Competition and Advertising in Specialized Markets: A Study of the U.S. Pharmaceutical Industry

Job Market Paper

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Abstract

This paper analyzes advertising incentives and strategies in specialized markets, where consumers' decisions are dictated by experts. By analyzing the market stealing and market expanding aspects of advertising, this study shows that in a sub-game perfect equilibrium only some (and not all) firms may choose to advertise to consumers. From the welfare perspective, consumer advertising is socially optimal when advertising has only market expanding effects. Furthermore, a simple game-theoretic model shows that when only some firms advertise to consumers, the crucial determinant of advertising is the number of advertisers. In particular, with increased competition from rival advertisers, each firm's advertising decreases. Modeling specific features of the U.S. prescription drugs market the theoretical analysis suggests that the wide variation in direct-to-consumer-advertising (DTCA) by U.S. pharmaceutical companies both within and across drug classes is due to differences in disease-familiarity and heterogeneity in patients' types. Using annual, brand-level DTCA expenditure data for prescription drugs, empirical results give evidence of the negative impact of competition on advertising.

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1 Introduction

In most markets the consumers themselves make all their purchasing decisions. For some markets, however, the consumers are oblivious in the sense that they are not aware of their best consumption choices. Instead there are agents or *experts*, who decide on behalf of the consumers which product to purchase, how much to purchase and whether to make any purchase at all. Some examples of such *specialized* markets are the real-estate market, travel market, prescription drugs market and contractor market. While previous studies have investigated aspects of expert-advertising in specialized markets,[1] so far there are very few economic studies of direct-to-consumer-advertising (DTCA) in presence of market experts[2]. The aim of this paper is to analyze different consumer-advertising strategies that can benefit the manufacturers in the specialized markets.

The first goal of this paper is to explain, using theoretical models, why the strategy of consumer-advertising can be beneficial to manufacturers even when the consumers do not control their own purchasing decisions. That is, the goal is to see what incentives firms have to spend on advertising targeted to consumers when consumption choices are made by someone else. Next, the paper studies whether consumer-advertising strategy should be universally accepted or rejected by *all* firms in the market, or in equilibrium, only some firms will choose to engage in consumer advertising. From a welfare perspective the paper comments on whether there is "too much" or "too little" advertising in equilibrium. Furthermore, the research investigates how competition affects advertising in specialized markets. In doing so the study analyzes whether the effect of competition is captured by the total "number of competitors", or by the "number of competitors who advertise" when only some brands in the market engage in advertising. Finally, some of the theoretical findings are empirically tested using U.S. data.

The research on DTCA is now even more relevant because the recent upsurge in DTCA expenditure by the U.S. pharmaceutical industry has caught the attention of people from different fields of study. The theoretical models used in this paper are inspired by the features of the U.S. pharmaceutical industry. The U.S. is one of the only two countries that allow consumer advertising of

[1]For example, Bond and Lean (1977), Hurwitz and Caves (1988), Leffer (1981), Vernon (1981).

[2]Theoretical studies of DTCA are extremely scarce. Rubin and Schrag (1999) studies how consumer-advertising by a monopolist seller in the prescription drugs market can influence a HMO's incentives to choose a cheaper alternative. On the empirical ground, however, some recent papers (Berndt et al (1995), Rosenthal et al (2003), Iizuka and Jin (2005), Wosinska (2002)) study DTCA in the prescription drugs market with a clear emphasis on the demand-side analysis. Iizuka (2004) provides a supply-side study of DTCA.

prescription drugs. The rest of the world, with the exception of New Zealand, does not. A patient's inability to choose his own medication has made direct-to-consumer-advertising (DTCA) of prescription drugs a highly controversial means of promotion.

The research in this paper finds that the firms can have both market-expanding and business-stealing motives for advertising to consumers even when the consumers have to depend on the experts for their purchasing decisions. When consumer advertising has only market-expanding effects, some firms bear the burden of advertising while their competitors become *free-riders* on them.

The equilibrium analysis suggests that the observed variation in consumer advertising by the U.S. pharmaceutical companies both within and across therapeutic classes is due to differences in disease-familiarity and heterogeneity in patients' types. When patients do not try to influence their doctors' decisions, then for familiar diseases there should be no advertising at all. But if the disease is very unfamiliar, then some firms always engage in DTCA.

There is an ongoing debate regarding the effect of DTCA on social welfare. This paper shows that for market-expanding advertising, oligopolistic firms choose the socially optimum level of advertisements. However, when advertising has only market-stealing effects, there is "too much" advertising by firms which results in a social waste.

The theoretical analysis also implies that consumer-advertising by each firm is negatively affected by competition from other advertisers in the market. The theoretical models establish a direct relationship between advertising and the number of advertisers.

Finally, empirical investigation supports the negative association between advertising and competition from other advertisers. Using annual, brand-level direct-to-consumer-advertising (DTCA) expenditure data for brand-name prescription drugs belonging to 5 therapeutic classes over the period 1996-1999, empirical study offers support for the negative relationship between consumer advertising expenditure and competition from rival advertisers.

The following section provides a brief overview of DTCA of prescription drugs in the U.S. and summarizes the literature related to this paper. Section 3 describes the theoretical models of consumer advertising in a specialized market set-up. Section 4 presents details of the empirical framework for testing theoretical results and reports the empirical findings. Section 5 concludes.

2 Brief Overview of Advertising of Prescription Drugs

Direct-to-consumer-advertising (DTCA) of prescription drugs is a fairly new phenomenon in the U.S.. Until 20 years ago, physician advertisements in the forms of sampling, detailing and medical journal entries were the traditional ways of advertising prescription drugs. In recent years, however, drug companies have increased their advertisement budget to acquaint American consumers with diseases like depression, erectile dysfunction, acid reflux disease and toenail fungus etc. After the relaxation of advertising restriction on the broadcast media by the Food and Drug Administration (FDA) in August 1997, direct-to-consumer-advertising (DTCA) expenditure by the U.S. pharmaceutical companies has skyrocketed. DTCA spending has increased both in absolute terms and as a percentage of total promotional spending. The average annual growth rate in DTCA was 33 percent between 1996 and 2000, compared to a 14 percent growth rate for total promotional spending during the same period. In 2001, spending for DTCA ($2.7 billion) comprised 15 percent of total promotional spending, up from 8 percent ($800 million) in 1996[3]. Even though DTCA has grown disproportionately compared to other forms of drug promotions over the last decade, physicians still remain the primary focus of marketing efforts (85 percent of total promotional spending)[4].

The U.S. pharmaceutical companies have universally accepted the strategy of marketing prescription drugs to the physicians. However, they differ significantly in their practice when it comes to promoting prescription drugs directly to the consumers:

- Consumer advertising of prescription drugs is limited to very few therapeutic classes.
- Even within a class of drugs there exists significant variation in DTCA participation.

There are a few consumer-survey findings that are interesting as well. The most widely cited set of surveys are those conducted yearly by *Prevention* magazine. The 1997 survey finds that 29% of consumers asked for a particular prescription from their doctor after viewing an advertisement for that drug and 73% of those consumers got what they requested.

[3] A recent New York Times article (August 3, 2005: Drug Makers to Police Consumer Campaigns) reports that spending on DTCA in 2004 was 4 billion dollars

[4] *source:* Prescription Drugs Trends, a chartbook update by Kaiser Family Foundation, November 2001.

This provides some support for the view that even if patients cannot write their own prescriptions, they try to influence their doctor's decision. It should be noted, however, that there is no information available in these surveys on whether the doctor was going to prescribe that particular brand anyway or he did it due to the pressure from the patient.

