Advertising and Generic Market Entry

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Abstract

The effect of advertising on generic market entry and social welfare is analysed. An incumbent has the possibility to invest in advertising which affects the prescribing physician’s perceived relative qualities of the brand-name and the generic version of the drug. Advertising thus creates product differentiation and can induce generic market entry which is deterred without differentiation due to strong Bertrand competition. Advertising can be welfare increasing, because it decreases prices after market entry. The conditions are analysed under which a strictly positive amount of advertising is socially efficient. The advantages of advertising are strengthened at the presence of a rather lenient price regulation, whereas a strict price regulation makes it redundant.

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1 Introduction

The health care market is very special because competition does often not work very well. Patients are uninformed and lack the information which treatment is most effective. They depend on physicians who diagnose and suggest some treatment. However, as physicians neither directly benefit from treatment nor must pay for it, they are a weak link between provider and consumer of a treatment. With their important position physicians directly affect the extent of competition between different providers of a certain treatment. So, the physician can be taken as the main determinant of whether a brand-name or a generic drug version is prescribed, as the empirical evidence in Hellerstein (1998) suggests. Therefore it is not surprising that in the pharmaceutical market, where price competition would be fierce if the products were not differentiated somehow, the physician is the target of huge advertising expenditures. Advertising expenditures with about 20-30 percent of sales are often even larger than those for R&D (Hurwitz and Caves (1988)). Jacobzone (2000) shows that within the OECD countries, the research-oriented pharmaceutical firms spent 24 percent of sales on marketing in 1989. And Scherer (2000) reports that in the US, the ethical pharmaceutical industry spent 18 percent of sales on marketing in 1997.

This article is concerned with a pharmaceutical market where after the expiry of a patent the incumbent faces the threat of generic market entry. During patent life the incumbent has the possibility to invest in advertising targeted at the prescribing physician with the effect that the brand-name drug’s quality is perceived as higher than the generic drug’s quality.\textsuperscript{1} With this artificial vertical product differentiation the incumbent can reduce competition after the patent expired and can additionally increase the monopoly price during patent life. Using the basic idea of Fudenberg and Tirole (1984) of building a stock of goodwill through advertising in a differentiated product market, this article shows that under certain circumstances advertising is both profitable for the brand-name firm and socially efficient. As detailing decreases competition, market entry for the generic firm is more profitable than without detailing where profits of both firms are driven down through fierce competition. Thus, similar

\textsuperscript{1}This kind of advertising will often be referred to as detailing in what follows. Detailing means that the pharmaceutical firms’ representative visits a physician in order to advertise a specific drug. Detailing with about 70 percent (Hurwitz and Caves (1988)) has the biggest share of advertising targeted to the physician. Additionally, advertising targeted at physicians also encompasses printed advertising, sponsored conferences, and so on.
to other models that focus on advertising as an instrument to build up goodwill, this model shows that advertising can be a means to accommodate market entry rather than to deter it. Additionally, advertising can be shown as socially optimal in certain circumstances, as generic market entry results in lower drug prices and more patients treated, where this effect is reduced the stricter is potential price regulation.

There is a rather extensive empirical literature that tries to capture the effect of advertising on generic market entry. Among them are e.g.:\(^2\)

Hurwitz and Caves (1988) find that current and past investments in goodwill (advertising) preserve the incumbent’s market share, whereas generic price discounts reduce it. These are exactly the effects that this model is based upon. But whereas Hurwitz and Caves (1988) conclude that advertising deters generic market entry, the present model requires a minimum amount of advertising to guarantee product differentiation and thus market entry. It is, however, in line with Hurwitz and Caves (1988) with respect to the result that generic market entry becomes less profitable, the more the incumbent invests in advertising.

Rizzo (1999) finds that brand-name advertising decreases the price-elasticity of demand in the pharmaceutical industry because it increases brand loyalty. He therefore concludes that advertising inhibits generic market entry. The present model incorporates the effect that advertising lowers the price sensitivity and therefore decreases the potential generic profit. However, a certain minimum amount of brand-name advertising is concluded to be optimal even for the generic firm.

So, given that there is a positive amount of advertising, the present model is in line with these two empirical studies. But neither Hurwitz and Caves (1988) nor Rizzo (1999) test the hypothetical situation of no advertising and its effect on generic market entry compared to some positive amount of advertising.

The closest relevant empirical study in this sense is maybe Scott Morton (2000). She examines the role of pre-expiration brand-name advertising on the generic market entry decision after patent expiry. She thereby assumes advertising to be an endogenous variable, as it is in the present model, which might be used to deter generic market entry. She finds that


\(^3\)See also the following rather old studies: Vernon (1971) finds no statistically significant effect of advertising on market entry. Telser et al. (1975) and Leffler (1980) both find a positive relationship between advertising and generic market entry.
advertising is not a barrier to market entry.

Theoretically, advertising in the pharmaceutical market has mostly been modelled with respect to competition between therapeutically equivalent brand name drugs, ie. horizontal product differentiation models have been applied: Konrad (2002) investigates the question whether marketing strategies distort the prescription choice and lead to suboptimal matches between patient types and pharmaceutical products. He shows that a large share of the possible producer rent is dissipated in the promotional competition, and the more price-cost margins differ between the producers, the larger is the share of wrong prescriptions.

Brekke and Kuhn (2003) analyse the interaction between detailing and direct-to-consumer advertising (DTCA) where they assume advertising to be informative, ie. it decreases any mismatches between product and patient. They find that firms respond to the opportunity of DTCA by lowering their spending on detailing because this softens detailing competition. Altogether the welfare impact of DTCA is ambiguous, because the social gains from DTCA may well be offset by the industry cost of DTCA.

Brand-name drugs are not therapeutically equivalent. They can be used to treat the same illness, however, patients differ in their susceptibility towards them. The objective quality is the same. On the contrary, brand-name and generic drugs are therapeutically equivalent by definition, but they differ in the perceived quality. At the same price every patient would prefer the brand-name product. Fridman et al (1987) found out, for example, that only half of 245 surveyed physicians believe that generic drugs are as effective as the original.

Cabrales (2004) studies oligopolistic competition in off-patent pharmaceutical markets where advertising is used to create perceived differences in the quality of the brand-name and generic drug. The model can both explain why countries with stricter price regulations have smaller generic market shares, and why countries optimally set price ceilings above marginal costs and thus above the minimal level that just guarantees the firms’ participation. The reason is that the firms’ investment in quality responds less than proportionally to the exogenously imposed price ceiling and this positive quality effect dominates the negative effect of higher prices for low price ceilings.

Equivalent to Cabrales (2004), the present model uses vertical product differentiation between brand-name and generic drugs. But it focuses on another aspect: It stresses that advertising is a way to induce the necessary differentiation between brand-name and generic
firms that makes generic market entry possible (whereas the entry decision in Cabrales (2004) is exogeneously given). Market entry creates competition after patent expiry and therefore reduces prices as compared to without market entry. A regulator who decides whether to allow advertising in the pharmaceutical market should therefore be aware of his decision’s impact on the market structure after patent expiry.

The situation is modelled in a 2-periods-game. The first period represents the period, in which the incumbent is protected by a patent. There is no competition, therefore the firm can set the monopoly price. Additionally, the optimal amount of detailing can be set, where detailing is modelled in a way that it increases the detailed physician’s quality perception of that drug. There are thus two markets. Detailed physicians perceive the brand-name quality to be higher than not-detailed physicians. Because of detailing, a higher monopoly price can be set in the first period.

In the second period, there is potential generic market entry. As market entry is costly (e.g. setup costs or costs for the necessary filing to get a concession), the expected generic profit must be high enough. If the incumbent did not invest in detailing in the first period, the perceived qualities do not differ, and fierce competition will drive down profits in the second period such that the generic firm will anticipate an expected loss and not enter the market. Detailing, however, creates vertical product differentiation and positive profits for both the incumbent and the entrant despite market entry.

This article is concerned about the question, whether and under which conditions detailing can be welfare increasing as it increases the probability of market entry and thus the access to lower generic prices. Advertising can be shown to decrease both brand-name and generic prices in the second period and therefore more patients will be treated with either of the two versions.

The paper is structured as follows: In section 2, the model is presented before the equilibrium of the game is analysed in section 3 with detailing and in section 4 without detailing. In the following section 5, the welfare implications are discussed. In section 6, price regulation will

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4This is in line with some articles in the medical literature which report about how advertising affects the physicians’ prescribing behaviour: Avon et al. (1982) find out, for example, that the physicians’ beliefs about certain drugs are more in line with the advertisement claims than actual measures of the pharmaceutical’s performance. Chren and Landefeld (1994) conclude that the likelihood for a physician to request a specific drug to be added to a hospital’s formulary positively depends on his interaction with the drug company.
be introduced. Finally, there is the conclusion where some policy implications are discussed.

