DISCUSSION PAPER

No 45

The Effects of Rebate Contracts on the Health Care System

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March 2012

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Abstract

Group Purchasing Organizations (GPOs) increasingly gain in importance with respect to the supply of pharmaceutical products and frequently use multiple or exclusive rebate contracts to exercise market power. Based on a Hotelling model of horizontal and vertical product differentiation, we examine the controversy whether there exists a superior rebate scheme as far as consumer surplus, firms profits and total welfare are concerned. Accounting for horizontal and vertical differentiation, we find that firms clearly prefer multiple over exclusive rebate contracts. Contrary, there exists no rebate form that per se lowers total costs for the members of the GPOs or maximizes total welfare.

JEL Classification: I11; L13; L42

Keywords: GPOs; Rebate Contracts; Vertical Differentiation

1 Introduction

In the last five years, the global turnover of pharmaceuticals steadily increased up to 806.6 billion US-Dollar in 2009. About 54 percent of this turnover was generated in the USA (300.75 billion US-Dollar), in Japan (89.87 billion US-Dollar) and in Germany (41.28 billion US-Dollar). In Germany for instance, the health care expenditures in total constitute about 10 percent of the GDP.[1] To reduce these enormous costs, innumerable attempts have been taken.

One approach is to increase the buyer power of hospitals, nursing homes and other health care providing organizations as they form group purchasing organizations (GPOs).[2] Generally, GPOs do not purchase drugs and resell them but aggregate their members' demand and solicit bids from manufacturers. Supply contracts typically including rebates, are conducted with one or more firms and the members of the GPOs are able to purchase at the prices and other terms specified in the contracts. It is up to the GPOs whether they conclude rebate contracts with all possible manufacturers (multiple rebate contracts) or exclusively with one of them (exclusive rebate contracts). In order to increase total volume discounts and thereby lower prices for all members of the GPOs, it might pay to restrict consumers' choice via exclusive rebate contracts. Though, if a pharmaceutical product is not covered by the rebate contract, and there are no possibilities to buy off-contract, consumers have to substitute the horizontally differentiated pharmaceutical products.

Additionally to this horizontal differentiation based on individual preferences, pharmaceutical products are also vertically differentiated products. Although from a chemical point of view the drugs are identical, they may however differ in qualities. This results on the one hand, from effective quality differences as different sizes, routes of administration or byeffects. On the other hand, certain drugs have a higher perceived quality due to effective marketing and reputation.

Horizontal as well as vertical differentiations are often not taken into consideration by the GPOs. They minimize expenditures and hence their sole decision variables are the unit prices possibly net of rebates. Depending on the magnitude of differentiation, the GPOs are likely to opt for a rebate scheme that is not in the interest of their members.

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[1] See German Association for Pharmaceutical Industry: 'Pharma Data 2010' Berlin, 2010.

[2] In Germany for example, insurances may also act like GPOs, bundling their insurants' demand and negotiate directly with pharmaceutical manufacturers. To generalize the setup and as it does not affect the outcomes whether the members of the GPOs are hospitals or individual patients, we assume them to be hospitals or health care providing organizations.

The aim of this paper is to investigate the impacts of both rebate forms (multiple and exclusive rebate contracts) and answer the question whether there is a rebate form that is superior as far as consumer surplus and firms profits are concerned. Additionally, we propose a third rebate scheme under which the members of the GPOs are not bound to the exclusive rebate contracts of their GPOs. Under these so called partially exclusive rebate contracts, the members of the GPOs are not necessarily obliged to buy the pharmaceutical products under the terms of the exclusive rebate contract. Therefore, they can still choose between all manufacturers but possibly forgo rebates. Based on a model of horizontal and vertical differentiation, we focus on consumer surplus as well as on firms' profits and total welfare.

We show that in case of no vertical differentiation, both rebate forms (exclusive and multiple rebate contracts) lower total costs for the members of the GPOs compared to no rebate contracts and are thus advantageous. However, exclusive rebate contracts, even though they reduce product variety, lower overall costs even further than multiple rebate contracts. The third alternative of partially exclusive rebate contracts leads to highest total costs for the members of the GPOs. Assuming two manufacturers, they both prefer multiple over partially exclusive over exclusive rebate contracts, as fierce competition in case of (partially) exclusive rebate contracts leads to lower profits.

Considering quality differences, only exclusive rebate contracts with the manufacturer offering higher quality products are favorable independent of quality differences. Total costs for exclusive rebate contracts with the manufacturer offering the lower quality product, multiple rebate contracts and partially exclusive rebate contracts depend on quality differences. For sufficiently high quality differences, exclusive rebate contracts with the manufacturer offering the lower quality drug yield highest aggregated costs. We also find that it does not reduce costs for the members of the GPOs to conduct partially exclusive rebate contracts instead of exclusive rebate contracts with the manufacturer offering the higher quality product. Regarding rebate contracts with the lower quality firm, the favorability between partially exclusive and exclusive rebate contracts depends on quality differences. Manufacturers on the other hand, can increase their profits via partially exclusive rebate contracts compared to exclusive rebate contracts.

The rest of the paper is organized as follows: Section 2 introduces related literature. In section 3, we present the underlying model of horizontal differentiation including the specification of the rebate schemes. Focusing on the two forms of rebate schemes in section 4, we present the benchmark cases of multiple and exclusive contracts which are compared to multiple and exclusive rebate contracts in section 5. In this chapter we also analyze firms'

profits and total cost for the consumers and introduce the third alternative rebate scheme of partially exclusive rebate contracts. In part 6, we investigate the effects of quality differences on multiple, exclusive and partially exclusive rebate contracts. We provide a detailed evaluation of all discount forms concerning consumer surplus, firms' profits and total welfare. Finally, section 7 explores the robustness of the results by discussing some of the main assumptions of the paper and by providing concluding remarks.

2   Related Literature

To date there is a vast body of empirical surveys regarding GPOs and rebate contracts like the articles from Burns and Lee (2008), Kolasky (2009), Schneller (2009) and Ellison and Snyder (2001). Based on empirical findings, they point to the price reductions and efficiency gains due to rebate contracts. On the other hand, publications by Hovenkamp (2002), Elhauge (2002) and Lindsay (2009) focus on legal aspects of GPOs and discounts. Many theoretical and empirical studies investigate how GPOs enhance buyer power (e.g. Snyder (1998), Dana (2006), Inderst and Wey (2007) and Tyagi (2001)) but non of these works evaluates different forms of rebate contracts. Hence the paper closes this gap, by providing a theoretical model dealing with GPOs and two alternative discount forms, taking also quality differences into consideration.

