Informative Narrowcasting with Consumer Search

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Abstract: Improved consumer addressability in electronic markets allows vendors to send focused promotional messages to specific customers, facilitating a targeted advertising approach that we call “narrowcasting”. We characterize a rational consumer's market participation decision and identify a narrowcasting firm’s optimal targeting decision when buyers face nontrivial search costs. In the special case where consumer reservation utility is relatively low and search cost is relatively high, consumers will neither search nor purchase blindly without search, and the market breaks down. Our main contribution here is to show that narrowcasting can help a seller revitalize this market by replacing learning by consumers with learning and targeting by the seller.

I. INTRODUCTION

The Internet helps e-commerce vendors collect and process large amounts of detailed customer information. Improved consumer addressability in electronic markets allows vendors to send focused promotional messages to specific customers, facilitating a targeted advertising approach that we call “narrowcasting”. Practitioners have long recognized the potential power of narrowcasting in selling highly specialized goods and services. Door to door selling and direct marketing are but two examples of conventional marketing techniques that selectively target consumers. Using information technology has added a layer of sophistication and ease to this approach. Marketers have been mining their customer data to identify useful patterns for market segmentation and direct targeting purposes. The contemporary information technologies, including the Internet, customer tracking technologies such as cookies and collaborative filtering, push technologies and email further enhance marketers' capability to identify and reach individual customers. For instance, advertisement comprises 85% of the revenue at Web content portal Yahoo.com, and at least 90% of the ads it sells are targeted in some way [5]. Email marketing using detailed preference mapping further enhances this. While narrowcasting is already being practiced, analytical research models on it have been lacking.

The primary objective of this paper is to show the value of narrowcasting technologies in marketing of goods and services that are highly specialized. In some such markets, the consumer search costs can be so high that the there is not market unless the seller takes the initiative to search out target customers. Oreck vacuum cleaners, Fuller cleaning brushes, and specialty insurance products are examples of such products. These products are typically not advertised broadly but selectively marketed to targeted groups. They are sold by door to door salesmen who selective target certain neighborhoods or by forming links with other brokers who service potential customers. Narrowcasting on the Internet represents an online version of selective targeting. Some sites are using it as part of email based advertising. For instance, travel sites such as Expedia and Travelocity send emails with come-on deals for travel to destinations that are chosen on the basis of user profiles. To exhibit the value of narrowcasting strategies, we examine a horizontally differentiated market with consumer search for a product that best fits their ideal. In a differentiated product market with imperfect information, consumers are ex ante anonymous to the firm and have no prior knowledge about the attribute of the brand it offers. There are two channels to bridge this informational gap: consumers invest in information-gathering activities (search) or the firm disseminates its product and/or price information (advertising). In other words, consumers' ignorance about the available offering can be ameliorated by either advertising or search. In fact, advertising can also influence potential buyers' preferences, but here we assume buyers' tastes are exogenously determined and only consider informative narrowcasting.

This article draws on the literature in markets with imperfect information (or search and informative advertising specifically). Imperfect information is an important source of monopolistic power. For example, in a homogeneous goods market with identical costs, Diamond [4] shows that the unique Nash equilibrium is the monopoly price. Consumers’ heterogeneity in their ability to search has been an explanatory factor for existence of price dispersion, where consumers differ
either in their fixed [11, 13] or marginal [1, 8, 12] costs of search. Researchers have also analyzed sequential search in markets of differentiated products. Wolinsky [14,15] study search in the circular-market model of Salop [10] and derive asymmetric price equilibrium among differentiated products. Bakos [2] shows that electronic markets have produced higher market efficiency and social welfare than conventional markets by reducing consumers' search costs. Here we examine consumer’s search decision in a Hotelling [7] model with a single product, assuming that consumers only know the existence but not the detailed attribute of this product.

