Reference Pricing Systems on the Pharmaceutical Market
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Constantly rising expenditures for pharmaceuticals require government intervention in firms’ pricing decisions. To this end, reference pricing systems are a frequently employed regulatory mechanism. This paper considers a duopoly market with vertically differentiated firms under different competition types. Starting from the existing literature it can be confirmed that the introduction of a reference price leads to lower equilibrium prices and induces fiercer competition between brand-name and generic firms. Further, it can be shown that reference pricing promotes generic usage and leads to increased market coverage. Hence, an improved provision of medical supply is achieved due to the lower prices and the stimulated demand for drugs. The paper demonstrates that even under the increased demand consumer and insurance expenditures are reduced. The effects of the regulation are mainly born by the firm producing the original drug. The model isolates the mechanisms of reference pricing and shows the effects on consumer decisions. Lastly, due to lower prices consumer surplus increases when implementing the regulation.

**Keywords:** reference pricing · pharmaceutical market · copayment · price cap · price competition · expenditures · consumer surplus

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1. Introduction

Worldwide, the market for pharmaceuticals is subject to various regulations. Rising expenditures of statutory health insurances and increasing fees for patients due to high drug prices have led to a multitude of regulatory instruments. The pharmaceutical market is highly innovative and always subject to change: new drugs are continually introduced to the market, often bringing therapeutic advantages for the patients. After a long period of research and development eventually a firm introduces a new drug treating a certain sickness onto the market. In order to compensate the firms for their research expenditures incurred in order to come up with the innovations, these brand-name drugs obtain a period of patent protection (Verband forschender Arzneimittelhersteller (vfa) e.V., 2015).

During this period the firms can set their price freely, if and only if the new drugs are “sufficiently innovative” (Bundesgesundheitsministerium, 2016). This criterion is imposed on firms in Germany when entering the market. If the firms cannot prove the therapeutic advantages and novelty of their drug, they will be clustered with other drugs right away and, therefore, subject to the price regulation from their first market entrance on.

Besides these original drugs over time rival firms come up with cheaper alternatives such as generics or branded copies. The former can enter the market after patent expiry only, while the latter can directly enter without violating the patent protection of the brand-name drug. Thus, there exist many slightly different drugs on the market being capable to treat the same disease while being categorized into different groups: brand-name, generics or branded copy.

Generic drugs as well as branded copies treat the same diseases as the associated original drug, one also speaks of therapeutic equivalence. Generics are (more or less exact) copies of the original brand-name drug, since they contain the same active substance in combination with varying additive components. Therefore, they are not only characterized by therapeutic but also by pharmacological equivalence. In comparison branded copies consist of different active substances and, therefore, these drugs are of therapeutic equivalence only. Consequently, they are not violating the patent protection (via “inventing around”) and can enter the market at the same time (simultaneous price competition). Generic versions, due to their pharmacological equivalence, have to wait for the patent to expire in order to enter the market, here to a certain extend the firms compete sequentially.

Since drugs can be referred to as confidence goods the market for drugs exhibits an information asymmetry. Actually patients often do not know about the existence or the substitutability (López-Casanovas and Puig-Junoy, 2000) of these cheaper alternatives, like generics or branded copies, or they believe at least that they are of inferior quality. Therefore, patients tend to purchase high-priced brand-name drugs instead of their alternatives. This lack of information leads to unnecessarily high expenses since brand-name drugs are significantly more expensive in comparison to their alternatives.

In order to handle the increase in expenditures and to overcome the high price difference between the drug types, among other regulatory measures reference pricing
systems are implemented in several (European) countries, e.g., Germany, France, Spain (Kaiser, Mendez, and Ronde, 2010).

**Institutional Background.** Before deriving the model it proves necessary to shortly consider the institutional background concerning the applied reimbursement scheme. In Germany drugs usually are clustered according to their therapeutic equivalence (Danzon and Ketcham, 2004). Hence, drugs treating the same disease will be sorted into one group on which then the reference price is applied. Consequently, the brand-name drug can be clustered with its respective generic versions as well as with branded copies.