# 2 The model

Assume that the market for prescription drugs consists of a continuum of patients distributed uniformly on the segment \([0, \bar{t}]\), where the patients suffer from the same illness which is treated with the same medication. The position \(t\) can be interpreted as the extent to which they are ill, and corresponds to their valuation for a specific drug \(v(t) = et\) with \(e > 0\) and \(v(0) = 0\). \(e\) is a parameter that indicates how price elastic demand is. The larger is \(e\), the larger is the price-inelastic part of demand compared to the price-elastic part of the demand function. \(v'(t) = e > 0\), i.e. the more severe the patients are ill, the higher is their willingness to pay for a specific drug. The patients are not informed about the available medication and therefore need to go to a physician to get a suitable prescription. There is a mass of \(N = 1\) ex ante identical physicians among whom they can choose and who are assumed to act in the patients’ best interest (i.e. it is abstracted from any agency problems).\(^5\) The physicians can perfectly observe \(t\) such that their ex ante valuation for a specific medication is also \(t\) and depends on the patient for whom to prescribe the drug. But physicians can be target of advertising. Physicians that are targeted and respond to advertising perceive the quality of the drug to be higher than those who are not targeted or do not respond to detailing. The advertising firm therefore decides on the fraction \(k\) of physicians that is supposed to be detailed and whose valuation increases from \(t\) to \(\theta t\) with \(\theta > 1\) where it is assumed that the effect of advertising does not cease.\(^6\) The cost of detailing \(A(k) = \frac{1}{\gamma+1}k^{\gamma+1}\) (with \(\gamma > 0\)) is assumed to be increasing in the fraction of physicians to be reached \((A'(k) = k^\gamma > 0)\) and convex \((A''(k) = \gamma k^{\gamma-1} > 0)\).\(^7\) Note that due to \(k \in [0, 1]\), the advertising costs are smaller, the larger is \(\gamma\). After detailing, physicians therefore differ in their quality perception which they base their prescription choice upon. Patients cannot observe whether a physician has been detailed or not, therefore it is assumed that every physician has the same representative

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\(^5\)It is of course more realistic to model explicitly the relationship between the physician and the patient, as the physician might not only incorporate the patient’s utility, but also his own financial benefits. If he is corrupted by the pharmaceutical firm, then his prescription choice might be further distorted. But to stress the point that I want to make, this assumption is left out for mathematical convenience.

\(^6\)Alternatively, physicians can be seen as both optimizing their patients’ utility and being corrupted or obliged to the pharmaceutical company to the extent of \(\theta\).

\(^7\)That is a standard cost function in this strand of literature. See e.g. Cabrales (2004).
sample of patients uniformly distributed on \([0, \bar{t}]\).

The sequence of events is the following:

<table>
<thead>
<tr>
<th>Stage 0</th>
<th>Period 1: Patent Protection</th>
<th>Period 2: No Patent Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>The regulator decides whether advertising is allowed.</td>
<td>B chooses a detailing level (k) (if advertising is allowed).</td>
<td>B chooses the price level (p^*_B).</td>
</tr>
<tr>
<td></td>
<td>G’s market entry decision. ME: B and G choose simultaneously the prices (p^<em>_B) and (p^</em>_G). No ME: B chooses the price level (p^*_B).</td>
<td></td>
</tr>
</tbody>
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At stage zero, a benevolent regulator decides on whether advertising is allowed or not. Then the actual game starts.

In the first period (superscript = 1) there is only one brand-name firm in the market (indexed \(i = B\)) because it is protected by a patent. But the incumbent faces the threat of market entry after the patent expired.

If advertising was allowed in stage zero, the incumbent has two decisions to make in this period. First the incumbent chooses the optimal level of detailing \(k\), and then he decides on the optimal price level \(p^*_B\) where there is no price discrimination between detailed and not-detailed physicians possible. Demand consists of \(D^1_B(p^*_B, \theta) = \bar{t} - \frac{1}{\theta e} p^*_B\) from the \(k\) detailed physicians and \(D^1_B(p^*_B, 1) = \bar{t} - \frac{1}{e} p^*_B\) from the \((1 - k)\) not-detailed physicians. \(\bar{t}\) is the customer with the highest valuation for the drug and \(\frac{1}{\theta e} p^*_B\) defines the position \(t\) of the patient who is just indifferent between receiving the drug or not. The factor \(\frac{1}{\theta}\) is attached by the detailed physicians that perceive the quality to be higher and thus distort the indifferent patient downwards. Demand is higher, the lower is the price level and the larger is the perceived quality in the detailed market. The respective revenues are \(R^1_B(p^*_B, \theta) = (p^*_B - c) \cdot [\bar{t} - \frac{1}{\theta e} p^*_B]\) and \(R^1_B(p^*_B, 1) = (p^*_B - c) \cdot [\bar{t} - \frac{1}{e} p^*_B]\) where in what follows it will be abstracted from any variable costs \(c (c = 0)\).

If advertising was not allowed in stage zero, the decision on how much to spend on advertising becomes nonrelevant. The incumbent only decides on the optimal monopoly price level \(p^{1M}_B\) in the first period, where there is only one not-detailed market with the revenue \(R^1_B(p^*_B, 1) = p^*_B \cdot [\bar{t} - \frac{1}{e} p^*_B]\).

In the second period (superscript = 2), when the patent has expired, market entry by firm G (indexed \(i = G\), offering a generic version of the drug, is possible where there are some market entry costs \(F\), which are sunk after market entry has occurred. As the generic drug
had to prove bioequivalence, it can be assumed that both the brand-name and the generic version have the same quality normalized to 1 except for the difference in the perceived quality $\theta > 1$ that the detailed physicians attach to the brand-name version of the product. As a mathematical simplification, it is assumed that there is no more detailing possible in the second period, neither by the brand-name nor the generic firm.\footnote{It will be shown later that this assumption is in line with dynamic consistency, because the advertising level that the incumbent chooses in the first period is larger than what he would choose in the second period alone (see section 3.2.2).}

There are two cases possible:

If advertising was not allowed in the first period, then the incumbent will even after patent expiry face no competition, because no advertising means no product differentiation between the brand-name and the potential generic drug and thus fierce Bertrand competition. Bertrand competition results in zero returns for both firms and the generic firm’s sunk market entry costs cannot be recovered. The incumbent sets thus the optimal monopoly price $p_{BM}^2$. The revenue is $R_B^2(p_B^2, 1) = p_B^2 \cdot [\bar{t} - \frac{1}{e} p_B^2]$ in the single market of not-detailed physicians.

If, however, advertising was allowed in the first period, then there will be market entry (assuming that the sunk market entry costs $F$ are not too high).\footnote{See section 3.1.2 for a definition.} The revenues depend on both prices $p_B^2$ and $p_G^2$, whose optimal level the firms are assumed to set simultaneously, and on the perceived qualities. A vertical product differentiation model as in Shaked and Sutton (1982) must be applied in the detailed market. The incumbent’s revenue is $R_B^2(p_B^2, p_G^2, \theta) = p_B^2 \cdot [\tilde{t} - \hat{t}]$ and the entrant’s revenue is $R_G^2(p_B^2, p_G^2, \theta) = p_G^2 \cdot [\hat{t} - \frac{1}{e} p_G^2]$ with $\tilde{t}$ defined by $\theta e \hat{t} - p_B^2 = e \hat{t} - p_G^2 \Leftrightarrow \hat{t} = \frac{p_B^2 - p_G^2}{e(\theta - 1)}$. For $p_B^2 > p_G^2$ (which will later be shown to be the case in equilibrium), this means that there exists a $\hat{t}$ such that all patients with $t > \hat{t}$ receive the advertised drug, whereas all others receive the not-advertised drug. Any change in the price level or the perceived quality affects the demand, because the indifferent patient $\hat{t}$ changes. Demand for the brand-name firm decreases with the own price level and increases with the generic price level. The larger is the perceived quality difference, the larger is the incumbent’s demand, but it also weakens the own negative price effect, whereas it reinforces the competitor’s positive price effect. Demand for the generic firm reacts just the opposite way.

The not-detailed physicians do not believe that the two versions differ in quality. In this
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In what follows, the game will be solved by backward induction, first for the case that advertising was allowed in stage zero, and then in the following section for the case that advertising was not allowed.

3 The Equilibrium of the Game with Advertising

3.1 The Equilibrium in the Second Period

In the second period, the entrant decides whether to enter the market or not. Given market entry, the optimal prices in the second period can be found that form a Nash-Equilibrium in prices, whereas the monopoly price is set by the incumbent, if there is no market entry. In what follows, only the Nash-Equilibrium in prices with market entry is derived, because it will be shown that there is always market entry with advertising being allowed (for sufficiently small $F$, as assumed).

Stage 4: The Optimal Price Level

There is a Nash-Equilibrium in which the incumbent sets a higher price level than the entrant ($p_{2*}^B > p_{2*}^G$). Applying this assumption to the underlying profit functions, it can be shown, that the optimal prices indeed form a Nash-Equilibrium.

Lemma 1 There is a Nash-Equilibrium in prices, in which the incumbent sets a higher price than the entrant ($p_{2*}^B > p_{2*}^G$).

The formal proof is relegated to the Appendix (A1). The generic firm sets a lower price than the brand-name firm, because a higher generic price than the brand-name price would lead
to zero profits for the entrant. Both detailed and not-detailed physicians would prescribe
the brand-name version. Only if the generic price is lower than the brand-name price, the
physicians are inclined to change their prescription behavior towards the generic drug. The
brand-name firm sets a higher price than the generic firm. On the one side, the brand-name
firm forgos the profits in the not-detailed market, however, on the other side, the optimal
price in the detailed market will not be distorted.

