Who is Calling, Please? On Anonymous Calling and Caller ID

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Abstract

The caller ID service sold by phone service providers enables users to identify callers. ID blocking, sold by the same phone companies, enable anonymous calling. A monopoly seller of such services faces an interesting pricing problem: the more ID they sell, the greater the demand for ID blocking. The more ID blocking they sell, the lower the demand for caller ID. These effects make the efficient allocation of identification and anoymity services dependent on one another. Without both a well established right to identify callers, and well functioning markets for the services, inefficient allocations are expected. This insight applies to other similar economic situations and may help explain excessive telemarketing, spam e-mail, junk mail and other distractions and intrusions on one's attention.

1 Introduction

Verizon, the major phone service provider in New York sells a Caller ID service that identifies callers by name and number. Caller ID costs $7.99 per month. The most likely buyers of this service include take-out restaurants, credit card companies, nosy parents, and people who wish to identify calls from telemarketers or tiresome friends. Verizon *also* offers ID blocking. Blocking overrides ID, meaning people with blocking can still still call people with Caller ID anonymously. Verizon wants to help, though. For an extra $3.00 per month people can buy Anonymous Call Rejection, or for $5.95 per month they can buy the premier Call Intercept service that "prompts unidentified callers to announce who they are before your phone rings." Call intercept requires a

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subscription to Caller ID, so the ultimate identification package–Caller ID plus Call Intercept–costs users $14 per month.

Verizon is in the enviable position of selling both ID *and* ID blocking. Actually, they grant blocking for free to anyone requesting it. The most likely requesters? Telemarketers, unrequited lovers, obscene phone callers, and desperate types generally, the very types most of us want to identify so we can avoid them. Essentially, Verizon is giving away one service–ID block and the privilege of making anonymous phone calls–so they can sell more of different services–Caller ID, Anonymous Call Rejection, and Call Intercept.

The Verizon observation interested us for two reasons. First, is the micro pricing problem they face: The more ID they sell, the more requests for blocking. The more blocking they sell (or give away), the lower the demand for inferior Caller ID, but the greater the demand for the superior Intercept and Anonymous Call Rejection services (we call such goods "completutes"). How do they price that?

We were also curious that Verizon is in the enviable position of selling both the offense and the defense. Phone users–and that includes a large proportion of adult households in the U.S.– are not entitled to identify callers *or* to call anonymously. We suspect that the profit motives (presumably) guiding Verizon's sales of these services results in too little identification, and too much anonymity.

Our model can also be applied to telemarketing, junk mail, and spam. Judging from the 59 million Americans who quickly signed up for the Do Not Call List created by Congress, excessive telemarketing is a real annoyance. Junk mail and Spam are related problems too.[1] Though quotidian, these problems are not trivial. According to the most conservative estimate, the typical American worker wastes $50 per year sorting through and deleting spam e-mail (Hansell 2003). The real cost, of course, is that answering unwanted telemarketing calls, and sifting through spam and junk mail limits the attention we pay to important messages.

Attention is a scarce resource, so paying attention is costly. Limited attention is a real problem that has been linked, among other things, to financial market inefficiencies (Hershliefer and Teoh 2002). In general, attending to the right matters in the right degree strike us as first-order determinants of human wealth and welfare. The obvious upside of modern information technology–mail, telephone, and the Internet–is the valuable information they bring to our attention at relatively low cost. That benefit explains their ubiquity. The down side of these media–and their low cost–is the low value messages they attract from commercial vendors, junk mailers, telemarketers, and spammers. Paying attention to these sorts of messages is costly to the recipient. The question that really interests us is whether these distractors, or the firms that grant them our attention, are paying the right price for our attention? Should attention be treated as a scarce property right or as a free good, available to anyone to cap-

[1] Media and advertising are the more general problem: the broader the cast, the more advertisers are attracted. The more advertising, the less attractive the media, e.g., highway and billboards.

ture? Is the attention deficit that concerns so many partly a stimulus surplus endemic to modern information technologies with ill-defined attention rights?

We think about those big questions using a simple model where people call each other randomly for some unspecified purpose. Just like with Verizon, calls can be identified by name and number or they can be anonymous. Callers and recipients both care about the rules of contact, but in different degrees; some people really care who is calling, while others couldn't care less. Some people really value their anonymity, others less so. We assume the identification technology is costless, and can be allowed by merely flipping a switch.

We characterize how a Utilitarian or Paretian social planner would allocate identification and anonymity, and then contrast those allocations to a monopoly and competitive allocation. The latter market allocations may depend on initial "property" rights, that is, whether people are initially entitled to anonymity (the status quo before ID was invented), identification, or neither. Depending on the right, the monopolist or competitive firms will buy anonymity rights and sell identities (name and number), or vice versa. If people have neither right, the provider gets to sell both ID and Blocking, as with Verizon. While we frame everything in terms of ID and blocking, our analysis should extend to discussion of telemarketing and Do Not Call Lists, and to the sale of e-mail and address lists that are the stock in trade of Spammers and junk mailers.[2] We characterize the allocations for general distributions of preference, and compute them for uniform distributions. Consumer welfare under a monopolist varies depending on whether agents have rights to remain anonymous, to ID others, or neither right. Competition may provide higher welfare than a monopolist, but the type of competition matters. Crude, unmediated competition where firms sell ID and blocking separately, without regard for the other side of the market, or of inframarginal users, results in lower welfare than mediated competition where an intermediary sells both services and internalizes the cross-market effects. Mediated competition can deliver the Paretian planner's welfare level, but not the Utilitarian level. We are not ready to recommend policy yet, but we think it is useful to think harder about attention rights, and the resulting market that would arise around that.

