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**Direct to Consumer Advertising
in Pharmaceutical Markets**

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Direct to Consumer Advertising in Pharmaceutical Markets

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Abstract

We study effects of direct-to-consumer advertising (DTCA) in the prescription drug market. There are two pharmaceutical firms providing horizontally differentiated (branded) drugs. Patients differ in their susceptibility to the drugs. A fraction of the patients know their illness and visit a physician. Visits from the residual fraction ('potential' patients) can be induced by DTCA, if allowed. Physicians perfectly observe the patients' disease type, but rely on information to prescribe the correct drug. Drug information is conveyed by marketing (detailing), creating a monopolistic (captive) and a competitive (selective) segment of physicians. First, we show that detailing, DTCA and price (if not regulated) are complementary strategies for the firms. Thus, allowing DTCA induces more detailing and higher prices. Second, firms benefit from DTCA if detailing competition initially is not too fierce, which is true if the advertising technology is sufficiently costly. Finally, DTCA is likely to be welfare improving only if the copayment rate is sufficiently high. If insurance is generous, detailing and possibly also DTCA tend to be excessive.

Keywords: Marketing; Pharmaceuticals; Oligopoly

JEL Classification: I11; L13; L65; M37

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1 Introduction

The pharmaceutical industry is one of the most advertising-intensive industries (see e.g., Scherer and Ross, 1990). Promotional expenditures often amount to 20-30 percent of sales, sometimes even exceeding expenditures on R&D.¹ However, contrary to most other industries the vast amount of promotional spending are not targeted at the consumers, but rather at the physicians making the prescriptions. While this can be explained by the important role of the physician as the patient's agent, another important reason lies with the regulatory restrictions on direct-to-consumer advertising (DTCA) of prescription drugs that are present in most countries.

Recently, however, there has been a trend towards a more liberal legislation on DTCA. In the US, the Food and Drug Administration issued new guidelines in 1997 for broadcast advertising of prescription drugs directly to consumers, facilitating the use of television for DTCA. A similar liberalisation is carried through in New Zealand. In the European Union a 5-year pilot project of allowing DTCA for three long-term and chronic diseases - diabetes, AIDS and asthma - has recently been proposed.

The role of DTCA has generated a controversial debate (see e.g., Wilkes *et al.*, 2000). Opponents claim that DTCA causes physicians to waste valuable time during encounters with patients and encourages the use of expensive and sometimes unnecessary medications. Proponents argue that DTCA increases the consumers' awareness and knowledge about available medical treatments, and this may enable them to detect a possible disease at an earlier stage and more actively take part in the decision of which drug to prescribe.

This paper aims at contributing to the debate about DTCA along two different dimensions: First, most opponents and proponents focus on isolated effects of DTCA. They seem to ignore that pharmaceutical companies already spend tremendous amounts of money on promotion aimed at influencing the physicians' prescription choices in ways favourable to

¹According to Schweitzer (1997) the marketing expenses for three of the largest US pharmaceutical companies - Merck, Pfizer, and Eli Lilly - ranged from 21 to 40% of annual sales, while the R&D expenses varied between 11 and 15%. Similar figures are reported from Novartis and Aventis, the largest pharmaceutical companies in Europe. See also Hurwitz and Caves (1988) for US data or Zweifel and Breyer (1997) for figures in Germany and Switzerland.

the companies.² In this paper we therefore focus on the interaction between advertising directed at consumers, on the one hand, and physician-oriented marketing, on the other.

Second, there have recently been quite a number of empirical studies on various aspects of DTCA (e.g., Berndt et al., 1995, Calfee et al., 2002, Iizuka, 2004, Iizuka and Jin, 2005, Ling et al., 2002, Rosenthal et al., 2002). Theoretical studies of DTCA are virtually non-existing. Taking into account the specific market conditions and institutional arrangements in the prescription drug market, general theoretical studies may be insufficient for the purpose of predicting and interpreting empirical findings. We aim therefore to fill this gap in the literature by explicitly model physician-oriented and consumer-oriented marketing in the prescription drug market. We are especially interested in analysing how the availability of DTCA affects firms' spending on detailing, the drug prices, and eventually profits. We are also interested in the effects of DTCA on the physicians' prescription decisions, the benefit to the patients', and eventually social welfare.

In constructing the model we make use of stylised facts and recent empirical evidence on DTCA and physician-oriented marketing in this industry. We consider a particular therapeutic market, for instance, high cholesterol. In this market we assume there are two pharmaceutical firms offering horizontally differentiated (patented/branded) drugs. For the high cholesterol example, we can think of Pfizer and Merck as the two firms offering their branded drugs, Lipitor and Zocor, respectively. These drugs are have different chemical compounds, potentially involving different effectiveness, contradictions and side-effects. The net treatment effect may also depend on the patients' personal characteristics and/or the type of illness they suffer from. To capture these features we make use of the familiar model of Hotelling (1929), assuming the two drugs to be located at either end of a unit interval. This means that we focus on *branded vs. branded* competition in the prescription drug market, and not on branded vs. generic competition.³ There is evidence that most illnesses

²Rosenthal *et al.* (2002) report that annual spending on DTCA for prescription drugs in the US tripled between 1996 and 2000, when it reached \$2,5 billion. Despite this increase, DTCA accounts for only 15% of the total drug promotion expenses. Promotion to professionals (e.g., detailing, journal advertising, free samples) accounts for the residual 85%, with a spending of \$13,241 billion in 2000.

³Generic drugs are rarely advertised at any extent. Studies of marketing in this context have mostly been concerned with the issue of whether advertising act as a barrier for generic entry. See e.g., Scott Morton

can be treated by a variety of medications, and that many drugs meet competition from chemically differentiated substitutes even under patent protection.⁴

Patients differ in their susceptibility towards the different drugs with their location on the Hotelling-line being associated with a particular disease type and/or personal characteristics. This means that some patients are better off with, say, drug 1, while others are better off with the alternative drug. Thus, there is no strict hierarchy in which one drug is universally better than another, implying that optimal treatment depends on the individual case and is a matter of *matching*. We also assume demand to be *elastic* in the sense that some patients are better off with an outside treatment (e.g., physical exercise). This introduces the possibility of over- or underutilisation of medication.

The patients cannot observe their disease type nor the treatment effects of the different drugs.⁵ We assume that only a fraction of the individuals suffering from the disease in question actually enter the physician market. The remaining fraction are also ill, but for some reason do not visit a physician.⁶ For instance, they may feel unwell, but are not sure they actually are ill. These individuals are ‘potential’ drug consumers and the fraction measures the size of the potential market. It is well-known that a lot of diseases are underdiagnosed and/or undertreated. Iizuka (2004) empirically analyses a set of diseases, and finds that firms spend more on DTCA when the number of potential patients, rather than currently treated patients, is large. This is a feature of our model as well.

(2000) for an empirical study, and Cabrales (2003) and Königbauer (2004) for theoretical studies.

⁴Scherer (2000) reports that the number of drugs per symptom group ranged from 1 to 50, with a median of 5 drugs and mean of 6.04. Lu and Comanor (1998) find that all but 13 of 148 new branded chemical entities introduced in the US between 1978-87 had at least one fairly close substitute; the average number of substitutes being 1.86.

⁵There are several justifications for this. First, (most) patients have not taken medical training and are thus not capable of diagnosing. Second, drugs are experience (not search) goods, implying that the treatment effects cannot be easily observed by reading about the drugs’ chemical compounds, effectiveness, etc.

⁶There may be several reasons for why not everybody suffering from a disease seek medical care. First, some individuals receive weaker symptoms than others. In fact, some persons do not receive any signal of being ill. Second, individuals may have different skills or experience in interpreting symptoms. Third, individuals may be heterogenous with respect to their inclination to seek medical care, or more broadly, individuals may face different opportunity costs.

If allowed by the health authorities, the pharmaceutical firms can advertise directly to consumers. We assume that DTCA affects the potential patients' decision of whether or not to seek medical advice by a physician. An ad from, say, firm 1 (Merck), informs the patient about the existence of drug 1 (Zocor), possible symptoms (high cholesterol has no symptoms) and risks (e.g., diabetes) associated with the disease in question. Besides this the ads provide no valuable information to the patient. Thus, in our model DTCA merely prompts visits by potential patients, and has thus a market expansion effect. This modelling approach is in line with existing empirical findings.⁷ For instance, Iizuka and Jin (2005) find that DTCA leads to a large increase in the number of patient visits, a moderate increase in the time spent with physicians, but no effect on physicians' specific choice among prescription drugs within a therapeutic class. This result is consistent with the claim that DTCA encourage patient visits but do not challenge the physicians' authority.

Physicians are assumed to be *ex ante* identical and face the same distribution of patients. They have the skills to verify whether or not an individual is sick, and to identify his/hers particular disease type. The physicians are perfect agents for the patients, but assumed to be *a priori* uninformed about the two drugs. Thus, to be able to prescribe the correct (or most suitable) medical treatment to a patient, they need information about the available drugs. Obviously, physicians may search for drug information, for instance, by reading medical journals. In this paper, we focus on another, and less costly, source for information for the physicians, namely drug marketing.

We assume that a physician that has been exposed to marketing by a firm perfectly obtains information about the effectiveness, contradictions and side-effect of this firm's drug. Thus, the physician is capable of calculating each visiting patient's utility from being treated by this drug. Obviously, physician-oriented marketing is costly, implying that the firms are not able to reach every physician in the market. As a consequence, we have (ex post) three types of physicians, namely fully informed physicians, partially informed physicians, and physicians that remain uninformed. The first type trade-off the two drugs, the second type trade-off the known drug against an outside treatment, while the last type recommends an outside treatment. Thus, firms face two different segments; a monopolistic segment

⁷We thank an anonymous referee for drawing our attention to the empirical findings on this issue.

associated with the partially informed physicians, and a competitive segment associated with the fully informed physicians. As a consequence physician-oriented marketing involves both a market-expanding effect and a business-stealing effect.

This approach follows closely the informative advertising framework as introduced by Butters (1977), Grossman and Shapiro (1984), among others. The modelling approach is also consistent with the empirical evidence provided by Berndt et al. (1995) for the anti-ulcer industry. They suggest an empirical method to distinguish between "industry-expanding" and "rivalrous" physician-oriented marketing efforts. Their results suggest that such marketing involves both elements. In our model these two effects are associated with the monopolistic segment consisting of partially informed (or captive) physicians and the competitive segment consisting of fully informed (or selective) physicians.

We analyse the following game: First, the regulator decides whether or not to allow DTCA. Second, the firms set the levels of marketing aimed at physicians and, if allowed, at consumers. Third, the physicians choose which drug to prescribe, or whether they recommend an outside treatment. Finally, the patients decide whether or not consult a physician. We analyse both the case of price competition and the case of price regulation. This enables us to compare the effects of DTCA across health care systems in which firms compete on price (e.g., in the US) and systems in which prices are regulated (e.g., in Europe).⁸

Based on this model we derive the following results. First, we find that detailing and DTCA are complementary strategies for the pharmaceutical firms. The intuition is that a high level of DTCA implies more physician visits, which makes it profitable for the firms to spend more on detailing to get the physicians to prescribe their drug. Thus, allowing DTCA leads to higher levels of detailing. This result is consistent with empirical findings. For instance, Rosenthal et al. (2002) demonstrate that spending on DTCA increased dramatically after the new FDA guidelines in 1997, and tripled for the whole period of 1996 and 2000, ending on \$2,5 billion. For the same period they also show that promotional spending on physician increased from \$8,3 to \$13,2 billion.⁹

⁸Most European countries exercise some form of price regulation on prescription drugs. See e.g. Mossialos (1998) for an overview of the different ways drug prices are regulated in Europe.

⁹Note that spending on conferences, meetings, events and also gifts are not included, so the figures

Moreover, we find that if firms can set prices, the complementarity between the two marketing strategies is re-enforced. The main reason for this is that the price is increasing in the level of physician-oriented marketing. This result is interesting for the following two reasons: First, it is contrary to Grossman and Shapiro (1984) who find that informative advertising leads to lower prices. The basic difference between the two models is that we assume *elastic* demand in the monopolistic segment, while they assume *inelastic* demand in this segment. In our model a firm face two effects of lowering its price; (i) it steals some consumers from the rival in the competitive segment; and (ii) it increases the demand in the monopolistic segment. In the Grossman-Shapiro (1984) model only the first effect is present. Interestingly, it turns out that this assumption qualitatively changes the effect of marketing upon prices.

