(ii) *Heterogeneous privacy harms*. Our analysis assumed that solicitations cause the same direct privacy harm to both consumer segments. Realistically, the direct privacy harm caused by solicitations might differ, because for instance, people differ in their opportunity cost of time. Let the direct privacy harms to high- and low-type consumers be w_h and w_l. Then, by the same analysis as leading to (9) and (12), as long as

$$\{1-[1-\varphi(k_j)\rho(e_j)]^{S_1+\cdots+S_N}\}V_h-[S_1+\cdots+S_N]\varphi(k_j)\rho(e_j)w_h \geq -[S_1+\cdots+S_N]\varphi(k_i)\rho(e_i)w_l, \quad (22)$$

high-type consumers would derive more benefit from solicitations than low-type consumers. By constructing reaction functions similar to (10), (11), (13), (14), and (18), the analysis is identical to that presented above. If, however, (22) does not hold, then high-type consumers would choose more marketing avoidance than low-type consumers. Nevertheless, the results and conclusions are similar.[18]

(iii) *Low-type consumers' demand*. We assumed that the demand of low-type consumers was sufficiently low that sellers would price the item such that $V_l(p) \leq 0$. What happens if this does not hold, and low-type consumers would buy the item if they receive solicitations? In this case, as with (17), seller m's profit from H high-type and L low-type consumers would be

$$\Pi(S_m) = H\{1-[1-\varphi(k_h)\rho(e_h)]^{S_{\sim m}+S_m}\}\frac{S_m}{S_{\sim m}+S_m}pq_h + L\{1-[1-\varphi(k_l)\rho(e_l)]^{S_{\sim m}+S_m}\}\frac{S_m}{S_{\sim m}+S_m}pq_l - C(S_m, \Lambda). \quad (23)$$

There are two changes in the findings. Regarding Proposition 2, sellers' solicitation is a strategic substitute with all consumers' efforts in deflection. If low-type consumers' demand for the item, $q_l(p)$, is sufficiently low relative to high-type consumers, then sellers' solicitation is a strategic substitute with high-type consumers' effort in concealment and a strategic complement with low-type consumers' effort in concealment. If, however, $q_l(p)$ is large, then low-type consumers' effort in concealment would reduce seller profit, which would induce sellers to decrease solicitation. That is, sellers' solicitation would become a strategic substitute with low-type consumers' effort in concealment.[19]

Finally, regarding Proposition 4, the optimal charge is also decreasing in the expected surplus of low-type consumers.

(iv) *Pricing*. Our analysis can be extended to endogenize sellers' pricing in either of two ways. One way supposes that each seller is subject to monopolistic competition and sets price p before sending solicitations. Referring to (10), (11), (13), (14), and (18), let the equilibrium solicitations and avoidance be (S, k_h, e_h, k_l, e_l). Then, in the prior stage, each seller maximizes expected profit by setting price according to:

$$\frac{d}{dp}\Pi(S_m) = \frac{d}{dp}\left\{H\{1-[1-\varphi(k_h)\rho(e_h)]^{[N-1]S+S_m}\} \cdot \frac{S_m}{[N-1]S+S_m}pq_h(p) - C(S_m, \Lambda)\right\}. \quad (24)$$

The other way to endogenize pricing supposes that sellers set prices and send solicitations at the same time under conditions of oligopoly. Then, sellers will randomize prices according to a set of distributions $F_y(p)$ over an interval, say $[\underline{p}, \bar{p}]$ (Varian 1980, Narasimhan 1988, Raju et al. 1990, McAfee 1994). Each high-type consumer would buy from the seller offering the lowest price among the solicitations that she receives. The distribution of the lowest price among a set of N price distributions is $1-\prod_{y\in N}[1-F_y(p)]$.

[17] Specifically, suppose that there are Q products, with each product being offered by a distinct group of sellers. Each consumer is interested in a subset of the Q products. Then, we can construct consumers' expected utilities in a similar way as leading to (9), and, for each product, the seller's profit in a similar way as leading to (17). Following the approach in §4, we can derive the strategic responses of sellers and consumers, and after ranking consumers by their expected utilities, we can derive the equilibrium.

[18] In this case, high-type consumers would choose positive efforts in concealment and deflection in equilibrium, and hence Propositions 4 and 5 would hold even without the profitability condition. The other changes in findings are (i) in Figure 1, the high-type consumer's concealment curve would lie to the right of that for low-type consumers, and start from the origin; (ii) in Proposition 3, the direct harm would increase in high-type consumers' effort in concealment, and decrease in low-type consumers' effort in concealment.

[19] Note, however, that this case is less empirically relevant, as it implies that all consumers would buy the item upon receiving solicitations from sellers, which does not seem realistic. The proofs of the changes in findings are presented in the online appendix.