In the academic context, our analysis relates to the two-sided markets literature. It is similar to the intermarket externalities studied in the analysis of two-sided markets by Parker and Van Alstyne (2000), and Rochet and Tirole (2002, 2003). In our model the willingness of a person to pay for information is dependent on the proportion of the market that is willing to yield its information. Similarly, the willingness of a person to pay to block identification is dependent on the likelihood of their being identified, that is, on the proportion of agents that seek to gather information. Although our environment is clearly two-sided, it differs from other models in two ways. First, while the monopolist (or planner) that organizes the market must keep both sides on board (those seeking identify and those seeking anonymity), the marketer collects revenue

[2]The telemarketing application is very close to what Ayers and Nalebuff suggest: "Want to Call Me? Pay Me!," Wall Street Journal, October 7, 2003.

not from the product of the mass of these two groups, but instead, in the case of public information for example, collects revenue from those who protect their privacy, and must pay those who refrain from gathering identification. This is distinct from the models of Rochet and Tirole (2002, 2003) or Schmalensee (2002) in which revenue is collected on the transactions that consist of the product of the mass of high-valued customers on both sides of the market. Second, it is distinct from Parker and Van Alstyne (2000) in that in the case of information exchange we consider, more information gathering yields more privacy protection, a strategic complement. However, more privacy protection yields less willingness to gather information, a strategic substitute. Parker and Van Alstyne briefly consider this case, but focus primarily on the case in which each side of the market is strategically complementary with the other.

2 Model

Imagine a large network of people, e.g., a phone system. People in the network call each other at random (for now): everyone in the network makes one call per period at random.[3] Contact can be either identified, meaning the answerer knows the caller's name, number, and location, or anonymous, meaning the answerer does not know these caller characteristics. We assume the ID technology is costless–a simple flip of a switch.

The utility from contact for both caller and answerer depends on whether the call is identified or anonymous. Anonymous calls are the benchmark, meaning they yield utility 0 (or some positive constant) to either party. Identified calls produce utility γ for the answerer and disutility $\beta > 0$ for the caller. These utility parameters differ across people, as some people are nosier than others, and some people are more private or reclusive than others.[4] In general, we will assume that the specific type of a particular individual is unknown, thereby ruling out price discrimination on the basis of type. The cumulative distributions are $F(\gamma)$ and $G(\beta)$ on the interval $[0, 1]$.[5] We assume that the distributions are

[3] Contact could be endogenized if both calling and answering had costs and benefits. The cost of answering is, of course, the attention one must pay the caller. The benefit it whatever information one recieves, e.g., an invitation, a sales pitch, etc. The cost of calling is the time spent dialing and offering the pitch. The benefits are the possibility of a sales. Given these parameters, everyone decides whether to call, and whether to answer. Of course, the calling decision depends on the probablity of an anwer, and vice versa. This analysis could get complicated so for now, we stick with exogenous contact.

[4] In our model, a person with Caller ID does not receive any positive utility from a person that has installed ID Block. The benefit of Caller ID is knowing the specific identity of the caller–for example, a take-out restaurant can verify the address of the caller automatically to insure that the order is valid. Simply observing a blocked number does not convey such caller-specific information. While all telemarketers may block their calls, in our model this does not convey the specific information the receiver of the call benefits from, namely which particular telemarketer is calling. To avoid telemarketers, more specific products, such as one known as the "Telezapper" are available to consumers.

[5] Alternatively, the support of F could include negative values of β. We could specify, for example that the support of F is the interval $[\underline{\beta}, 1]$, where $-1 \leq \underline{\beta} \leq 0$. The reason for this consideration is that, in some circumstances, callers wish to be identified, for example, when

twice continuously differentiable. The hazard functions associated with each distribution are assumed to be increasing.

This setup captures telemarketing and "spam" as well. Telemarketers gain positive utility from their calls, γ; recipients of telemarketing calls receive negative utility in expectation, $-\beta$. Receivers of telemarketing calls may have available a technology, like the "Do Not Call" list, that blocks telemarketing calls. Senders and receivers of spam e-mail face a similar situation, with various filters for the blocking of spam e-mails playing the role of the blocking technology.[6]

2.1 Optimal Allocations

The next two sections contrast a utilitarian planner's allocations of ID and Blocking to those of a Pareto planner. The utilitarian planner does not make transfers among agents to compensate for the disutility of those whose identities are revealed, but the Pareto planner can do so. The utilitarian planner's solution is useful to examine, as it displays the external effects in this two-sided market well. Because an individual's type is not observable by the planner, neither planner can price discriminate on type.

2.1.1 Utilitarian Planner (No Transfers)

How would a utility maximizing planner confer caller identification and blocking? The planner knows the distributions of types and can therefore measure the utility and disutility everyone gets from identification. By utilitarian, we mean the planner does not have to consider initial rights, i.e., the solution may not be Paretian; the planner simply maximizes the sum of utilities. We start with this case because it illustrates the particular externality in our setup.