2.1 Existing Literature

Early theoretical literature relating competition and advertising found that with increased competition advertising decreases. Grossman and Shapiro (1984) studied the case of differentiated product oligopoly and found that with increase in the number of close substitutes, consumers are likely to receive an advertisement from a product that provides a better match and this reduces a firm's incentive to advertise. On the other hand, there are papers which conclude that firms increase advertising when competition intensifies. Becker and Murphy (1993) give examples[5] and argue that firms may try to distinguish themselves from their close substitute products by using advertising and this will lead to an increase in advertising expenditure. In case of business-stealing advertising, Cabral (2000) argues that incentive to advertise may increase as the number of competitors increases. Since the literature generally does not distinguish between advertising participation decision and choice of advertising quantity, the number of competitors is often equivalent to the number of competitors who advertise. Theoretical paper by Haller and Chakrabarti (2002), one of the exceptions, finds that equilibrium levels of advertising decrease in the total number of firms.

Economic studies of advertising of prescription drugs to physicians by Bond and Lean (1977), Hurwitz and Caves (1988), Leffer (1981), and Vernon (1981) suggested that this marketing was more "persuasive" than "informative" in nature, although the distinction between the two was not unambiguous. There is literature on advertising that assumes that advertising changes consumer preferences (Kaldor 1950), or advertising that informs consumers about existence and price of a product (Butters 1977), or advertising that informs consumers about product characteristics and price (Stigler 1961). The closest theoretical study to this paper, a paper that studies DTCA, is by Rubin and Schrag (1999) who showed that a monopolist seller of prescription drugs could use DTCA to influence the HMO's preference for cheaper drugs for its patients. Of course,

[5]They mention that products in competitive markets are advertised to persuade consumers. For example, Perdue chicken is extensively advertised to convince consumers that a pound of Perdue chicken is worth significantly more than any other company's chicken.

the objective and setting of this paper is very different from Rubin and Schrag.[6]

Empirical papers have studied demand aspects of DTCA of prescription drugs using U.S. data. For example, Berndt et al (1995), Iizuka and Jin (2003), Wosinska (2002), Rosenthal et al (2003) to name a few. These papers find that DTCA increases market size for an entire class, but it has no significant impact on market share within a class. On the supply side Iizuka (2004) finds out that drugs that are new, for under treated diseases and are of high quality are more likely to be advertised to consumers. Iizuka (2004) also finds that with increased competition from other firms, consumer advertising decreases. In a very influential empirical study, Telser (1964) found little support for an inverse association between advertising and competition, despite some plausible theorizing to the contrary. In brief, there is no unanimity in the literature regarding how advertising is affected by increased competition.

3 Theoretical Models of Consumer Advertising in Specialized Markets

The main goal of the theoretical analysis is to model the features of a market where a consumer's purchasing decisions are made by an expert and study how the firms make their decisions regarding consumer advertising. The main features of the models are inspired by the U.S. prescription drugs market. Two separate theoretical questions are asked regarding consumer advertising. First, this section investigates how advertising is affected by competition from other firms. Second, the equilibrium number of advertising firms are chosen.

The Setup:

There are three different groups of agents in the model. *Firms* who sell brand-name prescription drugs, *potential patients (consumers)* who want to purchase those medications and *doctors* who write prescriptions for the patients. At the beginning of the game, each firm decides whether to advertise to consumers or not and depending on that decision they decide how much to advertise. The advertising firms then send out advertisements randomly to consumers and each consumer *may* receive advertisements from one or more firms.

[6] A companion paper of this paper, "Advertising in Specialized Markets: Example from the U.S. Pharmaceutical Industry", analyzes the existence of sub-game perfect Nash Equilibriums in a two-firm setting in light of the prescription drugs market and finds conditions for SPNEs.

The patients then see the doctors. The doctors make their prescribing decisions based on their conversation with the patients and their prior knowledge of each drug. Once a patient gets a prescription, he purchases the drug.

On the supply side, there are η oligopolistic firms selling brand-name drugs that belong to the same therapeutic class. A firm makes profit only if a patient is prescribed its brand by the doctor. All firms can advertise to consumers. Marginal cost of advertising to consumers is C (C¿0), assumed same for all firms. Marginal cost of production is normalized to zero.

Firms who advertise to consumers randomly send out fliers which contain information on what disease/symptoms the drug is used to treat and how effective the drug is for treatment.
To distinguish between a firm's participation decision and the firm's decision of how much to advertise the following simple assumption is introduced . If a firm chooses to advertise to consumers, it has to incur a small fixed cost, F which would not exist otherwise. It can be thought of as a regulatory requirement. For example, the FDA requires that if a company advertises to consumers, it has to put up a website on the internet that gives information on the drug's effectiveness and major side effects. The companies who do not engage in consumer advertising do not have to have a website. But any firm that does consumer advertising must comply to this regulation irrespective of *how much* advertising it does.

The amount of doctor advertising by a firm is exogenous and normalized to zero.[7]

There are N consumers in the market and N is assumed to be very large. Each consumer has unit demand. To focus on firms' advertising decisions, demand is assumed to be price-inelastic.[8] In the entire analysis it is implicitly assumed that there are no over-the-counter medicines available for treating the

[7] In a companion paper, it was shown that even when doctor advertising is persuasive, it does not have any trade off with consumer advertising. The same intuition will hold in this set up. In this paper the focus is on consumer advertising only.

[8] It is widely accepted that demand is price inelastic for brand name prescription drugs. These drugs are a necessity to a patient, there are not many substitutes available and the effective price that an insured consumer has to pay is small. Prescription coverage by insurance companies has been steadily increasing shifting the burden of drug expenditures away from consumers to private and government insurance programs.
Source: Prescription Drugs Trends, a chart book update by Kaiser Family Foundation, November 2001.
It is assumed that the demand is price inelastic between $[0, p]$ and for a price higher than p, demand drops to zero. It automatically follows from this assumption that each firm will charge the highest possible price p for which demand is positive. Firms do not compete over price, instead price is given by market convention. However, price guaranties excess profit margin.

same disease. This guaranties that once a consumer is aware of a disease, he has to visit the doctor. We also assume that there are no generic substitute drugs available for these brand-name drugs.

Even though a patient cannot write his own prescription, he can however, influence a doctor's decision for obtaining a particular brand of drug. There is an exogenously given probability ϕ that a consumer is "stubborn type". A stubborn person is easily impressed by an advertisement and insists to the doctor for prescribing that brand of drug[9]. If a doctor encounters a stubborn person, he prescribes what the stubborn person wants. In case, a stubborn person receives advertisement from more than one firm, then he is confused and relies entirely on the doctor's decision. A non-stubborn person always relies on the doctor's wisdom. No patient is ex-ante aware of the existence and effectiveness of any brand of drug.

The number of doctors is normalized to one and the doctor has full information regarding the existence and effectiveness of all the available brands in the market.[10] The probability with which a doctor prescribes a particular brand of medicine, in reality, depends on many factors like the doctor's belief regarding the effectiveness of that drug, whether a patient is actually diagnosed for the disease in concern[11], interaction of the drug with other medicines the patient might be taking etc. It is also quite possible that since doctors observe consumer advertising of drugs too, they may have special liking or disliking for drugs doing DTCA[12].

Once a consumer visits the doctor, the doctor either prescribes any of the available η brands or the doctor does not prescribe any medication if the diagnosis is negative for that disease. It is assumed that the doctor prescribes each brand of medicine that engages in DTCA with an equal and exogenously given probability, α. [13].

[9]Instead, it can be assumed that some consumers know more about pharmacy than others, so these consumers have more confidence to react to a particular advertisement positively.