Second, the price effect of detailing is consistent with empirical findings. In the context of branded competition Rizzo (1999) analyse the demand for high cholesterol (antihypertensive) drugs for 1988-1993, and finds that detailing lowers the price elasticity. This effect is dedicated to detailing being persuasive rather than informative.¹⁰ We show, however, that informative advertising might lead to higher prices. Thus, one cannot conclude that promotion to physicians are persuasive, and not informative, from the empirical observation of a less price elastic demand.

We also find that firms overinvest in detailing and underinvest in DTCA from an industry perspective. Since DTCA prompts physician visits, but does not affect the prescription choice, it is purely market-expanding. The public good nature of DTCA induces the firms to invest less than they would if they could cooperate. Detailing, on the other hand, involves elements of both market-expansion and business-stealing. Business-stealing implies a negative externality between the firms, inducing them to invest more in detailing than if they could coordinate.

Turning to profitability, we find that firms benefit from DTCA if detailing competition is not too fierce initially, which is true if the advertising technology is sufficiently costly. While this is true under both price competition and price regulation, the restriction is more

underestimate total expenditures on marketing to physicians.

¹⁰There has been quite an extensive debate on whether physician-oriented marketing is persuasive or informative, see e.g., Leffler (1981), Hurwitz and Caves (1988), and others.

severe in the latter case, implying that DTCA is more likely to be profitable under price competition than price regulation. This type of result is not unfamiliar to the advertising literature. For instance, Grossman and Shapiro (1984) arrive at a similar result. As in their model, the intuition is related to the *strategic* effect of the advertising technology on the competition. More precisely, if advertising (detailing) is costly, the monopolistic (captive) segment is relatively large compared with the competitive (selective) segment of the market. Thus, costly advertising softens competition, which is profitable to the firms.

Finally, we consider welfare effects of DTCA, obtaining the following two results: First, we show that a regulator in general cannot achieve first-best but needs to trade-off the following three inefficiencies: suboptimal DTCA, excessive detailing, and too few prescriptions (in the monopolistic segment). DTCA is suboptimal due to its public good nature, while detailing is excessive due its business-stealing effect. In the price competition case, prices are too high due to imperfect competition, which in turn results in too few prescriptions (in the monopolistic segment). In the price regulation case, the regulator can scale up and down the marketing levels by changing the price. However, first-best detailing results in suboptimal DTCA, and first-best DTCA results in excessive detailing. In either case, the (captive) physicians make too few prescriptions for a social perspective.

Second, we show that the welfare effect of DTCA is in general ambiguous, and depends on the *intensity* of detailing competition. In particular, if the copayments are small and detailing technology is efficient (i.e., weakly convex detailing costs), firms compete fiercely in terms of detailing. A removal of a ban on DTCA triggers detailing competition even further due to the complementarity between the two marketing strategies, inducing excessive detailing from a welfare perspective. When firms can set prices, a low copayment facilitates high prices, which amplifies the incentives to spend money on marketing. When prices are regulated, a high price has the same effect. Thus, in health care systems with a generous insurance and/or price regulation regime, it is less likely that DTCA is welfare improving.

There are some other theoretical papers on marketing in the pharmaceutical market. The closest paper to ours is Rubin and Schrag (1999) who analyse the effect of DTCA on the provision of drugs by HMOs to their patients. Assuming a more effective drug being supplied by a monopolist and a less effective drug being supplied by a competitive

market, Rubin and Schrag (1999) show that the monopolist can mitigate the incentive for the HMO to supply the cheaper but less effective drug by using DTCA to inform patients about its product. Despite some similarities, they do not consider competition in terms of advertising and prices, and they are not concerned about the role of detailing on physician's prescription choice, which are the main issues of our paper. Another related paper is Konrad (2002) who is concerned about how detailing may distort physicians' prescription choices and potentially impose a utility loss on patients due to mismatching. He models detailing as purely persuasive and competition as a rent-seeking contest. As DTCA is not a part of the model, this paper is very different from ours.

The rest of the paper is organised as follows. In section 2 the basic analytical framework is described. In section 3 and 4, we analyse marketing competition in the case of price regulation and price competition, respectively. Section 5 is devoted to analyse the welfare implications of DTCA. Section 6 concludes the paper.

2 Model

Consider a particular therapeutic market, for instance high cholesterol. In this market there is a continuum of individuals distributed uniformly on the line segment $[0, 1]$ with mass 1. We assume all individuals are sick and need medical treatment. The location of an arbitrary patient, $x \in [0, 1]$, is associated with his/her disease type and/or personal characteristics.

There are two pharmaceutical firms, indexed by $i = 0, 1$, in this market, where firm i sells drug i at a uniform price p_i . For the high cholesterol example, the firms could be Pfizer and Merck offering their drugs Zocor and Lipitor, respectively, in the market. The drugs are both able to cure the disease. The drugs' locations on the unit line reflect their chemical compounds and associated treatment effects. We restrict attention to competition between branded (or patented) drugs. Obviously, patent protection rules out the existence of identical, generic drugs (co-locations), and imposes a certain degree of horizontal differentiation between the branded drugs. We capture this by assuming the drugs to be located at either end of the unit interval.

The patients are in need of one unit of drug 0 or 1 (unit demand). The surplus (utility)

derived by patient x from getting a unit of drug i is

$$U(x, i, p_i) = v - t|x - i| - \tau p_i, \quad (1)$$

where $v > 0$, $t > 0$, and $\tau \in (0, 1]$. The parameter v represents the gross "effectiveness" (or quality) of drug i . The two drugs have the same gross effectiveness, but patients vary with respect to their susceptibility to treatment with the two (chemically) differentiated drugs. The parameter t captures the utility loss ('mismatch cost') per unit distance between drug i and a patient's most suitable drug. The mismatch cost, represented by the term $t|x - i|$, can be thought of as reflecting side-effects or other factors that reduces the net effectiveness of the drug treatment. Finally, the parameter τ is the copayment rate.¹¹

We assume that the patients cannot observe their disease type nor the treatment effects of the different drugs.¹² Patients just experience a symptom, and based on this, they decide whether or not to visit a physicians. We let $z \in [0, 1]$ be the fraction of patients that seek medical care by a physician. The remaining fraction $(1 - z)$ consists of individuals with a condition who do not visit a physician. For instance, they may feel unwell, but are not sure they actually are ill. These individuals are 'potential' consumers of the two drugs, and the fraction $(1 - z)$ measures the size of this potential market.

If allowed by the health authorities, the pharmaceutical firms can advertise directly to consumers. We assume that DTCA influences the 'potential' patients' decision of whether or not to seek medical advice by a physician. Let $\Phi_i \in [0, 1]$ denote the fraction of patients who receive an ad from firm i . We assume that the ads inform the patient about the existence of a drug and the possible symptoms that are associated with the disease in question. Besides this the ads provide no valuable information to the patient. Since all patients are ill and in need of one of the drugs, we assume that a patient who has seen at least one ad will visit the physician. Only those potential patients who have not been exposed to an ad do not seek medical advice. This fraction is given by $(1 - \Phi_0)(1 - \Phi_1)$. We can now derive the number

¹¹Alternatively, we can think of τ as a measure of to what extent physicians take prices into account when making prescription choices. In other words, τ can be interpreted as a measure of (ex post) moral hazard.

¹²There are several justifications for this. First, (most) patients have not taken medical training and are thus not capable of diagnosing. Second, drugs are experience (not search) goods, implying that the treatment effects cannot be easily observed by reading about the drugs chemical compounds, effectiveness, etc.

(or the fraction) of individuals suffering from a particular disease who attend a physician for medical advice:

$$N(\Phi_0, \Phi_1) = z + (1 - z) [1 - (1 - \Phi_0)(1 - \Phi_1)]. \quad (2)$$

Considering the physician market, we normalise the number of physicians to 1. The physicians are *ex ante* identical and face the same distribution of patients. They have the skills to verify whether or not an individual is sick, and to identify his particular disease type, i.e., the location $x \in [0, 1]$. The physicians are perfect agents for the patients, but are assumed to be *a priori* uninformed about the two drugs. Thus, to be able to prescribe the most suitable medical treatment to a patient, they need information about the available drugs. Obviously, physicians may search for drug information, for instance, by reading medical journals. In this paper, we focus on another, and less costly, source for information for the physicians, namely drug marketing.

The pharmaceutical firms' use a wide set of marketing activities to affect the physicians' prescription choices. It is common to distinguish between medical journal advertising and "detailing", where physicians are visited by sales representatives. Since in our model physicians are *ex ante* identical, targeting of advertising plays no role. As a consequence there is no real distinction between journal advertising and detailing. For simplicity, though, we refer to marketing aimed at the physicians as detailing in the following. Let θ_i denote the fraction of physicians who have been exposed to detailing by firm i . Unlike DTCA we assume that detailing provides information not only about the existence of a drug, but also about its effectiveness, v , and characteristics, i.e., location.¹³ Thus, physicians who have been exposed to detailing by firm i are perfectly informed about drug i 's properties. Detailing then divides physicians into four possible segments: (i) physicians informed about both drugs, $\theta_0\theta_1$; (ii) physicians informed about drug 0 only; $\theta_0(1 - \theta_1)$; (iii) physicians informed about the drug 1 only; $\theta_1(1 - \theta_0)$; and (iv) uninformed physicians, $(1 - \theta_0)(1 - \theta_1)$.

Consider a physician who has only been exposed to detailing by firm i . This physician is

¹³Obviously, detailing contains elements of both information and persuasion. Although there are regulatory restrictions on the content of drug marketing, there are ways to increase the physicians inclination to prescribe a drug, which may not depend on the drugs' properties only. Below we will present a way to interpret detailing as both informative and persuasive.

partially informed and knows the properties of drug i but not those of the other drug. The criteria for prescribing drug i to patient x is that the benefit from the medical treatment net of its monetary costs is non-negative:¹⁴

$$U(x, i, p_i) \geq 0 \quad \Leftrightarrow \quad v - t|x - i| - \tau p_i \geq 0.$$

If $U(\cdot) < 0$, then the physician either prescribes an outside treatment (e.g., physical exercise) or recommends no treatment at all (e.g., "just wait until it gets better"). The benefit of an outside (or no) treatment is normalised to zero. Let \tilde{x}_i denote the patient that is equally well off (indifferent) between being treated by drug i and an outside treatment. The locations of the marginal consumers' of drug 0 and 1, are given by:

$$\tilde{x}_0 = \frac{v - \tau p_0}{t} \quad \text{and} \quad \tilde{x}_1 = 1 - \frac{v - \tau p_1}{t}, \quad (3)$$

respectively. Thus, physicians who have received information from firm 0 alone, prescribe drug 0 to every visiting patients within the interval $[0, \tilde{x}_0]$. Physicians who have been informed by firm 1 alone, prescribe drug 1 to every visiting patient within the interval $[1 - \tilde{x}_1, 1]$. Thus, the fraction of partially informed physicians constitutes a *monopolistic* (or captive) segment for the respective firm. Note from (3) that if the copayments become sufficiently small relative to v , then $\tilde{x}_0 = 1$ and $\tilde{x}_1 = 0$, implying that every patient will be prescribed a drug. In most of the analysis we restrict attention to the case of elastic demand, which implies that we assume that $\tau p_i > v - t$.

Consider a physician who has been exposed to the detailing of both firms. This physician is fully informed and knows the properties of both drugs. She is thus capable of deciding which drug is the more suitable for every visiting patient. A fully informed physician prescribes drug 0 to patient x if the following is true:

$$U(x, 0, p_0) \geq U(x, 1, p_1) \quad \Leftrightarrow \quad v - tx - \tau p_0 \geq v - t(1 - x) - \tau p_1.$$

¹⁴One could question the role of the prices in the physician's prescription choice. However, there is empirical evidence that physicians do care about patients' expenditures when deciding which drug to prescribe (Lundin, 2000). Moreover, Rizzo (1999) estimates that in absence of detailing effort demand responds quite elastically to changes in prices. In any instance, section 3 will capture the case where prices do not matter for the prescription choice.