In case patients do not actively decide to take part in a private health insurance they are required to be insured via a statutory health insurance. When they are insured in a statutory health insurance patients only have to bear a (percentage) part of the drug price (the so called “copayment”) in addition to their (fixed) insurance premium. The remaining amount is funded by their insurance. In Germany the reimbursement scheme patients face when purchasing a prescription drug is as follows, see Herr and Suppliet (2011), Bundesgesundheitsministerium (2019):

\[
\text{copayment} = \begin{cases} 
  p & \text{if } p < 5 \text{€} \\
  5\text{€} & \text{if } 5\text{€} \leq p < 50\text{€} \\
  0.1 \times p & \text{if } 50\text{€} < p \leq 100\text{€} \\
  10\text{€} & \text{if } 100\text{€} < p
\end{cases}
\]

Consequently, patients tend to overuse drugs, see López-Casanovas and Puig-Junoy (2000), since they do not fully consider the high price difference between the brand-name drug and its therapeutic alternatives. Here the reference price intervenes by imposing a further payment for the consumers when purchasing the brand-name drug. In addition to their usual copayment they have to pay the amount by which the brand-name’s price is higher than the respective reference price. The theoretical model of this paper deals with patients participating in the statutory health insurance and considers the range of intermediate drug prices where patients have to bear a percentage part of the price as the copayment. In Germany the patients are required to pay 10% of the prescription drug price when it falls in between 50 € and 100 €.

**Literature Review.** Reference pricing systems in different variations as a regulator mechanism have been analyzed in theoretical and especially in empirical work. The first relevant contribution concerning the competition between brand-name drugs and generic versions was contributed by Grabowski and Vernon (1992). They derived that while brand-name prices steadily increase, the prices of generic versions will remain low due to competition among them. Scherer (1993) found that after generic entry, when the original product’s patent expired, the brand-name producers maintained their high-price-strategy (“generic competition paradox”). This finding was confirmed by Frank and Salkever (1997). Dalen, Strom, and Haabeth (2006) found evidence for brand-name firms answering generic entrance with a price
increase in order to reach the market segment with the brand loyal customers. These results reveal the need for regulation. More recently Pavcnik (2002) found in an empirical study that reference pricing leads to lower prices for both firms, while the decrease was even stronger for the brand-name firm. Various academic works found that besides decreasing prices, reference pricing also intensifies competition, see Pavcnik (2002), Brekke, Koenigbauer, and Straume (2007), Brekke, Grasdal, and Holmås (2009), Brekke, Holmås, and Straume (2011), Brekke, Canta, and Straume (2016). Further, Brekke et al. (2011) showed empirically that the brand-name firm’s market share decrease and that the reference pricing lead to significant cost savings. Berndt, McGuire, and Newhouse (2011) analyzed drug pricing in the U.S. for generic and branded drugs to highlight the choice of copayment versus coinsurance. In contrast to this setup in Germany copayment and coinsurance are implemented alongside. Based on the example of a reference price reform in Denmark affecting the price sensitivity of patients Kaiser et al. (2010) showed that expenditures decline in a more restrictive reference pricing calculation. Stargardt (2011) showed that generic entry has substantial effects on the prices of branded drugs and, therefore, the competitive effect is not negligible. Recently, Antoñanzas, Juaréz-Castelló, and Rodríguez-Ibeas (2017) analyzed the effect of reference pricing under exogenous and endogenous reference pricing systems on price setting.