The planner simply uses a cutoff in bestowing ID: people with $\gamma \geq \bar{\gamma}$ get ID, people with $\gamma < \bar{\gamma}$ do not. Likewise, with blocking: people with $\beta \geq \bar{\beta}$ get blocking, people with $\beta < \bar{\beta}$ do not. Given these cutoffs, $1 - F(\bar{\gamma})$ of the population get ID. The proportion of people they will be able to identify, i.e., the proportion without blocking is $G(\bar{\beta})$. In the end, each person gets assigned to one of these four categories:

they call for takeout pizza, or when they call to authorize their credit cards. We will not analyze that case in this paper, but for levels of $\underline{\beta}$ close to zero, we think that our results will not be affected significantly.

[6] Yet another interpretation of the model is that γ represents the benefits one receives from learning more about another person, and β represents the disutility of revealing increasing levels of information about oneself. For example, one may not mind revealing one's name or appearance to another person, but be more reticent about revealing one's income or sexual history to another. Hence preferences for an individual are represented by F and G. And the model seeks to find the cutoff levels of information gathered about another, and the information revealed about oneself.

$\gamma \geq \bar{\gamma} \Longleftrightarrow$ID?	$\beta \geq \bar{\beta} \Leftrightarrow$Block?	Utility
no	yes	0
no	no	$-\beta[1 - F(\bar{\gamma})]$
yes	yes	$\gamma G(\bar{\beta})$
yes	no	$\gamma G(\bar{\beta}) - \beta[1 - F(\bar{\gamma})]$.

People in the top row get block, but not ID. That was the status quo before caller ID was invented, so we treat that case as the benchmark with zero (or some constant) utility. If the planner takes blocking privileges from someone, i.e., reallocates them from row one to row two, that persons expected loss is their personal disutility of being identified- β - times the probability they call someone that with ID $= 1 - F(\bar{\gamma})$. If the planner grants ID to someone that already has block, i.e., reallocates them from row one to row three, the expected gain to that person is their personal utility of identifying a caller–γ– times the probability their caller does not have block - $\gamma G(\bar{\beta})$. If the planner takes away blocking but grants ID–row four–that person gains the difference: $\gamma G(\bar{\beta}) - \beta[1 - F(\bar{\gamma})]$.

Aggregate welfare is the sum of the utility of people in each class, where that sum is the integral of the utility in each class over the relevant set of γ and β. Several terms cancel upon integration (appendix), leaving a simple term for aggregate welfare:

$$W(\bar{\gamma}, \bar{\beta}) = G(\bar{\beta}) \int_{\bar{\gamma}}^{1} \gamma f(\gamma) \delta\gamma - [1 - F(\bar{\gamma})] \int_{0}^{\bar{\beta}} \beta g(\beta) \delta\beta. \tag{1}$$

Aggregate welfare is simply the difference between two terms: the sum of utility of all people granted ID, times the fraction of people *not* granted blocking (i.e., the fraction that are identifiable) less the aggregate *dis*utility of people *not* granted blocking, times the fraction of people granted ID (i.e., the fraction that may identify them). Notice that welfare does not depend (directly) on the measure of people that *do* get block ($\beta > \bar{\beta}$) or the measure of people that do *not* get ID ($\gamma < \bar{\gamma}$).

Assuming an interior solution, the first-order conditions for $\bar{\gamma}$ is

$$\bar{\gamma} G(\bar{\beta}) = \int_{0}^{\bar{\beta}} \beta g(\beta) \delta\beta. \tag{2}$$

Raising the ID cutoff has costs and benefits. On the one (left) hand, raising $\bar{\gamma}$ costs the individual that gets the cutoff utility, $\bar{\gamma}$, times the probability their caller does not have block. On the other (right) hand, raising the ID cutoff increases the utility of everyone without block. The planner clearly considers

the public bad aspect of ID in this case. Note the first order condition mixes margins and averages; the marginal utility of the unit of ID equals the average utility of the people without block (conditional on not having block).

Integrating (2) by parts implies

$$(\bar{\gamma} - \bar{\beta})G(\bar{\beta}) = -\int_0^{\bar{\beta}} G(\beta)\delta\beta \tag{3}$$

We were surprised that $\bar{\gamma} < \bar{\beta}$. If the utility of the marginal person with ID is less than the disutility of the marginal person with blocking, why would the planner allow the former to ID the latter? Because raising $\bar{\gamma}$ would subject the marginal person without ID to anonymous calls from *all* the people without block, including inframarginal people where $\beta < \bar{\gamma}$.

The first order condition for blocking is

$$\bar{\beta}[1 - F(\bar{\gamma})] = \int_{\bar{\gamma}}^1 \gamma f(\gamma)\delta\gamma. \tag{4}$$

Raising the cutoff for blocking reduces the utility of the person that just misses the cutoff (times the probability they call someone with ID), but increases the utility of everyone with ID. This condition mixes margins and averages too; the utility of the marginal person with blocking, equals the average utility of people with ID (conditional on having ID).

Equations (2) and (4) determine the cutoffs chosen by the utilitarian planner.[7] There may be multiple solutions, or none.

2.1.2 Pareto Planner (with Transfers)

The utilitarian planner's solution above is *not* Pareto optimal; people who have blocking privileges taken away are worse off than in the status quo, with zero utility. Suppose instead that the planner can make transfers, and that the the planner cannot lower anyone's utility below zero. If this Pareto planner wishes to identify an agent, it has to compensate the agent by paying a price p_B to the agent. We assume that utility is increasing linearly in income, and that utility of income and ID or blocking is separable. The planner finances the subsidy by selling ID at a price p_I.