Let \hat{x} denote the patient that is equally well off (indifferent) with either drug. The location of this patient is given by:

$$\hat{x} = \frac{1}{2} - \frac{\tau(p_0 - p_1)}{2t}. \quad (4)$$

A fully informed physician would thus prescribe drug 0 to every patient in the interval $[0, \hat{x}]$ and drug 1 to every patient in the remaining interval $(\hat{x}, 1]$. Since the fully informed physicians trade-off the two drugs, this fraction constitutes the *competitive* segment for the two firms. Note that if the copayments are sufficiently high, the two firms become local monopolists. To restrict attention to the competitive regime, we need to assume that $U(\hat{x}, 0, p_0) = U(1 - \hat{x}, 1, p_1) > 0$, which is satisfied if $\tau p_i/2 < v - t/2 - \tau p_j/2$, where $i, j = 0, 1$ and $i \neq j$.

The final group of physicians are the ones that have received information from neither firm. These, physicians remain uninformed and recommend either an outside treatment or no treatment, providing the visiting patients with zero utility. From the physicians' prescription choices described above, we can now derive the shares of patients that end up with either drug 0 or 1:

$$M_0 = \theta_0 [\theta_1 \hat{x} + (1 - \theta_1) \tilde{x}_0] \quad \text{and} \quad M_1 = \theta_1 [\theta_0 (1 - \hat{x}) + (1 - \theta_0) (1 - \tilde{x}_1)]. \quad (5)$$

Firm i faces thus the following demand for its drug:

$$Q_i(\Phi, \theta, \mathbf{p}) = N(\Phi) \cdot M_i(\theta, \mathbf{p}), \quad (6)$$

where $\Phi = (\Phi_0, \Phi_1)$, $\theta = (\theta_0, \theta_1)$ and $\mathbf{p} = (p_0, p_1)$.

The pharmaceutical firms face identical and constant marginal production costs, which we normalise to zero. The R&D costs are considered sunk at the time marketing and price decisions are taking place and play no role in the analysis. The advertising technology follows Butters (1977). More precisely, we assume that the cost of reaching a fraction θ_i of physicians and a fraction Φ_i of patients is given by the following general advertising cost function, $K(\theta_i, \Phi_i)$. We assume that $K(\cdot)$ is increasing and convex in both detailing and DTCA. The two marketing strategies are distinctly different. We therefore assume that detailing and DTCA are separable in the cost function, i.e., $\partial^2 K / \partial \theta_i \partial \Phi_i = 0$. We can now specify firm i 's profit function:

$$\pi_i(\Phi, \theta, \mathbf{p}) = p_i Q_i(\Phi, \theta, \mathbf{p}) - K(\theta_i, \Phi_i). \quad (7)$$

The following sequence of moves is considered:

- Stage 1: The regulator decides on whether or not to allow DTCA.
- Stage 2: The pharmaceutical firms determine spending on detailing, and, if allowed, they set prices and the level of DTCA.
- Stage 3: The physician prescribes drug 0, drug 1 or the outside treatment to the patients.

As usual, the game is solved by backward induction.¹⁵

3 Price regulation

Let us first examine the firms' marketing strategies in the absence of price competition. This captures the situation in most European countries, where prices of prescription drugs are subject to governmental regulation.¹⁶ Firm 0 maximises (7) with respect to θ_0 and Φ_0 , anticipating the number of patients attending the physicians, given by (2), and the physicians' prescription choices, given by (5). The solution to the problem is given by the following first-order conditions:¹⁷

$$\frac{\partial \pi_0}{\partial \theta_0} = p_0 N [\theta_1 \hat{x} + (1 - \theta_1) \tilde{x}_0] - \frac{\partial K}{\partial \theta_0} = 0, \quad (8)$$

$$\frac{\partial \pi_0}{\partial \Phi_0} = p_0 M_0 (1 - z) (1 - \Phi_1) - \frac{\partial K}{\partial \Phi_0} = 0. \quad (9)$$

Firm 1 faces a symmetric problem and a symmetric set of first-order conditions. We assume that the regulator imposes the same price on both drugs, i.e., $p_0 = p_1 = p$. This is a

¹⁵One could argue that marketing is more of a long-term decision than price setting, and should therefore be determined at a stage previous of the price game. As this only complicates the analysis without providing any qualitatively different results, we have decided to follow Grossman and Shapiro (1984), **and several others**, by assuming marketing and price decisions to take place at the same stage of the game.

¹⁶See e.g. Mossialos (1998) for an overview of different ways drug prices are regulated in Europe.

¹⁷For the second order conditions to be fulfilled, the following must hold:

$$\left(\frac{\partial^2 K}{\partial \theta_0^2} \right) \left(\frac{\partial^2 K}{\partial \phi_0^2} \right) > (p(1 - z)(1 - \phi_1) [(1 - \theta_1) \tilde{x} + \theta_1 \hat{x}])^2$$

trivial assumption since the drugs have the same effectiveness, v , and are symmetrically differentiated. Moreover, the firms face identical cost conditions and make their choices simultaneously. Thus, there is no reason for the regulator to set different prices on the two drugs. With identical prices, the physicians will prescribe the two drugs according to:

$$\hat{x} = 1 - \hat{x} = \frac{1}{2} \quad \text{and} \quad \tilde{x}_0 = 1 - \tilde{x}_1 = \frac{v - \tau p}{t}. \quad (10)$$

To simplify exposition let us define $\tilde{x} = \frac{v - \tau p}{t}$. Note that if $\tau p \leq v - \frac{t}{2}$, then $\tilde{x} = 1$, which means that the partially informed physicians prescribe to every visiting patient the drug they know about. As a consequence the monopolistic segment and total demand become inelastic. Moreover, if $\tau p \geq v - t$, then $\hat{x} = \tilde{x} \leq \frac{1}{2}$. Thus, if the copayments are sufficiently high, then the two drugs are not perceived to be substitutes, and the competitive region disappears. In the following, we restrict attention to the case with a competitive region and a monopolistic region with elastic demand, i.e., $\hat{x} < \tilde{x} < 1$. For this to be true, we need to assume the following:

$$v - t < \tau p < v - \frac{t}{2}. \quad (11)$$

Given this assumption, the symmetric detailing and DTCA equilibrium levels are (implicitly) defined by the following set of equations:¹⁸

$$pN \left[(1 - \theta^r) \tilde{x} + \frac{\theta^r}{2} \right] - K_\theta(\theta^r) = 0, \quad (12)$$

$$pM(1 - z)(1 - \Phi^r) - K_\Phi(\Phi^r) = 0, \quad (13)$$

where

$$N = z + (1 - z) \left[1 - (1 - \Phi)^2 \right],$$

$$M = \theta \left[(1 - \theta) \tilde{x} + \frac{\theta}{2} \right].$$

The superscript (r) denotes the equilibrium under price regulation. Note that symmetry allows us to drop the indexing of the variables. For notational convenience, we will use K_θ and K_Φ instead of $\partial K / \partial \theta$ and $\partial K / \partial \Phi$, respectively, in the following.

¹⁸Provided that $K_{\Phi\Phi}$ and $K_{\theta\theta}$ are positive and sufficiently large the system (12) and (13) has a unique and stable equilibrium. Also note that $\theta \leq 1$ implies $pN \leq 2K_\theta(1)$.

Let us explore the interaction between the two marketing variables; detailing and DTCA. By total differentiation of (12), we obtain the following:

$$\frac{d\theta^r}{d\Phi} = \frac{2p(1-z)(1-\Phi)[(1-\theta)\tilde{x} + \frac{\theta}{2}]}{pN(\tilde{x} - \frac{1}{2}) + K_{\theta\theta}} > 0. \quad (14)$$

This expression tells us how equilibrium detailing responds to a change in the level of DTCA. Noticing that $\tilde{x} > 1/2$, it is easily verified that DTCA has a positive effect on detailing. The intuition is that a higher level of DTCA induces more patients to visit the physicians. Facing a larger market, it becomes more profitable for the firms to promote their drugs to the physicians in order to increase individual demand.

The effect of a change in detailing on the equilibrium level of DTCA is found by differentiating (13):

$$\frac{d\Phi^r}{d\theta} = \frac{p(1-z)(1-\Phi)[(1-2\theta)\tilde{x} + \theta]}{pM(1-z) + K_{\Phi\Phi}} > 0 \quad (15)$$

Noticing that $(1-2\theta)\tilde{x} + \theta > 0$ for all valid values, it is easily verified that the sign is positive. Thus, a higher level of detailing increases the firms' incentives to spend money on DTCA. To understand this recall that physicians who have not been exposed to detailing are not aware of the available drugs and thus recommend an outside treatment. Low levels of detailing mean low individual demand for the drugs, which in turn provides weak incentives for the firms to prompt patient visits via DTCA. We may sum up the results in the following proposition:

Proposition 1 *DTCA and detailing are complementary marketing strategies for the firms in the case of price regulation.*

Thus, our model predicts that allowing DTCA would lead to more detailing. Vice versa, a stricter regulation of detailing would reduce firms' spending on DTCA. There are empirical evidence suggesting a positive relationship between DTCA and detailing. In the US, DTCA was liberalised in 1997. Based on US marketing data, Rosenthal et al. (2002) find that spending on DTCA for prescription drugs tripled between 1996 and 2000. For the same period promotional spending to physicians also increased (except for journal advertising). Our model provides an intuition for a positive correlation between the two marketing strategies.

Let us briefly consider the industry-maximising (or cooperative) marketing levels. The profit function under symmetry is given by:

$$\pi(\theta, \Phi) = pN(\Phi)M(\theta) - K(\theta, \Phi). \quad (16)$$

Maximising this with respect to θ and Φ give us the optimal levels of marketing at the industry level, as defined by the following set of first-order conditions:

$$\frac{\partial \pi}{\partial \theta} = pN[(1 - \theta)\tilde{x} + (1 - \tilde{x})\theta] - K_\theta = 0, \quad (17)$$

$$\frac{\partial \pi}{\partial \Phi} = 2pM(1 - z)(1 - \Phi) - K_\Phi = 0. \quad (18)$$

Comparing the industry-maximising marketing levels with the competitive marketing levels, provides the following result.

Lemma 1 *Firms overinvest in detailing and underinvest in DTCA from an industry perspective under price regulation.*

Proof. The result follows by direct inspection, when comparing (12) with (17), while observing $(1 - \tilde{x}) < \frac{1}{2}$, and (13) with (18). ■

The Lemma states that if firms could coordinate their marketing investments, they would choose a lower level of detailing and a higher level of DTCA. Basically, this results from the fact that DTCA is purely market-expanding, while detailing contains elements of both market expansion and business-stealing. Since DTCA induces patients to visit a physician, but does not affect the choice of drug, there is an incentive for the firms to free-ride on each other. Spending money on DTCA has a positive spillover on the rival. It is thus no surprise that firms tend to underinvest in DTCA.

Detailing has a very different effect. In contrast to DTCA, detailing tends to shift market shares between the duopolists and the 'outside treatment', and amongst the duopolists themselves. On the one hand, by providing information to some previously uninformed physicians detailing by, say, firm 0 contributes towards expanding the market share of drug 0 at the expense of the outside treatment. This leaves the rival firm 1 unaffected. On the other hand, however, by informing physicians who were previously informed about drug 1 only, detailing by firm 0 also shifts demand from firm 1's monopolistic segment into the

competitive segment. This form of business stealing constitutes a negative externality and, thus, implies over-investment.