[10]It is assumed that the doctor is honest and cannot be influenced by persuasive advertising from the drug-companies.

[11]Sometimes people visit the doctor even if they do not have any *real* problem, or sometimes they think they have one disease but the diagnosis reveals that the patient suffers from a completely different problem. In these cases the patient is not prescribed any of the η brands.

[12]2002 Physician survey by the Division of Drug Marketing, Advertising and Communications, FDA reports that 62% doctors felt that DTCA of a particular drug created some level of tension between him and the patient. Hence doctor's preference for a drug might be influenced by the DTCA behavior of that medicine.

[13]The doctor prescribes each of the non-DTCA drug with a probability α', where $\alpha' >=< \alpha$. It is sufficient to assume that the doctor does not have a significant negative preference for the non-DTCA drugs over the DTCA-drugs. Also, there is always some positive probability that the doctor

Let firm i randomly sends σ_i, ($i = 1, 2, ..., I$; where $I \leq \eta$) advertisements to consumers. Then with probability β_i a consumer receives at least one advertisement from firm i. Following Butters'(1977) advertising model, if firm i send σ_i fliers to consumers, then the probability that a consumer receives no advertisement from firm i is given by

$$(1 - 1/N)^{\sigma_i} \approx e^{-\sigma_i/N}$$

since N is assumed to be a very large number. So it follows that,

$$\beta_i = 1 - e^{-\sigma_i/N}; i = 1, 2, ...I; I \leq \eta$$

Each firm's advertising decisions are made in 2 stages. In *Stage I*, all the firms simultaneously decide whether to advertise to consumers or not. At the end of *Stage I*, the firms observe each-others' decisions. In *Stage II*, firms play a Cournot style simultaneous move game to choose DTCA quantity. The game is solved using backward induction.

The focus of the theoretical analysis will be to find out the relationship between DTCA and the number of advertising rivals in the second stage given the different strategy choices made by firms in Stage I. It will be possible to empirically test the theoretical hypothesis which relates competition and advertising. The study then finds out the equilibrium number of firms that advertise to consumers. The equilibrium concept in SPNE.

Under the assumptions made above, any firm i has two channels to earn profit:

1. The stubborn patients who received advertisement(s) from only firm i and not from any other firm make the doctor prescribe brand i and thus affect market share of firm i. This is the "market stealing" effect of DTCA.

2. All the non-stubborn patients who received advertisement (s) and those stubborn patients who received advertisements from more than one firm seek doctor's opinion. If the disease is diagnosed then doctor prescribes medicine i with probability α.

The above analysis explains that any consumer who received an advertisement visits the doctor. But what happens to those consumers who did not receive an advertisement? If the symptom/disease is such that the patients ex-ante do not realize that they should visit the doctor, then all those patients who did not receive any advertisement do not visit the doctor. In this case, if these potential patients received advertisements they could increase market size

does not prescribe any medication to a patient.

for all brands. However, if the disease is such that the consumers know that they should visit the doctor anyway, then DTCA loses its "market expansion effect". In that case, the only way a firm can benefit from DTCA is when a stubborn patient receives advertisement(s) from only a particular firm. So, the benefits of using DTCA depend on two factors: a market characteristic given by ϕ which is same for all classes of drugs, and an "awareness" factor which varies across classes of drugs. Later four different cases combining all possible extreme values of ϕ and "awareness" will be discussed.

For now, the focus is on two broad cases:

- *Case I:* Where *no consumer* visits the doctor unless he receives one advertisement. When $\phi = 0$, then this case represents only the "market expansion effect" of DTCA.
- *Case II:* Where *all consumers* would visit the doctor in spite of not receiving any advertisement from any firm. This scenario represents only the "market-stealing" effect of DTCA.

The next sub-section analyzes Stage II of the two-stage game (to be solved by backward induction) and proves the negative association between consumer advertising and the number of advertising rivals for both Case I and Case II. In the following sub-section, SPNE equilibrium analysis will determine equilibrium number of advertising firms.

3.1 Relationship Between Advertising and Advertising Rivals

Firms can gain from advertising in two ways. When non-stubborn patients previously unaware of treatment now visit the doctor because of receiving an advertisement, or when stubborn patients who received advertisements from more than a singe firm visit the doctor. In these cases, each firm in the market expects revenue depending on the doctor's prescribing probability. The second way of gaining from advertising is when a stubborn patient receives advertisement (s) from a single firm and visits the doctor insisting for this particular brand. This results in an increased market share for the advertising firm. The following analysis (Stage II of the game is analyzed first using backward induction) reveals how marginal benefit of advertising goes down as one more rival starts advertising.

3.1.1 *Case I:* Consumers do not visit the doctor unless they receive an advertisement

In this section it is assumed that the total market is made up of those stubborn and non-stubborn patients who received at least one advertisement from any advertising firm. That is, DTCA retains both informative and market-stealing qualities. Under this assumption, the expected profit of firm k, for any $k = 1, 2, ..I$ when I firms are advertising to consumers and $(\eta - I)$ firms are not can be written as,

$$E[\pi_k(\sigma_k)] = NP[\phi(1 - e^{-\sigma_k/N}) \prod_{i=1, i\neq k}^{I} e^{-\sigma_i/N} + \alpha[\phi\{(1 - \sum_{i=1}^{I}((1 - e^{-\sigma_i/N}) \prod_{j=1, j\neq i}^{I} e^{-\sigma_j/N}) - \prod_{i=1}^{I} e^{-\sigma_i/N}\} + (1 - \phi)(1 - \prod_{i=1}^{I} e^{-\sigma_i/N})]] - \sigma_k C - F$$

The first part of the profit function, $[\phi(1 - e^{-\sigma_k/N}) \prod_{i=1, i\neq k}^{I} e^{-\sigma_i/N}]$, represents all those stubborn patients who received advertisement (s) from only firm k and not from any other firm. Firm k sells to these people with certainty since the doctors is forced to prescribe drug k.

The next part of the profit function represents all those patients who depend on the doctor's wisdom only. $[\phi\{(1 - \sum_{i=1}^{I}((1 - e^{-\sigma_i/N}) \prod_{j=1, j\neq i}^{I} e^{-\sigma_j/N}) - \prod_{i=1}^{I} e^{-\sigma_i/N}\}]$ are the stubborn patients who received advertisements from more than one firm and $[(1 - \phi)(1 - \prod_{i=1}^{I} e^{-\sigma_i/N})]$ represents those non-stubborn patients who received at least one advertisement from any firm. Recall that in this case, consumers do not visit the doctor unless they receive an advertisement. Interestingly, the total number of firms in the market η, does not enter the profit function unless all the firms in the market advertise.

F.O.C. for profit maximization implies[14],

$$\{\phi(1 - \alpha) + \alpha\} \prod_{i=1}^{I} e^{-\sigma_i/N} + \phi\alpha \sum_{i=1, i\neq k}^{I} \{(1 - e^{-\sigma_i/N}) \prod_{j=1, j\neq j}^{I} e^{-\sigma_j/N}\} = \frac{C}{P}$$

To proceed further analytically, we keep our focus on a symmetric equilibrium only. For a symmetric equilibrium we can write,

$$\sigma_1 = \sigma_2 = ... = \sigma_k = ... = \sigma_I = \sigma$$

Hence, the F.O.C. now implies,

[14]S.O.C. satisfied as well

$$[e^{-\sigma/N}]^I\{\phi + \alpha - \phi\alpha I\} + \phi\alpha(I-1)[e^{-\sigma/N}]^{(I-1)} = \frac{C}{P} \quad (1)$$

Due to analytical complexity, it is not possible to solve for σ explicitly from equation (1). In 3.1.5, equation (1) will be discussed again to provide sufficient condition and numerical analysis for showing a negative association between σ and I. For now, a special case of (1) is discussed in the following subsection.