There will be competition between the two products. The optimal prices \( p^2_B \) and \( p^2_G \) are set
simultaneously and are found by maximising the incumbent’s and the entrant’s second-period
profit functions.

\[
\begin{align*}
\pi^2_{BA} &= k \left[ \bar{t} - \hat{t} \right] p^2_B \\
\pi^2_{GA} &= \left[ k \left( \bar{t} - \frac{1}{e} p^2_G \right) + (1 - k) \left( \bar{t} - \frac{1}{e} p^2_G \right) \right] p^2_G
\end{align*}
\]

\[
\begin{align*}
\frac{d\pi_{BA}}{dp^2_B} = 0 &\iff p^2_B = \frac{1}{2} \left[ e\bar{t}(\theta - 1) - p^2_G \right] \\
\frac{d\pi_{GA}}{dp^2_G} = 0 &\iff p^2_G = \frac{k p^2_B + (1 - k)(\theta - 1)e\bar{t}}{2(k + \theta - 1)}
\end{align*}
\]

\[
\begin{align*}
p^2^*_B &= e\bar{t}(\theta - 1) \frac{k + 2\theta - 1}{3k + 4\theta - 4} \\
p^2^*_G &= e\bar{t}(\theta - 1) \frac{2 - k}{3k + 4\theta - 4}
\end{align*}
\]

where A is the index for advertising being allowed (and generic market entry being ac-
commodated). The incumbent’s profit depends only on the revenue in the detailed market where
B serves the high-valuation patients. The price \( p^2^*_B \) will be set such that the marginal revenue
on the detailed market is exactly zero.

The entrant serves both the low-valuation patients of the detailed physicians and all pa-
tients of the not-detailed physicians who prescribe the generic product to all types of pa-
tients, whose valuation is at least as high as the price, because the price is lower and the
perceived quality is the same. Firm G also sets its price \( p^2^*_G \) such that the overall marginal
revenue is zero. However, as price differentiation is not possible, on both the detailed and
the not-detailed market, the marginal revenue is not equal to zero.\(^{10}\) The entrant would like
to set a higher price in the not-detailed market and a lower price in the detailed market:

\(^{10}\)This critically hinges on the fact that there is no price discrimination possible between the two markets. This assumption can be justified because the generic firm cannot observe which of the physicians was detailed by the incumbent.
\( p^2_G(\text{DM}) = \frac{1}{2} e\bar{t} \frac{\theta-1}{2\theta-1} \) and \( p^2_G(\text{NDM}) = \frac{1}{2} e\bar{t}. \) The generic firm does not face competition in the not-detailed market such that with a price increase it looses some customers whose willingness to pay is lower than the price, but it does not loose any customers to the competitor.

This competition effect exists, however, in the detailed market, where any price increase additionally leads to some customers switching to the brand-name firm.

This competition effect is also the reason that the optimal second-period prices increase with the other firm’s price level and decrease with advertising:

Lemma 2

(i) \( p^2_B \) and \( p^2_G \) are strategic complements. A change in the competitor’s price level has a larger effect on the brand-name price level than on the generic price level.

(ii) \( p^2_B \) and \( p^2_G \) decrease with the advertising level. The effect of advertising on the generic price level is larger than on the brand-name price level.

Proof:

(i) \( \frac{dp^2_B}{dp^2_G} = \frac{1}{2} > \frac{1}{2} \frac{k}{k+\theta-1} = \frac{dp^2_G}{dp^2_B} \)

(ii) \( \left| \frac{dp^2_B}{dk} \right| = \left| -e\bar{t}(\theta-1) \frac{2\theta+1}{(3k+4\theta-4)^2} \right| < \left| -2e\bar{t}(\theta-1) \frac{2\theta+1}{(3k+4\theta-4)^2} \right| = \left| \frac{dp^2_G}{dk} \right| \)

The competition effect in the detailed market is the reason that the second-period prices are strategic complements. If one firm decreases its price level, then more patients switch to this firm. In order to counteract this effect, the other firm must also decrease its price level. The effect on the generic price level is smaller, because the generic firm also takes account of the not-detailed market, where it would optimally set a higher price level and which therefore reduces the effect of the competitor’s price level.

If the advertising level increases, then the detailed market values more. This has no direct effect on the optimal brand-name price, because \( p^2_B \) is already found by only optimizing the detailed market’s return. But there is a direct effect on the optimal generic price level. \( p^2_G \) trades off the detailed and the not-detailed market. If \( k \) increases, then the detailed market weights more, where \( G \) would optimally set a lower price level. If now the generic price decreases, this has an indirect effect on \( p^2_B \) which decreases by the competition effect. This decrease in \( p^2_B \) finally reinforces as an indirect effect the decrease in the generic price level even further.

Stage 3: Market Entry Decision
Anticipating the optimal prices in stage 4 and thus the resulting profits, the entrant decides on market entry comparing the profits with and without market entry. Market entry is profitable, if

$$\pi_{GA}^2 \geq 0 \iff k \left[ \hat{t} - \frac{1}{e} p_G^2 \right] p_G^2 + (1 - k) \left[ \check{t} - \frac{1}{e} p_G^2 \right] p_G^2 \geq F$$

$$\epsilon \check{t}^2(\theta - 1) \left[ (1 - k)^2(k + \theta - 1) \right] \geq F$$

(5)

The decision clearly depends on the level of advertising $k$, which is determined in the first period, and on the fixed costs $F$:

$$\frac{d\pi_{GA}(k)}{dk} = -\epsilon \check{t}^2(2-k) \frac{3k[2(2\theta - 1) + k] + 4(2\theta - 1)(\theta - 1)}{(3k + 4\theta - 4)^3} < 0$$

(6)

If there is more advertising, then the gain in the detailed market is more than offset by the loss in the not-detailed market, because demand is higher in the not-detailed market without competition ($\check{t} > \hat{t}$). Additionally, competition in the detailed market increases even further, such that $G$ looses further demand in the detailed market. Overall, the effect of an increase in advertising is negative on the generic firm’s profit and the generic firm would like an advertising level as low as possible.

A high advertising level and ultimatively $k = 1$ thus means that the profits of the entrant are the lowest. In this case there is only the detailed market where the two firms compete with different perceived quality levels. There are still positive profits possible for the entrant and to keep the problem tractable, it will be assumed that these profits are sufficient to cover market entry costs $F$:

$$\pi_{GA}(k = 1) = \epsilon \check{t}^2(\theta - 1) \frac{\theta}{(4\theta - 1)^2} - F \geq 0$$

(7)

This assumption can be rationalized if the generic firm is thought of as a firm that operates already in another therapeutic market and incurs thus only minor setup-costs to enter an additional market.

A special case arises if there is no advertising at all ($k = 0$). Then there is only the not-detailed market, where both firms operate in case of market entry. But this would result in fierce Bertrand competition with zero returns for both firms. Anticipating this, the generic firm would not enter the market. No advertising could thus be a way for the incumbent to deter market entry. However, the credibility of the threat depends heavily on the assumption
that advertising is only allowed in the first period. Assume for a moment, that this is not the case and advertising is also allowed in the second period. Then this threat is not credible: If the incumbent does not advertise in the first period in order to threaten with Bertrand competition and the entrant enters the market anyway, then it is not optimal anymore, not to invest in advertising, because the incumbent’s marginal second-period profit for $k = 0$ is positive:

$$\pi_{BA}^2 = k [\bar{\bar{t}} - \hat{\bar{t}}] p_{BA}^2 - A(k) = k\bar{e}t^2(\theta - 1) \left( \frac{k + 2\theta - 1}{3k + 4\theta - 4} \right)^2 - \frac{1}{\gamma + 1} k^{\gamma+1}$$

$$\frac{d\pi_{BA}^2}{dk} = e\bar{t}^2(\theta - 1)(k + 2\theta - 1) \frac{3k^2 + 6k\theta - 9k + 8\theta^2 - 12\theta + 4}{(3k + 4\theta - 4)^3} - k^\gamma$$

$$\frac{d\pi_{BA}^2}{dk} |_{k=0} = e\bar{t}^2 \frac{(2\theta - 1)^2}{16(\theta - 1)} > 0 \quad \text{(8)}$$

It is only for mathematical reasons that advertising is restricted to the first period. This assumption creates somehow artificially the possibility to deter market entry. If the incumbent did not invest in the first period, then he cannot invest anymore in the second period by assumption. Therefore there is no market entry. As this, however, critically hinges on a assumption, this way of market entry deterrence is disregarded here.

Thus for any advertising level $k > 0$, there is always generic market entry. This is illustrated in Figure 1, where the generic return $R_G$ is decreasing in the advertising level $k$ and discontinuous at $k = 0$. 

Figure 1: The Profit Function of the Generic Entrant
3.2 The Equilibrium in the First Period

It can therefore be summarized that there will be market entry in the second period, if advertising is allowed. This will be anticipated by the brand-name firm in the first period. Market entry in the second period has no effect on the first-period brand-name price level, because the price levels are set independently for each period. But the advertising level links both periods with each other and depends therefore on the fact, that there will be market entry.