Having established that detailing is excessive and DTCA suboptimal from an industry perspective, let us examine directly the effect on profits of allowing DTCA. The criteria for DTCA to be profitable to the firms is given by the following condition:

$$\begin{aligned}\Delta\pi(\Phi) &= \pi[\theta(\Phi), \Phi] - \pi[\theta(0), 0] > 0, \\ &= p[N(\Phi)M[\theta(\Phi)] - zM[\theta(0)]] - K[\theta(\Phi), \Phi] + K[\theta(0), 0] > 0,\end{aligned}\tag{19}$$

where $\theta(\Phi)$ expresses the equilibrium level of detailing as a function of DTCA. Generally, we see that the value of higher demand due to DTCA, measure by the first term, must be higher than the net increase in marketing costs, measured by the two last terms. Evaluating (19) for equilibrium detailing and DTCA, we obtain the following result:

Proposition 2 *DTCA unambiguously increase firms' profits if the detailing costs are sufficiently convex, i.e. if*

$$\frac{K_{\theta\theta}}{K_{\theta}} > \frac{\tilde{x} - 1/2}{\tilde{x} - \theta(\tilde{x} - 1/2)} \in (0, 1).^{19}$$

A proof is provided in the Appendix.

At first glance it may seem strange that firms should benefit from DTCA only when the detailing cost function is sufficiently convex, especially since DTCA triggers higher levels of detailing. The intuition is, however, closely linked to a *strategic* effect of a costly detailing technology. When detailing costs are very convex, firms spend little on detailing. At low levels of detailing the monopolistic segment of the market is relatively large compared with the competitive segment. Thus, competition is softened by a costly detailing technology. In this case, the direct market-expanding effect of DTCA dominates the (indirect) stiffening of detailing competition, and DTCA is beneficial to the firms.

¹⁹To examine the condition in the proposition, consider the following class of cost functions: $K(\theta) = \beta\theta^{\gamma}$, where $\beta > 0$, $\gamma > 1$. Taking the first and the second derivative of this function, we find that

$$\frac{K_{\theta\theta}}{K_{\theta}} = \frac{\gamma - 1}{\theta} > 1 \text{ iff } \gamma > 1 + \theta.$$

Thus, firms benefit from DTCA for a quadratic detailing cost function, or any detailing cost function with a higher degree of convexity.

This type of result is not unfamiliar to the advertising literature, and has been identified by, for instance, Grossman and Shapiro (1984). They show that firms can benefit from a more costly advertising technology. The argument is that advertising has two effects: a direct and a strategic effect. The direct effect of a more convex advertising technology is higher costs and lower profits. The positive, strategic effect is that a costly advertising technology limits the size of the competitive segment. There are clear parallels between these results.

Finally, let us take a brief look at the comparative statics. Some effects are more straightforward than others. Ignoring for a moment the interaction between detailing and DTCA, we see from (12) and (13) that both marketing strategies are increasing in v , and decreasing in t and τ . Taking into account that detailing and DTCA are complementary strategies, then, obviously, v , t and τ have the same qualitative effects in equilibrium. Quantitatively the effects are in fact *amplified* due to the positive interaction between the two marketing strategies. For instance, the negative effect of a higher mismatch cost, t , on detailing is reinforced by the availability of DTCA.

The effects of p and z are more complex. Instead of deriving the comparative statics analytically we rely on numerical illustration, which eases the presentation of the intuition.²⁰ We will for this part assume that the advertising cost function takes the following form: $K(\theta, \Phi) = \frac{1}{2}(\theta^2 + \Phi^2)$. Although we restrict ourselves to a relatively small set of numerical examples, several regularities can be identified that shed some light on the mechanisms of the model.

Consider first the effects of an increase in the fraction of *regular patients* (z). A higher z increases detailing since the number of patients attending the physicians becomes higher. However, a higher z also reduces DTCA since the "potential" market becomes smaller. Since lower DTCA reduces the number of visiting patients, this has a negative indirect effect on detailing. Thus, the net effect of a change in z is ambiguous in general. Table 1 provides a numerical illustrations of the effects of z .

Table 1: Comparative statics with respect to z

²⁰Interested readers can contact the authors for the analytical derivation of the comparative statics.

z	θ^r	Φ^r	M^r	N^r	π^r
0.0	.3133	.2083	.2104	.3732	.0274
0.2	.4039	.2077	.2621	.4978	.0600
0.4	.4735	.1832	.2991	.5997	.0953
0.6	.5423	.1428	.3332	.7061	.1369
0.8	.6192	.0844	.3686	.8323	.1882
1.0	.7143	0	.4085	1	.2551

Assumptions: $v = 2$, $t = 1$, $\tau p = 1.25$.

From the table we see that detailing is increasing, while DTCA is decreasing, in the level of z . Thus, the direct effect dominates the indirect complementarity effect for the specific parameter values chosen.²¹ Moreover, we see that each firm's market share, M , increases in z . Since the demand in the monopolistic segment is fixed ($\tilde{x} = 0.75$), the increase in the firms' market shares follow directly from the increase in detailing due to a change in z . The number of patients visiting the physicians, N , is also increasing in z , despite the fact that DTCA is reduced. Since DTCA attracts 'potential' patients only with a probability, this can never exceed the direct effect of one more 'regular' patient with certainty. Finally, we see that profits are increasing in z . This is the net result of higher individual demand versus the difference between higher detailing costs and lower DTCA costs.

The effects of an increase in the *regulated price* (p) are also complicated due to counter-vailing forces. On the one hand, a higher p increases the revenues from every patient buying the product, which triggers the incentives for both detailing and DTCA. On the other hand, a higher p lowers demand in the monopolistic segment, as drug consumption now becomes more expensive. Table 2 provides a numerical illustration.

Table 2: Comparative statics with respect to p

²¹In fact, it is possible to show that the direct effect dominates the indirect effect for a wide set of parameter values. The exception is when the copayment rate τ is very low.

p	θ^r	Φ^r	\tilde{x}^r	M^r	N^r	π^r
1.5	.7028	.2548	1.0	.4558	.7223	.0151
1.7	.7523	.2770	.9	.4507	.7386	.0512
1.9	.8017	.2988	.8	.4485	.7541	.0925
2.1	.8555	.3221	.7	.4525	.7702	.1431
2.3	.9212	.3498	.6	.4679	.7886	.2131

Assumptions: $v = 1.75$, $t = 1$, $z = 0.5$, $\tau = 0.5$.

As expected the demand in the monopolistic segment, \tilde{x} , drops as the price increases. Despite the "demand-reducing" effect, both detailing and DTCA are increasing in p . This means that the direct positive effect of a higher price dominates the negative demand effect for the set of parameter values considered in Table 2.²² Moreover, we see that the number of patients entering the physician market, N , increases in p , which follows straightforwardly from the effect of price on DTCA. The effect on market shares, M , is more complicated, though. At low price levels M is decreasing in p , while at high price levels M is increasing in p . Basically, this is the net result of changes in \tilde{x} and θ^r due to price increases. Finally, we see that the firms benefit from price increases, which just reflects that the net revenue effect of a higher price more than offsets the increase in marketing costs.

4 Price competition

Let us now consider the case where the Health Authority allows the pharmaceutical firms to set the prices of their products. This situation is relevant for some markets, in particular the US.²³ When prices are not subject to regulation, the nature of the market game changes, and this makes it interesting to examine the impact of price competition on firms' marketing strategies.

At stage two of the game, firm 0 now maximises (7) with respect to θ_0 , Φ_0 and p_0 , anticipating the number of patients attending the physicians, given by (2), and the physicians'

²²In fact, it is possible to show that the "mark-up" effect dominates the "reduced-demand" effect for almost every valid set of parameter values. The exception is when the copayment rate is very high.

²³The German market, too, used to exhibit relatively free pricing. However, this has changed after recent reforms, where reference pricing is now being practiced.

prescription choices, given by (5). The solution to this problem is defined by the set of first-order conditions consisting of (8), (9), and

$$\begin{aligned}\frac{\partial \pi_0}{\partial p_0} &= M_0 + p_0 \left[\frac{\partial M_0}{\partial \hat{x}} \frac{\partial \hat{x}}{\partial p_0} + \frac{\partial M_0}{\partial \tilde{x}_0} \frac{\partial \tilde{x}_0}{\partial p_0} \right] = 0, \\ &= \theta_0 \left[\theta_1 \hat{x} + (1 - \theta_1) \tilde{x}_0 - p_0 \frac{\tau}{t} \left(1 - \frac{\theta_1}{2} \right) \right] = 0.\end{aligned}\tag{20}$$

Firm 1 faces a symmetric problem and a symmetric set of first-order conditions. We therefore impose symmetry in order to derive the equilibrium. Under symmetry we know that the physicians would prescribe according to (10). Inserting this into (20) and solving for p , we find the equilibrium price to be (implicitly) given by

$$p^c = \frac{2v(1 - \theta) + t\theta}{\tau(4 - 3\theta)},\tag{21}$$

with the superscript (c) denoting the price competition regime. Thus, the symmetric equilibrium under price competition is defined by (12), (13) and (21).²⁴ Inserting (21) into (10), we obtain the following market shares for the competitive and the monopolistic segment,

$$\hat{x} = \frac{1}{2} \quad \text{and} \quad \tilde{x}^c = \frac{2v - \theta(v + t)}{t(4 - 3\theta)},\tag{22}$$

respectively. The restriction securing an equilibrium with a competitive region and an elastic, monopolistic region, i.e., $\hat{x} < \tilde{x} < 1$, is now given by

$$\frac{t(4 - \theta)}{2(2 - \theta)} < v < 2t, \quad \text{where} \quad \frac{t(4 - \theta)}{2(2 - \theta)} \in \left[t, \frac{3}{2}t \right].\tag{23}$$

Thus, the gross effectiveness (or quality) of the drug, v , must neither be too large nor too small relative to the mismatch cost, t . We assume (23) to hold in the following.

Interestingly, we observe that only detailing has a direct effect on the equilibrium price. The price depends on DTCA only indirectly via the effect of DTCA on detailing. The same holds for the demand in the monopolistic segment as defined by \tilde{x}^c . The reason is that DTCA does not affect the physicians' prescription choices, which in turn determine the price elasticity of demand. Differentiating (21) and (22) with respect to detailing, we get

$$\frac{\partial p^c}{\partial \theta} = \frac{2(2t - v)}{\tau(4 - 3\theta)^2} > 0 \quad \text{and} \quad \frac{\partial \tilde{x}^c}{\partial \theta} = -\frac{2(2t - v)}{t(4 - 3\theta)^2} < 0.\tag{24}$$

²⁴Provided that $K_{\Phi\Phi}$ and $K_{\theta\theta}$ are positive and sufficiently large the system (12), (13) and (21) has a unique and stable equilibrium. Here, $\theta^c \leq 1$ implies $2K_{\theta}(1) \geq \frac{Nt}{\tau}$ or, equivalently, $\tau \geq \frac{Nt}{2K_{\theta}(1)}$.

Thus, a higher level of detailing increases the equilibrium price and thus decreases the demand in the monopolistic segment. As a consequence, the effect of more detailing on each firm's market share, as given by M , now becomes ambiguous. Inserting (22) into (5), we find that:

$$M = \frac{\theta(2-\theta)(2v(1-\theta)+t\theta)}{2t(4-3\theta)}. \quad (25)$$

Differentiating this with respect to detailing, and noticing the restriction in (23), we can show that:

$$\frac{\partial M}{\partial \theta} = \frac{8v + 8t\theta - 24v\theta + 21v\theta^2 - 9t\theta^2 + 3t\theta^3 - 6v\theta^3}{t(4-3\theta)^2} > 0.$$

Thus, the direct positive effect of detailing on market shares more than offsets the indirect negative price effect. We can summarize this in the following way:

Lemma 2 (i) *Detailing increases the equilibrium price.* (ii) *Detailing lowers demand in the monopolistic segment, but increases overall demand.*

The effect on prices of detailing is interesting for the following two reasons. First, it is contrary to other theoretical findings using an informative advertising framework. For instance, Grossman and Shapiro (1984) show that informative advertising leads to lower prices. The argument is that advertising increases the fraction of fully informed buyers, i.e., competitive segment, and this triggers price competition. Our model resembles the Grossman and Shapiro (1984) model. In fact, if we assume no DTCA, the only difference between the two models is that we assume *elastic* demand in the monopolistic segment, while they assume *inelastic* demand.²⁵ Interestingly, this turns out to have a qualitatively different effect on the impact of marketing on prices. The intuition is due to the fact that firms facing an elastic monopolistic segment trade-off higher prices against lower demand, while firms facing inelastic demand only set the price equal to the consumers' reservation price.