Our paper relates to several research streams, including rebate contracts and quality differences. The rebate forms in our model are specified as all-units discounts, which are common for a health care setup and also used by Kolay et al. (2004) and Greenlee et al. (2008). Nevertheless, neither of these two papers considers the specific role of GPOs which are a central aspect of this paper. Chen and Roma (2001) study GPOs in a setup with two retailers and one manufacturer, offering all-units discounts. They show that symmetric retailers always profit from rebate contracts conducted via GPOs. In our model, we assume the buyers to be consumers, either hospitals or health care providing organizations, and we do not consider a single manufacturer but two competing firms at the upstream level. However, we also find that under most circumstances rebate contracts irrespective of the concrete design are advantageous for the members of the GPOs. Therefore, our findings are also in line with Marvel and Yang (2008) who argue that loyalty discounts lead to far more competitive outcomes than Bertrand-Nash competition, lowering total costs for the consumers. The model of Marvel and Yang (2008) also deals with rebate contracts in a health care context and as we do they use the model of horizontal differentiation by Hotelling (1929). But contrary to their

model, we evaluate the impact of the two alternative rebate forms; multiple and exclusive rebate contracts.

Additionally, we also account for quality differences. Especially in the health care context quality differences have to be considered carefully. One of the first to analyze quality differences in a Hotelling setup is Weizsäcker (1984). He develops a model consisting of two firms competing for consumers incurring quality differences. Consumers' decisions to switch the manufacturer depend on their relative position to the suppliers which can change over time. In the model of Weizsäcker (1984) quality differences are not explicitly specified and consumers' decision to change the supplier is solved implicitly. This very general setup has been enriched by health care specific factors in various articles. Schlesinger and Schulenburg (1991) model quality differences explicitly but compared to search costs. Quality differences are also covered by Brekke et al. (2006), Miraldo (2008) and Hu and Schwarz (2011) and specified very similar to our approach. In contrast to our paper, Brekke et al. (2006) and Miraldo (2008) cover quality differences in the context of reference pricing and Hu and Scharz (2011) consider quality differences in combination with contract administration fees that GPOs demand from manufacturers.

Our paper combines both rebate contracts and quality differences and contributes to the growing body of literature on health care issues. Although various effects of GPOs on market outcomes have already been studied, as far as we know rebate contracts in combination with quality differences have not yet been analyzed.

3   The Model

Drugs for the treatment of one particular disease are assumed to be horizontally differentiated goods. Although they have the same main ingredient, consumers have different preferences. The importance of differentiated preferences may vary between consumers, depending on personal characteristics. To incorporate this and in line with the existing literature, we base our setup on a standard Hotelling model of horizontal differentiation. Two manufacturers, 1 and 2, are located at the opposite ends of a unit interval. The consumers, being either hospitals or other health care providing organizations of a unity mass, are distributed uniformly along this line. All these consumers are members of one GPO. Consuming a certain type of drug from firm 1 or 2 provides each member of the GPO a basic constant utility of *V*, reduced by the prices they have to pay and the possible mismatch between the real and their ideal product. The prices are payed directly to the pharmaceutical firms. Additionally to the

unit prices, the utility of the members of the GPO is also reduced by linear transportation costs. Transportation costs reflect consumers preferences for certain drugs and hence the fact that they are not perceived as homogeneous goods.

The members of the GPO have delegated the decision-making power to the GPO. But in contrast to the members of the GPO, the GPO might not be able or willing to account for non monetary costs due to differentiation. Consequently, the GPO is assumed not to minimize total costs of the consumers, but total expenditures and takes prices as sole decision variable when it chooses between the manufacturers.

As far as the number of firms serving the market is concerned, two alternative contract systems are possible: either one or two firms may be active. Generally, there are no legal constraints and the GPO is free to choose between both alternatives.

Typically, the GPO aggregates its members' demand and thus possesses bargaining power. As a result it does not only inform its members about prices and quantities but actively influences the market outcomes. One alternative is to ask the affiliates to grant rebates. In case a manufacturer wants to be listed by the GPO and thus available for the members of the GPO, it has to grant discounts. Within these rebate contract systems there are various possibilities for a GPO to exercise market power. We present two alternatives in the context of rebate contracts: exclusive rebate contracts and multiple rebate contracts.

Hence four cases have to be distinguished depending on the number of affiliates and whether rebates are granted:

Table 1: Possible Regimes

	One firm serves the market	**Two firms serve the market**
No rebate contracts	Exclusive Contracts (EC)	Multiple Contracts (MC)
Rebates contracts	Exclusive Rebate Contracts (ER)	Multiple Rebate Contracts (MR)

3.1 Rebate Contracts

Two different concepts of rebate contracts have to be distinguished. There are legally fixed rebates and more common voluntary ones. Compulsory discounts are e.g. rebates of up to 16 % on the list prices as manufacturers in Germany have to grant them (Bundesministerium für Gesundheit 2012). Alternatively, GPOs can demand certain fixed rebates from their sup-

pliers. The discounts may vary depending on the size and the bargaining power of the GPO. Rebate contracts are typically given in the form of all-units discounts. Even though each member of the GPO is assumed to buy at most one unit, it may receive a volume discount. There are no individual rebates on the basis of each member, but discounts are accorded to the GPO for all its members. The GPO distributes the rebates between all members, buying from the same firm. We assume that rebates are spread evenly among all buyers and thus to derive individual discounts, total rebates have to be divided by the number of consumers buying their product from the same manufacturer. The individual decision of every consumer is hence influenced by the choice of the other members of the GPO.

In order to incorporate best the idea of individual rebates depending on collective decisions, polynomial all-units discounts are implemented. Another advantage of rebates of the form $R(x) := rx^m$ with $m > 1$ is that they reflect the concept of economies of scale. Development and production costs of pharmaceutical products decrease with increasing sale volumes. Therefore, manufacturers typically do not offer constant discounts but significantly higher ones for larger volumes.

Total rebates are specified as $R(x) := rx^2$, where $x \in [0, 1]$ is equivalent to the total quantity bought from one of the two manufacturers. As r is either legally fixed or set by the GPO, it is assumed to be constant, identical for both firms, independent of quantity and $r < t$ holds to insure positive quantities in equilibrium. For comparability, all other parameters are specified according to the underlying Hotelling model.