Stage 2: The Optimal Price Level

The profit-maximising price $p^{1*}_B$ with advertising in the first period can be found by maximising the first period profit function of firm B. The resulting optimal price level depends on the ex ante chosen advertising level $k$ that will be derived afterwards.

$$\pi^{1}_{BA} = k \left( \bar{t} - \frac{1}{\theta e} p^{1}_B \right) p^{1}_B + (1 - k) \left( \bar{t} - \frac{1}{e} p^{1}_B \right) p^{1}_B$$  \hspace{1cm} (9)

$$\frac{d\pi^{1}_{BA}}{dp^{1}_B} = 0 \Rightarrow p^{1*}_B = e\bar{t} \frac{\theta}{2(k + \theta - \theta k)}$$  \hspace{1cm} (10)

The optimal price $p^{1*}_B$ trades-off the marginal return in the detailed market and in the not-detailed market. The more important gets the detailed market, the larger will the price level be:

$$\frac{dp^{1*}_B}{dk} = e\bar{t}(\theta - 1) \frac{\theta}{2(k + \theta - \theta k)^2}$$  \hspace{1cm} (11)

Lemma 3 The price level in the first period increases with $k$.

The optimal price $p^{1*}_B$ depends positively on the amount of advertising, because the larger the market with detailed physicians, the more profitable it is for the incumbent to approach the optimal price of this market by further distorting the optimal price of the not-detailed market. No competition effect needs to be taken into account, because there is patent protection in the first period.

Stage 1: The Optimal Level of Detailing

The advertising level is chosen in the first stage and links both periods of the game with each other. The brand-name firm anticipates that there will be always market entry and that
the larger the advertising level \( k \), the smaller the second-period prices. However, B knows also, that the first-period price depends positively on the level of advertising. Both effects are traded off in stage 1, when the optimal advertising level is chosen. Unfortunately, the optimal amount of detailing with market entry cannot be derived explicitly by maximising the overall profit \( \pi_{BA} \). This has to be done for specific numerical examples. However, the equation that implicitly determines \( k^* \) can be derived:

\[
\pi_{BA} = \delta \left[ \bar{t} - \frac{p_{1B}}{e} \left( k \frac{1}{\theta} + 1 - k \right) \right] p_{1B}^1 + k \left[ \bar{t} - \hat{t} \right] p_{1B}^2 - \frac{1}{\gamma+1} k^{\gamma+1}
\]

\[
\frac{d\pi_{BA}}{dk} = 0 \Rightarrow e\bar{t}^2(\theta - 1) \left[ \frac{\delta \theta}{4(k+\theta-\theta k)^2} + (k + 2\theta - 1) \frac{3k^2 + 6k - 9k + 8\theta^2 - 12\theta + 4}{(3k + 4\theta - 4)^4} \right] - k^\gamma = 0
\]

\( \delta \) is a parameter that indicates how long the period of patent protection lasts. The larger \( \delta \), the longer the first period is compared to the second period without patent protection. \( \delta = 1 \) means that both periods are equally long.\(^{11}\)

The optimal level \( k^* \) exactly equalizes the marginal return in both periods and the marginal cost of advertising as well as the competition effect, because the entrant reacts with a price decrease.

Now it is possible to show that the ex ante assumption to restrict advertising to the first period is in line with dynamic consistency in the sense that the incumbent does not want to further increase his advertising in the second period given \( k^* \). The optimal advertising level in the second period alone, \( k^*_2 \), is defined by:

\[
\frac{d\pi_2^BA}{dk} = e\bar{t}^2(\theta - 1)(k + 2\theta - 1) \frac{3k^2 + 6k - 9k + 8\theta^2 - 12\theta + 4}{(3k + 4\theta - 4)^4} - k^\gamma = 0
\]

Comparing the two definitions of \( k^* \) and \( k^*_2 \), it is clear that \( k^* > k^*_2 \), because the marginal return of advertising in the first period is strictly positive. Thus the incumbent does not want to further increase the advertising level in the second period. This is quite intuitive: Although the incumbent might want to set a higher advertising level in the second period than in the first period, if the decisions were analysed separately, he can set this higher advertising level as well already in the first period, because more advertising in the first period is better than less, given that the advertising costs must be paid anyway.

\(^{11}\)The nominal patent life is 20 years in the European Union and 17 years in the United States, but because the patent life includes some of the initial time required for clinical testing and approval, the patent life effectively reduces to e.g. 6.4 years in Germany, 8.7 years in the United Kingdom, and 9.7 years in the United States (see Taggart (1993)). Therefore it is sensible to assume that the period of patent protection is smaller than the period with potential generic competition. This fact is taken into account by assuming \( \delta \in (0,1) \).
The maximal overall profits with advertising are

\[
\pi_{BA}^* = \delta \left[ \bar{t} - \frac{B_B^*}{e} \left( k^* \frac{1}{\theta} + 1 - k^* \right) \right] p_B^{1*} + k^* \left[ \bar{t} - \frac{B_B^*}{e} \right] p_B^{2*} - \frac{1}{\gamma + 1} (k^*)^{\gamma + 1}
\]

\[
= e\tilde{t}^2(\theta - 1) \left[ \frac{\delta \theta}{4(k^* + \theta - \theta k^*)^2} + k^* \left( \frac{k^* + 2\theta - 1}{3k^* + 4\theta - 4} \right)^2 \right] - \frac{1}{\gamma + 1} (k^*)^{\gamma + 1} \tag{15}
\]

\[
\pi_{GA}^* = \left[ k^* \bar{t} + (1 - k^*)\bar{t} - \frac{1}{e} p_G^{2*} \right] p_G^{2*} - F
\]

\[
= e\tilde{t}^2(\theta - 1) \left( 1 - k^* \right)^2 \left( k^* + \theta - 1 \right) - F \tag{16}
\]

4 The Equilibrium of the Game without Advertising

Now the equilibrium of the game is analysed, given that advertising was not allowed in stage zero. Without advertising, there is no product differentiation between the generic and the brand-name version of the drug. Therefore there would be fierce Bertrand competition in the second stage, if a generic firm entered the market. Anticipating this, there will be no market entry, because the generic firm could not cover the positive market entry costs. In what follows, only the optimal price levels in stage 2 and 4 need to be analysed. In both stages there is no competition, thus both prices are equal \(p_B^M\). Both the market entry decision in stage 3 and the investment in advertising in stage 1 are nonrelevant.

There is no competition in either of the two periods without advertising. Only firm B is on the market and finds the optimal price \(p_B^M\) by maximising the profit function.

\[
\pi_{BD} = \left[ \bar{t} - \frac{1}{e} p_B \right] p_B \tag{17}
\]

\[
\frac{d\pi_{BD}}{dp_B} = 0 \Rightarrow p_B^M = \frac{1}{e}\tilde{t} \tag{18}
\]

with D as index for no market entry. The maximal overall profit of the brand-name firm without advertising is then:

\[
\pi_{BD}^M = (1 + \delta) \left[ \bar{t} - \frac{1}{e} p_B^M \right] p_B^M = (\delta + 1) \frac{1}{4} e\tilde{t}^2 \tag{19}
\]
5 (Second-Best) Welfare Analysis

The correct welfare analysis in the presence of (persuasive) advertising is a difficult problem that must be handled very carefully. The question is whether to take the standard demand function or the demand function with the artificially increased valuation as basis to undertake the welfare analysis.\(^{12}\) In the present model only the physicians have different quality perceptions, whereas the patients only care about the success of the medication. As both the generic and the brand-name version are therapeutically equivalent by assumption and should therefore be equally successful, welfare evaluations are thus based on the patients’ actual valuation and not on the physicians’ perceived valuation. This has the effect that advertising does not create any artificial welfare increase because the quality is perceived to be higher. If welfare rises with advertising, than this increase relies on beneficial price decreases and thus on more patients being treated, and not on the creation of artificial valuation.

Welfare in this setting will thus be derived as follows: Both the pharmaceutical firms’ profits and the patients’ valuation are taken into account. The profits and the valuation are equally weighted for mathematical convenience. As marginal costs were assumed to be zero, welfare increases more, the more patients are prescribed the drug. So, the lower the price level, the higher is welfare.

