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ORIGINAL PAPER

The effects of rebate contracts on the health care system

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Abstract Group purchasing organizations gain increasing importance with respect to the supply of pharmaceutical products and frequently use multiple, exclusive or partially exclusive rebate contracts to exercise market power. Based on a Hotelling model of horizontal and vertical product differentiation, we examine the controversy around whether a superior rebate scheme exists, as far as consumer surplus, firms' profits and total welfare are concerned. We find that firms clearly prefer partially exclusive over multiple, and multiple over exclusive rebate contracts. In contrast, no rebate form exists that lowers total costs per se for the consumers or maximizes total welfare.

Keywords GPOs · Rebate contracts · Vertical differentiation

JEL Classification I11 · L13 · L42

Introduction

In the last 5 years, the global turnover of pharmaceuticals has steadily increased and reached US$956 billion in 2011 [14]. Total expenditures on pharmaceuticals and other medical non-durables make up a significant proportion of total expenditures on health. In 2010 they constituted 14.8 percent of total expenditures on health in Germany and 11.9 percent in the US [22]. Innumerable attempts have been made to reduce these enormous costs.

One approach is to increase the buyer power of hospitals, nursing homes and other health care providing organizations by forming group purchasing organizations (GPOs). The importance of GPOs in the health care sector is increasing rapidly and globally. Burns and Lee [5] find, in their empirical evaluation for the US, that 80 percent of the hospitals in their survey make 50 percent or more of their pharmaceutical purchases via GPOs. Recently German statutory health insurances have also been acting like GPOs, bundling their insurants' demand and negotiating directly with pharmaceutical manufacturers.

Generally, GPOs do not purchase drugs and resell them; rather, they aggregate their members' demand and solicit bids from manufacturers. To reduce costs, 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. Depending on the number of affiliates and the possibility to buy off-contract, three regimes have to be distinguished: multiple, exclusive and partially exclusive rebate contracts. It is up to the GPOs whether they conclude rebate contracts with all horizontally differentiated manufacturers (multiple rebate contracts) or exclusively with one of them (exclusive rebate contracts). Hybrid forms are referred to as partially exclusive rebate contracts. In these cases, the GPOs conduct rebate contracts with one of the manufacturers; however, the members of the GPOs are not obliged to buy the pharmaceutical products under the terms of the rebate contract, but have the possibility to buy off-contract. Therefore, they can still choose between all manufacturers, which ensures maximum product variety, but potentially forgo rebates.

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Partially exclusive rebate contracts correspond to the situation in Germany after the Act for Restructuring the Drug Market (Arzneimittelneuordnungsgesetz, AMNOG) came into effect on 1 January 2011. Before that, members of statutory health insurances were bound to the exclusive rebate contracts of their insurances. Consequently, some insurants were obliged to change their pharmaceutical products. With the Act for Restructuring the Drug Market, patients are now able to maintain their usual drugs. However, they have to pay any price differences to the substitute in the rebate contract themselves.

A trend to restrict consumers' choices also exists, which can, for example, be found when analyzing the behavior of HMOs in the US acting like GPOs. Roughly 100 million Americans are covered by the 38 Blue Cross and Blue Shield companies [1]. Every Blue Cross and Blue Shield company develops a prescription drug list, which is updated regularly. Criteria for drugs to be included in the prescription drug list are the safety, effectiveness and cost of the drug [2]. It restricts the choice of members at lower copayment levels to the listed prescription drugs, meaning drugs not listed are only available at a higher copayment.

Besides horizontal differentiation based on individual preferences, pharmaceutical products are also vertically differentiated. Although from a chemical point of view the drugs are identical, they may however differ in quality. On the one hand, these quality differences may manifest in different sizes, routes of administration or side effects. 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 acting as intermediary between their members and pharmaceutical manufacturers. They minimize expenditures and hence their sole decision variables are 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.

The aim of this article is to investigate the impacts of three rebate contract forms: multiple, exclusive and partially exclusive rebate contracts. We answer the question whether there is a rebate form that is superior as far as consumer surplus, firms' profits and total welfare are concerned. Additionally, we address potential delegation problems between the GPOs and their members due to differences between total costs and total expenditures.