The timing of the game is as follows: first the GPO announces publicly whether it asks the firms to grant rebates or not. Secondly, whether one or two firms will serve the market. Next, in case of multiple (rebate) contracts, both manufacturers are accepted as contract partners and set their prices. Though to increase total and individual discounts granted, the GPO can restrict consumers' choices to one of the firms and conduct exclusive (rebate) contracts. In case of exclusive (rebate) contracts the two manufacturers make simultaneous take-it-or-leave-it offers to the GPO. The GPO minimizes expenditures and hence accepts the firm offering lower prices. In case of identical prices, we assume that she decides for manufacturer 1.

Typically, the bids under exclusive rebate contracts also involve all-units discounts which are modeled equivalently to the rebates in case of multiple rebate contracts as $R(x) := rx^2$. Initially, we assume exclusive rebate contracts to be entirely exclusive and as a consequence the members of the GPO do not have the opportunity to buy off-contract and product variety is reduced. We will soften this assumption in section 5.4, by accounting for different

compliances.

Proposition 1 *Given that all consumers purchase one of the goods, two aspects have to be considered:*[3]

> *i) Exclusive rebate contracts yield weakly higher total and individual rebates than multiple rebate contracts.*

> *ii) Multiple rebate contracts lead to weakly lower total and individual transportation costs than exclusive rebate contracts.*

The tradeoff between overall rebates granted and product variety has to be taken into consideration in order to find the cost minimizing rebate form. In the following sections, we further investigate the four different outcomes depending on the number of accepted firms and whether rebates are offered. We focus on the question whether there exists a regime that is superior, yielding lowest total costs for the consumers or highest profits for the firms.

4 No Rebate Contracts

First of all, we analyze the two alternatives under no rebate contracts. Both contract forms are taken as benchmarks to answer the question whether the introduction of rebates lowers cost for the members of the GPO or increases firms' profits.

4.1 Multiple Contracts

In case of no rebate contracts and both firms serving the market, the net utility for a consumer with address x choosing either the product from manufacturer 1 or 2 is given by

$$U_1(x) := V - p_1 - tx$$

or

$$U_2(x) := V - p_2 - t(1 - x).$$

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[3]Remark Proposition 1:

> i) Comparing total rebates granted in case of multiple and exclusive rebate contracts yields:
> $rx^2 + r(1 - x)^2 \leq r$, with individual rebates being: $rx \leq r \vee r(1 - x) \leq r$.

> ii) Comparing total transportation costs in case of multiple and exclusive rebate contracts yields:
> $\frac{1}{2}tx^2 + \frac{1}{2}t(1 - x)^2 \leq \frac{1}{2}t$, with individual transportation costs being: $tx \leq t \vee t(1 - x) \leq t$.

Total consumer surplus (CS) is defined by

$$CS_{MC} = \int_0^x V - (p_1 + t\epsilon)d\epsilon + \int_0^{1-x} V - (p_2 + t\epsilon)d\epsilon$$

and equivalently total cost (C) for the consumers by

$$C_{MC} = \int_0^x (p_1 + t\epsilon)d\epsilon + \int_0^{1-x} (p_2 + t\epsilon)d\epsilon.$$

We assume that the distribution of the consumers is common knowledge but the manufacturers are unable to identify individual preferences. This limited information prevents firms from price discrimination. Hence, the demand functions are given by

$$D_i^{MC}(p_i, p_j) = \begin{cases} 1 & \text{if } p_j - p_i \geq t \\ \frac{p_j - p_i + t}{2t} & \text{if } -t \leq p_j - p_i \leq t \\ 0 & \text{if } p_j - p_i \leq -t, \end{cases}$$

for $i \neq j = \{1, 2\}$ with the indifferent consumer located at $\frac{p_j - p_i + t}{2t}$. The two firms produce with identical marginal cost $c > 0$.[4] Hence, both manufacturers maximize profits of $\pi_1^{MC} = (p_1 - c)D_1(p_1, p_2)$ and $\pi_2^{MC} = (p_2 - c)D_1(p_1, p_2)$.

A simultaneous maximization of firms' profits gives the unique Bertrand-Nash equilibrium, with both manufacturers charging prices $p_1^{MC} = p_2^{MC} = c + t$ and supplying one half of the market. In the symmetric setup, each firm earns profits of $\pi_1^{MC} = \pi_2^{MC} = 0.5t$. Total costs for all members of the GPO are given by $C_{MC} = c + 1.25t$. Overall costs include expenditures for purchasing the pharmaceutical product and transportation costs caused by possible mismatches. Price competition in this setup does not induce manufacturers to price at marginal costs. This is due to the fact that decreasing prices do not only affect consumer at the margin but are offered to every member of the GPO, lowering overall profits.

Total expenditures which the GPO tries to minimize are given by $E_{MC} = c + t$.

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[4]We assume identical linear production costs. All the results we present are robust to a change in production costs as long as both firms' production cost functions are identical, which is rather likely in the health care context.

4.2 Exclusive Contracts

The GPO tenders exclusive rebate contracts and waits for the manufacturers to hand in their offers. The manufacturer offering the lower price is accepted as affiliate and serves the whole market. Being not admitted in case of exclusive rebate contracts is equivalent to market exclusion. With firms anticipating this, they hand in the lowest possible prices guaranteeing them non-negative profits. We assume without loss of generality, that the whole market is served by firm 1, setting the lowest possible equilibrium price of $p_1^{EC} = c$. Hence, both firms are left with zero profits. Total costs the consumers occur amount to $C_{EC} = c + 0.5t$, while total expenditures are given by $E_{EC} = c$.

5 Rebate Contracts

5.1 Multiple Rebate Contracts

In case of multiple rebate contracts, the GPO admits both manufacturers. This ensures that each member is offered his favorite type of pharmaceutical product and consequently maximum product variety. Manufacturers are asked to grant all-units discounts and thus considered when both firms simultaneously maximize their profits.