Second, the effect of prices is consistent with empirical findings. Considering competition between branded drugs, Rizzo (1999) finds that advertising, or detailing more precisely,

²⁵Formally, Grossman and Shapiro (1984) assume that the partially informed fractions, i.e., $\theta_0(1-\theta_1)$ and $\theta_1(1-\theta_0)$, purchase the product at any price p_0 and p_1 , implying that $\tilde{x}_0 = 1 - \tilde{x}_1 = 1$.

makes demand less elastic to prices, and thus leads to higher prices. This result is then interpreted as drug marketing being persuasive rather than informative. Our model demonstrates that even informative advertising might lead to higher prices, given that demand in the monopolistic segment is sufficiently elastic. Thus, the issue of persuasive versus informative drug marketing is unresolved.

Let us now examine the interaction between the firms' strategies. We know from (14) and (15) that detailing and DTCA are complementary strategies. This is true for any positive price, and thus also true for the equilibrium price under price competition. The issue now is to analyse the interaction between price and the two marketing strategies. Previously, we demonstrated that a change in the regulated price involved two opposing effects on marketing (cf. Table 2): (i) a direct positive effect due to a higher mark-up, and (ii) an indirect negative effect due to lower demand in the monopolistic segment. Thus, the net effects on detailing and DTCA are not clear-cut. By differentiating (12) and (13), we obtain the following:

$$\frac{d\theta^c}{dp} = \frac{N \left[(1 - \theta) \left(\frac{v - 2\tau p}{t} \right) + \frac{\theta}{2} \right]}{pN \left(\tilde{x} - \frac{1}{2} \right) + K_{\theta\theta}}, \quad (26)$$

$$\frac{d\Phi^c}{dp} = \frac{(1 - z)(1 - \Phi)\theta \left[(1 - \theta) \left(\frac{v - 2\tau p}{t} \right) + \frac{\theta}{2} \right]}{pM(1 - z) + K_{\Phi\Phi}}. \quad (27)$$

The countervailing effects are captured by the term $(v - 2\tau p)/t$, which may be positive or negative depending on the price level. Evaluating (26) and (27) for the equilibrium price level, given by (21), we obtain the following result:

Proposition 3 *Detailing, DTCA and price are complementary strategies for the firms in the case of price competition.*

A proof is provided in the Appendix.

Recall from Proposition 2 that detailing and DTCA were complementary strategies in the case of fixed prices. The basic intuition was that DTCA induced more patients to visit a physician, which made it more profitable for the firms to use detailing in order to influence the prescription choices. Vice versa, low levels of detailing, meaning few informed physicians, made it less profitable to trigger physician visits by DTCA.

Things change somewhat for price-setting firms. As mentioned above, a higher price has two opposing effects: First, it increases the revenues per drug sold. Second, it lowers demand (in the monopolistic segment). The proposition states that the first effect dominates, so that a higher price actually has a positive impact on both detailing and DTCA. As a consequence, the availability of price as a strategic variable *amplifies* the complementarity between the two marketing strategies. Compared with the price regulation case, a higher level of detailing not only increases DTCA but also prices. Moreover, higher prices have a positive feedback on both detailing and DTCA. Thus, there is a complementarity between all the strategy variables.

Under price regulation we showed that firms tend to overinvest in detailing and underinvest in DTCA from an industry perspective. Let us now examine this issue for the price competition case. The symmetric profit function is now given by:

$$\pi(p, \theta, \Phi) = pN(\Phi)M(\theta, p) - K(\theta, \Phi). \quad (28)$$

Maximising this with respect to p , θ and Φ give us the industry maximising levels of marketing and price for each firm. Noting that the detailing and DTCA levels are given by (17) and (18), respectively, we focus on the optimal price condition, which is given by:

$$\frac{\partial \pi}{\partial p} = M - p\theta(1 - \theta)\frac{\tau}{t} = 0. \quad (29)$$

Comparing the industry maximising levels and the non-cooperative equilibrium, provide the following result.

Lemma 3 *Under price competition, firms overinvest in detailing, underinvest in DTCA, and set too low prices from an industry perspective.*

Proof. The result with respect to detailing and DTCA is given in Lemma 1. The result with respect to price is derived by imposing symmetry on the first-order condition in (20), which then becomes

$$M - p\theta\left(1 - \frac{\theta}{2}\right)\frac{\tau}{t} = 0.$$

Then comparing this with (29), the result follows straightforwardly. ■

The intuition of the underinvestment in DTCA and overinvestment in detailing was explained in relation to Lemma 1. Basically, firms underinvest in DTCA due to its public good nature, and overinvest in detailing due to its business-stealing nature. Turning to prices, it is not surprising that the industry maximising prices are higher than the duopoly prices. As in most cases, if firms can coordinate their price setting in a credible way, this results in higher prices.

Let us now examine whether or not firms benefit from the availability of DTCA under price competition. As for the price regulation case, the criteria for DTCA to be profitable for the firms is determined by the difference in profits with and without DTCA, as defined by (19). Taking into account the equilibrium price, we obtain the following result:

Proposition 4 (i) *DTCA unambiguously increases firms' profits if the detailing costs are sufficiently convex, i.e. if*

$$\frac{K_{\theta\theta}}{K_{\theta}} > \frac{\tilde{x} - \frac{1}{2} - \frac{\tau\theta}{2t} \frac{\partial p^c}{\partial \theta}}{\tilde{x} - \theta(\tilde{x} - 1/2)} \in (0, 1)^{26}.$$

(ii) *Under price competition DTCA is profitable for a wider range of parameters than in the case of price regulation.*

A proof is provided in the Appendix.

Recall from Proposition 2 that firms benefit from DTCA if the detailing cost function is sufficiently convex. This result was derived for any price, including the equilibrium price under price competition. The above proposition demonstrates that price competition relaxes this condition.²⁷ As more detailing tends to allow the firms to charge a higher equilibrium price, the problem of over-investment into detailing is now less pronounced. The stiffening of detailing competition when DTCA is allowed is then "less costly" to the firms and DTCA tends to be more profitable than under price regulation.

The comparative statics are more complicated under price competition than under price regulation, since now also the price is affected by changes in the parameters. However, the

²⁶As for the price regulation case, this condition is not very strict. Firms benefit from DTCA for a quadratic detailing cost function, or any other detailing cost function with a higher degree of convexity. See footnote X.

²⁷Note that $\frac{\partial p^c}{\partial \theta} > 0$

effects of v and τ are still straightforward. From (21), (8) and (9) we see that a higher v increases the equilibrium price, detailing and DTCA. Conversely, a higher co-payment τ increases the price elasticity of demand in both the monopolistic and competitive segment and therefore curbs the equilibrium price, detailing and DTCA.

The complicated effects are thus associated with the parameters t and z . It can easily be shown that the comparative statics with respect to z are qualitatively the same as for the price regulation case except for the fact that prices are increasing in z . The reason for this is the interaction with detailing. A higher z leads to more detailing, which in turn has a positive effect on prices.

Table 3: Comparative statics with respect to z

z	p^c	θ^c	Φ^c	\tilde{x}^c	M^c	N^c	π^c
0.0	1.8566	.7483	.4467	.8217	.4348	.6938	.1802
0.2	1.8601	.7588	.3946	.8200	.4380	.7068	.2100
0.4	1.8672	.7793	.3322	.8164	.4441	.7324	.2485
0.6	1.8811	.8153	.2547	.8094	.4542	.7778	.2999
0.8	1.9102	.8771	.1523	.7949	.4703	.8563	.3731
1.0	2.0	1.0	.0	.75	.5	1.0	.5

Assumptions: $v = 1.75$, $t = 1$, $\tau = 0.5$

Turning to the comparative statics with respect to t , recall that under price regulation a higher t implied less detailing and less DTCA. The reason was that a higher t reduced demand from the monopolistic segment, all else equal. While the demand-reducing effect is still present under price competition, this effect is now counteracted by a positive impact on price of t . More differentiated drugs enable the firms to set higher prices. This is a very standard effect and is readily verified from (21). Thus, it is not clear whether a higher t leads to more or less marketing and, in turn, to higher or lower profits. Table 4 below demonstrates the relationship.

Table 4: Comparative statics with respect to t

t	p^c	θ^c	Φ^c	\tilde{x}^c	M^c	N^c	π^c
0.875	1.750	0.7935	0.2952	1.000	0.4787	0.7517	0.2713
0.900	1.775	0.7933	0.2951	0.959	0.4719	0.7516	0.2711
0.925	1.799	0.7933	0.2951	0.920	0.4654	0.7515	0.2711
0.950	1.824	0.7935	0.2952	0.882	0.4594	0.7516	0.2713
0.975	1.848	0.7940	0.2954	0.847	0.4538	0.7518	0.2716
1.000	1.873	0.7949	0.2958	0.814	0.4486	0.7521	0.2722
1.250	2.179	0.8425	0.3165	0.528	0.4250	0.7664	0.3048

Assumptions: $v = 1.75$, $z = 0.5$, $\tau = 0.5$.

As expected, the equilibrium price is unambiguously increasing in t . Moreover, a higher price and a higher t contribute both to a lower demand in the monopolistic segment, which is given by \tilde{x} in the table. However, the effects of t on the two marketing strategies are ambiguous. At low levels of t , both detailing and DTCA are decreasing due to a marginal increase in t . Contrary, at high levels, the marginal effect of t is positive. The intuition is that the demand-reducing effect of t dominates the price-increasing effect for low levels of t , while the opposite is true for high levels of t . This explains also the effect of changes in t on profits.

5 Welfare

In this final section, we address the following two questions: (i) Does the firms provide excessive or suboptimal levels of the two marketing strategies; detailing and DTCA? (ii) Is DTCA welfare improving or should it be prohibited? Let us start by characterising first-best. The total number of patients is normalised to 1, of which a fraction $N \in [0, 1]$, as given by (2), decides to visit a physician for medical advice. The patients that enter the physician market face three types of physicians: fully informed, partially informed, and uninformed. Obviously, the benefit of the consultation depends on the degree to which the physician is informed about the available drugs and their properties. Formally, the consumer surplus

associated with the fully informed physicians, i.e., the competitive segment, is defined by:

$$\begin{aligned} C &= \theta_0 \theta_1 \left[\int_0^{\hat{x}} (v - \tau p_0 - ty) dy + \int_{\hat{x}}^1 (v - \tau p_1 - t(1 - y)) dy \right], \\ &= \theta_0 \theta_1 \left[v - \tau p_0 \hat{x} - \tau p_1 (1 - \hat{x}) - \frac{t}{2} (\hat{x}^2 + (1 - \hat{x})^2) \right]. \end{aligned} \quad (30)$$

The consumer surplus associated with partially informed physicians, i.e., the monopolistic segment, is defined by

$$\begin{aligned} D &= \theta_0 (1 - \theta_1) \int_0^{\tilde{x}_0} (v - \tau p_0 - ty) dy + \theta_1 (1 - \theta_0) \int_{1 - \tilde{x}_1}^1 (v - \tau p_1 - t(1 - y)) dy, \\ &= \theta_0 (1 - \theta_1) \left(\tilde{x}_0 (v - \tau p_0) - \frac{t}{2} \tilde{x}_0^2 \right) + \theta_1 (1 - \theta_0) \left(\tilde{x}_1 (v - \tau p_1) - \frac{t}{2} \tilde{x}_1^2 \right). \end{aligned} \quad (31)$$

Note that C measures the improvements in *matching* due to detailing, while D measures social benefits of *increased consumption* due to detailing. The consumer surplus for the patients that visit uninformed physicians are zero. Total consumer surplus is thus,

$$CS = N(C + D) \quad (32)$$

Total welfare is defined as the consumers' surplus and firms' profits (producers' surplus) net of the third-party transfers. Formally, welfare is given by:

$$W = CS + \pi_0 + \pi_1 - (1 - \tau)(p_0 Q_0 + p_1 Q_1).$$

Here the last term refers to the third-party payer's expenditure. Evidently a moral hazard problem will lead to an expansion of pharmaceutical expenditure whenever patients are, in the presence of health insurance, only exposed to a share $\tau < 1$ of the price of drugs. Generally, pharmaceutical expenditure is not a purely redistributive transfer, as is assumed here, but carries a social cost, e.g. due to the distorting effect of taxation or social insurance on labour supply. If this cost was sufficiently high this would imply an a priori case of excessive advertising and may justify a ban of DTCA. In order to isolate some of the more intricate effects on social welfare of advertising we assume the absence of any costs of funds implying that health care expenditure as such is purely redistributive and carries no social cost. To this end, the social planner is not concerned about moral hazard effects. As we will see in the following advertising may be socially wasteful nonetheless.