Given the above definition of welfare, welfare with advertising and without advertising are respectively:

\[
W_A = \delta \int_{\frac{1}{2}p_B^M}^t et \, dt + \int_{\frac{1}{2}p_G^*}^t et \, dt - \frac{1}{\gamma + 1} (k^*)^{\gamma + 1} - F
\]
\[
= \frac{1}{2}e t^2 \left[ (\delta + 1) - \left( \frac{\theta}{2(k^* + \theta - \theta k^*)} \right)^2 - \left( \frac{(\theta - 1)(2 - k^*)}{3k^* + 4\theta - 4} \right)^2 \right] - \frac{1}{\gamma + 1} (k^*)^{\gamma + 1} - F \tag{20}
\]
\[
W_D = (\delta + 1) \int_{\frac{1}{2}p_B^M}^t et \, dt = (\delta + 1) \frac{3}{8} et^2 \tag{21}
\]

Welfare without advertising only considers how many patients are treated in both periods at the price level \(p_B^M\). As there is no advertising, the quality perception and therefore the demand is not deterred. The indifferent consumer is found at \(t = \frac{1}{e} p_B^M\). Welfare with advertising considers first of all the advertising and the generic market entry costs and how

\(^{12}\)See the discussion in Dixit and Norman (1978).
many patients are treated in both periods. The relevant price level in the second period is $p_G^{2*}$, because this is the lower price level of the two and thus determines the patient that is just indifferent between being treated or not. The generic drug is prescribed by either a detailed or a not-detailed physician. Both attach the valuation $\theta = 1$ to the generic version such that the total amount of treated patients is not distorted by advertising. Welfare in the first period with advertising is more difficult to determine, because the quality perception in the detailed market is distorted which now distorts demand (see figure 2). The more the quality perception is increased (the larger is $\theta$), the more patients will be treated with the drug, although their actual valuation is smaller than the price. Given the above welfare definition, that both combines the patients’ utility and the firm’s profit, this area should be included positively into welfare.\(^{13}\) However, in order to show that the positive welfare aspect of advertising does not crucially depend on this distorted demand, it will deliberately be left out of welfare. If advertising is socially beneficial with this stricter definition, then it is certainly also beneficial if this demand increase is included.

\[13\delta \int \frac{k^*}{\theta(\theta-1)} \frac{\delta \theta}{\delta \theta} \frac{k^*}{\theta-\theta^*} \frac{1}{(k^*+\theta-\theta^*)^2} dt = \delta \epsilon t^2 \]
Welfare with advertising can only be larger than welfare without advertising, if the second-period generic price level is lower than the monopoly price level without advertising.

**Lemma 4** Advertising stimulates competition and thus lowers prices in the second period: \( p_{M}^{G} \geq p_{G}^{2} \).

**Proof:** \( p_{M}^{G} \geq p_{G}^{2} \iff \frac{1}{2}e\bar{t} \geq e\bar{t}(\theta - 1)\frac{2 - k^{*}}{3k^{*} + 4\theta - 4} \iff k^{*}(2\theta + 1) \geq 0 \) □

The generic price \( p_{G}^{2} \) in the second period is smaller than \( p_{M}^{G} \), because the generic firm must additionally consider the competition with the brand-name firm, whereas in the case of no market entry, this is not the case.

Advertising is beneficial and therefore market entry is socially desireable compared to market entry deterrence, if the following unequality holds:

\[
\int_{\frac{1}{2}e\bar{t}}^{e\bar{t}} et \, dt \geq \delta \int_{\frac{1}{2}e\bar{t}}^{e\bar{t}} et \, dt + \frac{1}{\gamma + 1}(k^{*})^{\gamma + 1} + F
\]
\[
\frac{1}{2}e\bar{t}^{2}\left[1 + \delta - \left(\frac{(\theta - 1)(2 - k^{*})}{(3k^{*} + 4\theta - 4)}\right)^{2}\right] \geq \delta \frac{1}{2}e\bar{t}^{2}\left(\frac{\theta}{2(k^{*} + \theta - \theta k^{*})}\right)^{2} - \frac{1}{\gamma + 1}(k^{*})^{\gamma + 1} + F \quad (22)
\]

The left-hand side of the unequality represents the welfare gain because the lower-price version in the second period results in more patients being served. The right-hand side shows the welfare loss because of advertising and market entry. It consists of the welfare loss in the first period, where a higher price will be set, and the welfare loss because of higher advertising costs. Therefore, if the additional consumer rent in the second period is larger than the welfare loss in the first period, welfare increases with market entry and thus some advertising is indeed socially beneficial.

**Lemma 5** For \( \delta < \frac{\theta(2\theta + 1)}{4(\theta - 1)^{2}} \), a benevolent regulator would set a strictly positive amount of advertising.

**Proof:**
There are two solutions for this problem. Welfare with advertising is concave:

\[
\frac{d\Delta(W_A - W_D)}{dk} = \frac{dW_A}{dk} - \delta p_B^* \frac{dp_B^*}{dk} - \gamma
\]

\[
= -\delta eG \frac{\theta}{2(k + \theta - \theta k)} \cdot \delta eG \frac{\theta(\theta - 1)}{2(k + \theta - \theta k)^2} - eG(\theta - 1) \frac{2 - k}{3k + 4\theta - 4} \cdot eG(\theta - 1) \frac{2k + 4\theta + 2 - 3k}{(3k + 4\theta - 4)^2}
\]

The welfare function with advertising is concave:

\[
\frac{d^2\Delta(W_A - W_D)}{dk^2} = \frac{d^2W_A}{dk^2} = -\delta \left( \frac{dp_B^*}{dk} \right)^2 - \delta p_B^* \frac{dp_B^*}{dk^2} - \left( \frac{dp_B^*}{dk} \right)^2 - \gamma k^{-1} < 0
\]

The regulator cannot set the (socially beneficial) advertising level \( k^* \), but needs to consider the optimally chosen advertising level \( k^* \). The question is now, whether for this advertising level \( k^* \) welfare is also larger than without advertising at all \( k = 0 \). In order to do this, the advertising level \( \tilde{k} \) is calculated at which welfare with advertising exactly equals welfare without advertising (see Figure 3):

\[
\frac{1}{2}eG^2 \left[ \frac{\theta(\theta - 1)(2 - k)}{3k + 4\theta - 4} \right]^2 - \delta \left( \frac{\theta(\theta - 1)(2 - k)}{2(3k + 4\theta - 4)} \right)^2 - \frac{1}{\gamma + 1} \tilde{k}^{-1} = \nonumber
\]

\[
- \frac{1}{\gamma + 1} \tilde{k}^{-1} = F = 0 \quad (23)
\]

There are two solutions for this problem. Welfare with \( k = 0 \) is of course equal to \( W_D \) but there is also a second, strictly positive advertising level \( \tilde{k} \). If the incumbent optimally chooses an advertising level \( k^* \) within \([0, \tilde{k}]\), then welfare with advertising is larger than without.

### A Numerical Illustration

Unfortunately, it cannot be solved explicitly for neither \( k^* \) nor \( \tilde{k} \), therefore the solution has to be approximated numerically. The procedure is the following: First of all, \( k^* \) and \( \tilde{k} \) are
approximated for different and relevant values of the parameters $\theta$ and $\delta$. Then it is checked whether the optimally chosen advertising level $k^*$ is smaller or equal to the maximally socially beneficial advertising level $\tilde{k}$. If this is the case, then advertising should be allowed in stage zero. It should not be allowed otherwise.

<table>
<thead>
<tr>
<th>Value</th>
<th>$k^*$</th>
<th>$\tilde{k}$</th>
<th>$\triangle(\tilde{k} - k^*)$</th>
<th>$p_{B}^{1*}$</th>
<th>$p_{B}^{2*}$</th>
<th>$p_{G}^{2*}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta$</td>
<td>1.3</td>
<td>0.2104</td>
<td>0.4092</td>
<td>0.1989</td>
<td>0.526</td>
<td>0.297</td>
</tr>
<tr>
<td></td>
<td>1.5</td>
<td>0.2883</td>
<td>0.3470</td>
<td>0.0586</td>
<td>0.553</td>
<td>0.399</td>
</tr>
<tr>
<td></td>
<td>1.75</td>
<td>0.3809</td>
<td>0.2810</td>
<td>-0.1000</td>
<td>0.598</td>
<td>0.522</td>
</tr>
<tr>
<td>$\delta$</td>
<td>2</td>
<td>0.4787</td>
<td>0.2283</td>
<td>-0.2504</td>
<td>0.657</td>
<td>0.640</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1</td>
<td>0.1049</td>
<td>-0.8951</td>
<td>1.500</td>
<td>1.091</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>1</td>
<td>0.0473</td>
<td>-0.9527</td>
<td>2.000</td>
<td>1.600</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>1</td>
<td>0.0151</td>
<td>-0.9849</td>
<td>2.500</td>
<td>2.105</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
<td>0.2674</td>
<td>0.3802</td>
<td>0.1129</td>
<td>0.549</td>
<td>0.405</td>
</tr>
<tr>
<td></td>
<td>0.8</td>
<td>0.2883</td>
<td>0.3470</td>
<td>0.0586</td>
<td>0.553</td>
<td>0.399</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>0.3031</td>
<td>0.3261</td>
<td>0.0230</td>
<td>0.556</td>
<td>0.396</td>
</tr>
</tbody>
</table>

The table summarizes the results. In order to facilitate the illustration, only one parameter is changed at a time and all others are held constant. The parameters’ default values are: $\theta = 1.5$, $\delta = 0.8$, $\tilde{\ell} = 1$, $e = 1$, $\gamma = 1$, and $F = 0$. The results for other default values are not listed here, because they show only quantitative, not qualitative differences. Welfare with advertising is higher than welfare without advertising, if $\triangle(\tilde{k} - k^*)$ is positive. For the interpretation, it is therefore important, how the parameter change affects both $k^*$ and $\tilde{k}$.