Aggregate welfare in this case reflects these transfers:

$$W(\bar{\gamma}, \bar{\beta}) = G(\bar{\beta}) \int_{\bar{\gamma}}^1 \gamma f(\gamma)\delta\gamma - [1 - F(\bar{\gamma})] \int_0^{\bar{\beta}} \beta g(\beta)\delta\beta + p_B G(\bar{\beta}) - p_I[1 - F(\bar{\gamma})] \tag{5}$$

[7] The second-order condition for a maximum – $-G(\bar{\beta}) < 0$ and $-[1 - F(\bar{\gamma})] < 0$–are satisfied.

The voluntary participation and budget constraints on the Pareto planner are[8]:

$$p_I \leq \bar{\gamma} G(\bar{\beta}) \tag{6}$$

$$\bar{\beta}[1 - F(\bar{\gamma})] \leq p_B \tag{7}$$

$$p_I[1 - F(\bar{\gamma})] \geq p_B G(\bar{\beta}). \tag{8}$$

Equation (6) dictates that the price of ID cannot exceed the expected utility of the marginal person that pays it. Equation (7) requires that the price paid to people who give up blocking cannot be less than the expected marginal disutility of being IDed. The budget constraint (7) requires that the revenue from selling ID must cover the cost of buying blocking privileges. As social welfare is increasing in p_B and decreasing in p_I, all three constraints are likely to bind. If all bind and $\bar{\gamma}$ and $\bar{\beta}$ lie in the interior the unit interval, we have that

$$\bar{\gamma} = \bar{\beta} \tag{9}$$

The utility of ID for the marginal person with ID equals the disutility of being ID for the marginal person without block. That sounds reasonable, but it differs from the allocation chosen by the utilitarian planner, in which $\bar{\gamma} < \bar{\beta}$. Using (9) to eliminate $\bar{\beta}$ from (5), then maximizing with respect to $\bar{\gamma}$ implies:

$$f(\bar{\gamma})[\bar{\gamma} G(\bar{\beta}) - \int_0^{\bar{\beta}} \beta g(\beta) \delta\beta] = g(\bar{\beta})[\int_{\bar{\gamma}}^1 \gamma f(\gamma) \delta\gamma - \bar{\beta}[1 - F(\bar{\gamma})]] \tag{10}$$

The utilitarian planner set the differences in (10) above to zero (in (2), (4)). That solution is not feasible for the Pareto planner so he trades off the deviations from that solution for each type. Since $\bar{\gamma} G(\bar{\beta}) > \int_0^{\bar{\beta}} \beta g(\beta) \delta\beta$, the marginal utility of the last person with ID exceeds the aggregate disutility of the people that get identified, the people without block. That is a waste. Lowering the ID cutoff, i.e., lowering the price of ID, would eliminate that waste, but it would lower the utility of all the people that sold their blocking rights. Since $\int_{\bar{\gamma}}^1 \gamma f(\gamma) \delta\gamma > \bar{\beta}[1 - F(\bar{\gamma})]$, the disutility of the last person to sell their blocking is less than the aggregate utility of all the people with ID. That is also a waste. Raising the blocking cutoff, i.e., raising the price of block, would reduce that waste. But since the Pareto planner must keep $\bar{\gamma} = \bar{\beta}$, it cannot lower the

[8] In addition, the planner is constrained in that the cutoffs $\bar{\gamma}$ and $\bar{\beta}$ are bounded between zero and one. We will focus only on interior solutions in which both $\bar{\gamma}$ and $\bar{\beta}$ are strictly greater than zero and less than one .

ID cutoff, and raise the block cutoff. Instead, it chooses the single cutoff that equates the waste on both sides.

3 Implementation

3.1 Monopoly

The monopolist will allocate ID (I) and blocking (B) differently than the planners. The precise differences will depend on property rights, that is, whether people are initially entitled to identification or blocking (or neither) as those rights determine who the monopolist pays for relinquishing their right, and who pays the monopolist.

3.1.1 Anonymity Rights

Suppose people are initially entitled to make anonymous calls, the status quo before caller ID was invented.[9] People with little demand for anonymity will be willing to sell their right to the monopolist who can in turn sell their identities to people with strong demand for identification. As in the case of the Pareto planner, let p_B denote the price the monopolist pays for anonymity. Let p_I denote the price people pay when they identify their caller. People's willingness to sell anonymity and pay for identities will depend not just on these prices, but also on the cost of giving up a right and the benefits of acquiring a right. Those in turn, will depend on the aggregate fraction of people buying and selling. For a given price for privacy, people below some cutoff $\bar{\beta}$ will sell their right to anonymity while people above the cutoff (e.g., telemarketers who value anonymity) will not sell (i.e., they will retain ID blocking). For a given price of ID, people above some cutoff $\bar{\gamma}$ will buy caller ID. People below $\bar{\gamma}$ will pass. Note that anonymous callers have the rights here, so people who retain their anonymity get to make anonymous calls even to people who have caller ID. Caller ID is defense only against callers that have sold their anonymity. Thus, an individual's willingness buy caller ID will depend on the aggregate fractions of people that *have* sold their anonymity, i.e., people with $\beta \leq \bar{\beta}$. Given that fraction, the expected utility of ID for the marginal buyer must be at least as high as the price:

$$\bar{\gamma} G(\bar{\beta}) \geq p_I \tag{11}$$

This is essentially the demand for caller ID facing the monopolist. On the supply side, the price the monopolist pays anonymity sellers for relinquishing that right must be at least as high as the marginal sellers' expected disutility being identified:

[9] We ignore caller's own ID systems, e.g. ring once, hang up, then ring again.

$$\bar{\beta}[1 - F(\bar{\gamma})] \leq p_B \tag{12}$$

The monopolist chooses prices to maximize profits:

$$p_I[1 - F(\bar{\gamma})] - p_B G(\bar{\beta}). \tag{13}$$

Assuming the constraints are strictly binding, the monopolist's problem can be restated as a choice of cutoffs (instead of prices):

$$Max \quad [\bar{\gamma} - \bar{\beta}][1 - F(\bar{\gamma})]G(\bar{\beta}) \tag{14}$$

Combining the first-order conditions implies:

$$[\bar{\gamma} - \bar{\beta}] = \frac{1 - F(\bar{\gamma})}{f(\bar{\gamma})} = \frac{G(\bar{\beta})}{g(\bar{\beta})} \tag{15}$$

It is clear that this solution differs from the utilitarian planner's solution, where $\bar{\gamma} < \bar{\beta}$, as well as from the Pareto planner's solution, where $\bar{\gamma} = \bar{\beta}$. The monopolist sets the price of anonymity too low (resulting in too much blocking), and sets the price of identification too high, restricts the sales of ID (high cutoff). That captures the flavor of the Verizon solution noted at the outset; ID is costly, but blocking is free.

3.1.2 Identity Rights

If people are initially entitled to know their caller, the monopolist must pay willing parties to give up that right. The monopolist in turn sells that right to people wishing to make anonymous calls. The monopolist maximizes

$$p_B[1 - G(\bar{\beta})] - p_I F(\bar{\gamma}) \tag{16}$$

Subject to:

$$\bar{\gamma} G(\bar{\beta}) \leq p_I \tag{17}$$

$$\bar{\beta}[1 - F(\bar{\gamma})] \geq p_B \tag{18}$$

Contrast the supply and demand constraints in this ID rights case and the anonymity rights case just considered. ID right suppliers compare the benefit of selling their right–the price they receive–to the cost of selling–the chances that a given caller will be identifiable, i.e., the $G(\bar{\beta})$ fraction of people that sold their anonymity rights. The demand curves in the two property rights cases differ simply in the direction of the inequality in the participation constraints.

The monopolist's profit maximizing cutoffs in the ID rights case must satisfy:

$$\bar{\gamma} = \frac{-G(\bar{\beta})F(\bar{\gamma}) - \bar{\beta}f(\bar{\gamma})}{G(\bar{\beta})f(\bar{\gamma})} \tag{19}$$

$$\bar{\beta} = \frac{G(\bar{\beta})F(\bar{\gamma}) + 1 - G(\bar{\beta}) - F(\bar{\gamma})}{g(\bar{\beta})[1 - F(\bar{\gamma})]} \tag{20}$$

In this case, we see that $\bar{\gamma} < 0$ for all $\bar{\gamma}$, $\bar{\beta}$ in the interior of the unit interval. With anonymity rights, the monopolist set $\bar{\gamma} > \bar{\beta}$. In the ID rights case, the monopolist keeps $\bar{\beta} > \bar{\gamma} = 0$. This reversal makes sense. With anonymity rights, the monopolist restricts ID sales (high $\bar{\gamma}$). With ID rights, the monopolist restricts anonymity sales (high $\bar{\beta}$). The monopolist in this case will never find it profitable to restrict ID sales for two reasons. First, restricting ID sales (paying agents to forego Caller ID) results in direct expenditures for the monopolist. Second, restricting ID sales results in reduced demand for blocking, and therefore a reduced price and revenue from sales of blocking. The monopolist finds it optimal to allow all people to ID, and thereby maximize the revenue of blocking sales.

At $\bar{\gamma} = 0$, the cutoff level of blocking chosen by the monopolist is

$$\bar{\beta} = \frac{1 - G(\bar{\beta})}{g(\bar{\beta})} \tag{21}$$

3.1.3 Neither Right

If anonymity and identification are not defined, the monopolist is in the enviable position of selling to *both* sides of the market. Suppose anonymity is the status quo–but not the right. In this case, the monopolist can charge people to retain anonymity privileges. People that refuse to pay to retain their anonymity will be subject to identification by people who pay for ID. People who retain anonymity will be able to make anonymous calls even to people with ID. Conversely, people that pay for ID will get to identify people that have *not* retained their anonymity, but not those that have purchased retained anonymity.

This lucky monopolist maximizes the *sum* of revenues from the two markets:

$$p_I[1 - F(\bar{\gamma})] + p_B[1 - G(\bar{\beta})] \tag{22}$$

Subject to:

$$\bar{\gamma}G(\bar{\beta}) \geq p_I \tag{23}$$

$$\bar{\beta}[1 - F(\bar{\gamma})] \geq p_B \tag{24}$$

The first order conditions for this problem imply:

$$\bar{\beta} - \bar{\gamma} = \frac{1-G}{g} = \frac{\bar{\beta}f - [1-F]G}{fG}. \tag{25}$$

The monopolist sets $\bar{\beta} > \bar{\gamma}$,as in the ID rights case.

3.2 Competition

Whether competition will lead to the efficient allocation of ID and blocking depends on the nature of competition. Unmediated competition, meaning there are many, independent firms–one set selling ID services directly and another set selling blocking–will be inefficient. With free entry into either business, the prices of ID and blocking will be driven to marginal costs–zero–and all everyone will end up "buying" ID ($\bar{\gamma} = 0$) and blocking ($\bar{\beta} = 0$). Universal anonymity is not as good as the Pareto allocation. The problem is that unmediated competitors do not internalize the externalities between ID and blocking.