Collecting terms, social welfare can be written as:

$$W = N \cdot \Omega - K(\theta_0, \Phi_0) - K(\theta_1, \Phi_1), \quad (33)$$

where

$$\begin{aligned} \Omega \equiv & \theta_0 \theta_1 \left(v - \frac{t}{2} (\hat{x}^2 + (1 - \hat{x})^2) \right) \\ & + \theta_0 (1 - \theta_1) \tilde{x}_0 \left(v - \frac{t}{2} \tilde{x}_0 \right) + \theta_1 (1 - \theta_0) \tilde{x}_1 \left(v - \frac{t}{2} \tilde{x}_1 \right). \end{aligned} \quad (34)$$

Observe that welfare does not directly depend on prices. The social planner's problem is to maximise (33) with respect to \hat{x} , \tilde{x}_i , θ_i and Φ_i . The solution to this problem defines first-best and is given by the following set of first-order conditions:

$$\frac{\partial W}{\partial \hat{x}} = N \cdot [\theta_0 \theta_1 t (1 - 2\hat{x})] = 0, \quad (35)$$

$$\frac{\partial W}{\partial \tilde{x}_i} = N \cdot [\theta_i (1 - \theta_j) (v - t\tilde{x}_i)] = 0, \quad (36)$$

$$\frac{\partial W}{\partial \theta_i} = N \cdot \frac{\partial \Omega}{\partial \theta_i} - \frac{\partial K}{\partial \theta_i} = 0, \quad (37)$$

$$\frac{\partial W}{\partial \Phi_i} = (1 - z) (1 - \Phi_j) \cdot \Omega - \frac{\partial K}{\partial \Phi_i} = 0, \quad (38)$$

where

$$\frac{\partial \Omega}{\partial \theta_i} = \theta_j \left(v - \frac{t}{2} (\hat{x}^2 + (1 - \hat{x})^2) \right) + (1 - \theta_j) \tilde{x}_i \left(v - \frac{t}{2} \tilde{x}_i \right) - \theta_j \tilde{x}_j \left(v - \frac{t}{2} \tilde{x}_j \right).$$

From (36) we see that the first-best prescription choice in the competitive segment is

$$\hat{x}^{fb} = \frac{1}{2}. \quad (39)$$

Thus, the fully informed physicians should prescribe drug 0 to every individual with a disease type within the interval $[0, 1/2]$ and drug 1 to every individual with a disease type within $(1/2, 1]$. Clearly, this is the prescription choice that minimises the mismatch costs under symmetry. It is also clear that there is no divergence between the first-best and the equilibrium market share in this regard.

From (35) we obtain the first-best prescription choice of the monopolistic segment:

$$\tilde{x}_0^{fb} = \tilde{x}_1^{fb} = \begin{cases} \frac{v}{t} & \text{if } v < t \\ 1 & \text{if } v \geq t \end{cases}.$$

Thus, the partially informed physicians should prescribe the known drug to every visiting patient if the effectiveness of the drug, v , is sufficiently large relative to the mismatch costs, t . However, if $v < t$, then the first-best implies $\tilde{x}_i^{fb} < 1$. Obviously, this implies two candidates for first-best detailing and DTCA. In the price competition case, we know from (23) that $v > t$ for the equilibrium to be well-defined. In the following, we therefore assume $v \geq t$ and thus $\tilde{x}_i^{fb} = 1$. Given this assumption, the (symmetric) first-best detailing and DTCA levels are defined by the following two equations:

$$[z + (1 - z)\Phi(2 - \Phi)] \cdot \left[v(1 - \theta) - \frac{t}{4}(2 - 3\theta) \right] - K_\theta = 0 \quad (40)$$

$$(1 - z)(1 - \Phi) \cdot \theta \left[v(2 - \theta) - \frac{t}{4}(4 - 3\theta) \right] - K_\Phi = 0 \quad (41)$$

Having derived the first-best, we want to analyse whether the equilibrium detailing and DTCA levels are excessive or suboptimal from a welfare point-of-view. Comparing (40) and (41) with the price regulation outcomes in (12) and (13) we find that equilibrium detailing is equal to first-best if and only if the following is true:

$$v(1 - \theta^{fb}) - \frac{t}{4}(2 - 3\theta^{fb}) = p^k \left[(1 - \theta^{fb}) \left(\frac{v - \tau p^k}{t} \right) + \frac{\theta^{fb}}{2} \right], \quad (42)$$

where the superscript denotes whether it is the price regulation or the price competition case, i.e., $k = r, c$. Moreover, equilibrium DTCA is equal to first-best DTCA if the following is true:

$$v(2 - \theta^{fb}) - \frac{t}{4}(4 - 3\theta^{fb}) = p^k \left[(1 - \theta^{fb}) \left(\frac{v - \tau p^k}{t} \right) + \frac{\theta^{fb}}{2} \right]. \quad (43)$$

Define as $\hat{\tau}_\theta^k$ and $\hat{\tau}_\Phi^k$ the two values of τ for which (42) and (43) are satisfied as equalities, i.e., the values of τ for which $\theta^k = \theta^{fb}$ and $\Phi^k = \Phi^{fb}$. Observing that $\theta^k \leq \theta^{fb} \iff \tau > \hat{\tau}_\theta^k$ and $\Phi^k \leq \Phi^{fb} \iff \tau > \hat{\tau}_\Phi^k$, we obtain the following proposition.

Proposition 5 *Under price regulation the following is true: (ia) For a 'low' price $p \in [v - \frac{t}{2}, 2v - t]$ DTCA is always suboptimal and detailing is suboptimal if and only if z is sufficiently low and $\tau > \hat{\tau}_\theta^r$. (ib) For a 'high' price $p \in [2v - t, 2v - \frac{t}{2}]$ DTCA is excessive if and only if z is sufficiently low $\tau < \hat{\tau}_\Phi^r$, while detailing is always excessive. (ii) Under price competition DTCA and detailing are excessive if $\tau < \hat{\tau}_\Phi^c$, DTCA is suboptimal and detailing is excessive if $\hat{\tau}_\Phi^c < \tau < \hat{\tau}_\theta^c$, and DTCA and detailing are suboptimal if z is sufficiently low and $\tau > \hat{\tau}_\theta^c$.*

Whether DTCA and detailing are excessive or suboptimal under price regulation depends crucially on the price that is implemented and on the copayment rate. Here, a relatively low level of price leads to suboptimal DTCA for any admissible level of the co-payment. Nonetheless the incentive of firms to over-invest in detailing leads to a level that is excessive from a social point of view, too, when insurance is sufficiently generous. Note the additional dependency on the share of patients z who visit the physician even in the absence of DTCA. As we have seen, a high z tends to boost the equilibrium level of detailing θ^r which may turn out to be socially excessive even in the presence of substantial coinsurance. A relatively high price level leads to excessive detailing irrespective of the coinsurance rate. The high price combined with the high levels of detailing also boost the incentive to engage in DTCA and this is now excessive unless this effect is offset by high coinsurance. Again if the incentives to engage in detailing are very high for a high z no admissible coinsurance rate can stifle the tendency towards socially excessive DTCA.

The problem is similar in the case of price competition. Again, a generous insurance system with a low copayment, provides strong incentives for the firms to invest in marketing. The reason is that a low τ enables the firms to charge higher prices without losing demand in the monopolistic segment. This makes it more profitable for the firms to attract more patients to the market (DTCA), and to inform a larger fraction of physicians about their drug (detailing). Since the social marginal benefit of the two marketing strategies is independent of the copayment rate (and the price), we have cases both of excessive and suboptimal marketing. The proposition also demonstrates that excessive detailing is more likely to arise than excessive DTCA. The explanation is once more due to the public good nature of DTCA and the business-stealing effect of detailing that induce the firms to expend too little on DTCA and too much on detailing.

Optimal price regulation and insurance (copayment rates) are clearly outside the scope of this paper. Price regulation is mainly concerned with the trade-off between R&D incentives and cost containment, while insurance is concerned with moral hazard and adverse selection problems. However, Proposition **X** contains some policy implications not irrelevant for this industry taking into account the amount of money pharmaceutical firms spend on marketing.

Corollary 1 *First-best detailing and DTCA are in general not achievable via price and/or*

co-payment regulation. In particular, the regulator needs to trade-off suboptimal DTCA against excessive detailing.

In the price competition case, the regulator has one instrument, τ , to induce socially optimal levels of three variables, θ , Φ and p . This is clearly a difficult issue. In the price regulation case, the regulator has in fact two instruments, τ and p , to induce optimal levels of two variables, θ and Φ . However, since these instruments cannot be tailored at neither detailing nor DTCA, and since they have the same effect on both marketing strategies, it follows that in general first-best cannot be achieved. We show that first-best detailing is obtained at the expense of suboptimal levels of DTCA, and vice versa, first-best DTCA is obtained at the expense of excessive levels of detailing.

Although there are obvious social gains of DTCA, we cannot rule out that allowing DTCA actually lowers welfare. In particular, for low copayment levels, the firms provide excessive levels of detailing, and possibly also of DTCA. In this case, the marketing costs may exceed its benefits, leading to lower welfare. Assuming symmetry, and collecting terms, we can write the social welfare function as

$$W(\theta, \Phi) = N(\Phi) \cdot \theta \left[\theta \left(v - \frac{t}{4} \right) + (1 - \theta) \frac{v^2 - (\tau p)^2}{t} \right] - 2K(\theta, \Phi). \quad (44)$$

The criteria for DTCA to be socially beneficial is the following

$$\Delta W(\Phi) \equiv W[\theta(\Phi), \Phi] - W[\theta(0), 0] > 0, \quad (45)$$

where $\theta(\Phi)$ is the best choice of detailing for a level Φ of DTCA. An analytical approach to this comparison of welfare levels with and without DTCA proves to be intractable. We therefore resort to numerical analysis. As for the previous numerical analysis, we assume the advertising cost function takes the following form: $K(\theta, \Phi) = \frac{1}{2}(\theta^2 + \Phi^2)$. Although we restrict ourselves to a relatively small set of numerical examples, several regularities can be identified that shed some light on the mechanisms of the model.

Consider first the case of price regulation. Table 4 below provides a numerical illustration of the welfare effects of allowing DTCA depending on the regulated price (p), the fraction of regular patients (z), and the copayment rate (τ).

Table 4: $\Delta W(\Phi)$ depending on p , z and τ - price regulation

	$p = 2.4$		$p = 1.5$	
z	$\tau = 0.35$	$\tau = 0.50$	$\tau = 0.55$	$\tau = 0.80$
0.2	-.0270	-.0217	.1856	.0810
0.4	-.0070	-.0014	.1451	.0862
0.6	-.0008	.0039	.0842	.0621
0.8	-	-	.0270	.0241

Assumptions: $v = 1.75$, $t = 1$

Interestingly, we see that DTCA improves welfare only if p is sufficiently low and τ is sufficiently high. The intuition is that for a high price and a low copayment, detailing is very likely to be excessive from a welfare perspective, as demonstrated above. In this situation, then an removal of a ban on DTCA, would lead to large investments in DTCA which in turn triggers even further investments in detailing. We also see that DTCA is more likely to be welfare improving in cases with a small "potential" market.

Consider now the case of price competition. Evaluating the expression in (45) for different levels of z and τ , we can compile the following table.

Table 5: $\Delta W(\Phi)$ depending on z and τ - price competition

z/τ	0.4	0.41	0.42	0.43	0.44	0.45
0	-	-0.0658	-0.0318	-0.0037	0.0202	0.0409
0.2	-0.0743	-0.0350	-0.0044	0.0209	0.0425	0.0611
0.4	-	-0.0334	-0.0079	0.0129	0.0303	0.0454
0.6	-	-0.0433	-0.0222	-0.0061	0.0067	0.0174
0.8	-	-	-	-	-0.0111	-0.0043

Assumptions: $v = 1.75$; $t = 1$

Each cell gives the differential welfare $\Delta W(\Phi)$ for a particular combination of z and τ .²⁸ Note that $\Delta W(\Phi)$ tends to increase in the co-payment τ for any value of z .²⁹ Indeed, it

²⁸Empty cells correspond to combinations of z and τ that are non-admissible as they would give rise to a level of detailing $\theta > 1$.