We show that multiple rebate contracts lower total costs for the members of the GPOs and exclusive rebate contracts leave them unaffected compared to no rebate contracts. Consequently, both rebate forms are advantageous.

Considering quality differences, only exclusive rebate contracts with the high-quality manufacturer are favorable, independent of quality differences. Total costs for exclusive rebate contracts with the low-quality manufacturer, multiple rebate contracts and partially exclusive rebate contracts depend on quality differences. For sufficiently significant quality differences, exclusive rebate contracts with the low-quality manufacturer yield highest aggregated costs. We also find that it never reduces costs for the members of the GPOs to conduct partially exclusive rebate contracts instead of exclusive rebate contracts with the high-quality manufacturer. Regarding rebate contracts with the low-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 multiple and exclusive rebate contracts. They both prefer partially exclusive over multiple, and multiple over exclusive rebate contracts.

As well as total cost, total welfare also depends on the degree of differentiation. For rather small quality differences, partially exclusive rebate contracts are superior to exclusive rebate contracts, and multiple rebate contracts lead to the highest welfare. With increasing quality differences, exclusive rebate contracts gain in attractivity, while multiple rebate contracts lose.

We also find that delegation problems may arise as the GPOs are likely to opt for exclusive rebate contracts irrespective of the affiliate, while the members of the GPOs evaluate exclusive rebate contracts with high- or low-quality firms differently. Furthermore, based on expenditures, the GPOs are likely to ignore the advantages of partially exclusive rebate contracts.

The rest of the article is organized as follows: "Related literature" introduces relavant literature. In "Model", we present the underlying model of horizontal differentiation, including the specification of the different rebate schemes. In "No rebate contracts", we analyze the benchmark cases before the introduction of rebate contracts. Focusing on the three different rebate schemes, in "Rebate contracts" we present total costs and expenditures for the consumers, firms' profits and total welfare. In Comparison of the rebate schemes, we set up a ranking of the different rebate schemes depending on quality differences. Finally, "Discussion" explores the robustness of the results by discussing some of the main assumptions of the article and by providing concluding remarks as well.

Related literature

To date there is a vast body of empirical surveys regarding GPOs and rebate contracts, including the articles from Burns and Lee [5], Kolasky [16], Schneller [24], and Ellison and Snyder [9]. Based on empirical findings, they

point to price reductions and efficiency gains due to rebate contracts. Publications by Hovenkamp [12], Elhauge [8] and Lindsay [19] focus on legal aspects of GPOs and discounts. Many theoretical and empirical studies investigate how GPOs enhance buyer power (e.g., Snyder [25], Dana [7], Inderst and Wey [15], and Tyagi [26]), but none of these works evaluates different forms of rebate contracts. Hence, this article is, to the best of our knowledge, the first that provides a theoretical model dealing with GPOs and alternative discount forms, taking also quality differences into consideration.

Our article relates to several research streams, including rebate contracts and quality differences. The rebates in our model are specified as all-units discounts, which are common for a health care setup and also used by Kolay et al. [17] and Greenlee et al. [10], revealing ambiguous results concerning the effects of rebate contracts on consumer surplus and total welfare. Nevertheless, neither of these two articles considers the specific role of GPOs and different rebate schemes, which are a central aspect of this article. Chen and Roma [6] study GPOs in a setup with two retailers and one manufacturer, offering all-units discounts. They show that under linear demand curves, symmetric retailers always profit from rebate contracts conducted via GPOs. In our model, we assume the buyers to be consumers, either insurants, 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 [20], who argue that loyalty discounts lead to far more competitive outcomes than Bertrand-Nash competition with linear tariffs, lowering total costs for the consumers. The model of Marvel and Yang [20] also deals with rebate contracts in a health care context and, as we do, they use the model of horizontal differentiation by Hotelling [11]. In their model, the GPOs offer the manufacturers the possibility of implementing rebate contracts, and thus they generate allocative efficiencies. However, contrary to their setup, we assume a functional form of the rebate contracts and evaluate the impact of alternative discount forms.