The parameter changes can affect the marginal profitability of advertising and therefore change $k^*$ both directly, but of course also indirectly via price changes induced by the parameter changes. Note that additionally the first-period brand-name price increases and the second-period prices decrease with $k^*$. For the effect on $k^*$, the parameter effects on $p_{B}^{1*}$, $p_{B}^{2*}$, and $p_{G}^{2*}$ are important. The marginal profit of advertising increases, the larger is $p_{B}^{1*}$ and $p_{G}^{2*}$, and the lower is $p_{B}^{2*}$. A larger marginal profit of advertising means, however, that more will be invested in advertising. $k^*$ increases. For the welfare implications ($\tilde{k}$), the indirect parameter effects on $p_{B}^{M}$, $p_{B}^{1*}$, and $p_{G}^{2*}$ are important. $\tilde{k}$ increases, i.e. advertising is more probable to be socially efficient, if $p_{B}^{M}$ increases and both $p_{B}^{1*}$ and $p_{G}^{2*}$ decrease with the parameter change.

**The Welfare Implications of** $\theta$ **(perceived brand-name quality):**

$\triangle(\tilde{k} - k^*)$ decreases with $\theta$, because the incumbent invests more in advertising, whereas the maximal socially beneficial advertising level decreases. This means that the the larger gets
the perceived quality of the advertised product, the more probable advertising should be banned.

An increase in \( \theta \) has both direct and indirect effects on \( k^* \). In both periods, an increase in \( \theta \) directly affects demand positively, because in the detailed market the indifferent patient between buying or not buying (first period) respective between B and G (second period) is distorted downwards. For the indirect effects, the price changes need to be considered: A higher quality perception increases the valuation in the detailed market and thus increases the optimal price level \( p_{1B}^* \) directly and indirectly through a higher advertising level. \( p_{1B}^* \) increases, because the valuation of its high-valuation patients in the detailed market increases even further, which dominates the effect that a larger \( k^* \) reduces \( p_{2B}^* \). The change in \( p_{2B}^* \) is important because it affects the competition effect. A larger \( \theta \) also increases \( p_{2B}^* \) as a direct effect, although G’s customers do not attach \( \theta \) to their valuation. The reason is that the two drugs are perceived to be more differentiated such that \( p_{2B}^* \) increases and both drugs are strategic complements. A larger \( k^* \), however, reduces \( p_{2B}^* \) indirectly. Whereas the direct positive valuation effect always dominates the negative advertising effect on \( p_{2B}^* \) (at least for the parameter range considered here), the valuation effect on \( p_{2B}^* \) only dominates for small \( \theta \) (and very large \( \theta \), when there is a corner solution for \( k^* = 1 \) and thus no indirect advertising effect on the generic price). In this case, \( p_{2B}^* \) increases with \( \theta \) and reduces the competition effect. For larger \( \theta \), the negative advertising effect dominates and increases thus the competition effect.

The first-period brand-name price increase and a second-period generic price increase are both positive for the marginal profit of advertising, whereas the second-period brand-name increase and a second-period generic price decrease are negative for the marginal profit of advertising. All direct and indirect effects taken together, the data show that the positive effects weight more and \( k^* \) increases with \( \theta \).

\( \tilde{k} \) decreases: The price level without advertising \( p_M^B \) is not affected by \( \theta \). The welfare-relevant prices with advertising are the first-period brand-name price \( p_{1B}^* \) and the second-period generic price level \( p_{2G}^* \). Although the generic price level decreases with \( \theta \) for some values, \( \tilde{k} \) decreases at the whole value range of \( \theta \), because this effect is dominated by the price increase in the first period.

The Welfare Implications of \( \delta \) (patent length):
The patent length \( \delta \) does not affect prices directly. But it increases the period without
competition, when the incumbent can reap off all benefits from advertising. This is the reason why the incumbent will optimally choose a higher $k^*$. A higher $k^*$ increases indirectly the first period price level $p_B^1$ and decreases indirectly both second-period price levels. The data show this indirect price change slightly.

$\tilde{k}$ will decrease, however, because $\delta$ does not affect the welfare without advertising, but decreases welfare with advertising due to the fact that the period with the high price level $p_B^1$ now is longer. The fact that the second-period price levels decrease, because a higher $k^*$ is chosen, is dominated.

**Proposition 1** Welfare with advertising is larger than without advertising for a small perceived product differentiation and a short period of patent protection.\textsuperscript{14}

## 6 Price Regulation

Until now it was assumed that the market is not price regulated or that price regulation was not binding. This would be a model that describes the U.S. pharmaceutical market. In Europe, however, most countries regulate their pharmaceutical markets. The model will now be extended in this direction and the implications for welfare are discussed. It will be assumed that there is a price cap on pharmaceutical drugs that cannot be exceeded. In this framework, three different cases must be considered concerning whether the price cap is binding or not:

1. The price cap is not binding in either of the two periods. This case is the one that has been analysed so far.

2. The price cap is only binding in the first period.

3. The price cap is binding in both periods.

For the relevant parameter ranges, that have been discussed in section 5, it is not possible that the price cap is binding in the second period, if it is not binding in the first period.

\textsuperscript{14}Both parameters are assumed to be exogenous in this model. However, they can of course be influenced by the brand-name firm and/or the regulator. This will be discussed in the conclusion.
The numerical simulation has shown that the incumbent would optimally set a higher price in the first period than in the second period if he was not regulated.

### 6.1 The Equilibrium of the Game

The game will now be solved for the case that advertising is allowed. If advertising was not allowed, then the incumbent would simply set \( p_B^M = \frac{1}{2}e\bar{t} \), if \( \frac{1}{2}e\bar{t} < \bar{p} \), or \( p_B^M = \bar{p} \) for \( \frac{1}{2}e\bar{t} > \bar{p} \).

**Price Cap is Only Binding in the First Period**

If the price cap is only binding in the first period, then the following condition must hold:

\[
\frac{\theta}{2(k + \theta - \theta k)} \bar{p} > e\bar{t}(\theta - 1) \frac{k + 2\theta - 1}{3k + 4\theta - 4} \tag{24}
\]

The first boundary simply says that for the price cap to be binding at all, it must be smaller than the optimal first-period brand-name price level without price regulation. The second boundary makes sure, that the price cap is only binding in the first period. \( \bar{p} \) must be larger than the optimal second-period brand-name price level that additionally takes into account, that the advertising level \( k \) changes, if the optimal first-period price level is distorted downwards. This is illustrated by the bar above the optimal price level in order to differentiate it from the optimal price level without price regulation.

The game will again be solved by backward induction. Starting in the second period, the Nash-Equilibrium in prices does not change with respect to the case without price caps. The only difference is that the level of advertising might change and therefore the absolute level of prices. If the assumption is not changed that the sunk market entry costs \( F \) are not too high, then there will be market entry for sure because there is no credible threat for B to deter market entry.

In the first period, the optimal price level \( p_B^* \) is higher than the price cap \( \bar{p} \) by assumption. Therefore the incumbent simply sets the maximal price that is allowed and generates the following overall profit level:

\[
\pi_B = \delta \left[ \bar{t} - \frac{\bar{p}}{e} \left( \frac{k}{\theta} + 1 - k \right) \right] \bar{p} + k \bar{t} \left[ \bar{t} - \hat{t} \right] \bar{p}_B^2 - A(k) \\
= \delta \left[ \bar{t} - \frac{\bar{p}}{e} \left( \frac{k}{\theta} + 1 - k \right) \right] \bar{p} + ke\bar{t}^2(\theta - 1) \left( \frac{k + 2\theta - 1}{3k + 4\theta - 4} \right)^2 - \frac{1}{\gamma + 1} k^{\gamma + 1} \tag{25}
\]
The optimal advertising level is defined by

\[ \frac{d\bar{p}}{dk} = \delta \frac{\bar{p}^2}{\bar{p}} (1 - \frac{1}{\theta}) + e\bar{t}^2 (\theta - 1)(k + 2\theta - 1) \frac{3k^2 + 6k\theta - 9k + 9\theta^2 - 12\theta + 4}{(3k + 4\theta - 4)^4} - k^2 = 0 \]  

(26)

Compared to the situation without a binding price cap, the incumbent adjusts his investment in ex ante advertising according to the price cap level.

**Lemma 6** A binding price cap in the first period reduces the ex ante investment in advertising. The smaller the price cap, the less the incumbent invests ex ante in advertising.

**Proof:** \( \bar{k}^* < k^* \) \( \iff \) \( \delta \frac{\bar{p}^2}{\bar{p}} (1 - \frac{1}{\theta}) < e\bar{t}^2 \frac{\delta(\theta - 1)}{e\theta} \cdot \bar{p} > \frac{\delta(\theta - 1)}{e\theta} \cdot \bar{p}^1 < \bar{p} > e\bar{t}(\theta - 1) \frac{1 - k}{k + 2\theta - 2} \) \( \iff \) \( \frac{d\bar{p}}{d\bar{p}} = -\frac{2\bar{p}^2(1 - \frac{1}{\theta})}{SOC} > 0 \)

The advertising level with a price cap binding in the first period is lower than without, because whereas the marginal return of advertising in the second period does not change, the marginal return in the first period is reduced heavily. The first period is the period in which the incumbent can earn most of the advertising’s return. This possibility is now constrained, because the optimal price level cannot be set, and the incumbent reacts with less advertising.