3.1.2 Special case when $\phi = 0$: Advertising has only market-size effect

Equation (1) now becomes,

$$[e^{-\sigma/N}]^I = \frac{C}{\alpha P}$$

After taking log on both sides and simplifying we get,

$$\frac{\sigma}{N} = \frac{1}{I}[\log P + \log\alpha - \log C]$$

Differentiating σ with respect to I in this equation we can conclude,

$$\frac{\partial\sigma}{\partial I} < 0$$

Proposition 1: *Suppose $\phi = 0$ and patients have no awareness ex-ante about visiting the doctor. Then for any $I \leq \eta$, $\frac{\partial\sigma}{\partial I} < 0$. That is, when advertising has only market-size effect, advertising by any individual firm decreases with increased competition from other advertisers.*

When advertising has only market expansion effect firms can free-ride on rivals' advertising and hence, marginal benefit of advertising goes down. As more rivals advertise, more patients (all non-stubborn) visit the doctor and depending on the doctor's prescribing decisions each firm earns revenue. Thus, even if one firm does not advertise itself, it can earn same profit without spending on advertising if more of its rival firms are advertising.

3.1.3 Welfare Analysis: Only Market-Size Effect

If a social planner chooses optimal advertising ($\bar{\sigma}$) to maximize social welfare, he maximizes the following social welfare function:

$$SW(\bar{\sigma}) = NP\alpha(1 - e^{-\bar{\sigma}/N}) - \bar{\sigma}C - F$$

Solving the F.O.C. for welfare maximization the socially optimum amount of advertising is obtained as,

$$\bar{\sigma} = N[\log P + \log \alpha - \log C]$$

In Section 2.1.2 profit maximizing level of advertising by each individual firm was obtained as,

$$\frac{\sigma}{N} = \frac{1}{I}[\log P + \log \alpha - \log C]$$

Thus, *total* market advertising by I symmetric profit-maximizing firms can be written as $\hat{\sigma}$,

$$\hat{\sigma} = [\log P + \log \alpha - \log C]$$

Thus it is shown that $\hat{\sigma} = \bar{\sigma}$. That is, profit maximization by individual firms lead to the socially optimum level of advertisements in the market when advertising has only market-size effect.

3.1.4 *Case II:* Consumers visit doctor irrespective of receiving any advertisement

In this section it is assumed that the total market-size (the number of potential patients who visit the doctor) is constant and equals N consumers. That is, N patients always visit the doctor even if they did not receive any advertisement. Under this assumption DTCA has only the "market stealing effect". A firm benefits from DTCA only when a stubborn-consumer receives advertisements from only this firm and from no other firm. Expected profit of firm k, for any $k = 1, 2, ..., I$ when I firms are advertising to consumers is given by,

$$E[\pi_k(\sigma_k)] = NP[\phi(1 - e^{-\sigma_k/N}) \prod_{i=1, i \neq k}^{I} e^{-\sigma_i/N} + \alpha[\phi(1 - \sum_{i=1}^{I}((1 - e^{-\sigma_i/N}) \prod_{j=1, j \neq i}^{I} e^{-\sigma_j/N}) + (1 - \phi)]] - \sigma_k C - F$$

$[\phi(1-e^{-\sigma_k/N})\prod_{i=1,i\neq k}^{I}e^{-\sigma_i/N}]$ represents all those stubborn patients who received at least one advertisement from firm k and no other advertisement from any other firm. $[\phi(1-\sum_{i=1}^{I}((1-e^{-\sigma_i/N})\prod_{j=1,j\neq i}^{I}e^{-\sigma_j/N})]$ are those stubborn patients who received advertisements from more than one firm and those who received no advertisement from any firm. Finally, $(1-\phi)$ are all the non-stubborn patients who visit the doctor irrespective of receiving any advertisement.

F.O.C. for profit maximization implies[15],

$$\{\phi(1-\alpha)\}\prod_{i=1}^{I}e^{-\sigma_i/N}+\phi\alpha\sum_{i=1,i\neq k}^{I}\{(1-e^{-\sigma_i/N})\prod_{j=1,j\neq i}^{I}e^{-\sigma_j/N}\}=\frac{C}{P}$$

To proceed further analytically, we keep our focus on a symmetric equilibrium only. For a symmetric equilibrium we can write,

$$\sigma_1=\sigma_2=.....=\sigma_k=....=\sigma_I=\sigma$$

Hence, the F.O.C. now implies,

$$[e^{-\sigma/N}]^I(1-\alpha I)+\alpha(I-1)[e^{-\sigma/N}]^{(I-1)}=\frac{C}{P\phi} \quad (2)$$

When advertising has only market stealing effect, marginal benefit of advertising for a firm decreases as more rivals advertise for two reasons:

- It becomes more difficult that a stubborn patient receives advertisement from only this firm and from no other firm.
- A stubborn patient who previously received advertisement from only one rival firm can now be "neutralized" to see the doctor if he receives advertisement from another advertising rival even if this firm does not advertise itself.

3.1.5 Relation Between σ and I: General Case

Implicit function theorem is used to determine the relationship between I and σ from (1) and (2). That gives us *Proposition 2.* (see Appendix 1 for proof)

Proposition 2: *For* $\frac{\partial\sigma}{\partial I}<0$*, a sufficient condition is* $\frac{\sigma(I-1)}{N}>1-e^{-\sigma/N}$*. This says that the probability that a consumer receives* an *advertisement from*

[15]S.O.C. for profit maximization also satisfied

any competing firm is greater than the probability that a consumer receives at least one *advertisement from a particular firm.*

Since our interest is in the directional relationship between I and σ, we also solve for σ in (1) and (2) using different values of I. Numerical analysis of (1) and (2) implies that for given values of α, P, N and C, as I increases, the amount of advertisement (σ) goes down. See Appendix 2 for details.

The above analysis shows that under both market expansion effect and market stealing effect, consumer advertising by each firm goes down as more rival firms advertise. Also, under the assumptions of the model, the total number of firms in the industry (η) does not affect the profit levels of firms and their advertising choices unless *all* the firms choose to advertise. Later in this paper, the prediction regarding the negative association between advertising and the number of advertising rivals will be empirically tested using U.S. data.

3.1.6 Welfare Analysis: Only Market-Stealing Effect

When advertising has only market-stealing effect, all patients visit the doctor irrespective of receiving any advertisement. Thus, socially optimum level of advertisement($\bar{\sigma}$) in that case is zero. However, from equation (2) it can be said with certainty that profit maximizing level of advertisement is greater than zero.
Thus, "too much" advertising leads to social waste when advertising has only market-stealing effect.

Proposition 3: *When advertising has only market-expanding effect, profit maximizing firms choose the socially optimum level of advertising. However, in the case of market-stealing advertisements, "too much" advertising causes a decrease in social welfare.*

3.2 Sub-game Perfect Nash Equilibrium

The next theoretical question is, what should be the equilibrium number of advertising firms ? It has been already shown that there is a negative relationship between advertising and the number of advertisers. But, why a striking variation is observed in DTCA both within and across therapeutic classes ? In the U.S. most classes of drugs do not have any DTCA at all. Even in classes where consumer advertising is observed, only some firms engage in advertising. This section will try to provide explanations for such observed facts.

3.2.1 *Case I:* Consumers do not visit the doctor unless they receive an advertisement

Due to analytical complexity, it not possible to solve for equilibrium in the general set up. To get some intuition first we keep our focus on "market expanding" DTCA. That is, the case when, $\phi = 0$.