Additionally, we also account for quality differences. Especially in the health care context, quality differences have to be taken into account. One of the first to analyze quality differences in a Hotelling setup was Weizsäcker [27]. He developed a model consisting of two firms competing for consumers, with differences in the quality of their products. Consumers' decisions to switch manufacturer depend on their relative position to the suppliers, which can change over time. This very general setup has been enriched by health care-specific factors in various articles. Schlesinger and Schulenburg [23] model quality differences explicitly, but compared to search costs. Quality differences are also covered by Brekke et al. [3], Miraldo [21], and Hu and Schwarz [13] and specified in a very similar way to our approach. In contrast to our article, Brekke et al. [3] and Miraldo [21] cover quality differences in the context of reference pricing, and Hu and Schwarz [13] consider quality differences in combination with contract administration fees that GPOs might demand from manufacturers.

Based on the combination of rebate contracts and quality differences, our article also provides a theoretical model for the evidence-based discussion on the harms and benefits of rebate contracts. As far as Germany is concerned, for example, before the introduction of the Act for Restructuring the Drug Market (Arzneimittelneuordnungsgesetz, AMNOG) in 2011, exclusive rebate contracts did not include the option to buy off-contract. Consequently, they may have forced patients to substitute their drugs. Leutgeb et al. [18] find in their study that about 52 percent of the patients who have to substitute their drugs feel unsure and about 20 percent face difficulties taking different drugs. Thus, by evaluating the impact of different rebate contract schemes, we provide possible policy conclusions for Germany and beyond, and contribute to the growing body of literature on health care issues.

Model

Drugs for the treatment of one particular disease are assumed to be horizontally differentiated goods. Although they have the same main ingredient, consumers hold 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, health care-providing organizations or individual insurants 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 with 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. Prices are paid directly to the pharmaceutical firms. Additionally to the unit prices, the utility is also reduced by linear transportation costs. Transportation costs reflect consumers' preferences for certain drugs and thus the fact that they are not perceived as homogeneous goods.

On top of that, drugs often 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 such as the ease of drug-taking and the coating of a pill. On the other hand, certain drugs might have a higher perceived quality because of effective marketing and reputation. Very often these quality differences also have a temporal component. Being the first to introduce a new product often guarantees the manufacturer the ability to create long-lasting consumer relations, leading to entry barriers favoring the incumbent. 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 $0 < \beta < 3t - r$.

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 caused by differentiation. This may be due to heterogeneous preferences, depending, for example, on the age of the consumers. Even in the case of homogeneous preferences, data on patients' preferences may be missing or only available at high cost. As consumers' willingness to change the GPO is rather low in the health care context, the pressure on the GPO to take all costs into consideration is moderate. Consequently, the GPO is assumed not to minimize total costs of the consumers, but rather to minimize total expenditures and to take prices as the sole decision variable when it chooses the contract partner.

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 not only informs its members about prices and quantities, but also actively influences market outcomes. One alternative is to ask the affiliates to grant rebates. Where 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. The most common ones in the context of rebate contracts are exclusive rebate contracts and multiple rebate contracts.

Table 1 illustrates the four cases that have to be distinguished depending on the number of affiliates and whether rebates are granted.

A third, hybrid form also exists: partially exclusive rebate contracts. In the case of partially exclusive rebate contracts, the GPO conducts a rebate contract with one of the firms, but both of them are able to serve the market. However, buying from the firm offering off-contract products means there are no discounts for the members of the GPO.

Table 1 Possible regimes

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

Rebate schemes

Different concepts of rebate contracts have to be distinguished. There are legally fixed rebates and even more common voluntary ones. Compulsory discounts are, for example, rebates of up to 16 percent on the list prices, as manufacturers in Germany have to grant them [4]. Alternatively, a GPO can demand certain fixed volume discounts from their suppliers, potentially also in combination with a cash discount for prompt payment. The discounts may vary depending on the size and the bargaining power of the GPO. In Germany, statutory health insurances, acting like GPOs, demand a minimum rebate on the list price, which pharmaceutical companies have to offer if they want to be considered as suppliers.