²⁹We have omitted $z = 1$ as this implies the trivial outcome $\Delta W(\Phi) = 0$. Note, however, that for $z \rightarrow 1$ we obtain $\Delta W(\Phi) < 0$ for all admissible $\tau < 0.5$. Hence, the argument we present in the following extends

is true for all z that $\Delta W(\Phi) < 0$ if and only if the co-payment falls below some threshold.³⁰ Low co-payment rates allow the duopolists to charge high prices. More specifically under substantial co-payments price may exceed the average consumer surplus. This is due to moral hazard on the part of the physician who only considers the effective price τp charged to the patient. While excessive prices do not constitute a welfare loss as such, they provide strong incentives to engage in advertising. As it turns out advertising may then be excessive from a welfare point of view, where the improvements in the allocation of drugs to patients is more than offset by the advertising cost. A ban on DTCA may then be socially desirable as it curbs the incentive to engage in detailing, leading to a reduction in cost that more than compensates the loss in consumer surplus due to a lower market coverage.

Somewhat surprisingly, the impact of the share of patients z who are regular visitors to the physician on $\Delta W(\Phi)$ is not monotonous. Note that for all τ , differential welfare $\Delta W(\Phi)$ is increasing in z at low levels of z but then decreasing, eventually turning negative as z becomes sufficiently large.³¹ For high numbers of regular visitors to the doctor, the potential underinvestment in DTCA on the part of firms makes little difference from a social point of view. However, as a high z tends to boost detailing competition, overinvestment is likely from a social point of view. As we see, a ban on DTCA is then usually warranted on welfare grounds. Note that as z approaches 1 the welfare difference $\Delta W(\Phi)$, albeit negative, becomes arbitrarily small. This is because even in the absence of a ban, firms will engage in close to none DTCA. But then the additional impact on wasteful detailing of permitting DTCA is small and so is the associated welfare loss. While banning DTCA is still advisable under these circumstances, the social stakes are relatively low under these circumstances. The findings are more mixed for low levels of z . Here, a ban is warranted only if the co-payment rate is sufficiently small. The case $\tau = 0.43$ is particularly instructive. Here, $\Delta W(\Phi) < 0$ obtains for $z = 0$ and $z = 0.6$ but not for the intermediate values $z = 0.2$ and $c0.4$. The issue for $z = 0$ is that while DTCA is a prerequisite to generate any patient

to $z \in (0.8, 1)$.

³⁰It can be shown that $\Delta W(\Phi) > 0$ is true for all τ in above this threshold including all the possible 'large' values of τ that remain unreported here.

³¹For $\Delta W(\Phi) < 0$ at $z \in (0.8, 1)$, we have $\frac{d\Delta W(\Phi)}{dz} > 0$ again. However, $\Delta W(\Phi) < 0$ will then pertain for all $z \in (0.8, 1)$.

surplus at all, these gains still tend to be limited to a relatively small share N of visitors. But then the benefits of detailing competition spread across too small a share of attending patients as to offset the cost, giving rise to a negative net surplus. As an increase in z allows a greater share of patients N to benefit from the improved matching under detailing, this tends to overturn the negative net surplus.

Table 6: $\Delta W(\Phi)$ depending on t and τ - price competition

t/τ	0.4	0.41	0.42	0.43	0.44	0.45
0.875	0.0417	0.0505	0.0587	0.0663	0.0733	0.0798
0.9	0.0278	0.038	0.0475	0.0561	0.064	0.0712
0.95	-0.0072	0.008	0.0212	0.0331	0.0435	0.053
1.0	-	-0.0376	-0.0147	0.0037	0.0188	0.0317
1.05	-	-	-	-0.0452	-0.016	0.0045
1.1	-	-	-	-	-	-0.0423

Assumptions: $v = 1.75$; $z = 0.5$

The dependency of $\Delta W(\Phi)$ on the degree of differentiation (transport cost) t is more straightforward. The poorer is the substitutability between the drugs, i.e. the higher t , the lower is the net welfare gain from allowing DTCA. This is true for any rate of co-payment. There are two reasons for why greater differentiation erodes the social gains from DTCA. First, a greater t implies a lower benefit from the drug for those patients who do not receive their ideal drug. This lowers the direct social return from DTCA (and detailing). Second, as greater differentiation allows the firms to set higher prices, this provides an additional incentive to engage in excessive marketing, in particular, in excessive detailing. If the over-investment in marketing grows in strength for relatively high t , this leads to a further reduction in the social return to DTCA.

We can summarise our findings in the following Proposition.

Proposition 6 (i) *The availability of DTCA improves social welfare if and only if the copayments are sufficiently high. (ii) There exists a range of co-payments for which DTCA improves social welfare if and only if the share of regular patient visits, z , takes on an intermediate value. (iii) Given the rate of coinsurance, DTCA is more prone to improve social welfare for drugs that are good substitutes.*

Thus, in health systems with generous insurance, it is likely that firms spend excessive amounts of resources on marketing, not only to physicians, but also to consumers. As a consequence, the benefits of detailing due to improved matching and DTCA due to less undertreatment are more than offset by the cost of marketing. Consequently only health care systems with less generous insurance should expect to benefit from DTCA.

6 Concluding remarks

In this paper we have studied the effects of DTCA in the prescription drug market. Especially, we have been concerned with the effect of DTCA on firms' profits and social welfare. Building on the informative advertising models developed by Butters (1977), Grossman and Shapiro (1984), among others, we have focused on the interaction between consumer-oriented (DTCA) and physician-oriented (detailing) marketing. Due to the variation of health care systems, we have analysed both the case with and the case without price regulation. We have also analysed different generosity levels of insurance (copayments).

Considering the profitability of DTCA, the paper reports the following three findings: First, we show that DTCA and detailing are complementary strategies for the firms. Thus, allowing DTCA increases spending on detailing. Second, firms tend to overinvest in detailing and underinvest in DTCA from an industry perspective. This is due to the market-expanding effect of DTCA and the business-stealing effect of detailing. Third, we show that firms benefit from DTCA if the detailing technology is sufficiently costly. Otherwise, firms compete intensive in terms of detailing, implying that an allowance of DTCA would induce even more excessive detailing.

Turning to welfare, we derive the following results: First, we show that both DTCA and detailing can be excessive or suboptimal depending on the copayment. Generally, first-best cannot be achieved, and the regulator must trade-off suboptimal levels of DTCA against excessive levels of detailing. Once more this reflects the public good nature of DTCA and the business-stealing effect of detailing. Second, we find that the impact of DTCA on welfare is generally ambiguous, and depends on, especially, the copayment rate and the advertising technology.

The model is closely linked to empirical findings and stylised facts of marketing in the

prescription drug market. In this sense it contributes to explaining and interpreting the empirical findings. It also contributes to the theoretical literature, not only by filling the gap with respect to DTCA, but also by extending the basic model to involve two marketing strategies.

We should stress two conceptual aspects of our finding. First, by modelling both DTCA and detailing as informative, we have depicted, in a way, the most positive case for advertising. The fact that our findings suggest that - at least DTCA - may not be socially beneficial for the low levels of coinsurance that are prevalent in most health care systems tends to reinforce a potential case against DTCA. Note that this is so despite the unambiguous benefit on the part of consumers from advertising - at least in the absence of price competition. Second, the reason for excessive advertising lies in what one may consider an indirect cost of 'moral hazard'. The presence of moral hazard allows monopolistic firms to shift surplus from the tax-payer. Although we ignore the direct social costs of excessive pharmaceutical budgets, the rent-seeking effort on the part of firms, here in the form of excessive marketing activity, constitutes a social waste in as far as these activities are stretched beyond their value to patients. The bottom line is that a welfare evaluation of the losses from moral hazard in health insurance may well underestimate the social cost of moral hazard if the additional waste from rent-seeking activities such as advertising are ignored.

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A Appendix: Proofs of Lemmas and Propositions

Proof of Lemma 1: First, evaluating (12) and (13) for the corner-solutions, we get

$$\left. \frac{\partial \pi}{\partial \Phi} \right|_{\Phi=0} = pM(1-z) > 0, \quad \text{and} \quad \left. \frac{\partial \pi}{\partial \Phi} \right|_{\Phi=1} = -K_{\Phi}(1) < 0,$$

$$\left. \frac{\partial \pi}{\partial \theta} \right|_{\theta=0} = pN\tilde{x} > 0, \quad \text{and} \quad \left. \frac{\partial \pi}{\partial \theta} \right|_{\theta=1} = p\frac{N}{2} - K_{\theta}(1) < 0.$$

This proves that the equilibrium is interior.

Uniqueness is checked by calculating the Jacobian, which is given by:

$$\begin{aligned} |J| &= (pN(x-1/2) + K_{\theta\theta})(pM(1-z) + K_{\Phi\Phi}) \\ &\quad - p^2(1-z)^2(1-\Phi)^2(\tilde{x} - \theta\tilde{x} + \theta/2)(2\tilde{x} - 4\theta\tilde{x} + 2\theta) \end{aligned}$$

From the second-order conditions, see footnote x, the following must be true in equilibrium

$$K_{\theta\theta}K_{\Phi\Phi} > p^2(1-z)^2(1-\Phi)^2[\tilde{x} - \theta\tilde{x} + \theta/2]^2.$$

Then it is easily verified that $|J| > 0$. This completes the proof. ■

Proof of Proposition 2: From (19) we see that $\Delta\pi(0) = 0$. Write the equilibrium detailing condition, given by (12), in the following way $pN(\Phi)M(\theta^r) = \theta^r K_{\theta}(\theta^r)$. Inserting this into (19), we obtain the following expression:

$$\Delta\pi(\theta^r(\Phi), \Phi) = \theta^r(\Phi) \cdot K_{\theta}(\theta^r(\Phi)) - pM(\theta^r(0))z - K(\theta^r(\Phi), \Phi) + K(\theta^r(0), 0), \quad (46)$$

which now is a function of DTCA only. Differentiating this with respect to Φ , we get:

$$\frac{d\Delta\pi}{d\Phi} = \frac{d\pi}{d\Phi} = \theta^r K_{\theta\theta} \frac{d\theta^r}{d\Phi} - K_{\Phi}. \quad (47)$$

Then insert (??) and rearranging the expression, we obtain:

$$\frac{d\Delta\pi}{d\Phi} = K_{\theta\theta} \frac{2p(1-z)(1-\Phi)M}{pN(\tilde{x} - \frac{1}{2}) + K_{\theta\theta}} - K_{\Phi}, \quad (48)$$

which can be positive and negative depending on the relative size of the two terms. Evaluating (48) for the equilibrium DTCA level, given by (13), and rearranging the expression, we obtain the following:

$$\left. \frac{d\pi}{d\Phi} \right|_{\Phi=\Phi^r} = K_{\Phi} \left[\frac{K_{\theta\theta} - pN(\tilde{x} - \frac{1}{2})}{K_{\theta\theta} + pN(\tilde{x} - \frac{1}{2})} \right]. \quad (49)$$

Obviously, this is positive if and only if $K_{\theta\theta} > pN(\tilde{x} - 1/2)$. Using the detailing condition in (12) once more, we can rewrite the condition as follows:

$$\frac{K_{\theta\theta}}{K_\theta} > \frac{\tilde{x} - 1/2}{\tilde{x} - \theta(\tilde{x} - 1/2)}, \quad (50)$$

where it is readily verified that³²

$$\frac{\tilde{x} - 1/2}{\tilde{x} - \theta(\tilde{x} - 1/2)} \in (0, 1). \blacksquare$$