The current literature on informative advertising assumes that the probability for a message to reach each consumer is equal, i.e., advertising is modeled as broadcasting. In this sense, our current study is a deviation from the extant literature. Grossman and Shapiro [6] study the informative role of broadcasting in a market of differentiated goods but ignore consumer search. Closest in spirit to this work are Butters [3] and Robert and Stahl [9], which examine firms’ broadcasting strategies when consumers search. However, consumers do not search optimally but instead follow a pre-specified simplifying search rule in Butters [3]. Furthermore, both studies are motivated in markets of homogeneous rather than differentiated goods. In contrast, our current paper captures firms’ learning ability in electronic channels and assumes that they can send messages to a selective group of consumers in a market of heterogeneous preferences.

In the special case detailed later where consumer reservation utility is relatively low and search cost is relatively high, consumers will neither search nor purchase blindly without search, and the market breaks down absent narrowcasting. A narrowcasting seller can only partially revitalize this market in that it only sells to the targeted favorable customers. Those not targeted would still stay outside the market. We characterize a rational consumer’s market participation decision and identify a narrowcasting firm’s optimal targeting decision when buyers face nontrivial search costs. The rest of the paper is organized as follows. Section 2 presents a model of narrowcasting and consumer search. Section 3 derives consumers’ optimal search decision in a monopoly with and without narrowcasting, respectively. Section 4 discusses our main contribution and limitations and points out future research directions.

II. THE MODEL

A. The Market and its Information Structure

Consider a linear market of unit length where consumers’ tastes are uniformly distributed over the interval [0,1]. A monopoly’s product positioning is exogenous and located at 0 without loss of generality. The monopoly faces a production technology with constant returns to scale. Normalize marginal cost to zero and ignore the fixed costs of production, if any. Each consumer has a unit demand subject to reservation utility or willingness-to-pay $r$. A brand located at distance $y$ away from the consumer generates a gross value of $r-ty$ for him, where $t$ is the fit cost and measures the rate of utility decay due to product mismatching.

Consumers know that the monopoly’s product is located at one end point of the product space, but do not know its location relative to their preferences. Consumers obtain product and price information through either viewing ads or search at a cost of $c$. We assume advertising is a perfect substitute for search, i.e., consumers can locate the same product at no effort once receiving the ads message from the seller. We also assume that the goods are highly specialized, i.e., only a small fraction of consumers are potential targets and hence broadcasting advertising is not considered feasible. Here we ignore the possibility of price discrimination in narrowcasting and assume that each seller charges a single price for its product. Consumers are risk-neutral and they enter the market if and only if the total (expected) transaction cost does not exceed their reservation utility $r$. Each seller is also risk neutral and attempts to maximize its expected profit in selecting its narrowcasting strategy.

B. The Narrowcasting Technology

The seller’s narrowcasting technology has two components: learning and targeting. First, in order to target the desired segment of consumers, the seller has to screen or learn about the preferences of the potential consumers. Learning is assumed to have decreasing returns and gleaning the tastes of a fraction $e$ of the total consumer population requires an expenditure of $be^2$, where $e$ is the called the seller’s learning intensity. Assume that $b$ is sufficiently large so that learning about all consumers is prohibitively expensive ($e < 1$). Alternatively, $e$ can be interpreted as the probability that an average consumer’s preference is collected, because learning is not a targeted activity. The decreasing-return assumption of learning is a realistic one. It becomes more difficult to gather the preference information of a larger proportion of the population, either because the seller’s information collection technology has limited capacity or because the diverse shopping patterns of consumers make their preference data not equally accessible to the seller.

Next, the seller can send messages to each selected individual at a constant cost of $d$. Here targeting is
assumed to demonstrate constant returns to scale, because the seller can inform each identified individual at largely the same cost via mail, email, telephone, or catalog.

C. The Timing of Events

The seller follows a Stackelberg strategy of narrowcasting and pricing vis-à-vis consumers. First, the seller decides on its investments in learning. After screening consumers’ preferences, it sends ads messages to its target audience. Notice that learning intensity, which segment of the market to target, and price are the seller’s decisions variables. Next, each consumer decides whether to purchase or to search, depending on whether he has received a message.