The ex ante advertising level is smaller the lower the price cap is. The reason is that the lower the price cap, the less the possibility is to harvest all benefits from advertising without any competition. If the incumbent reduces his advertising level therefore, then he can at least also reduce the competition effect in the second period, where the generic firm sets a higher price for a lower \( k^* \). This apparently dominates the effect that the detailed market share and therefore the only demand in the second period for the incumbent reduces.

**Binding Price Caps in both Periods**

If the price cap is binding in both periods, then the following inequality must hold, where it will be assumed that the price cap never limits the generic price level (second boundary):

\[ e\bar{t}(\theta - 1) \frac{k + 2\theta - 1}{3k + 4\theta - 4} > \bar{p} > \bar{p}^2 > e\bar{t}(\theta - 1) \frac{1 - k}{k + 2\theta - 2} \]  

(27)

The game facilitates because now the incumbent will simply set the maximally allowed price level \( \bar{p} \) in the second period, to which the entrant reacts optimally:

\[ \bar{p}^2 = \frac{e\bar{t}(\theta - 1)(1 - k) + k\bar{p}}{2(k + \theta - 1)} \]  

(28)
It can easily be seen that the second-period generic price level still decreases the larger the advertising level. It also decreases, the lower is the price cap. The reason is simply that the brand-name price and the generic price are strategic complements. If the price cap \( \bar{p} \) decreases, then this is equivalent to a brand-name price decrease to which the generic firm reacts by also reducing the generic price level.

Given the prices in each period, the overall profit of the brand name firm is

\[
\bar{\pi}_B = \delta \left[ \bar{t} - \frac{\bar{p}}{e} \left( k \frac{1}{\theta} + 1 - k \right) \right] \bar{p} + k \left[ \hat{\bar{t}} - \frac{\hat{\bar{p}}}{e} \left( \frac{1}{\theta} + 1 - k \right) \right] \hat{\bar{p}} - A(k)
\]

\[
= \delta \left[ \bar{t} - \frac{\bar{p}}{e} \left( k \frac{1}{\theta} + 1 - k \right) \right] \bar{p} + k \frac{(k + 2\theta - 1)(e\bar{t}(\theta - 1) - \bar{p})}{2e(\theta - 1)(k + \theta - 1)} \bar{p} - \frac{1}{\gamma + 1} k^{\gamma + 1} \tag{29}
\]

The optimal advertising level is thus defined by

\[
\frac{d\bar{\pi}_B}{dk} = \delta \left( 1 - \frac{1}{\theta} \right) + \bar{p}(e\bar{t}(\theta - 1) - \bar{p}) \frac{k^2 + 2\theta k - 2k + 2\theta^2 - 3\theta + 1}{2e(\theta - 1)(k + \theta - 1)^2} - k^\gamma = 0 \tag{30}
\]

There seems to be the additional problem that the marginal return of advertising in the second period can be negative for same parameter ranges. This would lead to the incumbent now being able to credibly threaten to deter market entry, if he did not invest in the first period. For this possibility to arise, the following condition must be met:

\[
\left. \frac{d^2\bar{\pi}_B}{dk^2} \right|_{k=0} = \bar{p}(e\bar{t}(\theta - 1) - \bar{p}) \frac{(\theta - 1)(2\theta - 1)}{2e(\theta - 1)^2} < 0 \quad \Leftrightarrow \quad \bar{p} > e\bar{t}(\theta - 1) \tag{31}
\]

But note that \( \bar{p} > e\bar{t}(\theta - 1) \) does not fulfill the condition that \( \bar{p} \) binds in both periods.

Again, the price cap has of course an effect on the optimal advertising level.

**Lemma 7** For a sufficiently high \( \bar{p} \), the investment in advertising decreases with a higher price cap, and vice versa.

**Proof:**

\[
\frac{d\bar{p}^*_B}{dp} = -\frac{2\bar{t}(\theta - 1) - 2\bar{t}}{\theta e} \frac{k^2 + 2\theta k - 2k + 2\theta^2 - 3\theta + 1}{2e(\theta - 1)(k + \theta - 1)^2} < 0
\]

\[
\Leftrightarrow \quad \bar{p}^*_B > \frac{1}{2} e\bar{t}(\theta - 1) \frac{k^2 + 2\theta k - 2k + 2\theta^2 - 3\theta + 1}{\theta e(k + 2\theta - 2) + (\theta - 1)(2\theta - 1)(k + \theta - 1)^2 - 2\theta(\theta - 1)^2} = \bar{p}
\]

where this range exists for some (but not all) parameter values.  

There is a range of price caps within which the incumbent increases his investment in advertising if the price cap is further reduced. The reason is that now the competition effect (the generic price level decreases with more advertising) does not weight as much anymore as the
brand-name price would optimally be set higher anyway. As long as the price cap is high enough, the investment in advertising pays off because it at least expands demand for the incumbent and the higher valuation for the brand-name drug in the detailed market can be exploited. Only if the lower boundary \( \bar{p} \) is passed, the investment in advertising decreases again, because the higher valuation of the detailed physicians cannot be exploited sufficiently anymore to justify the advertising costs.

6.2 Welfare Analysis

Price regulation has of course some significant implications on welfare. Using the same welfare definition as in section 5, welfare with advertising is higher compared to welfare without advertising, if the following condition holds:

\[
\delta \int_{\frac{1}{2}x\bar{p}^*_B}^{\bar{t}} e^{\bar{t}} dt + \int_{\frac{1}{2}p^*_G}^{\bar{t}} e^{\bar{t}} dt - \frac{1}{\gamma + 1} (\bar{k}^*)^{\gamma + 1} - F \geq \delta \int_{\frac{1}{2}x\bar{p}^*_B}^{\bar{t}} e^{\bar{t}} dt + \int_{\frac{1}{2}p^*_G}^{\bar{t}} e^{\bar{t}} dt - \frac{1}{\gamma + 1} (\bar{k}^*)^{\gamma + 1} + F
\]

where \( p^*_M = \bar{p} \) or \( p^*_B = \frac{1}{2}e\bar{t} \), depending on whether the price cap binds in the monopoly case without advertising or not. Again, it cannot be explicitly calculated whether welfare with or without advertising is larger. Therefore, the regulator’s decision with respect to advertising will be illustrated numerically again. In order to do this, it will be calculated again, in which range \( k^* \) must fall such that welfare with advertising is larger than without advertising. The following equation calculates in general the advertising level such that the regulator is just indifferent between advertising and no advertising:

\[
\Delta (\bar{W}_A - \bar{W}_D) = \frac{1}{2e} \left[ (1 + \delta)p^*_B \right]^2 - \frac{1}{\gamma + 1} (\bar{k}^*)^{\gamma + 1} - F = 0
\]

s.t. \( \bar{p}^*_B, p^*_M, p^*_G \leq \bar{p} \) (33)

Note that the price levels differ with respect to when the price cap binds. The change of \( \Delta (\bar{W}_A - \bar{W}_D) \), depending on \( k \) is illustrated in Figure 4.

The maximal socially beneficial advertising level \( \bar{k} \) indicates the maximal value of advertising that the incumbent may choose in order for advertising still to be socially beneficial as compared to no advertising. The driving force behind this upper limit are the advertising costs, that become too large to be justified. This effect then starts to dominate the positive effect of advertising on the generic price level.
With price regulation, a further boundary $\tilde{k}_{min}$ appears for some cases that indicates the minimal value of advertising that the incumbent may choose in order for advertising to be allowed. This lower boundary appears as soon as the monopoly price level without advertising is also constrained by the price cap. The reason is that below this boundary on $k$, the generic price level does not differ sufficiently enough from the (now also constrained) monopoly price level in order to justify the advertising costs. For both the case that the price level is only binding in the first period and the case that it is binding in both periods, the generic price level is larger, the lower is $k$, which cannot be compensated by the positive effect of a lower $\bar{p}$ on the generic price. Therefore, for too low advertising levels, the welfare without market entry is larger than the welfare with advertising. The driving force behind this lower limit is rather the negative effect of a low advertising level on the generic price rather than the advertising costs.

For $k < \tilde{k}_{min}$, the difference between the welfare with and without advertising gets larger, the smaller is $k$, until $k_*$ is reached. For $k = k_*$, the generic price level equals the price cap as well. For $k < k_*$, the generic price will be $\bar{p} - \epsilon$ with $\epsilon \to 0$, i.e. advertising does not lead to lower price levels as compared to no advertising. The only difference lies in the advertising costs that are decreasing, the lower is $k$.

For the numerical illustration, the default values ($\theta = 1.5$, $e = 1$, $\bar{\ell} = 1$, $\delta = 0.8$, $\gamma = 1$, $F = 0$) are used and it is analysed, how the price cap $\bar{p}$ affects the optimal advertising level $\bar{k}^*$ and the maximal socially beneficial advertising level $\tilde{k}$, as well as the prices. The following table summarizes the results, where the column “case” refers to the price levels that are restricted by $\bar{p}$. For this specific example, the monopoly price level without advertising $p_B^M$
is larger than the second-period brand-name price level \( \bar{p}^{2*}_B \).

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If \( \bar{p} \geq 0.55317 \), then the price cap binds in neither of the periods. This is the situation that was dealt with in the previous section.