Mediated competition of various sorts may internalize the externalities, or completute nature of the services we are studying. Competition in bundled-goods provisions–in which firms would deal with both sides of the market–would be an example. For example, competitive firms both sell Caller ID services and buy identification rights. Competitors face free entry but the caller ID side would pay the intermediary firm to identify its suppliers (the unblocked set of agents who sign up with that firm's "Do Call" list). So long as both purchasers of Caller ID and sellers of identification can"multihome," that is deal with multiple intermediary firms, competition can achieve the Pareto outcome. Competition among intermediaries will assure breakeven, which is the same as the feasibility constraint of the Pareto planner's problem.

Mediated competition can also occur through payments of an interchange (or access) fee among firms, each of which deal only with one side of the market. Suppose anonymity (blocking) is the initial property rights. Competitive firms sell caller ID services, and face free entry, and the case is the same for firms that serve the other side of the market. Those firms provide "tracking" services; the tracking firm purchases "names" of its registered customers.. A particular agent, indexed γ', has purchased caller ID services from competitive firm ID_j. Another agent, indexed β', has registered for tracking services from competitive firm B_k. Whenever γ'identifies an agent, say agent β', its service provider, ID_j, must pay the tracking service firm,B_k, a fee for the identification that occurs. The fee to be paid is $p_I = \bar{\gamma}G(\bar{\beta})$. The tracking firm pays registrants $p_B = \bar{\beta}\left[1 - F(\bar{\gamma})\right]$. Once again, the proportion of people buying ID services will be $[1 - F(\bar{\gamma})]$, and the proportion willing to register with the tracking firm will be $G(\bar{\beta})$. Competition in providing ID services and tracking services will drive profits to breakeven.

Mediated competition may be difficult to sustain. Single-good competitors can destabilize bundled-good competition. With interchange fees, the organization that sets the fee (similar in nature to the bank card associations in credit cards) may set the wrong fee. Interchange fee can help sustain tacit collusion, leading to monopoly outcomes. All these frictions can hamper efficient, mediated competition.

4 Solutions under Uniform Distributions

Solutions when γ and β are distributed uniformly over $[0, 1]$ are straightforward (see appendix). Consumer welfare is equal to the welfare as defined in the planners' solutions. We also calculate welfare as the sum of consumer welfare and monopoly profits, which we label social welfare. Solutions under alternative property rights and market structures are summarized below.

variables→ market/rights↓	$\underline{\bar{\gamma}}$	$\underline{\bar{\beta}}$	$\underline{p_I}$	$\underline{p_B}$	Consumer Welfare	Profits	Social Welfare
Planner:							
Utilitarian	1/3	2/3	na	na	4/27	na	4/27
Pareto	1/2	1/2	1/4	1/4	1/8	na	1/8
Monopoly:							
anonymity	2/3	1/3	2/9	1/9	1/27	1/27	2/27
ID	0	1/2	0	1/2	−1/8	1/4	1/8
neither	1/3	2/3	2/9	4/9	−4/27	8/27	4/27
Competition:							
mediated	same as Pareto planner						
unmediated	0	0	0	0	0	0	0

By social welfare the allocations rank as follows:

Utilitarian planner =Monopoly (Neither Right)> Pareto planner =Monopoly (ID rights)= Mediated Competition > Monopoly (Anonymity rights)> Unmediated Competition.

Ranked by consumer welfare, we have a significantly different line-up:

Utilitarian planner > Pareto planner =Competition (mediated) > Monopoly (Anonymity rights)> Unmediated Competition> Monopoly (ID Rights)> Monopoly (Neither right).

The poor showing by the monopolist in terms of consumer welfare is not surprising. Even when the monopolist achieves the same allocation of Caller ID and Blocking as the Utilitarian planner, which occurs when the monopolist sells to both sides of the market, significant profits are extracted from the consumers. A monopolist does internalize the externality implicit in with the completutes/substiments he is selling; however, unlike the planner, he does not maximize welfare, but profits.

5 Conclusion

A simple observation motivated this paper: when phone companies supply more caller ID, the demand for ID blocking increases. But selling more blocking reduces the demand for caller ID (at least the inferior levels of ID service). The two services are strategic complements in one way and substitutes the other way. "Completutes," or "substiments" are not uncommon. In general, the more popular the media or information channel, the more advertising it attracts. But the more advertising, the less attractive the media (at least to some viewers). The more e-mail addresses AOL and Yahoo register, the more billboards, banners, and pop up ads they sell. But the more distracting advertisement they sell, the lower the demand for AOL and Yahoo Internet addresses. The pricing of completutes/substiments is interesting, we think, but so is the bigger question of whether the external effects between markets gets properly internalized in a competitive market.

The simplest competitive paradigm, with many firms selling each service separately (ID and block) may not deliver the Pareto outcome. We now have firms that harvest internet addresses (via Internet raffles, for instance) and rent or sell the lists to advertisers. Do these companies consider the effect they have on the quality of Internet services? If not, the likely result is excess spam. No fees change hands among these parties (the ISPs, their customers, the spam senders, and those who sell spam-sending services to corporations) to compensate for the burden of spam E-mail.