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, not accounting for transportation costs, does not differentiate between its members according to their marginality. Consequently, it 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.

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 $m > 1$ and $x \in [0, 1]$ being the total quantity bought from one of the two manufacturers 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; instead, they offer significantly higher ones for larger volumes.

Total rebates are specified as $R(x) := rx^2$, with r being either legally fixed or set by the GPO. It is assumed to be constant, identical for both firms, independent of quantity, and $r < t$, with tx being linear transportation costs, holds to insure positive quantities in equilibrium.

The timing of the game is as follows: first the GPO announces publicly whether it asks the firms to grant rebates or not. This may either be a firm-specific decision or result from legal obligations. In both cases firms will accept the need to offer rebates, as they are either legally obliged to do so or they want to be considered as an affiliate and earn non-negative profits. Secondly, the GPO decides whether one or two firms will serve the market. Opting for multiple contracts, both manufacturers are accepted as contract partners and set their prices. In order to increase total and individual discounts, the GPO can restrict consumers' choices to one of the firms and conduct exclusive or partially exclusive contracts. In the case of exclusive or partially 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 the lowest prices. Where the prices are identical, we assume that it chooses manufacturer 1.

In the following sections, we further investigate the different outcomes depending on the number of affiliates and whether rebates are offered. We focus on whether a regime exists that is superior, yielding the lowest total costs for the consumers or highest profits for the firms.

No rebate contracts

First, we analyze the situation under no rebate contracts accounting for horizontal and vertical differentiation. Both contract forms are taken as benchmarks to answer the question whether the introduction of rebates lowers the total cost for the members of the GPO or increases firms' profits.

Multiple contracts

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

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

or by

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

with tx accounting for transportation costs and β for quality differences. Total consumer surplus (CS) is defined by

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

and equivalently total cost (C) for the consumers by

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

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

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

and

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

The two firms produce with identical marginal cost $c > 0$.[1] Thus, both manufacturers maximize profits of $\pi_1^{\mathrm{MC}} = (p_1 - c)D_1(p_1, p_2)$ and $\pi_2^{\mathrm{MC}} = (p_2 - c)D_2(p_1, p_2)$.

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

Quality differences constitute a competitive advantage for 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 consumers 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 $\pi_2^{\mathrm{MC}} = \frac{(3t-\beta)^2}{18t} < \frac{(3t+\beta)^2}{18t} = \pi_1^{\mathrm{MC}}$. Manufacturer 2 loses profits because of negative effects on prices and quantities, while firm 1 benefits from quality differences and can increase profits compared to the standard Hotelling model.

[1] 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 likely in the health care context.

The position of the indifferent consumer and prices in equilibrium lead to total costs incurred by consumers of $C_{\mathrm{MC}} = c + 1.25t + 0.5\beta - \frac{\beta^2}{36t}$. The members of the GPO are attached to manufacturer 1, allowing manufacturer 1 to exploit his competitive advantage. Overall costs include expenditures for purchasing the pharmaceutical product and transportation costs caused by possible mismatches. The GPO, on the other hand, takes neither horizontal nor vertical differentiation into account, and it minimizes expenditures, which are given by $E_{\mathrm{MC}} = c + t + \frac{\beta^2}{9t}$.

Exclusive contracts

The GPO can also tender exclusive contracts. The manufacturer offering the lowest price is accepted as affiliate and serves the whole market. When exclusive contracts are in place, not being accepted as a rebate partner is equivalent to market exclusion. With firms anticipating this, they hand in the lowest possible price that guarantees 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 $p_1^{\mathrm{EC}} = c$. Hence, both firms are left with zero profits, while total expenditures are given by $E_{\mathrm{EC1}} = c$.

The members of the GPO also consider differentiation and thus incur total costs of $C_{\mathrm{EC1}} = c + 0.5t$ in the case of exclusive contracts with manufacturer 1 and $C_{\mathrm{EC2}} = c + 0.5t + \beta$ under exclusive contracts with firm 2.