For \( 0.55317 > \bar{p} \geq 0.5 \), the price cap is only binding in the first period with advertising. It does not restrict the monopoly price without advertising. As it has already been explained (Lemma 6), the optimal investment in advertising \( \tilde{k}^* \) is smaller, the smaller is the price cap, because now the possibility to earn the advertising’s benefits without competition is constrained. However, the maximal socially beneficial advertising level \( \tilde{k} \) is larger, the smaller is the price cap. The reason is that although the second-period generic price level increases with a lower price cap, this is dominated by the effect that the first-period brand-name price level is restricted to \( \bar{p} \). Altogether it can be concluded that the smaller is the price cap, the more probable is advertising socially beneficial.

If \( 0.5 > \bar{p} \geq 0.406 \), then the price cap is still only binding in the first period with advertising, but it now also restricts the monopoly price without advertising. \( \tilde{k}^* \) decreases for lower price caps (see above). But now also \( \tilde{k} \) decreases for lower price caps. The reason is that now the generic price level is even higher than in the case above and approaches the monopoly price level that is now also restricted. Therefore it becomes more difficult to justify the advertising costs.

For \( 0.406 > \bar{p} \geq 0.355 \), the price cap is binding in both periods with advertising and for the
monopoly price without advertising. However, it does not bind the generic price level. The data show that the optimal advertising level $k^*$ is now larger, the smaller is the price cap. This rather counterintuitive result has already been pointed out in the analysis above: If the price cap is binding in both periods, then the advertising level increases for $\bar{p} > \bar{p} \approx 0.28$, which is clearly the case in this specific numerical example. The upper social limit $\bar{k}$ decreases, however, for the same reason as mentioned above. Altogether, the probability of advertising being socially beneficial, decreases therefore with a lower price cap. At the specific numeric example presented here, welfare with advertising is always less then without advertising, because the lower social limit $\bar{k}_{\text{min}}$ is not reached.

If $\bar{p} < 0.355$, then the price cap binds all price levels including the generic price level. This case is not illustrated above, because it would decrease welfare with certainty. If the price cap is too low, then the generic firm would simply set $\bar{p}_{CG}^{2*} = \bar{p} - \epsilon$ with $\epsilon \to 0$, which would basically result in the same prices irrespective of whether advertising is allowed or not. But then the advertising costs are clearly welfare decreasing. If the price cap is thus too low, then the only sensible decision that the regulator can take is to ban advertising.

**Proposition 2** Advertising in the presence of price regulation is only beneficial, if the price cap is not too low.

The intuition behind this is that advertising in this model is used as a way to induce competition after patent expiry in order to induce lower prices. If now the price cap is as low as to restrict the brand-name price even in the stage with competition, then advertising is basically taken its benefit with respect to welfare. Only if the price cap is chosen in a way that it only binds the brand-name price during patent protection, welfare with advertising increases because the downside of advertising is reduced and the advantage of advertising due to off-patent competition is unchanged. It can therefore be concluded that advertising and price regulation are complements as long as the price cap is not too low, and substitutes if price caps are regulated rather low.

This result is in line with Danzon and Chao (2000) who test the effect of price regulation on off-patent competition and find that price regulation decreases the impact of generic competition on prices.
7 Conclusion

The model is about the effect of advertising on generic market entry and on social welfare. Some main results can be retained:

First of all, advertising in this model is not an instrument to deter market entry, but rather to accommodate entry. The reason is that advertising creates artificial product differentiation which reduces competition between the brand-name and a generic firm after potential market entry. Without advertising, however, fierce competition after patent expiry results in zero returns for both firms. The generic firm anticipates this and that it will never be able to recover the sunk market entry costs and therefore stays out of the market.

Secondly, advertising can be socially efficient. It increases the brand-name price during the period of patent protection, but at the same time, both brand-name and generic prices decrease after patent expiry with advertising. The reason is that the more is advertised, the more important gets the detailed market for both firms, and therefore the more competition there will be in the detailed market. This results in lower prices for both firms.

Thirdly, market entry and advertising are more likely to be socially beneficial for a small perceived product differentiation and a short period of patent protection:

The degree of product differentiation is basically determined by the effectiveness of advertising, i.e. how persuasive the pharmaceutical firms’ detailing men are. Certainly the regulator cannot directly influence them but the effectiveness can be influenced indirectly. The regulator, here the health authority, can provide information material in order to proof the therapeutical equivalence between brand-name and generic drugs. This might be a way to reduce the effect that detailing has on the individual physician.\(^\text{15}\)

The (effective) patent length is already rather short and can of course be further adjusted, however, other aspects need to be taken into account such as reduced R&D-incentives. The patent length’s goal is primarily to grant the pharmaceutical firm some time of monopoly power during which it can recover any sunk innovation costs. This regulatory aim certainly is of more concern than the effect on advertising expenditure. But still this effect should not be neglected, considering that advertising expenditures easily even exceed R&D-expenditure.

\(^{15}\text{It is of course important to still guarantee that the qualities are perceived to be somehow differentiated in order not to deter market entry.}\)
Finally, advertising is a substitute for price regulation unless the price cap is rather high. The reason is that a high price cap limits the downfall of advertising which leads to higher prices during patent protection. A low price cap, however, makes the advantage of advertising redundant which is the stimulation of competition after patent expiry. In the U.S. pharmaceutical market, there is no price regulation and detailing is allowed. Advertising can here work as a substitute of price regulation, as it at least creates competition after patent expiry. In the European market, where there is price regulation and detailing, it remains ambiguous whether advertising is socially beneficial or not. In countries where the price regulation is rather strict, such as e.g. France and Italy, the benefits of advertising are reduced and most likely dominated by the welfare loss due to the advertising costs. In countries where the price regulation is rather lenient, such as e.g. Germany and the United Kingdom, advertising is more likely to be welfare increasing as a rather high price cap limits the price increase during patent protection on the one hand, and leaves competition after patent expiry to get low prices on the other hand.

This paper should not be understood as a pleading in favor of advertising. As the literature shows in general, advertising distorts prescription choices and is very often counter-competitive. However, the point needs to be stressed that detailing can have positive aspects as it can reduce ex-post competition and thus induce market entry. To show this point, the model has been severely simplified and important aspects have not been taken into account. The inclusion of a principal-agent relationship between the patients and their physicians, for example, would of course stress the downsides of advertising. Additionally, the aspect of competition has been limited to brand-name versus generic drug producers. Important aspects of advertising certainly concern the competition between several brand-name companies. Including the impact of advertising on competition during the period of patent protection, the investment in advertising would of course change, but to the expense that the presented model would become very complicated.
A Appendix

A.1 Proof of Lemma 1

It must be shown under which conditions $p_B^* > p_G^*$ forms a Nash-Equilibrium. This is the case if neither $B$ nor $G$ has an incentive to deviate from $p_B^*$ respectively $p_G^*$, given that the competitor does not deviate.

As a first step it can be shown that it is not optimal for $G$ to deviate from $p_G^*$, given that $B$ chooses $p_B^*$:

- If $p_G \geq p_B^*$, then the generic firm has no demand in both markets. In the detailed market, the physicians prescribe the perceived higher quality of the cheaper drug $B$ and also in the not-detailed market, the cheaper version $B$ is chosen. There will be thus no profits for $G$ in this case.\(^{16}\)

- The only possible Nash-Equilibrium is thus $p_G < p_B^*$. In this case $G$ gets the demand of the low-valuation patients in the detailed market and the whole demand in the not-detailed market.

- Given that $B$ chooses $p_B^*$, the generic firm certainly has no incentive to deviate from $p_G^*$. $p_G^*$ has been calculated as best response to $p_B^*$, given that the generic firm’s price level is lower than the brand-name firm’s price level.

The second step is to show that there is also no incentive for $B$ to deviate from $p_B^*$, given that $G$ sets $p_G^*$.

- $p_B > p_B^*$ is no equilibrium: $p_B^*$ was calculated as best response to $p_G^*$ in the case of $B$ setting a higher price level than $G$. To choose now an even higher price level than $p_B^*$ decreases $B$’s profit, because the negative demand effect is larger than the positive price effect on profits.

\(^{16}\)If both prices are equal, it is assumed that the incumbent’s drug is prescribed. This assumption can be rationalized, because during the period of patent protection, the physicians got used to prescribe the brand-name drug and they need to be induced to change their prescription behavior, e.g. by a lower generic price level.
• $p_B < p_B^{2*}$ is no equilibrium: One might think that there is an incentive to reduce the own price, because B might be able to drive G out of the market and serve the whole demand instead of only the detailed market. If this demand increase also increased the brand-name firm’s profit, then B might be induced to set a lower price level than $p_B^{2*}$. However, B’s threat to set a sufficiently low price level to drive G out of the market is not credible. As soon as G entered the market, G’s setup costs are sunk. If B wanted to serve the not-detailed market, too, then it had to engage in a fierce Bertrand competition which leads to zero profits for both firms. Comparing these zero profits with the profits that B can make by setting $p_B^{2*}$, it is obvious, that there is no incentive for B to set a lower price level than that.

Given that G chooses $p_G^{2*}$ it is thus indeed optimal for B to set $p_B^{2*}$. Both parties have no incentive to deviate from the optimal prices and $p_B^{2*} > p_G^{2*}$ forms a Nash-Equilibrium.

References