- **Sub-game Perfect Nash Equilibrium when $\phi = 0$**

  The goal is to find out under what conditions a non-symmetric DTCA participation[16] (where I firms advertise and $(\eta - I)$ firms do not) is a SPNE of this symmetric, two-stage game.

  Without loss of generality it can be assumed that when we say I firms advertise, we refer to the first I-firms. That is firm 1, firm 2, ...,firm I advertise and firm (I+1), firm (I+2),....,firm η do not.

  When I firms are advertising, profit of each of those advertising firms(including the I^{th} firm) in a symmetric equilibrium is,

$$\pi_{(I)}^{adv} = N[P\alpha - C\{1 + \frac{1}{I}[\log P + \log \alpha - \log C]\}] - F. \tag{3}$$

  Similarly, when I firms are advertising, profit of each $(\eta - I)$ firms who are not advertising is,

$$\pi_{(I)}^{not-adv} = N[P\alpha' - C] \tag{4}$$

  For this participation-choice to be SPNE we need to ensure that the $(I+1)^{th}$ firm has no incentive to start advertising and that the I^{th} firm has no incentive to stop-advertising.

  If the $(I+1)^{th}$ firm now starts advertising, then profit of the $(I+1)^{th}$ firm and other advertising firms will be,

$$\pi_{(I+1)}^{adv} = N[P\alpha - C\{1 + \frac{1}{I+1}[\log P + \log \alpha - \log C]\}] - F. \tag{5}$$

  Comparing (4) and (5) it can be concluded that the $(I+1)^{th}$ firm does not have any incentive to advertise as long as α' is not substantially smaller than α. It is reasonable to assume that doctors do not have extremely negative preference for non-DTCA drugs compared to those for DTCA-drugs[17]. Therefore, the $(I+1)^{th}$ firm will continue to "not-advertise".

[16] Since we only observe non-symmetric DTCA participation and symmetric-non-advertising DTCA in reality, we keep our main focus on these two kinds of SPNEs. The data which will be used later consists of classes where only non-symmetric DTCA participation is observed.

[17] In fact, the physician surveys conducted by FDA reveals that more doctors have dis-satisfaction with DTCA. Even if the doctor has different preference for each of the non-DTCA drugs, as long as those preferences are not substantially smaller than α, the argument still holds.

Now, profit of the I^{th} firm when it does not advertise but only $(I-1)$ firms advertise is given by,

$$\pi^{not-adv}_{(I-1)} = N[P\alpha' - C] \tag{6}$$

The I^{th} firm will continue to advertise only if its profit when only (I-1) firms are advertising is less than its profit when I-firms are advertising. That is,

$$\pi^{not-adv}_{(I-1)} < \pi^{adv}_{(I)}$$

Recall that in this set-up, each firm earns zero profit if no one advertises. Hence, $\pi^{not-adv}_{(I-1)} = 0$ if the $(I-1)$ firms are indifferent between advertising and not-advertising. This is true if,

$$N[P\alpha - C\{1 + \frac{1}{I-1}[\log P + \log\alpha - \log C\}] - F \leq 0. \tag{7}$$

This implies that $\pi^{not-adv}_{(I-1)} = 0$. Given this is true, the I^{th} firm will continue to advertise if

$$N[P\alpha - C\{1 + \frac{1}{I}[\log P + \log\alpha - \log C\}] - F > 0 \tag{8}$$

Thus, (7) and (8) give the necessary conditions for this non-symmetric strategy choice (I-firms advertise and $(\eta - I)$ firms do not) to be SPNE of this two-stage game. This is also a unique pure-strategy SPNE. Each firm internalizes the positive externality resulting from its rival's advertising.

Proposition 4: *When $\phi = 0$, under the symmetry assumption there exists a unique, pure-strategy SPNE where I firms advertise to consumers and $(\eta - I)$ firms do not if the two necessary conditions given by (7) and (8) are satisfied.*

Next, the focus can be shifted to (3) and (4) to compare the profits earned by the advertising firms to the profit earned by the non-advertising firms in this unique SPNE. If we reasonably assume that $\alpha' \not\ll \alpha$, then the non-advertising firms earn more profit and become "free-riders" on the advertising firms. Therefore:

Proposition 5: *The SPNE profit levels for the advertising and non-advertising firms given by (3) and (4) guaranty that $\pi^{not-adv}_{(I)} > \pi^{adv}_{(I)}$. Thus the non-advertising firms become free-riders on the advertising firms.*

- **Sub-game perfect Nash Equilibrium when $\phi = 1$**

  Next, the case is considered where DTCA has both market size effect and market stealing effect. Analytically, conditions for SPNE cannot be derived in this case. However, it can be said with certainty that when consumers are "unaware" and all patients are stubborn-type, *there cannot be a SPNE where no firm advertises, or only one firm advertises.* This is because if no firm advertises, then profits of all firms are zero (since there is no market). If only firm 1 advertises, then this firm owns the entire market since all consumers are stubborn. Once firm 2 starts advertising then some confused stubborn patients are created who rely on the doctor's decision and other patients are either prescribed medicine 1 or medicine 2 because they received advertisement(s) from only one single firm. As more firms advertise, more confused stubborn patients are created who depend on the doctor and can be prescribed any of the η medicines. However, nothing can be said with certainty regarding the possibilities of SPNEs where either all firms advertise, or not all but more than one firms advertise.

3.2.2 *Case II:* Consumers visit doctor irrespective of receiving any advertisement

In this case, advertising does not have any market size effect, but it is used only to steal market share from other firms.

- **Sub-game Perfect Nash Equilibrium when $\phi = 0$**

  When DTCA has no market-expansion effect, the only benefit of doing DTCA can come from market-stealing effect. But when $\phi = 0$, that is there are no stubborn patients, DTCA cannot have any market-stealing effect. Hence, the only possible unique SPNE is that no firm engages in DTCA.

  Proposition 6: *When $\phi = 0$ and patients have full "awareness" regarding visiting the doctor, the unique SPNE is $\sigma_i = 0$, $\forall i = 1, 2, .., \eta$.*

- **Sub-game Perfect Nash equilibrium when $\phi = 1$**

  It can be said with certainty that it is *not possible to have a SPNE where no firm advertises to consumers* because if firm 1 starts advertising it can definitely steal market share. However, it cannot be predicted with certainty, how many firms will advertise in SPNE.

3.3 Summary of Theoretical Findings

Theoretical analysis shown above proves that when $\phi = 1$, it is not possible to have a SPNE where no firm advertises to consumers irrespective of the level of "awareness". However, in the U.S. we observe most therapeutic classes with no DTCA. Therefore, if the theory is true then value of ϕ should not be very high in this country. In fact, the value of ϕ must be rather low since it has been already shown that when $\phi = 0$, it is possible to have both a non-symmetric DTCA SPNE (for the "unaware" diseases) and a symmetric non-advertising SPNE ("aware" diseases) as observed in this country.

A simple welfare analysis shows that consumer advertising has no negative impact on social welfare when advertising is done for unfamiliar diseases. However, when consumers already know about a disease or treatment possibility DTCA can be a social waste.

Furthermore, it was also shown that the amount of DTCA is affected by competition from other advertising rivals. In a non-symmetric DTCA participation where $I < \eta$, equilibrium quantity of DTCA is not affected by total number of competitors in the market. Section 2 obtained a negative relationship between amount of DTCA chosen by a firm and the number of advertising rivals. This negative association also holds in separate cases where DTCA has either market-expanding effects or market-stealing effects. The following section is going to test this theoretical prediction using U.S. data.