Building on the existing literature, this paper identifies the mechanisms of reference pricing in stimulating generic market shares and especially in reducing consumer and insurance expenditures. Further, reference pricing increases market coverage while simultaneously reducing expenditures: the increase in demand is compensated by a sufficiently large decrease in prices. The improved medical supply in combination with lower prices lead to an increase in consumer surplus. The paper also points out that the reduction in expenditures is mainly due to the price decrease of the brand-name drug. The brand-name firm is affected way more by the regulation in comparison to its competitor, independent from being a generic firm or a firm producing a branded copy. The profits of the firm producing the original drug decrease significantly. Lastly, the paper points out the shortcomings of reference pricing and depicts where the regulation fails to accomplish its objectives.

The paper considers a duopoly market with vertically differentiated firms, compare Merino Castelló (2003), while differing from the established literature in several ways. Simultaneous and sequential price competition will be analyzed alongside, emphasizing the differences and clarify the economic relevance of both competition types. The effects of the copayment rate and especially of the mechanism of the reference price on the market outcomes will be assessed. Also the effect on market coverage and consumers’ and insurance expenditures will be analyzed and the results for consumer and producer surplus are derived. Also the differences between the effects on the brand-name firm and on its competitor will be assessed. Besides, by means of an exogenously given price cap, e.g. Brekke et al. (2011), the superiority of reference pricing is proven. The intention of the paper is to isolate the effects of reference pricing on certain market parameters and to analyze the influence of the regulatory intensity via the comparative statics.
Hereafter, the paper is organized as follows: the second part deals with the model set-up, then introduces the reference price under sequential and simultaneous competition and briefly considers a price cap to show that exogenous regulation cannot achieve a satisfactory solution. The last part concludes.

2. Theoretical Model

■ Set-up. The paper examines a vertically differentiated duopolistic market with a brand-name firm \((i = 1)\) producing an original drug and a firm \((i = 2)\) producing either a generic version or a branded copy depending on the considered competition type.\(^1\) A constant copayment rate, \(k \in [0, 1]\), which the consumers face when purchasing a drug, is assumed. Thus, the patients bear a proportional part of the drug costs while the remaining amount is covered by the statutory health insurance. The brand-name drug 1 and the drug of firm 2 differ in their perceived quality \(\theta_i\), with \(i = 1, 2\) and \(0 < \theta_2 < \theta_1 \leq 1\). To enter the market the drugs are required to provide a minimum quality level, i.e. some bioequivalence criteria. The upper quality bound can be interpreted as the current research status (“state-of-the-art”).

The consumers are uniformly distributed according to their drug valuation \(\tau \in [0, 1]\). Consumers with a relatively high valuation prefer the brand-name drug, those are willing to pay a higher price for the higher (perceived) quality. Consumers with a lower drug valuation are not committed to purchasing a specific drug and, therefore, will decide to purchase the alternative drug due to its lower price.

The utility from buying one unit of the drug is given by the direct utility from drug consumption (as the product of the consumers’ valuation and the quality) minus the consumer’s copayment, i.e. \(c_i\). The consumers’ utility is defined as

\[
U(\tau, \theta_i) = \begin{cases} 
\tau \theta_i - c_i & \text{if consumer buys one unit} \\
0 & \text{otherwise.}
\end{cases}
\]

With the copayment

\[
c_i = \begin{cases} 
k p_1 + (p_1 - p_R) & \text{for } i = 1 \\
k p_2 & \text{for } i = 2.
\end{cases}
\]

Where both firms charge positive prices \(p_i, i = 1, 2\). The endogenous reference price is defined as a linear combination of the two drug prices

\[
p_R = \alpha p_2 + (1 - \alpha)p_1
\]

where \(\alpha \in [0, 1]\). The limit case of \(\alpha = 0\) in the subsequent results describes the unregulated situation. The higher the weight the more restrictive the regulation and, hence, the lower the implemented reference price. It has to hold for each

\(^1\)The analysis applies only to drugs which are available on prescription and therefore covered by statutory health insurance. Over-the-counter products are not included.