Compared to the findings in the benchmark case, presented in section 4.1, the introduction of multiple rebate contracts partially affects equilibrium outcomes. The individual net utilities from purchasing either from firm 1 or 2 change to

$$U_1^{MR}(x) := V - p_1 - tx + \frac{rx^2}{x} = V - p_1 + (r-t)x$$

and

$$U_2^{MR}(x) := V - p_2 - t(1-x) + \frac{r(1-x)^2}{(1-x)} = V - p_2 + (r-t)(1-x),$$

as consumers profit from equally shared rebates. Rebates reduce transportation cost for the individual consumer. Demand functions are given by

$$D_i^{MR}(p_i, p_j) = \begin{cases} 1 & \text{if } p_j - p_i \geq t - r \\ \frac{p_j - p_i + t - r}{2t - 2r} & \text{if } r - t \leq p_j - p_i \leq t - r \\ 0 & \text{if } p_j - p_i \leq r - t \end{cases}$$

for $i \neq j = \{1, 2\}$. Both manufacturers maximize their profits of $\pi_1^{MR} = (p_1 - c)D_1(p_1, p_2) - r(D_1(p_1, p_2))^2$ and $\pi_2^{MR} = (p_2 - c)D_2(p_1, p_2) - r(D_2(p_1, p_2))^2$, taking total costs for the quadratic discounts into consideration. However in this symmetric setup, rebates are not internalized by the manufacturers and thus the position of the indifferent consumer and prices in equilibrium are unaffected. Both firms still set prices of $p_1^{MR} = p_2^{MR} = c + t$ and supply one half of the market. With this equal partition of the market, members of the GPO obtain the same individual rebates irrespective of buying from manufacturer 1 or 2. Nevertheless, profits are reduced to $\pi_1^{MR} = \pi_2^{MR} = 0.5t - 0.25r$ as manufacturers are unable to treat rebates as an additional decision variable. Consumers benefit from multiple rebate contracts as total costs under multiple rebate contracts decrease to

$$C_{MR} = \int_0^x (p_1 + t\epsilon)d\epsilon - rx^2 + \int_0^{1-x} (p_2 + t\epsilon)d\epsilon - r(1 - x)^2 = c + 1.25t - 0.5r.$$

Taking rebates into account total expenditures are given by $E_{MR} = c + t - 0.5r$

5.2 Exclusive Rebate Contracts

On the other hand, the GPO can commit to exclusive rebate contracts with one of the manufacturers. As for the GPO prices are the single decision variable it will in any case opt for the manufacturer offering the lowest price. Equivalently to exclusive contracts, manufacturer 1 is assumed to serve the whole market offering prices of $p_1^{ER} = c + r$. For $p_1^{ER} = c + r$ manufacturer 2 has no incentive to undercut firm 1's offer as it would lead to negative profits. Hence, both firms are again left with the lowest possible profit of zero. Based on equilibrium prices, total costs for the members of the GPO are given by $C_{ER} = c + 0.5t$ and total expenditures amount to $E_{ER} = c$. They are both unaffected by rebate contracts as manufacturer 1 increases its prices by exactly the rebates it grants.

5.3 Comparison of the Rebate Schemes

Evaluating the four alternative concepts, we find that the introduction of rebate contracts lowers total costs in case of two firms serving the market. For one firm serving the market rebates do not affect total costs for the consumers as prices are increased exactly by the amount of the rebates granted. Consequently irrespective of the number of the affiliates, rebate contracts are generally favorable for the members of the GPO. The same holds true

from the point of view of the GPO, which aims to minimize expenditures.

Comparing the two rebate systems, there exists a trade off between multiple rebate contracts, with lower transportation costs and lower rebates, and exclusive rebate contracts, including higher transaction costs and higher rebates. However, exclusive rebate contracts are advantageous in any case. Even for prices identical to those in case of multiple rebate contracts $p_1^{MR} = p_2^{MR} = c + t$, exclusive rebate contracts still yield lower total costs. Although exclusive rebate contracts reduce product variety, the price effect in this setup always dominates the variety effect. Hence, a GPO intending to minimize its members' total costs, should opt for exclusive rebate contracts irrespective of the affiliate. This ranking coincides with the ordering of the GPO, aiming to minimize expenditures.

The manufacturers on the other hand prefer multiple (rebate) contracts over exclusive (rebate) contracts. Exclusive (rebate) contracts force them into fierce competition driving profits down to zero.

5.4 Partially Exclusive Rebate Contracts

There is a tradoff between rebates granted and product variety that is multiple and exclusive rebate contracts. In theory as well as in practice there exists a third alternative: partially exclusive rebate contracts. In case of partially exclusive rebate contracts, the GPO conducts rebate contracts with one of the manufacturers. However, the members of the GPO are not obliged to buy the pharmaceutical product under contract but can also purchase goods off-contract. Nevertheless, buying from the firm offering off-contract products involves no discounts. The degree to which the members of the GPO buy the contracted drug is called compliance. Generally, two cases have to be distinguished: partially exclusive rebate contracts with manufacturer 1 or 2.

If a GPO opts for partially exclusive rebate contracts with manufacturer i, the members of the GPO can continue to buy their pharmaceutical product from firm j. However, no rebates are granted in this case. This leads to net utilities for a consumer located at position x buying from firm i or j of either

$$U_i^{PERi}(x) := V - p_i - tx + rx$$

or

$$U_j^{PERi}(x) := V - p_j - t(1 - x)$$

for $i \neq j = \{1, 2\}$. Therefore, in equilibrium prices are given by $p_i^{PERi} = \frac{c(r-6t)+(r+2t)(r-3t)}{r-6t}$

and $p_j^{PERi} = \frac{c(r-6t)+3t(r-2t)}{r-6t}$ and the indifferent consumer is located at $\frac{r-3t}{r-6t}$. The manufacturers' profits in equilibrium are $\pi_i^{PERi} = \frac{2t(-r+3t)^2}{(r-6t)^2} < \frac{9t^2(2t-r)}{(r-6t)^2} = \pi_j^{PERi}$. Aggregated costs of the members of the GPO are given by

$$C_{PERi} = \int_0^x (p_1 + t\epsilon)d\epsilon - rx^2 + \int_0^{1-x} (p_2 + t\epsilon)d\epsilon = \frac{2c(r-6t)^2 + t\left(5r^2 - 48rt + 90t^2\right)}{2(r-6t)^2}.$$

For both alternatives of partially exclusive rebate contracts, we find that there is no complete compliance. For each opportunity some members of the GPO decide to buy off-contract.

Comparing total costs under partially exclusive rebate contracts to total costs under multiple or exclusive rebate contracts, partially exclusive rebate contracts lead to highest costs for the members of the GPO. This changes taking vertical differentiation into account.

Both manufacturers prefer partially exclusive rebate contracts over exclusive rebate contracts as they insure them positive profits. Irrespective of whether they are partners of a rebate contract or not, partially exclusive rebate contracts yield lower profits than multiple rebate contracts.

Additionally to the horizontal differentiation, pharmaceutical products are often also vertically differentiated. Thus we incorporate quality differenced into our model to test its robustness.