III. NARROWCASTING AND CONSUMER SEARCH IN A MONOPOLY

A. A Monopoly without Narrowcasting

Because narrowcasting and search are treated in a Stackelberg fashion, we start with analyzing consumers’ search decisions without narrowcasting. An average consumer has the following three options: (1) purchasing directly without search; (2) searching first and then deciding whether to purchase; (3) remaining idle (neither purchasing nor searching). When the consumer purchases without search, on average he is located at distance $\frac{1}{2}$ away from the product, and the expected gain from purchasing directly at price $p$ is

$$E_B = p - \frac{r - p}{2}. $$

When conducting search first, a consumer at distance $x$ away from the product will purchase if $p + tx \leq r$ since search cost is sunk. The probability for a consumer to purchase after search is thus $\frac{r - p}{t}$. The expected gain of search is

$$E_S = \frac{r - p}{t}(r - p - \frac{r - p}{2t}xt) - c = \frac{(r - p)^2}{2t} - c. $$

The expected gain of remaining idle is zero, of course. Figure 1 shows the decisions and corresponding payoffs of an average consumer.

Each consumer will choose the option yielding the maximum expected return. Absent narrowcasting, the monopoly’s profit function can be formulated as

$$\pi(p) = \begin{cases} 
0 & \text{when } \max\left\{\frac{(r - p)^2}{2t} - c, r - \frac{p - t}{2}\right\} < 0 \\
p & \text{otherwise} 
\end{cases}$$

Figure 1. A Consumer’s Decision Tree Absent Narrowcasting.

Notice the monopoly’s problem involves non-linear constraints. For ease of exposition, I shall focus on the case when $r < \frac{t}{2}$ in the ensuing analysis. Under this assumption, consumers will not purchase before search (even at zero price), and the monopoly’s problem reduces to:

$$\pi(p) = \begin{cases} 
0 & \text{when } p > r - \sqrt{2ct} \\
p & \text{otherwise} 
\end{cases}$$

This simplified problem can be easily solved. When consumer reservation utility is sufficiently high ($r > \sqrt{8ct}$), the monopoly can charge the optimal price under perfect information, $p^* = \frac{r}{2}$, and make a profit of $\frac{r^2}{4t}$. When $\sqrt{2ct} < r < \sqrt{8ct}$, the monopoly’s optimal price is $p^* = r - \sqrt{2ct}$ and its profit is $\frac{\sqrt{2ct}(r2ct)}{t}$. When $r < \sqrt{2ct}$, consumers never search and the market collapses. In other words, when search cost is sufficiently low ($c \leq \frac{r^2}{8t}$), the monopoly can charge the optimal price under perfect information without causing the market to break down (see Figure 4).
2A). When search cost is higher \( \frac{r^2}{8t} < c \leq \frac{r^2}{2t} \), the monopoly has to price lower to induce search (Figure 2B). When search cost is high enough \( c > \frac{r^2}{2t} \), the market simply breaks down.

![Figure 2A. Monopoly Profit when \( r < \frac{t}{2} \) and \( c \leq \frac{r^2}{8t} \).](image)

![Figure 2B. Monopoly Profit when \( r < \frac{t}{2} \) and \( c > \frac{r^2}{8t} \).](image)

**B. A Narrowcasting Monopoly**

Notice when \( 2r < t < 8c \), consumers neither purchase directly (the first inequality) nor search (second inequality), resulting in a market failure. In such a scenario, the monopoly can only resort to narrowcasting to reinvigorate the market. After learning, the monopoly will only target those who will purchase after seeing the narrowcasting message. We call consumers whose tastes lie within \( \frac{r-p}{t} \) away from the product the “favorable” consumers, which correspond to areas A1 and A2 in Figure 3. After learning, the monopoly will only target the favorable consumers whose preferences it has learned, i.e., the shaded region A2.

![Figure 3. Monopoly’s Targeting and Market Partition.](image)

When the monopoly adopts narrowcasting, \( \frac{\varepsilon(r-p)}{t} \) percent of consumers receive a message and the remaining consumers are not targeted. Each consumer follows the decision process illustrated in Figure 4. The targeted consumers will all purchase. A not targeted consumer has a probability \( q \) of being a favorable customer to the monopoly, where

\[
q = \frac{A1}{A1+B} = \frac{(1-\varepsilon)\frac{r-p}{t}}{1-\varepsilon\frac{r-p}{t}}.
\]

When not targeted, a consumer has an expected gain of buying directly (without search)

\[
E^{NC}_B = \frac{r-p}{2}q + (0 + \frac{r-p-t}{2})(1-q) = \frac{r-p-t}{2}(1-q)
\]

and his expected gain from search is

\[
E^{NC}_S = \frac{r-p}{2}q - c.
\]
Lemma 1. $E_B^{NC} < E_B$ and $E_S^{NC} < E_S$.