\(^2\)Uninformed consumers might perceive the alternative drug as being of inferior quality.
consumer that the utility from purchasing drug $i$ has to be higher than the utility from purchasing drug $j$, i.e. $U(\tau, \theta_i) \geq U(\tau, \theta_j)$, with $i, j = 1, 2$, $i \neq j$. Consumers only buy a drug if their utility is non-negative. When a consumer decides to buy the brand-name drug he is additionally charged the difference between the brand-name drug’s price and the reference price. The consumer indifferent between the brand-name drug and its alternative is located at $\tau_1 \geq \frac{(k+\alpha)(p_1-p_2)}{\theta_1-\theta_2}$ and the consumer indifferent between the alternative drug and no purchase is located at $\tau_2 \geq \frac{k p_2}{\theta_2}$. The demand system follows as depicted in Figure 1.

![Figure 1: Demand System](image)

Hence, the demand functions read $D_1 = 1 - \tau_1$ and $D_2 = \tau_1 - \tau_2$. The demand for drug 2 reacts more sensitively to price changes than the demand for the brand-name drug, i.e. $\frac{\partial D_2}{\partial p_2} < \frac{\partial D_1}{\partial p_1}$. The firms’ profits are given by the sum of the direct revenues obtained from the consumers and the revenues obtained from the statutory health insurance. Production costs are assumed to be zero. Then the firm profit is

$$\max_{p_i} \pi_i = \left[ (1-k)p_iD_i + (1-k)p_i D_i \right] = p_iD_i, \quad i = 1, 2. \quad (1)$$

### Sequential Price Competition.

Sequential price competition depicts the competition between a brand-name drug and its generic version, which can enter the market after patent expiry only. Firm 1 (brand-name firm as market leader) anticipates the reaction of the follower given by the reaction function of firm 2

$$R^S_2(p_1) \equiv p_2^S = \frac{(k+\alpha)\theta_2}{2(k\theta_1 + \alpha\theta_2)} p_1^S. \quad (2)$$

Resulting in the reduced-form optimization problem for firm 1:

$$\max_{p_1^S} \pi_1^S = p_1^S \left[ 1 - \frac{(k+\alpha)(2k\theta_1 + (\alpha-k)\theta_2)}{2(\theta_1-\theta_2)(k\theta_1 + \alpha\theta_2)} p_1^S \right]$$

The resulting equilibrium prices are

$$p_1^S = \frac{(\theta_1 - \theta_2)(k\theta_1 + \alpha\theta_2)}{(k+\alpha)(2k\theta_1 + (\alpha-k)\theta_2)} \quad \text{and} \quad p_2^S = \frac{\theta_2(\theta_1 - \theta_2)}{2(2k\theta_1 + (\alpha-k)\theta_2)}.$$
The lower the reference price, the more the firms will decrease their prices, i.e. \( \frac{\partial p^S_i}{\partial \alpha} < 0 \). The brand-name firm is directly affected via the additional copayment. Firm 2 realizes an indirect effect. Since prices are strategic complements, firm 2’s price also decreases under a more restrictive reference price. Nevertheless, the decrease in the price of firm 2 is comparably small, i.e. \( \frac{\partial p^S_2}{\partial \alpha} < \frac{\partial p^S_1}{\partial \alpha} \). Figure (5) in the appendix reveals that firm 1 reacts stronger to the implementation of the reference price. The copayment rate negatively affects the pricing decision of both firms, i.e. \( \frac{\partial p^S_i}{\partial k} < 0 \). The relative price ratio decreases in the weight of the reference price, hence, fiercer price competition can be induced by the regulation:

\[
\frac{\partial (p^S_1/p^S_2)}{\partial \alpha} = \frac{2k\theta_2^2 - 2k\theta_1\theta_2}{(k + \alpha)^2\theta_2^2} < 0
\]

In contrast the influence of the copayment rate on the relative price ratio is positive - a higher copayment decreases the competition intensity between the two firms:

\[
\frac{\partial (p^S_1/p^S_2)}{\partial k} = \frac{2\alpha\theta_1\theta_2 - 2\alpha\theta_2^2}{(k + \alpha)^2\theta_2^2} > 0
\]