6 Vertical Differentiation

In contrast to the standard Hotelling model of section 3, drugs often do not only differ horizontally but also vertically. We suppose there is a quality difference of β between the competitors. This might on the one hand result from effective quality differences as the easiness in drug-taking and the coating of a pill. On the other hand, certain drugs might have a higher perceived quality due to effective marketing and reputation.[5] All consumers perceive manufacturer 1 as offering the high quality drug and firm 2 as offering a pharmaceutical product of lower quality. To insure positive quantities in equilibrium, β is implemented as $0 < \beta < 3t - r$ for all consumers.

Accounting for quality differences affects equilibrium outcomes in the benchmark cases

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[5]Very often these quality differences also have a temporal component. Being the first to introduce a new product often guarantees the manufacturer the possibility to create long-lasting consumer relations leading to entry barriers favoring the incumbent.

of multiple and exclusive contracts.

In case of multiple contracts the utility of a consumer located at position x buying from manufacturer 1 or 2 is given by

$$U_1^{\beta,MC}(x) := V - p_1 - tx$$

or by

$$U_2^{\beta,MC}(x) := V - p_2 - t(1 - x) - \beta.$$

Consequently, demand functions change to

$$D_1^{\beta,MC}(p_1, p_2) = \begin{cases} 1 & \text{if } p_2 - p_1 \geq t - \beta \\ \frac{p_2 - p_1 + t + \beta}{2t} & \text{if } -\beta - t \leq p_2 - p_1 \leq t - \beta \\ 0 & \text{if } p_2 - p_1 \leq -\beta - t \end{cases}$$

and

$$D_2^{\beta,MC}(p_1, p_2) = \begin{cases} 1 & \text{if } p_1 - p_2 \geq t + \beta \\ \frac{p_1 - p_2 + t - \beta}{2t} & \text{if } \beta - t + r \leq p_1 - p_2 \leq t + \beta \\ 0 & \text{if } p_1 - p_2 \leq \beta - t. \end{cases}$$

Simultaneous maximization of firms' profits leads to equilibrium prices of $p_2^{\beta,MC} = c + t - \frac{\beta}{3} < p_1^{\beta,MC} = c + t + \frac{\beta}{3}$ and the position of the indifferent consumer of $0.5 + \frac{\beta}{6t}$.

Quality differences constitute a competitive advantage of firm 1, leading to higher prices compared to the prices in the standard Hotelling model. Manufacturer 2 on the other hand, has to overcome the disadvantage of quality differences by lowering its prices compared to prices in the standard Hotelling setup. Rising quality differences widen this competitive gap even further. Due to quality differences the number of members who decide to buy from manufacturer 2 is relatively small in equilibrium and the position of the indifferent consumer is shifted in favor of manufacturer 1.

Firms' profits are given by $\pi_2^{\beta,MC} = \frac{(3t-\beta)^2}{18t} < \frac{(3t+\beta)^2}{18t} = \pi_1^{\beta,MC}$. Manufacturer 2 loses profits due to negative effects on prices and quantities, while firm 1 benefits from quality differences and can increase profits compared to the standard Hotelling model presented in section 4.1.

The position of the indifferent consumer and prices in equilibrium lead to total costs

consumers incur of

$$C_{MC}^\beta = \int_0^x (p_1 + t\epsilon)d\epsilon + \int_0^{1-x} (p_2 + t\epsilon + \beta)d\epsilon = c + 1.25t + 0.5\beta - \frac{\beta^2}{36t}.$$

The members of the GPO are attached to manufacturer 1, which explores this competitive advantage. Thus, despite the lower prices of manufacturer 2, overall costs rise, compared to the benchmark case of section 4.1, as a larger proportion of consumers buys from firm 1 which increases prices.

Instead of accepting two manufacturers serving the market, the GPO can decide for one of them and exclusive contracts. The GPO decides between the two manufacturers on the basis of the prices they charge. As it takes neither horizontal nor vertical differentiation into account the results presented in 4.2 still hold with manufacturer 1 charging $p_1^{\beta,EC} = c$ and realizing zero profits. The members of the GPO on the other hand consider differentiation and and thus occur total costs of $C_{EC}^\beta = c + 0.5t$ is case of exclusive contracts with manufacturer 1 and $C_{EC}^\beta = c + 0.5t + \beta$ under exclusive contracts with firm 2.

Taking these results as benchmark, the GPO can still conduct either multiple or exclusive rebate contracts to reduce its members' costs.

6.1   Multiple Rebate Contracts with Quality Differences

Accounting for multiple rebate contracts in combination with asymmetric quality differences, leads to modified prices and quantities in equilibrium. For the indifferent consumer located at position x

$$V - p_1 - tx + rx = V - p_2 - t(1 - x) + r(1 - x) - \beta$$

has to hold and hence,

$$D_1^{\beta,MR}(p_1, p_2) = \begin{cases} 1 & \text{if } p_2 - p_1 \geq t - r - \beta \\ \frac{p_2 - p_1 + t + \beta - r}{2t - 2r} & \text{if } r - t - \beta \leq p_2 - p_1 \leq t - r - \beta \\ 0 & \text{if } p_2 - p_1 \leq r - t - \beta \end{cases}$$

and

$$D_2^{\beta,MR}(p_1, p_2) = \begin{cases} 1 & \text{if } p_2 - p_1 \geq t - r + \beta \\ \frac{p_1 - p_2 + t - \beta - r}{2t - 2r} & \text{if } r - t + \beta \leq p_2 - p_1 \leq t - r + \beta \\ 0 & \text{if } p_2 - p_1 \leq r - t + \beta. \end{cases}$$

Based on the demand functions, both manufacturers simultaneously maximize profits, leading to prices in equilibrium of $p_2^{\beta,MR} = c + t - \frac{t\beta}{3t-r} < c + t + \frac{t\beta}{3t-r} = p_1^{\beta,MR}$. With multiple rebate contracts, the discounts granted depend on the consumer basis of the manufacturers. More members of the GPO buy from firm 1 than from manufacturer 2, making firm 1 more attractive as far as rebates are concerned. Firm 1 profits from this additional competitive advantage and increases prices. Manufacturer 2 on the other hand, lowers its prices in order to compensate consumers for the rebate loss they incur. The position of the indifferent consumer is shifted in favor of manufacturer 1, compared to no rebate contracts, to $0.5 + \frac{\beta}{2(3t-r)}$.

An increase in horizontal product differentiation shifts the position of the indifferent consumer and leads to manufacturer 2 gaining more consumers. Creating larger rebates for each individual member, firm 2 can charge higher prices without losing profits. Contrary, manufacturer 1 loses customers yielding lower rebates. To compensate members for the rebate loss, prices of manufacturer 1 have to decrease.