Monopoly outcomes, in particular those in which the monopolist sells to both sides (which we've described as one in which consumers have rights to neither ID nor anonymity) may approximate the outcome of the Utilitarian planner (as in the uniform case), but at the expense of low consumer welfare. While monopolists internalize the externalities in these two-sided markets, they do so to maximize profits and not to maximize welfare.

In general, our results suggest that both market structure, and the property rights are important in assessing the outcome of these markets. In addition, welfare orderings will be changed substantially depending on whether the profits of the intermediaries in these markets are included in social welfare.

A government sponsored Do Not Call list is understandable, given the high rate of annoying calls many Americans receive. It may improve on the unregulated status quo, but it may not be first best. Ayres and Nalebuffs' (2003) suggestion–"Want to Call Me? Pay Me!," would likely lead to a more efficient allocation of ID and anonymity than the blanket injunction of a "Do Not Call List." Such a solution is more akin to Mediated Competition in our model, and could achieve the Pareto Planner's allocation.

The notion of "attention rights" deserves further attention. Phone providers now profit from both sides of the market. Rights in the case of caller ID are not defined at all; customer are not entitled to identification or to blocking. Verizon happens to give away blocking by request, but presumably only because zero is the profit maximizing price. At one time, postage on letters was paid by the recipient, not the sender. Recipients were willing to pay, presumably, because

they wanted to attend to the sender's message. No one is willing to pay for junk mail of course, so now postage gets paid by the sender. In a sense, we are asking whether the price of a stamp, or a phone call, or E-mail, is high enough to pay for our attention. Perhaps it covers the private cost of communication, but what of the social costs?

Our paper considers only interior solutions to these problems. Future research should examine the conditions under which interior solutions and corner solutions prevail. Furthermore, the rate of contact among agents is exogenous in the model. If there were costs and benefits to calling, and being called, the contact between people would be endogenous.

6 Appendix

6.1 Simplifying the social welfare function.

Social welfare is equal to (ignore the equation numbers that accompany the partial expressions here)

$$W(\bar{\gamma},\bar{\beta}) = \int_0^{\bar{\beta}}\int_0^{\bar{\gamma}} -\beta[1-F(\bar{\gamma})]f(\gamma)g(\beta)\delta\gamma\delta\beta + \tag{26}$$

$$\int_0^{\bar{\beta}}\int_{\bar{\gamma}}^1 [\gamma G(\bar{\beta}) - \beta[1-F(\bar{\gamma})]f(\gamma)g(\beta)\delta\gamma\delta\beta + \tag{27}$$

$$\int_{\bar{\beta}}^1\int_{\bar{\gamma}}^1 \gamma G(\bar{\beta})f(\gamma)g(\beta)\delta\gamma\delta\beta + \int_{\bar{\beta}}^1\int_0^{\bar{\gamma}} 0 f(\gamma)g(\beta)\delta\gamma\delta\beta. \tag{28}$$

This expression simplifies to

$$W(\bar{\gamma},\bar{\beta}) = \int_0^{\bar{\beta}} -\beta[1-F(\bar{\gamma})]g(\beta)\delta\beta F(\bar{\gamma}) + \tag{29}$$

$$\int_0^{\bar{\beta}}\int_{\bar{\gamma}}^1 [\gamma G(\bar{\beta}) - \beta[1-F(\bar{\gamma})]f(\gamma)g(\beta)\delta\gamma\delta\beta + \tag{30}$$

$$\int_{\bar{\gamma}}^1 \gamma G(\bar{\beta})f(\gamma)\delta\gamma[1-G(\beta)] \tag{31}$$

$$\int_0^{\bar{\beta}} -\beta[1-F(\bar{\gamma})]g(\beta)\delta\beta F(\bar{\gamma}) + \tag{32}$$

$$\int_{\bar{\gamma}}^1 \gamma G(\bar{\beta})f(\gamma)\delta\gamma G(\beta) - \int_0^{\bar{\beta}} \beta[1-F(\bar{\gamma})]g(\beta)\delta\beta[1-F(\bar{\gamma})] + \tag{33}$$

$$\int_{\bar{\gamma}}^1 \gamma G(\bar{\beta})f(\gamma)\delta\gamma[1-G(\beta)] \tag{34}$$

$$= \int_{\bar{\gamma}}^1 \gamma G(\bar{\beta})f(\gamma)\delta\gamma - \int_0^{\bar{\beta}} \beta[1-F(\bar{\gamma})]g(\beta)\delta\beta. \tag{35}$$

$W(\bar{\gamma},\bar{\beta}) = G(\bar{\beta})\int_{\bar{\gamma}}^1 \gamma f(\gamma)\delta\gamma - [1-F(\bar{\gamma})]\int_0^{\bar{\beta}} \beta g(\beta)\delta\beta.$

6.2 Solutions under uniform distribution

6.2.1 Utilitarian planner

The utilitarian social planner sets $\bar{\gamma}$ according to $\bar{\gamma}G(\bar{\beta}) = \int_0^{\bar{\beta}} \beta g(\beta)\delta\beta$, and $\bar{\beta}$ according to $\bar{\beta}[1-F(\bar{\gamma})] = \int_{\bar{\gamma}}^1 \gamma f(\gamma)\delta\gamma$. In the uniform distribution, recall that $G(\bar{\beta}) = \bar{\beta}$, $F(\bar{\gamma}) = \bar{\gamma}$. The first order conditions are equivalent to $\bar{\gamma} = \frac{\bar{\beta}}{2}$, and $\bar{\beta} = \frac{(1+\bar{\gamma})}{2}$. Together these imply that $\bar{\beta} = \frac{2}{3}$, $\bar{\gamma} = \frac{1}{3}$. Welfare is given by $G(\bar{\beta})\int_{\bar{\gamma}}^1 \gamma f(\gamma)\delta\gamma - [1-F(\bar{\gamma})]\int_0^{\bar{\beta}} \beta g(\beta)\delta\beta = (\frac{2}{3})[\frac{1-(\frac{1}{3})^2}{2}] - (\frac{2}{3})[\frac{(\frac{2}{3})^2}{2}] = \frac{4}{27} \cong .15$ (recall that there are no transfers in this case).