4 Empirical Evidence

The empirical goal is to test the following hypothesis:

Hypothesis: *Brand-name prescription drugs spend less on own-brand DTCA as the number of competing brands doing DTCA increases.*

4.1 Model Specifications

Direct-to-consumer-advertising is modeled as a censored regression model (Tobit) to explain DTCA expenditures as a function of advertising rivals:

$$y_{it}^* = x_{it}\beta + u_{it} \tag{9}$$

$$y_{it} = max\{0, y_{it}^*\} \tag{10}$$

where y_{it}^* is a latent variable and not observed. Instead, y_{it} is observed, which is the DTCA expenditure of product i at time t.

The term x_{it} represents the key explanatory variable, number of advertising rivals, and a set of control variables. These include the age of the drug, a dummy variable indicating whether a generic enters the market in next 5 years and another dummy variable indicating whether the drug is marketed by a leading pharmaceutical manufacturer.

The variable *Generic* is included because the literature suggests that near patent expiry date brands change their advertising behavior. Accurate data for patent expiry is hard to get, so entry of a generic drug in near future should capture the effect of proximity to patent expiry date[18]. The dummy variable *Manufacturer* is included because it is suggested that the pharmaceutical *giants* spend much more on DTCA than the rest. Finally, the *Age* variable is included because previous empirical works suggest that newer drugs are advertised more even though theoretical predictions relating advertising and age is not unambiguous.

The term u_{it} is the error component and is expected to contain unobservables like price, marginal cost of advertising and production, percentage of stubborn people in the population, doctor's preference for the drug, number of patients etc.

The theoretical analysis establishes that advertising (σ) and number of advertisers (I) are both determined within the model and they are negatively related. Hence, all the parameters of the theoretical models are expected to affect both advertising choice and the number of advertisers. Some examples of such parameters are the price of the drugs, marginal costs of advertising and production, doctor's probability of prescribing each drug, market size for a disease, percentage of "stubborn patients" in the population etc. Thus it can be concluded that the key explanatory variable, "number of advertising rivals" is endogenous. Since the goal is to establish a causal relationship between advertising and the number of competing advertisers, instrumental variable (IV) is used to deal with this endogeneity.

Two instrumental variables are used. First one is a variable "Top Manufacturer" which stands for the number of competitors marketed by one of the leading 5 pharmaceutical manufacturers. The more is the number of competing brands that are manufactured by a leading corporation, the more of them are

[18]In our data set no brand-name drug has a generic available in the market between 1996 and 1999. Hence we need not worry about any possible endogeneity regarding generic entry. The variable *Generic* only captures whether the drug is close to its patent expiry date.

likely to engage in DTCA. Hence, the number of competing brands introduced by the top pharmaceuticals is likely to be correlated with the number of competing advertisers, but unlikely to be correlated with any of the unobservables.

The second IV that is used for the endogenous regressor is called "Time" and represents "the time since entry of the first drug in a therapeutic class". It is predetermined when a breakthrough drug is invented. But once a breakthrough drug is invented, a market is created for such therapeutic class of drugs. For example, when Prozac was introduced it was the first antidepressant of its kind. With passage of time other manufactures learned the know-how and more of "me too" drugs, or brand-name drugs that compete with Prozac in the same therapeutic category were introduced.
Hence, the more time passes after the introduction of one breakthrough drug, more competing brands enter the same market and more of them can engage in consumer advertising. Therefore, our instrumental variable "time since entry of the first drug in a class" can be assumed to be correlated with "number of advertising rivals". Also, it is reasonable to assume that the instrument is uncorrelated with any unobservable (error) that affects "how much a firm advertises today".

Recent literature has widely discussed the problems caused by weak instruments. Hence the relevance of the two instruments are examined. The first stage F-statistic of the IVs is 39.72, which is much higher than 10, the minimum acceptable F-statistics proposed by Staiger and Stock (1997). The R^2 in the first stage regression is 0.47 for a total of 101 observations. Therefore, it is concluded that the instruments are not weak. The IVs also pass the J-test for overidentifying restrictions (J-stat is 2.05).

The final empirical model is thus a Tobit model with IV which uses *DTCA* as the dependent variable, *Advertising Rivals* as the endogenous explanatory variable, *Time* and *Top Manufacturer* as the excluded instruments, and *Age*, *Generic* and *Manufacturer* as the exogenous explanatory variables.

4.2 Description of the Data

The hypothesis is tested using a micro data set compiled from several sources described below. The data set contains a total of 116 drug-year observations for 29 brand-name drugs over the period 1996-1999. These drugs belong to one of the following five therapeutic classes: Rx-Statins, SSRI/SNRI, Proton Pump Inhibitors, Antihistamines and HIV-Reverse Transcriptive Inhibitors[19]. *Drug Facts and Comparisons*, a standard medical reference, was consulted to

[19] Since the goal is to find the effect on DTCA of the number of advertising competitors, those classes of drugs were chosen where at least some brands with positive DTCA amount are observed.

find out different therapeutic classes and drugs that belong to each of those classes. The manufacturer's name and information on existence of any generic substitute for each brand was also obtained from the same source.

DTCA expenditure for each brand-name drug was obtained from TNS Media Intelligence/Competitive Media Reporting (CMR). CMR monitors advertising units and expenditures for several different media, including cable TV, network TV, newspapers and magazines for all brand-name products. All advertisements for prescription drugs that appeared in these media are included in CMR database handbook AD$Summary[20].

FDA's Orange Book was consulted to find out approval date for each brand. Age of drug was calculated as the year since FDA approval. FDA's drug information was used to find out information on generic-entry of each drug and year of generic entry was obtained where applicable.

Ranking of pharmaceutical manufacturers by U.S. sales was obtained from IMS Health[21]. All the variables used in this paper and their sources are listed in Table 1.

Table 1: Description of Variables and Sources

Variable	Description	Source
DTCA	Annual total DTCA dollars($1000)	CMR
Age	Years since FDA approval	FDA *Orange Book*
Generic	Dummy =1 if generic entered the market within 5 years; 0 otherwise	FDA, Drug Facts and Comparisons
Advertising-Rivals	Number of rivals engaged in DTCA	CMR, Drug Facts and Comparisons
Manufacturer	Dummy =1 if brand is marketed by leading 5 manufacturers; 0 otherwise	FDA, IMS Health
Time	Time since approval of the first drug in a class	FDA

Table 2 shows the leading 10 pharmaceutical corporations by U.S. sales in 2000. The ranking was almost identical during the previous years. Table 3 presents the summary statistics. Notice that the annual DTCA expenditure varies from 0 to more than 77 million dollars. There are 58 observations in the

[20]CMR reports ad-expenditures only if total annual expenditure is $25,000 or more. However, it is reasonable to assume that no brand-name prescription drug spends on DTCA a positive amount, but less than this annual cut-off value.

[21]See Table 2 for details. *Source:* IMS Health, Retail and Provider Perspective^{TM},2001

data set with a zero value for DTCA. The appendix provides tables 5 and 6 that report all the additional details regarding the data.

Table 2: Leading 10 Corporations by U.S. Sales, 2000

Corporations	U.S. Sales $ (U.S. $Billions)
Pfizer/W-L	15,341.1
GW/SK	12,980.5
Merck	10,790.2
Bristol-Myers Squibb	8,999.4
AstraZeneca Corp	8,552.2
Johnson & Johnson	7,896.7
Pharmacia Corp	6,276.8
Lilly	6,133.2
American Home Prod	6,023.1
Schering Plough	5,773.4

Source: IMS Health, Retail and Provider Perspective^{TM},2001

Table 3: Summary Statistic

Variable	Obs	Mean	Std. Dev.	Min.	Max.
DTCA*	105	9946.3	19980.5	0	77303.6
Advertising-Rivals	124	2.2	1.3	0	5
Time	124	9.2	2.9	1	12
Age	105	4.3	3.3	0	12

*in ($1000)

4.3 Regression Results

Results from the instrumental variable Tobit regression are reported in Table 4.