Based on prices in equilibrium and the position of the indifferent consumer, manufacturers 1 and 2 realize profits of $\pi_2^{\beta,MR} = \frac{(2t-r)(r-3t+\beta)^2}{4(r-3t)^2} < \frac{(2t-r)(-r+3t+\beta)^2}{4(r-3t)^2} = \pi_1^{\beta,MR}$. Under multiple rebate contracts, firm 2's profits are smaller than those of manufacturer 1 due to lower prices and a lower consumer basis.

Accounting also for quality differences, overall costs C_{MC}^{β} the members of the GPO incur are given by

$$C_{MC}^{\beta} = \int_0^x (p_1 + t\epsilon)d\epsilon - rx^2 + \int_0^{1-x} (p_2 + t\epsilon + \beta)d\epsilon - r(1-x)^2 = \frac{1}{4}\left(4c - 2r + 5t + 2\beta - \frac{t\beta^2}{(r-3t)^2}\right).$$

The corresponding total expenditures are given by $E_{MC}^{\beta} = \frac{1}{2}\left(2c - r + 2t - \frac{(r-2t)\beta^2}{(r-3t)^2}\right)$.

6.2 Exclusive Rebate Contracts with Quality Differences

The members of the GPO strictly prefer manufacturer 1 over 2 due to quality differences. From the point of view of the members of the GPO, conducting exclusive rebate contracts with firm 1 yields total costs of $C_{ER1}^{\beta} = c + 0.5t$. In case of exclusive rebate contracts with

manufacturer 2 total costs are given by $C^{\beta}_{ER2} = c + 0.5t + \beta$. Hence the members of the GPO always regard exclusive rebate contracts with firm 2 as second best option.

However, the members of the GPO have delegated the choice of the affiliate to the GPO. The GPO neglects differentiation and regards both manufacturers as being equal. Consequently, the GPO treats prices net of rebates as sole decision variable, leading to the same results as presented in section 4.2. The GPO may opt for exclusive rebate contracts with firm 1 or with firm 2 as they both offer identical prices. The GPO considers both exclusive rebate contracts as being equal with total expenditures for its members of $E^{\beta}_{ER1} = E^{\beta}_{ER2} = c + 0.5t$. Not taking quality differences into consideration possibly causes, to the amount of β, higher total cost for the members of the GPO.

6.3   Partially Exclusive Rebate Contracts with Quality Differences

As presented above, under quality differences the evaluation of exclusive and multiple rebate contracts differs between the GPO and its members. To overcome the delegation problem, partially exclusive rebate contracts are one alternative. In case of partially exclusive rebate contracts, the GPO conducts rebate contracts with one of the manufacturers. However, the members of the GPO are not obliged to buy the pharmaceutical product under contract but can also purchase goods off-contract. This leads in case of partially exclusive rebate contracts with manufacturer 1 to net utilities for a consumer located at position x of either

$$U^{\beta, PER1}_1(x) := V - p_1 - tx + rx$$

or

$$U^{\beta, PER1}_2(x) := V - p_2 - t(1 - x) - \beta.$$

Therefore, in equilibrium prices are given by $p^{\beta, PER1}_1 = \frac{c(r-6t)+(r+2t)(r-3t-\beta)}{r-6t}$ and $p^{\beta, PER1}_2 = \frac{c(r-6t)+(r-2t)(3t-\beta)}{r-6t}$ and the indifferent consumer is located at $\frac{r-3t-\beta}{r-6t}$. Manufacturers' profits in equilibrium are $\pi^{\beta, PER1}_1 = \frac{2t(-r+3t+\beta)^2}{(r-6t)^2}$ and $\pi^{\beta, PER1}_2 = \frac{(2t-r)(-3t+\beta)^2}{(r-6t)^2}$. The aggregated costs of the members of the GPO are given by

$$C^{\beta}_{PER1} = \int_0^x (p_1 + t\epsilon)d\epsilon - rx^2 + \int_0^{1-x} (p_2 + t\epsilon + \beta)d\epsilon$$

$$= \frac{2c(r - 6t)^2 + t\left(5r^2 + 90t^2 + 36t\beta - 2\beta^2 - 4r(12t + \beta)\right)}{2(r - 6t)^2}.$$

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The corresponding total expenditures are given by $E^{\beta}_{PER1} = \frac{c(r-6t)^2 + 2r^2t + 4t(9t^2+\beta^2) - r(21t^2 - 2t\beta + \beta^2)}{(r-6t)^2}$.
On the other hand, the GPO can also opt for partially exclusive rebate contracts with firm 2. This changes the corresponding net utilities to

$$U^{\beta,PER2}_1(x) := V - p_1 - tx$$

and

$$U^{\beta,PER2}_2(x) := V - p_2 - t(1 - x) + r(1 - x) - \beta.$$

Simultaneous maximization of firms' profits leads to prices in equilibrium of $p^{\beta,PER2}_1 = \frac{c(r-6t)+(r-2t)(3t+\beta)}{r-6t}$ and $p^{\beta,PER2}_2 = \frac{c(r-6t)+(r+2t)(r-3t+\beta)}{r-6t}$, with the indifferent consumer at $\frac{3t+\beta}{6t-r}$. Firms' profits are given by $\pi^{\beta,PER2}_1 = \frac{(2t-r)(3t+\beta)^2}{(r-6t)^2}$ and $\pi^{\beta,PER2}_2 = \frac{2t(r-3t+\beta)^2}{(r-6t)^2}$. Prices and quantities in equilibrium cause total costs of

$$C^{\beta}_{ER2} = \int_0^x (p_1 + t\epsilon)d\epsilon + \int_0^{1-x}(p_2 + t\epsilon + \beta)d\epsilon - r(1-x)^2$$

$$= \frac{2c(r-6t)^2 + r^2(5t+2\beta) - 4rt(12t+5\beta) + 2t\left(45t^2 + 18t\beta - \beta^2\right)}{2(r-6t)^2}.$$

and total expenditures of $E^{\beta}_{PER2} = \frac{2r^3 + c(r-6t)^2 - 10r^2t - 3rt^2 + 36t^3 + 2r(2r-7t)\beta + (r+4t)\beta^2}{(r-6t)^2}$.

6.4   Comparison of the Rebate Schemes with Quality Differences

Comparing the findings regarding exclusive, partially exclusive and multiple rebate contracts two cases have to be distinguished. The perception of the members of the GPO, based on total costs, is given by Proposition 2, while the one of the GPO, based on expenditures, is summarized in Proposition 3.