6.2.2 Pareto planner

The Pareto social planner sets $\bar{\gamma}$ according to

$\bar{\gamma} = \frac{g(\bar{\beta})\int_{\bar{\gamma}}^1 \gamma f(\gamma)\delta\gamma + f(\bar{\gamma})\int_0^{\bar{\beta}} \beta g(\beta)\delta\beta}{f(\bar{\gamma})G(\bar{\beta}) + g(\bar{\beta})[1-F(\bar{\gamma})]} = \frac{1-\bar{\gamma}^2+\bar{\gamma}^2}{2}$. This yields $\bar{\gamma} = \bar{\beta} = \frac{1}{2}$. In this case, the planner makes transfers, but net welfare can be evaluated by $V(\bar{\gamma}) = G(\bar{\gamma})\int_{\bar{\gamma}}^1 \gamma f(\gamma)\delta\gamma - [1-F(\bar{\gamma})]\int_0^{\bar{\gamma}} \beta g(\beta)\delta\beta = (\frac{1}{2})[\frac{1-(\frac{1}{2})^2}{2}] - (\frac{1}{2})[\frac{(\frac{1}{2})^2}{2}] = \frac{1}{8}$. Prices for the planner will be $p_I = p_B = (\frac{1}{2})(\frac{1}{2}) = \frac{1}{4}$.

6.2.3 Monopoly–anonymity rights

The monopoly in the privacy rights regime maximizes the expression $\Pi_P = [\bar{\gamma}-\bar{\beta}]\beta(1-\bar{\gamma})$. First-order conditions yield quadratic expressions. The interior

solution is $\bar{\beta} = \frac{1}{3}, \bar{\gamma} = \frac{2}{3}$. Prices are equal to $p_I = \frac{2}{9}$, and $p_P = \frac{1}{9}$. Monopoly profits equal $\frac{1}{27}$. Welfare is evaluated taking into account the transfers made by the monopolist, and so is evaluated by $G(\bar{\beta}) \int_{\bar{\gamma}}^{1} \gamma f(\gamma)\delta\gamma - [1-F(\bar{\gamma})] \int_{0}^{\bar{\beta}} \beta g(\beta)\delta\beta +$ $p_B G(\bar{\beta}) - p_I[1 - F(\bar{\gamma})] =$
$(\frac{1}{3})[\frac{1-(\frac{2}{3})^2}{2}] - (\frac{1}{3})[\frac{(\frac{1}{3})^2}{2}] - \frac{2}{27} + \frac{1}{27} = \frac{1}{27}$.

6.2.4 Monopoly-ID rights

In the identification rights case the monopolist maximizes profits equal to $p_B[1 - G(\bar{\beta})] - p_I F(\bar{\gamma}) = (\bar{\gamma} - \bar{\beta})F(\bar{\gamma})[1 - G(\bar{\beta})] = (\bar{\gamma} - \bar{\beta})(\bar{\gamma})[1 - \bar{\beta}]$. The first order conditions for this problem yield the result that $\bar{\gamma} = 0$, and $\bar{\beta} = \frac{1}{2}$. Prices are equal to $p_I = 0$, and $p_P = \frac{1}{2}$, and profits equal $\frac{1}{4}$. Consumer welfare in this case is equal to $\frac{1}{2} \int_0^1 \gamma\delta\gamma - [1 - 0] \int_0^{\frac{1}{2}} \beta\delta\beta + 0 - \frac{1}{2}[1 - \frac{1}{2}] = -\frac{1}{8}$.

6.2.5 Neither right

When the monopolist has both property rights, profits equal $p_I[1 - F(\bar{\gamma})] + p_B[1 - G(\bar{\beta})] = \bar{\gamma}G(\bar{\beta})[1 - F(\bar{\gamma})] + \beta[1 - F(\bar{\gamma})][1 - G(\bar{\beta})]$. In the uniform case, this expression reduces to $(\bar{\gamma})(\bar{\beta})(1-\bar{\gamma}) + (\bar{\beta})(1-\bar{\gamma})(1-\bar{\beta})$. Solving the first order conditions yields, $\bar{\gamma} = \frac{1}{3}$, and $\bar{\beta} = \frac{2}{3}$. Prices are $p_I = \frac{2}{9}$, and $p_B = \frac{4}{9}$ Profits are equal to $\frac{8}{27}$, which exceeds profits in the other property rights regimes. Welfare in this case is evaluated by $G(\bar{\beta}) \int_{\bar{\gamma}}^{1} \gamma f(\gamma)\delta\gamma - [1 - F(\bar{\gamma})] \int_{0}^{\bar{\beta}} \beta g(\beta)\delta\beta - p_I[1 - F(\bar{\gamma})] - p_B[1 - G(\bar{\beta})]$, and is equal to $-\frac{8}{27}$. This arrangement of property rights yields lower welfare than either public or private information.

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