Proof: One can easily verify that
\begin{align*}
E_B^{NC} < E_B & \iff \frac{r-p}{2} - \frac{t}{2} (1-q) < r - p - \frac{t}{2} \iff q < \frac{r-p}{t} \\
E_S^{NC} < E_S & \iff \frac{r-p}{2} - q - c < \frac{(r-p)^2}{2t} - c \iff q < \frac{r-p}{t}.
\end{align*}

We complete this proof by pointing out that
\begin{align*}
q = \frac{Al}{Al + A2} < \frac{Al + A2}{Al + A2 + B} = \frac{r-p}{t}, \quad \text{Q.E.D.}
\end{align*}

Lemma 1 has intuitive interpretations. Absent narrowcasting, the ex ante probability for a consumer to be favorable to the monopoly is $\frac{r-p}{t}$. With narrowcasting, the probability for a not targeted consumer to be favorable has decreased, because the monopoly only targets the favorable customers whose preferences it has learned.

Proposition 1. When $2r < t < 8c$, narrowcasting prevents market failure in the monopoly, and its optimal price and learning intensity are $p^* = \frac{r+d}{2}$ and $\varepsilon^* = \frac{(r-d)^2}{8bt}$.

Proof: We have already seen that, under the same condition ($2r < t < 8c$), $E_B < 0$ and $E_S < 0$. According to Lemma 1, the not-targeted consumers would not enter the market. The monopoly’s problem is
\begin{align*}
\max_{p,\varepsilon} \varepsilon (p-d) \frac{r-p}{t} - be^2.
\end{align*}

This Proposition then follows from solving this simple optimization problem. Q.E.D.

When search cost is below $\frac{t^2}{8r}$, the monopoly can extract the same amount of rent as when consumers have perfect information, and the inefficiency of search does not affect its profit. When search cost is higher than this critical value, however, the monopoly’s profit will be affected by the inefficiency of imperfect information. When $2r < t < 8c$, the market can only be enabled by narrowcasting. When learning and targeting costs decrease, the monopoly will expand investment in learning and lower price, and the market coverage (as measured by $\varepsilon \frac{r-p}{t}$) will increase.

IV. CONCLUSIONS

The rapid adoption of information technologies such as database and Internet for marketing purposes has made narrowcasting a popular advertising practice with targeting flexibility and accuracy. Narrowcasting has the unique advantage of directing sellers’ messages to the most relevant audience and not distracting the other customers. In a simple spatial model, this paper has used game-theoretic methods to investigate the strategic interactions between consumers’ search and seller’s narrowcasting behavior.

We show that without narrowcasting, each consumer decides whether to search or purchase directly without search according to the expected returns of these actions. When the seller narrowcasts, the optimal targeting policy dictates that it only targets its favorable customers. Not receiving a message thus reveals extra information to the not-targeted consumers: on average they are less favorable to the seller than without narrowcasting. Compared with the case without narrowcasting, the not-targeted consumers have less incentive to participate in this market.

Our research on narrowcasting presented here is only an exploratory study and the results are preliminary. There are several important limitations to the current study. First, in contrast to broadcasting, a prominent feature of narrowcasting is its pricing flexibility, but here only uniform pricing is considered. Allowing price discrimination would be an important future extension. Second, we assume seller’s learning is perfect. As a result, all targeted consumers will purchase. In reality, sellers’ learning is imperfect and customers do not always respond to their targeting activities. Relaxing this rather stringent assumption would better conform to reality and potentially lead to
more interesting insights. Third, the current paper only studies a single seller and ignores the competitive role of narrowcasting. Clearly our modeling framework of narrowcasting in a differentiated product market can easily accommodate examination of competition among multiple sellers. We are actively pursuing these research directions.

V. REFERENCES