The generic market share under sequential competition results in equilibrium as

\[
\tilde{\gamma}^S = \sum_{i=1}^{2} \frac{D_i}{D_2} = \frac{k\theta_1 + \alpha\theta_2}{3k\theta_1 + 2\alpha\theta_2 - k\theta_2}
\]

with \( i = 1, 2 \). The more restrictive the reference price is, the higher the generic market share will be:

\[
\frac{\partial \tilde{\gamma}^S}{\partial \alpha} = \frac{k\theta_1\theta_2 - \theta_2^2}{(3k\theta_1 + 2\alpha\theta_2 - k\theta_2)^2} > 0
\]

Consumers tend to purchase more of the generic drug when a low reference price is implemented. However, the higher demand for generic drugs is not due to a switch of the consumers from the brand-name drug to the generic version. The consumption decision can be analyzed when examining the location of the respective indifferent consumer. When substituting for the equilibrium prices, the consumer who is indifferent between the two drug types is not affected by the reference price, i.e. \( \tau^S_i = 1/2 \). The higher generic usage results from a movement of the location of the second indifferent consumer to the left, i.e. \( \frac{\partial \tau^S_2}{\partial \alpha} < 0 \). The fraction of consumers who do not purchase decreases. So while consumers cannot be incentivized to switch from the brand-name drug to its generic version, nevertheless, a higher market coverage is induced by the reference price

\[
Q^S = \sum_{i=1}^{2} q_i = \frac{3k\theta_1 + 2\alpha\theta_2 - k\theta_2}{2(2k\theta_1 + (\alpha - k)\theta_2)}
\]

with \( i = 1, 2 \) and \( \frac{\partial Q^S}{\partial \alpha} > 0, \frac{\partial Q^S}{\partial k} < 0 \). So while prices are lower when firms are regulated, the demand for drugs increases since consumers have to pay less for their
drugs. Hence, it is possible to identify two contrary effects on consumer expenditures: lower prices decrease expenditures, while higher demanded quantities increase those. Consumer expenditures are defined as

\[ CE = \sum_{i=1}^{2} kp_i q_i \]  

with \( i = 1, 2 \). The effect of the price decrease dominates the higher demand, therefore, consumer expenditures unambiguously decrease under reference pricing. The same holds true for insurance expenditures

\[ IE = \sum_{i=1}^{2} (1 - k)p_i q_i. \]  

with \( i = 1, 2 \). Hence, as depicted by figure (2) overall expenditures incurred by consumers and insurance, i.e. \( ES = CE + IE \), decrease under regulation. Assuming that the brand-name drug’s quality is state-of-the-art, i.e. \( \theta_1 = 1 \), and the copayment rate is \( k = 0.1 \), which resembles the German copayment rate, the development of the expenditures in relation to the reference price and the difference in perceived quality can be shown. Expenditures are highest when no regulation is applied (\( \alpha = 0 \)) and when consumers perceive a high qualitative difference between the drugs (\( \theta_2 = 0 \)). The transition from an unregulated price setting to the introduction of a reference price leads to the largest expenditure savings. Between no regulation, i.e. \( \alpha = 0 \), and a quite high reference price \( \alpha = 0.2 \) the expenditures undergo a huge decrease. From \( \alpha = 0.2 \) on the expenditures decrease moderately.