Proposition 2 *From the point of view of **the members of the GPO** the ranking of the different rebate contract forms is given by:*

   i) For $0 < \beta < \frac{-(r-3t)^2 + \sqrt{(r-6t)(r-3t)^2(r-2t)}}{t}$: $C^{\beta}_{ER1} < C^{\beta}_{ER2} < C^{\beta}_{MR} < C^{\beta}_{PER2} < C^{\beta}_{PER1}$.

   ii) For $\frac{-(r-3t)^2 + \sqrt{(r-6t)(r-3t)^2(r-2t)}}{t} < \beta < r - 9t + \sqrt{3}\sqrt{r^2 - 12rt + 36t^2}$: $C^{\beta}_{ER1} < C^{\beta}_{MR} <$ $C^{\beta}_{ER2} < C^{\beta}_{PER2} < C^{\beta}_{PER1}$.

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iii) For $r - 9t + \sqrt{3}\sqrt{r^2 - 12rt + 36t^2} < \beta < \frac{-r^2 + \sqrt{(r-6t)^3(r-2t)} + 10rt - 18t^2}{2t} : C_{ER1}^\beta < C_{MR}^\beta <$ $C_{PER2}^\beta < C_{ER2}^\beta < C_{PER1}^\beta.$

iv) For $\frac{-r^2 + \sqrt{(r-6t)^3(r-2t)} + 10rt - 18t^2}{2t} < \beta : C_{ER1}^\beta < C_{MR}^\beta < C_{PER2}^\beta < C_{PER1}^\beta < C_{ER2}^\beta.$

Irrespective of quality differences β, exclusive rebate contracts with manufacturer 1 always yield lowest total costs. Negotiating with firm 1, it is cost minimizing for the members of the GPO to decide for exclusive rebate contracts instead of partially exclusive rebate contracts, irrespective of β. The reason for this is twofold, under partially exclusive rebate contracts total rebates are strictly lower than under exclusive rebate contracts as no complete compliance is realized. Additionally, firm 1 charges higher prices under partially exclusive rebate contracts than under exclusive rebate contracts.

For quality differences smaller than $r - 9t + \sqrt{3}\sqrt{r^2 - 12rt + 36t^2}$ this holds also true for discount contracts with manufacturer 2. For larger β it is cost minimizing to opt for the moderate form of exclusive rebate contracts: partially exclusive rebate contracts. Hence in case of sufficiently large quality differences, it decreases total costs for the members of the GOP to vote for partially exclusive rebate contracts with manufacturer 2 instead of exclusive rebate contracts with firm 2. For sufficiently high quality differences exclusive rebate contracts with manufacturer 2 yield highest total costs. Allowing both firms to be active on the market guarantees rather moderate total costs.

The GPO assumes the ranking to be different as it does not incorporate horizontal or vertical differentiation.

Proposition 3 *From the point of view of **the GPO** the ranking of the different rebate contract forms is given by:*

i) For $\beta < +4t - r - \sqrt{t(-2r + 7t)} : E_{ER1}^\beta = E_{ER2}^\beta < E_{MR}^\beta < E_{PER1}^\beta < E_{PER2}^\beta.$

ii) For $+4t - r - \sqrt{t(-2r + 7t)} < \beta : E_{ER1}^\beta = E_{ER2}^\beta < E_{MR}^\beta < E_{PER2}^\beta < E_{PER1}^\beta.$

The evaluation of the members of the GPO and the GPO itself differs. Not taking differentiation into account, the GPO is likely not to opt for the cost-minimizing alternative of exclusive rebate contracts irrespective of the manufacturer. In line with the ranking of the members of the GPO, partially exclusive rebate contracts with firm 2 yield lower total cost than those with manufacturer 1. But the members of the GPO clearly prefer exclusive rebate contracts with manufacturer 1 over partially exclusive rebate contracts with firm 1. This strict

ordering is not perceived analyzing the ranking of the GPO. For the GPO the favourability depends on quality differences. Additionally, exclusive rebate contracts with manufacturer 1 or 2 are treated equally in contrast to the rating of the members of the GPO. These different evaluations again give rise to possible delegation problem.

Proposition 4 *Adding the opportunity of partially exclusive rebate contracts also influences the ranking of firms' profits.*

i) For manufacturer 1 it depends on β and is given by:

- *For $\beta < -t + \sqrt{2}\sqrt{-rt + 2t^2} : 0 = \pi_1^{\beta,ER1} = \pi_1^{\beta,ER2} < \pi_1^{\beta,MR} < \pi_1^{\beta,PER1} < \pi_1^{\beta,PER2}$.*
- *For $-t + \sqrt{2}\sqrt{-rt + 2t^2} < \beta : 0 = \pi_1^{\beta,ER1} = \pi_1^{\beta,ER2} < \pi_1^{\beta,MR} < \pi_1^{\beta,PER2} < \pi_1^{\beta,PER1}$.*

ii) For firm 2 it is given by: $0 = \pi_2^{\beta,ER2} = \pi_2^{\beta,ER1} < \pi_2^{\beta,MR} < \pi_2^{\beta,PER2} < \pi_2^{\beta,PER1} \; \forall \beta_2$.

Both manufacturers profit from partially exclusive rebate contacts as they lead to higher profits than in case of exclusive rebate contracts or multiple rebate contracts. For quality differences smaller than $-t + \sqrt{2}\sqrt{-rt + 2t^2}$ manufacturer 1 profits from partially exclusive rebate contracts with manufacturer 2. The same holds true for firm 2 irrespective of quality differences. It is due to the fact that being no partner of partially exclusive rebate contracts still guarantees positive quantities without the obligation to grant rebates. For increasing β, manufacturer 1 prefers being a partner of partially exclusive rebate contracts instead of partially exclusive rebate contracts with manufacturer 2.

In oder to fully evaluate the effects of the different rebate contract forms on total costs for the members of the GPO and on firms' profits, we introduce total welfare as additional decision variable. Total welfare adds up consumer surplus and profits of the two manufacturers and is defined as

$$W_M^\beta = V - C_M^\beta + \pi_1^{\beta,M} + \pi_2^{\beta,M}$$

for all possible rebate contract opportunities, while M stands for the specific rebate contract form. Comparing the total welfare for all possible five regimes, gives a ranking of the different rebate contract forms of:

Proposition 5 *The welfare ranking of the different rebate contract forms depends on quality differences β:*

(i) For $0 < \beta < \frac{rt(3t-r)t}{2r^2 - 15rt + 24t^2} : W_{ER2}^\beta < W_{ER1}^\beta < W_{PER1}^\beta < W_{PER2}^\beta < W_{MR}^\beta$.