Then, adapting (9), the expected utility of a high-type consumer becomes

$$\begin{aligned} U_h(k_j, e_j) = {} & \{1-[1-\varphi(k_j)\rho(e_j)]^{S_1}\}\prod_{y=2}^{N}[1-\varphi(k_j)\rho(e_j)]^{S_y} \\ & \cdot\int_{\underline{p}}^{\bar{p}} V_h(p)\frac{d}{dp}\{1-[1-F_1(p)]\}\,dp \\ & +\cdots+\prod_{y=1}^{N}\{1-[1-\varphi(k_j)\rho(e_j)]^{S_y}\} \\ & \cdot\int_{\underline{p}}^{\bar{p}} V_h(p)\frac{d}{dp}\left\{1-\prod_{y=1}^{N}[1-F_y(p)]\right\}dp \\ & -[S_1+\cdots+S_N]\varphi(k_j)\rho(e_j)w \\ & -C_K(k_j)-C_E(e_j). \end{aligned} \tag{25}$$

Similarly, by enumerating the various combinations of solicitations that reach a high-type consumer and taking account of the sellers' price distributions, and then simplifying with McAfee's (1994) Equation (5), an individual seller's profit at any price p is

$$\begin{aligned} \widetilde{\Pi}_m(p) = {} & H\left\{\{1-[1-\varphi(k_h)\rho(e_h)]^{S_m}\}\prod_{\substack{y=1\\y\neq m}}^{N}[1-\varphi(k_h)\rho(e_h)]^{S_y}\right. \\ & +\cdots+\prod_{y=1}^{N}\{1-[1-\varphi(k_h)\rho(e_h)]^{S_1}\} \\ & \left.\cdot\prod_{\substack{y=1\\y\neq m}}^{N}[1-F_y(p)]\right\}pq_h(p)-C(S_m,\Lambda) \\ = {} & H\left\{\{1-[1-\varphi(k_h)\rho(e_h)]^{S_m}\}\right. \\ & \left.\cdot\prod_{\substack{y=1\\y\neq m}}^{N}\{1-\{1-[1-\varphi(k_h)\rho(e_h)]^{S_y}\}F_y(p)\}\right\} \\ & \cdot pq_h(p)-C(S_m,\Lambda). \end{aligned} \tag{26}$$

In a symmetric randomized-strategy equilibrium, $S_y = S$ and $F_y = F$ for all $y \neq m$, and the seller must earn equal profit, $\widetilde{\Pi}_m(p) = \widetilde{\Pi}_m(\bar{p})$, for all $p \in [\underline{p}, \bar{p}]$. Applying these conditions to (26) yields the price distribution

$$\begin{aligned} F(p) = {} & \frac{1}{1-[1-\varphi(k_h)\rho(e_h)]^{S}} \\ & \cdot\left\{1-[1-\varphi(k_h)\rho(e_h)]^{S}\left[\frac{\bar{p}q_h(\bar{p})}{pq_h(p)}\right]^{1/(N-1)}\right\}. \end{aligned} \tag{27}$$

Substituting (27) in (26), the seller's profit simplifies to

$$\begin{aligned} \widetilde{\Pi}_m(p) = {} & H[1-\varphi(k_h)\rho(e_h)]^{[N-1]S}\{1-[1-\varphi(k_h)\rho(e_h)]^{S_m}\} \\ & \cdot\bar{p}q_h(\bar{p})-C(S_m,\Lambda). \end{aligned} \tag{28}$$

Differentiating (28) with respect to S_m, and setting $S_m = S$, yields the equilibrium solicitations, S.

With randomized pricing, we can prove results corresponding to Propositions 2 and 3. However, whether Propositions 1, 4, and 5 generalize to the setting of randomized pricing is an open question for future research. The key challenge is that, by (25), the expected utility of high-type consumers, $U_h(k_j, e_j)$, is an intractable function of sellers' solicitations and price distributions.[20]

8. Concluding Remarks

Consumers widely avoid marketing to protect their privacy. Our contribution is to introduce the consideration of marketing avoidance into analytical research. Solicitations by sellers directly impose privacy harm on consumers, and indirectly induce consumer costs of concealment and deflection. We show that consumer concealment and deflection have distinct strategic and welfare implications depending on the trade-off between the externalities caused by solicitations and the benefit provided by the marketed item.

Our results are subject to several limitations. First, the analysis with randomized pricing left open questions on the strategic complementarity between consumer efforts in concealment and deflection with seller solicitations, and the welfare differences between concealment and deflection. These are key issues for future research.

Second, our analysis above was static. It did not allow sellers to collect consumer information in one period and use it for subsequent pricing (see, e.g., Chen et al. 2001, Taylor 2004, Acquisti and Varian 2005). It also did not consider repeat purchases. Such dynamic interactions, in the context of negative externalities imposed by seller solicitations, are an important direction for future work.

Third, we assumed that consumers do not proactively contact sellers. It would be interesting to analyze a setting in which both sellers and consumers seek out each other (Robert and Stahl 1993). If interested consumers seek out sellers, sellers can reduce marketing, both saving resources and reducing consumers' privacy costs. Such a setting, however, may not fit markets in which consumers are not aware of the item being advertised.

Finally, for analytical tractability, we restricted our analysis to symmetric equilibria, homogeneous

[20] In previous analyses of randomized pricing in oligopoly (Varian 1980, Narasimhan 1988, Raju et al. 1990, McAfee 1994), consumers were passive, and hence computing this surplus was not an issue. One setting which possibly avoids this problem is where consumers commit to efforts in concealment and deflection *before* sellers set prices.

sellers, and only two consumer types. Although some of these issues have been separately considered in the literature (e.g., McAfee 1994, Van Zandt 2004, Anderson and de Palma 2006), integrating them into a single analysis remains a challenging issue for future research.

9. Electronic Companion

An electronic companion to this paper is available as part of the online version that can be found at http://mansci.journal.informs.org/.

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