Figure 2: Expenditures, sequential competition, \( \theta_1 = 1, k = 0.1 \)
As a result of the decrease in consumer expenditures consumer surplus, given by equation (5), increases.

\[
CS = \int_{\tau_1}^{1} (\tau \theta_1 - k p_1) \, d\tau + \int_{\tau_2}^{\tau_1} (\tau \theta_2 - k p_2) \, d\tau
\]  

(5)

The more restrictive the regulation the better the situation for consumers. Figure (3) depicts the development in consumer surplus for a varying reference price weight parameter \(\alpha\) and perceived quality of firm 2. As expected consumer surplus increases as the regulation becomes stricter and the perceived quality difference decreases (7). Hence, to obtain a higher consumer surplus regulators should inform the patients about the non-existence of a quality difference. If consumers perceive the generics as being of high quality the consumer surplus could be increased. As in the case of expenditures the introduction of a reference price (moving from \(\alpha = 0\) to \(\alpha = 0.2\)) leads to a strong increase in consumer surplus.

![Figure 3: Consumer Surplus, sequential competition, \(\theta_1 = 1, k = 0.1\)](image)

Finally, it remains to calculate the profits of the two firms as their producer surplus:

\[
\pi_1^s = \frac{(\theta_1 - \theta_2)(k \theta_1 + \alpha \theta_2)}{2(\alpha + k)(2k \theta_1 + (\alpha - k) \theta_2)}
\]

\[
\pi_2^s = \frac{\theta_2(\theta_1 - \theta_2)(k \theta_1 + \alpha \theta_2)}{4(2k \theta_1 + (\alpha - k) \theta_2)^2}
\]

In contrast to the consumer surplus, the producer surplus, \(\Pi^s = \pi_1^s + \pi_2^s\), decreases if a more restrictive reference price is implemented. The increase in demand cannot compensate for the loss due to lower prices, hence, the profits of both firms decrease.
Figure (4) provides the development of producer surplus. Producers undergo a huge loss in surplus when reference pricing is introduced. For the brand-name firm it is preferable that the original drug is perceived as being of high-quality in comparison to the generic version. The high level of differentiation would facilitate the high-price-strategy of firm 1. The larger share of the loss in producer surplus originates from firm 1, see figure (6) in the appendix. The brand-name producer’s profits undergo a larger loss due to the stronger decrease in the price of the original drug. The profit-loss of the generic firm is relatively small in comparison, nevertheless the profits of the generic firm unambiguously decrease in $\alpha$. The effect of an increase in $\theta_2$ works into both directions. For a lower (perceived) quality, i.e. $0 < \theta_2 \leq 0.7$, profits increase and for the interval of $0.7 < \theta_2 \leq 1$ profits of the generic firm decrease. Which is quite intuitive, since the higher the quality of the firm producing the generic drug, the less the differentiation between both firms and the smaller the differentiation between the two firms the lower the price difference, see figure (5). While the price of the brand-name firm decreases in $\alpha$ as well as in $\theta_2$, the price of the generic version increases for $0 < \theta_2 \leq 0.6$ and decreases for $0.6 < \theta_2 < 1$. For the interval borders of the (perceived) quality of the generic drug, $\theta_2 = 0$ and also when allowing for $\theta_2 = 1$, the price and profit of the generic firm equal zero. Clearly, when providing zero quality the firm cannot set a positive price and for $\theta_2 = 1 = \theta_1$ firms are homogeneous and, therefore, price competition would drive the prices down to zero. Nevertheless, $\theta_2$ is smaller than $\theta_1$ by assumption, which makes the case of $\theta_2 = 1$ a theoretical benchmark only.\(^5\)

\(^5\)When deriving the profits of firm 1 for the case of $\theta_1 = \theta_2 = 1$ one obtains a non-defined solution, since $\theta_2 < \theta_1$ has to hold. This solution is due to the non-defined indifferent consumer for the brand-name drug, hence, the model does not allow for homogeneous products.
Simultaneous Price Competition. Due to the minor economic relevance the findings from simultaneous price competition will only be shortly summarized. The situation of competition between brand-names and branded copies is less common. Only a comparably small share of drugs is categorized as branded copies. From the optimization problem (1) result the equilibrium prices of the two firms:

\[ p_1^B = \frac{2(\theta_1 - \theta_2)(k\theta_1 + \alpha\theta_2)}{(k + \alpha)(4k\theta_1 + \alpha\theta_2) - (k + \alpha)\theta_2} \]

\[ p_2^B = \frac{\theta_2(\theta_1 - \theta_2)}{4k\theta_1 + \alpha\theta_2} - (k + \alpha)\theta_2. \]