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(ii) For $\frac{rt(3t-r)t}{2r^2-15rt+24t^2} < \beta < \frac{(r-3t)t}{r-5t}$: $W_{ER2}^\beta < W_{ER1}^\beta < W_{PER1}^\beta < W_{MR}^\beta < W_{PER2}^\beta$.

(iii) For $\frac{(r-3t)t}{r-5t} < \beta < \frac{(r-3t)t}{2r-5t}$: $W_{ER2}^\beta < W_{PER1}^\beta < W_{ER1}^\beta < W_{MR}^\beta < W_{PER2}^\beta$.

(iv) For $\frac{(r-3t)t}{2r-5t} < \beta < \frac{3t^2}{5t-r}$: $W_{ER2}^\beta < W_{PER1}^\beta < W_{MR}^\beta < W_{ER1}^\beta < W_{PER2}^\beta$.

(v) For $\frac{3t^2}{5t-r} < \beta$: $W_{ER2}^\beta < W_{PER1}^\beta < W_{MR}^\beta < W_{PER2}^\beta < W_{ER1}^\beta$.

From a welfare perspective, exclusive rebate contracts with manufacturer 2 yield lowest welfare irrespective of quality differences. Both manufacturers realize zero profits and members of the GPO have to purchase the product of lower quality. Driven by lower total costs, partially exclusive rebate contracts with manufacturer 2 are superior to exclusive rebate contracts with firm 2. For rather low quality differences this also holds for rebate contracts with manufacturer 1. Although both firms constantly realize zero profits, total welfare from exclusive rebate contracts with firm 1 increases with rising β, due to the comparative advantage from lowest total costs for the consumers. Neither exclusive nor partially exclusive rebate contracts with manufacturer 1 are favorable in all cases. The evaluation of multiple rebate contracts is also dependent of quality differences.

7 Discussion

The above discussion implies that neither multiple, nor exclusive nor partially exclusive rebate contracts are favorable in all cases regarding consumer surplus, firms' profits and total welfare. Comparing the three discount forms under horizontal differentiation, exclusive rebate contracts yield lowest total cost for the consumers followed by multiple and partially exclusive rebate contracts. This strict ordering does no longer hold under the additional vertical differentiation. Irrespective of quality differences, exclusive rebate contracts with the manufacturer offering the higher quality product are to be chosen by the GPOs aiming to minimize their members total costs. In this case the reduction of product variety is overcompensated by higher discounts. Contrary, for exclusive rebate contracts with the firm offering the lower quality product, multiple or partially exclusive rebate contracts the trade off between maximum discounts and efficiency has to be considered carefully by the GPOs selecting the rebate scheme for their members. Particularly in case of sufficiently high vertical differentiation, partially exclusive rebate contracts are superior to exclusive rebate contracts with the firm offering the lower quality product.

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Furthermore, we shed light on possible problems arising from the fact that GPOs often minimize expenditures instead of total costs. The GPOs are assumed to only take unit prices into consideration. Hence irrespective of vertical differentiation, they evaluate exclusive rebate contracts with both manufacturers als equal alternatives. Depending on the magnitude of the quality differences, the harm to consumers changes. Additionally, the GPOs tend to oversee the advantages of partially exclusive rebate contracts compared to exclusive rebate contracts.

The manufacturers prefer the alternative of multiple rebate contracts over exclusive rebate contracts. The introduction of partially exclusive rebate contracts gives them the possibility the increase profits above multiple rebate contracts.

By analyzing total welfare, we find that the ranking of the different rebate schemes clearly depends on the degree of vertical differentiation. For rather low β partially exclusive rebate contracts are superior to exclusive rebate contracts and multiple rebate contracts lead to higher welfare than partially exclusive rebate contracts.

These insights of our paper are important as they contribute to actual discussions in the health care sector. Contrary to some experts, we do not find arguments supporting per se the superiority of one of the rebate forms neither on the level of total costs for the members of the GPOs, nor regarding total expenditures, nor on the welfare level. In fact, our model shows that quality differences play a decisive role in finding the cost minimizing and welfare maximizing rebate form and should therefore be considered carefully.

As there is no clearcut ranking, a restriction to one of the rebate schemes by law is not useful. There exists the possibility that partially exclusive rebate contracts increase consumer surplus and total welfare and hence they should be considered as a third alternative by the GPOs. Despite cost criterion, partially and multiple rebate contracts are also supported by arguments concerning the security of supply, not covered in our model but decisive for the GPOs.

Additionally to different cases that have to be distinguished mathematically, the results have to be interpreted against the background of the complex real world. Concerning evidence on the rebate negotiations between GPOs and manufacturers there is a very limited data base. Both parties tend to keep fact secret, making it thus difficult to model them. Therefore, we make some simplifying assumptions which might however be discussed.

One simplification of our model is that in case of exclusive rebate contracts, prices go down till the zero-profit condition is reached. Nevertheless, in reality this might not be fulfilled and higher prices are realized. Due to bargaining power on the side on the manu-

facturer, they might force the GPOs to accept even higher prices. However, we also show that even for higher prices exclusive rebate contracts often yield lower total costs. In order to strengthen and possibly adjust the underlying model it would nevertheless be useful to further investigate the bargaining process between GPOs and manufacturers.

Another aspect that is closely related to the bargaining mechanism, is the rebate scheme. We simplified it to identical linear rebates based on the idea of economies of scale. In reality though, they might as well be non-linear and differing between the two manufacturers. This argument is especially put forward when comparing partially exclusive and exclusive rebate contracts. Manufacturers are supposed to grant higher rebates in case GPOs can guarantee exclusivity. Nevertheless, exclusivity is often difficult to monitor and identical rebates are offered irrespective of the contract form, which supports our assumption. Which form of rebate contracts fits best real world discount negotiations and whether a change in the rebate scheme affects the results fundamentally requires further analysis.

Additionally, our model also assumes that members of GPOs buy at most one unit of pharmaceutical products. In reality, for instance hospitals buy thousands of different products. Manufacturers take advantage from this fact by grouping different products into bundles. Analyzing for example the rebate contracts conducted by the AOK, a German public health insurance company, it strikes that the AOK conducted rebate contracts for 63 active substances only with 22 manufacturers out of many more available. It might be the case that some manufacturers made combined offers for two or more products. These kind of contracts are not incorporated in our model but might play an important role in reality.

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