The results are in line with the prediction of the theoretical model. In the first regression (1), the co-efficient for the number of advertising rivals is negative and significant providing support for the hypothesis that brand-name prescription drugs tend to spend less on own-brand DTCA as the number of competing brands doing DTCA increases. The coefficients for *Age* variable and

Table 4: Instrumental Variable Tobit Regression

Dependent Variable: DTCA		
Explanatory Variables	(1)	(2)
Advertising Rivals	-13,412**	...
	(4,543)	
Rivals	...	-6,788**
		(2,525)
Generic	969	4,166
	(14,731)	(15,260)
Manufacturer	19,926**	22,935**
	(7,538)	(8,209)
Age	-12	-157
	(1,499)	(1,577)
constant	13,630	17,333
	(11,295)	(13,401)
Observations	105	105
Instrumented:	Advertising Rivals	Rivals
Excluded Instruments: Time, Top Manufacturer		
Included Instruments: Generic, Manufacturer, Age		

Standard errors in parentheses; ** significant at 1 %

Generic variable are both insignificant. However, the result suggests that the drugs marketed by one of the top 5 pharmaceutical companies are likely to be advertised more to consumers.

Iizuka (2004) showed that the number of brand name drugs in each therapeutic class has a negative and significant effect on advertising. That is, on average, firms reduce DTCA as the number of brand-name competitors increases within each therapeutic class. Hence, he concluded that advertising decreases with competition.

The goal of this paper was to test the effect of competition on advertising as well. However, the crucial difference is that here competition is defined as the number of competitors in a therapeutic class who advertise themselves. In other words, the theory suggests that advertising should decrease in the number of advertisers irrespective of the total number of competitors in the market.

To compare the results of this paper with those from Iizuka (2004) the second regression (2) uses the total number of rivals as the endogenous explanatory variable instead of only those rivals who advertise. Regression (2) uses only "Time" as the instrumental variable. The coefficient on the number of advertising rivals is more than two times larger than the coefficient on the number of rivals. Thus, if *competition* is defined by total number of competitors in the market then the effect of competition is much small on DTCA than the effect of competition captured by those rivals who advertise themselves.

5 Conclusion

The main goal of this paper was to analyze different aspects of consumer-advertising in specialized markets. Even though consumer-advertising of prescription drugs is considered to be a highly controversial marketing strategy, it is shown here that it can be perfectly rational for the firms to engage in DTCA even when their competitors equally benefit from their advertising efforts.

In light of the features most closely associated with the prescription drugs market, the theoretical analysis establishes a strong and negative association of the number of rivals who advertise on a firm's advertising decisions. In fact, under the assumptions of the theoretical model it was shown that the total number of firms has no direct effect on the advertising choices when advertising participation is non-symmetric. The negative association between the number of advertising rivals and the amount of advertising was established in separate cases of "market expanding" and "market stealing" advertisements.

The theoretical analysis also provides new economic insights regarding why only some firms in a market may choose to advertise to consumers while others become free-riders on them. Explanation has been offered for the observed advertising behavior by the U.S. pharmaceutical industry. The theory suggests that the drugs treating diseases which are very familiar to the consumers do not advertise to consumers at all. However, for drugs that treat very unfamiliar diseases, a non-symmetric advertising participation can be observed.

A simple welfare analysis shows that in case of market-expanding DTCA, firms choose the socially optimum level of advertising. But in case of market-stealing advertising, DTCA results in a social waste.

Even though this paper closely follows the features of the prescription drugs market, the basic structure is same for any specialized markets like the travel, real-estate and contractor. The manufacturers in all specialized markets need to decide why and how much should they advertise to consumers even when the *experts* are fully informed about their products. The introduction of "stubborn patients" in the model makes it more applicable to other specialized markets because consumers have more power to influence the experts' decisions in markets like travel, real-estate etc. Thus the theoretical implications should hold very closely for the other forms of expert markets.

The empirical results are in line with the theoretical predictions and confirms a negative relationship between advertising expenditure and the number of advertising rivals. It is also shown that if the total number of competitors is used to explain the effect of competition on DTCA, then the effect of competition is much smaller than what it would be if competition was defined as the number of advertising rivals.

No study has previously investigated if the number of advertising-competitors affect advertising decisions independent of the total number of rivals in the market. That is why, number of rivals has always been the measure of competition in previous studies. However, this paper argues that in specialized markets a significant determinant of consumer advertising is the number of competing advertisers. While making advertising choices, firms should take into account how many of their rivals are advertising rather than concentrating on the total number of available brands.

Research on consumer advertising in specialized markets is scarce. Having models where firms choose both expert and consumer advertising endogenously can generate further economic insights. Also, a dynamic, multi-period advertising decision can be studied to infer on whether advertising should increase or decrease over time. This paper itself can generate other testable empirical hypothesis which could not be performed due to data constraints. Finally, a model of consumer advertising under a different legal setting can be very useful to understand why most countries do not allow DTCA of prescription drugs. All these research ideas and more belong to the future research agenda.

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A Appendix 1: Proof of Proposition 2

Implicit Function Theorem:

Let, $f(\sigma, I) = k$.
Then,

$$\frac{d\sigma}{dI} = -\frac{\frac{\partial f}{\partial I}}{\frac{\partial f}{\partial \sigma}}$$

A.1 Proof for Equation (1)

Equation (1) is:

$$[e^{-\sigma/N}]^I\{\phi+\alpha-\phi\alpha I\}+\phi\alpha(I-1)[e^{-\sigma/N}]^{(I-1)}=\frac{C}{P}$$

If L.H.S. is written as $f(\sigma, I)$, then after partial differentiations we get[22],

$$\frac{\partial f}{\partial \sigma}=-\frac{I}{N}[e^{-\sigma/N}]^I\{\alpha+\phi(1-\alpha I)\}-\frac{\phi\alpha(I-1)^2}{N}[e^{-\sigma/N}]^{(I-1)}<0$$

Also,

$$\frac{\partial f}{\partial I}=-\frac{\sigma}{N}[e^{-\sigma/N}]^I\{\alpha+\phi(1-\alpha I)\}-\phi\alpha[e^{-\sigma/N}]^I-\phi\alpha[e^{-\sigma/N}]^{(I-1)}[\frac{(I-1)\sigma}{N}-1]$$

Thus, a sufficient condition for $\frac{\partial f}{\partial I}<0$ is that,

$$[\frac{(I-1)\sigma}{N}]>[1-e^{-\sigma/N}]$$

.

A.2 Proof for Equation (2)

Equation (2) is:

$$[e^{-\sigma/N}]^I(1-\alpha I)+\alpha(I-1)[e^{-\sigma/N}]^{(I-1)}=\frac{C}{P\phi}$$

If L.H.S. is written as $f(\sigma, I)$, then after partial differentiations we get,

$$\frac{\partial f}{\partial \sigma}=-\frac{I}{N}[e^{-\sigma/N}]^I(1-\alpha I)-\frac{\alpha(I-1)^2}{N}[e^{-\sigma/N}]^{(I-1)}<0$$

Also,

$$\frac{\partial f}{\partial I}=-[\frac{\sigma(1-\alpha I)}{N}+\alpha][e^{-\sigma/N}]^I-[e^{-\sigma/N}]^{(I-1)}[\frac{(I-1)\sigma\alpha}{N}-\alpha]$$

Thus, a sufficient condition for $\frac{\partial f}{\partial I}<0$, is that

$$[\frac{(I-1)\sigma}{N}]>[1-e^{-\sigma/N}]$$

.