A more restrictive reference price leads to lower prices of both firms, i.e. \( \frac{\partial p_{RB}^i}{\partial \alpha} < 0, \ i = 1, 2 \). The direction of the effect of the copayment on the prices under reference pricing is unchanged, i.e. \( \frac{\partial p_{RB}^i}{\partial k} < 0, \ i = 1, 2 \).

A lower reference price induces fiercer price competition by reducing the relative price ratio:

\[ \frac{\partial (p_1^B/p_2^B)}{\partial \alpha} = \frac{2k\theta_2^2 - 2k_1\theta_2}{(\alpha + k)^2\theta_2^2} < 0 \]

A higher copayment for the patients leads to weaker price competition between the two firms, i.e. \( \frac{\partial (p_1^B/p_2^B)}{\partial k} > 0 \). The crucial difference to sequential competition is that the market share of the branded copy is constant under simultaneous price competition, i.e. \( \gamma_B^R = \frac{1}{3} \). The reference price cannot induce a higher usage of the alternative to the brand-name drug. The constant share of the branded copy is due to a parallel movement to the left of both indifferent consumers, which is reflected in \( \frac{\partial \tau_B^i}{\partial \alpha} < 0, \ i = 1, 2 \). Nevertheless, this leftward shift of both locations of indifferent consumers results in increased market coverage

\[ Q_B = \frac{3(k\theta_1 + \alpha\theta_2)}{4k\theta_1 + \alpha\theta_2} - (k + \alpha)\theta_2 \]

with \( \frac{\partial Q_B}{\partial \alpha} > 0 \) and \( \frac{\partial Q_B}{\partial k} < 0 \). Both drug types face increased demand, due to the lower prices more consumers decide to purchase. Still, the decrease in prices is high enough to compensate for the higher demand and leads to a decrease in consumer (3) and insurance expenditures (4) respectively. Consequently, consumer surplus, as given by equation (5), increases due to their lower expenditures for the drugs. On the contrary producer surplus, \( \Pi_B \), of both firms decreases under more restrictive reference pricing:

\[ \pi_1^B = \frac{4(\theta_1 - \theta_2)(k\theta_1 + \alpha\theta_2)^2}{(k + \alpha)(4k\theta_1 + \alpha\theta_2) - (k + \alpha)\theta_2} \]

\[ \pi_2^B = \frac{\theta_2(\theta_1 - \theta_2)(k\theta_1 + \alpha\theta_2)}{(4k\theta_1 + \alpha\theta_2) - (k + \alpha)\theta_2} \]

The effects of the interaction between the intensity of regulation and the perceived quality difference are qualitatively comparable to those under sequential price competition. The key difference between the two competition types is the independence of the branded-copy’s market share of the reference price.
**Price Cap.** Reference pricing might not achieve all desired regulatory outcomes, but to show that an exogenous regulation of prices performs even poorer, an exogenously given and binding price cap for the brand-name drug $1$, $p_1 = \bar{p}_1$ is assumed. Substituting this price cap $\bar{p}_1$ into the price reaction function of firm 2 yields the generic price $p_2^{PC} = \frac{\theta_2}{\theta_2} \bar{p}_1$.