Proof of Proposition 3: The sign of (26) and (27) are both determined by the sign of

$$\theta(1 - \theta) \left(\frac{v - 2\tau p}{t} \right) + \frac{\theta^2}{2}.$$

Evaluating this for the equilibrium price level, given by (21), we obtain:

$$\theta^2 \frac{2v(1 - \theta) + t\theta}{2t(4 - 3\theta)},$$

which is positive for any valid values of θ, v and t . Thus, the following is true:

$$\begin{aligned} \frac{d\theta^c}{dp} &= \frac{N\theta^2 [2v(1 - \theta) + t\theta]}{[pN(\tilde{x} - \frac{1}{2}) + K_{\theta\theta}] [2t(4 - 3\theta)]} > 0, \\ \frac{d\Phi^c}{dp} &= \frac{(1 - z)(1 - \Phi)\theta^2 [2v(1 - \theta) + t\theta]}{[pM(1 - z) + K_{\Phi\Phi}] [2t(4 - 3\theta)]} > 0. \end{aligned}$$

Finally, the interaction between detailing and DTCA (14) and (15), and the interaction between detailing and price is given by (24). This completes the proof. \blacksquare

Proof of Proposition 4: From (19) we see that $\Delta\pi(0) = 0$. Write the first-order condition for detailing, as given by (12), in the following way $p^c N(\Phi) M(\theta^c) = \theta^c K_\theta(\theta^c)$. Inserting this into (19), we obtain the following expression:

$$\Delta\pi(\theta^c(\Phi), \Phi) = \theta^c(\Phi) \cdot K_\theta(\theta^c(\Phi)) - \theta^c(0) \cdot K_\theta(\theta^c(0)) - K(\theta^c(\Phi), \Phi) + K(\theta^c(0), 0), \quad (51)$$

which is now a function of DTCA only. Differentiating this with respect to Φ , we obtain:

$$\frac{d\Delta\pi}{d\Phi} = \frac{d\pi}{d\Phi} = \theta^c(\Phi) K_{\theta\theta} \frac{d\theta^c}{d\Phi} - K_\Phi. \quad (52)$$

³²The concavity of $\frac{d\pi}{d\Phi}$ can be established under some mild conditions.

Note that the best-response functions $\theta^c(\Phi)$ and $p^c = p^c(\Phi)$ follow from the system of first-order-conditions (??) and (21). Applying Carmer's rule we can calculate

$$\frac{d\theta^c}{d\Phi} = \frac{2(1-z)(1-\Phi)(4-3\theta^c)\tau p^c M}{\theta^c |J'|}, \quad (53)$$

where

$$|J'| := \tau(4-3\theta^c) \left\{ K_{\theta\theta} + p^c N \left[\tilde{x} - \frac{1}{2} - \frac{\theta^c(2t-v)}{t(4-3\theta^c)^2} \right] \right\} > 0 \quad (54)$$

is the Jacobian determinant of the system (??) and (21) and where $\tilde{x} = \frac{v-\tau p^c}{t} \geq \frac{1}{2}$.³³

Inserting into (52) from (53) and rearranging, we obtain:

$$\frac{d\Delta\pi}{d\Phi} = 2K_{\theta\theta}(1-z)(1-\Phi)(4-3\theta^c)\tau p^c M |J'| - K_{\Phi}. \quad (55)$$

Evaluating (48) for the equilibrium DTCA level, given by (13), and rearranging the expression, we obtain

$$\frac{d\pi}{d\Phi} \Big|_{\Phi=\Phi^r} = \frac{K_{\Phi}\tau(4-3\theta^c)}{|J'|} \left\{ K_{\theta\theta} - p^c N \left[\tilde{x} - \frac{1}{2} - \frac{\theta^c(2t-v)}{t(4-3\theta^c)^2} \right] \right\}. \quad (56)$$

The RHS is positive if and only if the term in bracelets is positive. Using the first-order condition in (12), we can rewrite the condition as follows

$$\frac{K_{\theta\theta}}{K_{\theta}} > \frac{\tilde{x} - \frac{1}{2} - \frac{\theta^c(2t-v)}{t(4-3\theta^c)^2}}{\tilde{x} - \theta(\tilde{x} - \frac{1}{2})} = \frac{\tilde{x} - \frac{1}{2} - \frac{\tau\theta^c}{2t} \frac{\partial p^c}{\partial \theta}}{\tilde{x} - \theta(\tilde{x} - \frac{1}{2})}, \quad (57)$$

where the equality follows under observation of $\frac{\partial p^c}{\partial \theta^c} = \frac{2(2t-v)}{\tau(4-3\theta^c)^2} > 0$. It is readily verified that $\frac{\tilde{x} - \frac{1}{2} - \frac{\tau\theta^c}{2t} \frac{\partial p^c}{\partial \theta}}{\tilde{x} - \theta(\tilde{x} - \frac{1}{2})} < 1$ for all v and t and $\frac{\tilde{x} - \frac{1}{2} - \frac{\tau\theta^c}{2t} \frac{\partial p^c}{\partial \theta}}{\tilde{x} - \theta(\tilde{x} - \frac{1}{2})} < 0 \Leftrightarrow v \leq \frac{t(8-6\theta^c+3\theta^{c2})}{(8-8\theta^c+3\theta^{c2})}$. This completes the proof of part (i). Part (ii) follows directly from a comparison of the RHS in (50) and (57). ■

Proof of Proposition 5: Consider first the case of price regulation ($k=r$), where $p^r = p$. Noting that θ^{fb} is independent of τ and p , it is readily verified from (42) and (43) that

$$\theta^r \leq \theta^{fb} \Leftrightarrow \tau > \frac{p \left[(1-\theta^{fb})v + \frac{\theta^{fb}}{2}t \right] - t \left[v(1-\theta^{fb}) - \frac{t}{4}(2-3\theta^{fb}) \right]}{(1-\theta^{fb})p^2} =: \hat{\tau}_{\theta}^r, \quad (58)$$

³³It can be verified that $|J'| > 0$ for any convex function $K(\theta)$.

$$\Phi^r \leq \Phi^{fb} \Leftrightarrow \tau > \frac{p \left[(1 - \theta^{fb}) v + \frac{\theta^{fb}}{2} t \right] - t \left[v (2 - \theta^{fb}) - \frac{t}{4} (4 - 3\theta^{fb}) \right]}{(1 - \theta^{fb}) p^2} =: \hat{\tau}_{\Phi}^r. \quad (59)$$

It is easy to check that $\hat{\tau}_{\Phi}^r < \hat{\tau}_{\theta}^r$. Given v, t and p , the constraint in (11) and $\tau \leq 1$ imply that $\tau \in [\tau_{\min}, \tau_{\max}]$, where $\tau_{\min} := \frac{v-t}{p}$ and $\tau_{\max} := \max \left\{ \frac{v-t/2}{p}, 1 \right\}$. We then need to establish the conditions under which $\hat{\tau}_{\theta}^r$ and $\hat{\tau}_{\Phi}^r$ fall into the interval $[\tau_{\min}, \tau_{\max}]$. In order to contain the tedium of the analysis, we focus on a limited range of prices $p \in \left[v - \frac{t}{2}, 2v - \frac{t}{2} \right]$, which is sufficient to illustrate the key points.³⁴ Since $p \geq v - \frac{t}{2}$, we have $\tau_{\max} = \frac{v-t/2}{p}$. Using the definitions in (58) and (59), respectively, it can be checked that $p \in \left[v - \frac{t}{2}, 2v - \frac{t}{2} \right]$ implies $\hat{\tau}_{\theta}^r > \tau_{\min}$ and $\hat{\tau}_{\Phi}^r < \tau_{\max}$ for all $\theta^{fb} \in [0, 1]$. Furthermore, we obtain

$$\hat{\tau}_{\theta}^r < \tau_{\max} \Leftrightarrow F(p, \theta^{fb}) = \frac{p}{2} - v + \frac{t}{2} + \theta^{fb} \left(v - \frac{3t}{4} \right) < 0, \quad (60)$$

$$\hat{\tau}_{\Phi}^r > \tau_{\min} \Leftrightarrow G(p, \theta^{fb}) = p - 2v + t - \theta^{fb} \left(\frac{p}{2} - v + \frac{3t}{4} \right) > 0. \quad (61)$$

Consider (60) first, where $F_{\theta}(p, \theta^{fb}) > 0$, $F(p, 0) = \frac{p}{2} - v + \frac{t}{2}$ and $F(p, 1) = \frac{p}{2} - \frac{t}{4} > 0$ since $p > v - \frac{t}{2}$. Noting that $F(p, 0) > 0 \Leftrightarrow p > 2v - t$ it follows that $\hat{\tau}_{\theta}^r < \tau_{\max}$ if and only if $p < 2v - t$ and $\theta^{fb} < \frac{v - \frac{p}{2} - \frac{t}{2}}{v - \frac{3t}{4}} =: \bar{\theta}_{\theta}^r$. Now consider (61). Note that $p < 2v - \frac{t}{2}$ implies that $p - 2v + t < \frac{p}{2} - v + \frac{3t}{4}$. This can be used to show that $p < 2v - t \implies G(p, \theta^{fb}) < 0$. Now suppose $p > 2v - t$. As this implies $0 < p - 2v + t < \frac{p}{2} - v + \frac{3t}{4}$, it follows that $G(p, \theta^{fb}) < 0$. Furthermore, $G(p, 0) = p - 2v + t > 0$ and $G(p, 1) = \frac{p}{2} - v + \frac{t}{4} < 0$ since $p < 2v - \frac{t}{2}$. But then, $\hat{\tau}_{\Phi}^r > \tau_{\min}$ if and only if $p > 2v - t$ and $\theta^{fb} < \frac{p - 2v + t}{\frac{p}{2} - v + \frac{3t}{4}} =: \bar{\theta}_{\Phi}^r$. Since θ^{fb} can be shown to be strictly increasing in z the conditions $\theta^{fb} < \bar{\theta}_{\theta}^r$ and $\theta^{fb} < \bar{\theta}_{\Phi}^r$, respectively, are satisfied if and only if z is sufficiently low. Using the above findings, we obtain parts (ia) and (ib) of the Proposition.

Now consider the case of price competition ($k = r$), where $p^c = \frac{2v(1 - \theta^{fb}) + t\theta^{fb}}{\tau(4 - 3\theta^{fb})}$. Using $p_0 := \tau p^c$ in (42) and (43) we obtain

$$\theta^c \leq \theta^{fb} \Leftrightarrow \tau > p_0 \sqrt{\frac{(2 - \theta^{fb})}{2t \left[v (1 - \theta^{fb}) - \frac{t}{4} (2 - 3\theta^{fb}) \right]}} =: \hat{\tau}_{\theta}^c, \quad (62)$$

$$\Phi^c \leq \Phi^{fb} \Leftrightarrow \tau > p_0 \sqrt{\frac{(2 - \theta^{fb})}{2t \left[v (2 - \theta^{fb}) - \frac{t}{4} (4 - 3\theta^{fb}) \right]}} =: \hat{\tau}_{\Phi}^c.$$

³⁴ A fuller analysis including other levels of p is available from the authors upon request.

Here, $0 < \hat{\tau}_{\Phi}^c < \hat{\tau}_{\theta}^c$ are readily verified. For $\theta^{fb} \leq 1$, no further restrictions on $\tau \in [0, 1]$ are required under price competition.

From (62) we have that $\hat{\tau}_{\theta}^c < 1 \Leftrightarrow H(\theta^{fb}) = \frac{p_0^2(2-\theta^{fb})}{2t[v(1-\theta^{fb})-\frac{t}{4}(2-3\theta^{fb})]} < 1$. It is then easily verified that $H'(\theta^{fb}) = \frac{p_0^2(v-t)}{2t[v(1-\theta^{fb})-\frac{t}{4}(2-3\theta^{fb})]^2} + \frac{p_0(2-\theta^{fb})}{t[v(2-\theta^{fb})-\frac{t}{4}(4-3\theta^{fb})]} \frac{\partial p_0}{\partial \theta} > 0$, $H(0) = \frac{v^2}{4t(v-t/2)} < 1$ and $H(1) = 2$. Thus, defining $\bar{\theta}^c := \theta^{fb} | H(0) = 0$, we have $\hat{\tau}_{\Phi}^c < 1 \Leftrightarrow \theta^{fb} < \bar{\theta}^c$. Again, this implies z being sufficiently low. This completes the proof of part (ii) of the Proposition. ■

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