[22]By our assumption, $1/I>\alpha$ always. Even when all the brands advertise and so the doctor prescribes all the available brands with equal likeliness, the likeliness of the outcome that "no drug is prescribed to the consumer" is always positive.

B Appendix 2: Numerical Analysis

B.1 Analysis of Equation (1)

$$[e^{-\sigma/N}]^I\{\phi + \alpha - \phi\alpha I\} + \phi\alpha(I-1)[e^{-\sigma/N}]^{(I-1)} = \frac{C}{P}$$

We solve for σ as I increases from 1 to 10 given different values of ϕ, α, P, C and N. It is observed that as n increases, value of σ goes down.

- **Conditions on coefficients: N = 1000000, ϕ = 0.5, α = 0.08, P = 100, C = 10**

  I= $1; \sigma = 1.6864 \times 10^6$

  I= $2; \sigma = 894043.$

  I= $3; \sigma = 600482.$

  I= $4; \sigma = 451444.$

  I= $5; \sigma = 361556.$

  I= $6; \sigma = 301483.$

  I= $7; \sigma = 258514.$

  I= $8; \sigma = 226260.$

  I= $9; \sigma = 201158.$

  I= $10; \sigma = 181068.$

- **Conditions on coefficients: N = 100000, ϕ = 0.7, α = 1/15, P = 150, C = 20**

  I= $1; \sigma = 168640.$

  I= $2; \sigma = 88749.$

  I= $3; \sigma = 59557.4$

  I= $4; \sigma = 44764.2$

  I= $5; \sigma = 35847.2$

  I= $6; \sigma = 29889.4$

  I= $7; \sigma = 25628.6$

  I= $8; \sigma = 22430.4$

  I= $9; \sigma = 19941.6$

  I= $10; \sigma = 17949.8$

- **Conditions on coefficients: N = 500000, ϕ = 0.3, α = 1/18.5, P = 80, C = 5**

  I= $1; \sigma = 843700.$

  I= $2; \sigma = 438131.$

I= 3; σ = 293547.

I= 4; σ = 220525.

I= 5; σ = 176557.

I= 6; σ = 147196.

I= 7; σ = 126203.

I= 8; σ = 110449.

I= 9; σ = 98190.8

I= 10; σ = 88381.

B.2 Analysis of equation (2)

$$[e^{-\sigma/N}]^I(1-\alpha I)+\alpha(I-1)[e^{-\sigma/N}]^{(I-1)}=\frac{C}{P\phi}$$

We solve for σ as n increases from 1 to 10 given different values of ϕ, α, P, C and N. It is observed that as n increases, value of σ goes down.

- **Conditions on coefficients: N = 1000000, ϕ = 0.5, α = 0.08, P = 100, C = 10**

  I= 1; $\sigma = 1.52606 \times 10^6$

  I= 2; σ = 814978.

  I= 3; σ = 548565.

  I= 4; σ = 412801.

  I= 5; σ = 330778.

  I= 6; σ = 275909.

  I= 7; σ = 236638.

  I= 8; σ = 207146.

  I= 9; σ = 184188.

  I= 10; σ = 165809.

- **Conditions on coefficients: N = 100000, ϕ = 0.7, α = 1/15, P = 150, C = 20**

  I= 1; σ = 158924.

  I= 2; σ = 83951.3

  I= 3; σ = 56400.3

  I= 4; σ = 42411.7

  I= 5; σ = 33972.3

  I= 6; σ = 28330.9

I= 7; σ = 24295.

I= 8; σ = 21265.

I= 9; σ = 18906.7

I= 10; σ = 17019.1

- **Conditions on coefficients: N = 500000, ϕ = 0.3, α = 1/18.5, P = 80, C = 5**

  I= 1; σ = 756523.

  I= 2; σ = 394881.

  I= 3; σ = 264981.

  I= 4; σ = 199202.

  I= 5; σ = 159547.

  I= 6; σ = 133047.

  I= 7; σ = 114091.

  I= 8; σ = 99861.1

  I= 9; σ = 88786.1

  I= 10; σ = 79921.7

C Details of the Data

Table 5: Details on FDA Approval, Generic Entry & Manufacturer

Brand Name	FDA Approval Year	Generic Approval Year	Manufacturer
RX Statins			
Mevacor	1987	2002	Merck
Zocor	1991	N/A	Merck
Pravachol	1991	N/A	Briston-myers squibb
lescol	1993	N/A	Novartis
lipitor	1996	N/A	Pfizer
Baycol	1997	N/A	bayer
SSRI/SNRI			
Celexa	1998	2004	forest
prozac	1987	2001	EliLilly/Dista
luvox	1994	N/A	solvay
paxil	1992	2004	GlaxoSmithKline
Zoloft	1991	N/A	Pfizer
Effexor	1993	N/A	WyethAyerst
PPI			
Prilosec	1989	2001	Astra Zeneca
Prevacid	1995	N/A	TAP Pharm
Aciphex	1999	N/A	Eisai
Protonix	2000	N/A	WyethAyerst
HIV-RTI			
Videx	1991	N/A	BristolMyers Squibb
Epivir	1995	N/A	GlaxosmithKline
Zerit	1994	N/A	BMS Virology
Hivid	1992	N/A	Roche
Retrovir	1987	N/A	GlaxoSmith Kline
Ziagen	1998	N/A	GlaxoSmith Kline
Rescriptor	1997	N/A	Agouron
Sustiva	1998	N/A	BristonMyres Squibb
Viramune	1996	N/A	BoehringerIngelheim
Trizivir	2000	N/A	GlaxoSmith Kline
Combivir	1997	N/A	GlaxoSmith Kline
ANTIHISTAMINES			
Allegra	1996	N/A	Aventis
Zyrtec	1995	N/A	Pfizer
Astelin	1996	N/A	Hedpointe
Semprex-D	1994	N/A	Celltech Pharm

Table 6: Details on DTCA expenditures($000)

Brand Name	1996	1997	1998	1999
RX Statins				
Mevacor	0	0	0	0
Zocor	40749.6	45,593.80	39,724.70	34,187.50
Pravachol	19104.2	64,693.80	58,055.20	0.00
lescol	977.6	0	637.5	994
lipitor	0	0	7,754.30	54,628.10
Baycol	N/A	0	0.00	0.00
SSRI/SNRI				
Celexa	N/A	N/A	0	0
prozac	0	22,610.40	37,516.80	151.10
luvox	0	0	0	0
paxil	0	1006.1	0	31,513.20
Zoloft	0	0	0	0
Effexor	7559.5	6,285.20	25.00	0.00
PPI				
Prilosec	0	40,208.40	49,736.10	77,303.60
Prevacid	0	0	0	0
Aciphex	N/A	N/A	N/A	0
HIV-RTI				
Videx	0	0	0	0
Epivir	167.9	0	0	0
Zerit	0	2,640.90	1,256.60	0.00
Hivid	0	0	0	0
Retrovir	0	88.5	0	0
Ziagen	N/A	N/A	N/A	1,564.70
Rescriptor	N/A	0	42	0
Sustiva	N/A	N/A	20.9	720.9
Viramune	0	194.7	406.7	248.7
Combivir	N/A	542.2	3,039.30	1,976.50
Antihistamines				
Allegra	19,673.00	63,921.90	52,515.30	42,788.00
Zyrtec	28,794.20	50,440.30	75,235.00	57,068.40
Astelin	0	0	0	0
Semprex-D	0	0	0	0