A first shortcoming of this kind of regulation becomes visible in the price ratio which does not change in comparison to the benchmark case ($\alpha = 0$), i.e. $\frac{p_1}{p_2^{PC}} = \frac{\theta_1}{\theta_2}$. Hence, the price cap cannot induce fiercer competition. Further, it is sufficient to solve for the generic market share

$$\gamma_{PC} = \frac{k\theta_1\bar{p}_1}{(\theta_1 - \theta_2)(2\theta_1 - k\bar{p}_1)}.$$

The generic market share is increasing in the price cap, i.e. $\frac{\partial \gamma_{PC}}{d\bar{p}_1} > 0$. Consequently, decreasing the price cap leads to a lower generic market share, which constitutes a second shortcoming. A regulator would implement the lowest possible price cap to induce low prices, but this does not stimulate generic usage. A change in the price cap of a regulated product leads to a change in the same direction for the non-regulated product since prices are strategic complements. The price cap directly reduces prices but cannot overcome the price difference between the two drugs.

### 3. Conclusion

By briefly considering a price cap regulation it could be shown that it leads to lower prices, but neither it is capable of introducing fiercer price competition, nor it promotes generic usage. Hence, applying a price cap will not lead to the intended results of the market regulation.

Applying reference pricing proves more useful in achieving the intentions of the regulation. While the brand-name drug’s quantity stays constant under reference pricing (sequential price competition), the quantity of the generic drug increases. Consequently, this leads to a higher generic market share and increased market coverage. This is due to the effect of the reference pricing on the location of the consumer indifferent between purchasing the generic drug and no purchase at all. The lower prices shift the location of the indifferent consumer to the left: the higher the weight of the reference price the more the location shifts to the left. Turning to the expenditures it could be shown that consumer as well as insurance expenditures can be reduced when implementing a reference pricing system. Thus, the price decrease is sufficiently large to offset the effect of increased demand on expenditures.

When the regulation is initially introduced (from $\alpha = 0$ to $\alpha = 0.2$) the brand-name’s price drops significantly, whereas a further tightening of the regulation only leads to moderate decreases. This drop in prices drastically reduces expenditures and leads to an increase in consumer surplus. Clearly firms suffer under the regulation, whereby the reduction in producer surplus mainly originates from the loss in profits of the brand-name firm. Hence, the firm with the higher price in the beginning reacts more strongly to the introduction of the reference pricing system.

The decrease in prices and the intensified price competition are also visible under
simultaneous price competition. The equilibrium quantities increase, since more consumers decide to buy a drug due to lower prices. Nevertheless, the reference price is not able to induce a higher market share of firm 2. The usage of the branded-copy cannot be stimulated. The reference price influences the locations of both indifferent consumers (via $\alpha$). Both locations shift to the left, hence, increasing market coverage. But since this shift is parallel, the market share of firm 2 stays constant. The effects on expenditures and surpluses are similar to those under sequential price competition.

This paper confirmed the advantage of a reference pricing system in introducing fiercer price competition. Additionally, it demonstrated that under sequential price competition the generic market share increased as a consequence of the reference price. Sequential price competition is the more common type of competition for the pharmaceutical market. After patent expiry brand-name drugs are more often followed by generic versions instead of being threatened by firms inventing around the patent and coming up with branded copies. Furthermore, the improved market coverage shows that a reference price ensures that more consumers have access to medical treatment. Additionally, it could be shown that consumer and insurance expenditures decrease significantly under regulation - even when considering the increase in demand. Consequently, this leads to increased consumer surplus.

Of course introducing reference prices might lead to further changes in the insurance system, like an adjustment of the fixed health care contributions, as well as to effects on the firms' R&D investment decisions. Considering that brand-name firms will experience a significant drop in profits when being subject to a reference price, they even more need the period of free price setting when entering the market in order to compensate for expensive research expenditures. Consequently, it might be less attractive to enter the German pharmaceutical market when it is not certain that a new brand-name drug is characterized as “being sufficiently innovative” and then obtaining a period of free price setting. In case the firm cannot prove the therapeutic novelty of the drug it will be clustered and the reference price will be applied right away. However, these issues are beyond the scope of this paper.
Appendix

Figure 5: Prices, sequential competition, $\theta_1 = 1$, $k = 0.1$

Figure 6: Profits, sequential competition, $\theta_1 = 1$, $k = 0.1$
References