Taking these results as the benchmark, the GPO can conduct different forms of rebate contracts to reduce its members' costs.

Rebate contracts

Multiple rebate contracts

In the case of multiple rebate contracts, the GPO admits both manufacturers. This ensures that every member is offered their 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 "Multiple contracts", the introduction of multiple rebate contracts affects equilibrium outcomes. For the indifferent consumer located at position x

$$V - p_1 - tx + \frac{rx^2}{x} = V - p_2 - t(1-x) + \frac{r(1-x)^2}{(1-x)} - \beta$$

has to hold as consumers profit from equally shared rebates. Rebates reduce the transportation cost for the individual consumer. The modified demand functions are given by

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

and

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

Based on the demand functions, both manufacturers simultaneously maximize profits of $\pi_1^{\mathrm{MR}} = (p_1 - c)D_1(p_1, p_2) - r(D_1(p_1, p_2))^2$ and $\pi_2^{\mathrm{MR}} = (p_2 - c)D_2(p_1, p_2) - r(D_2(p_1, p_2))^2$, taking total costs for the quadratic discounts into consideration. This leads to prices in equilibrium of $p_2^{\mathrm{MR}} = c + t - \frac{t\beta}{3t-r} < c + t + \frac{t\beta}{3t-r} = p_1^{\mathrm{MR}}$.[2] 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 compared to the benchmark case. 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 multiple contracts, to $0.5 + \frac{\beta}{2(3t-r)}$.

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

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

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

The corresponding total expenditures amount to $E_{\mathrm{MR}} = c - 0.5r + t - \frac{(r-2t)\beta^2}{2(r-3t)^2}$.

[2] Proof can be found in the "Appendix".

Exclusive rebate contracts

On the other hand, the GPO can commit to exclusive rebate contracts with one of the manufacturers. For the GPO, prices are the single decision variable, and, it will, in any scenario, opt for the manufacturer offering the lower price. Equivalently to exclusive contracts, manufacturer 1 is assumed to serve the whole market offering prices of $p_1^{\mathrm{ER}} = c + r$ leading to total expenditures for of $E_{\mathrm{ER1}} = c$. For $p_1^{\mathrm{ER}} = c + r$ 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.

The members of the GPO have delegated the choice of the affiliate to the GPO. From their point of view, conducting exclusive rebate contracts with firm 1 yields total costs of $C_{\mathrm{ER1}} = c + 0.5t$. In the case of exclusive rebate contracts with manufacturer 2, total costs are given by $C_{\mathrm{ER2}} = c + 0.5t + \beta$. Not taking quality differences into consideration causes higher total cost for the members of the GPO, to the amount of β.

Partially exclusive rebate contracts

In theory as well as in practice a third alternative exists: partially exclusive rebate contracts. In the 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; they can also purchase goods off-contract. However, 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.

In the case of partially exclusive rebate contracts with manufacturer 1, the net utilities for a consumer located at position x are given by

$$U_1^{\mathrm{PER1}}(x) := V - p_1 - tx + rx$$

and

$$U_2^{\mathrm{PER1}}(x) := V - p_2 - t(1-x) - \beta.$$

Therefore, in equilibrium prices are given by $p_1^{\mathrm{PER1}} = \frac{c(r-6t)+(r+2t)(r-3t-\beta)}{r-6t}$ and $p_2^{\mathrm{PER1}} = \frac{c(r-6t)+(r-2t)(3t-\beta)}{r-6t}$ and the indifferent consumer is located at $\frac{3t+\beta-r}{6t-r}$. Manufacturers' profits in equilibrium are $\pi_1^{\mathrm{PER1}} = \frac{2t(3t-r+\beta)^2}{(r-6t)^2}$ and $\pi_2^{\mathrm{PER1}} = \frac{(2t-r)(\beta-3t)^2}{(r-6t)^2}$. The aggregated costs of the members of the GPO amount to

$$C_{\mathrm{PER1}} = \int_0^x (p_1 + t\epsilon)\mathrm{d}\epsilon - rx^2 + \int_0^{1-x} (p_2 + t\epsilon + \beta)\mathrm{d}\epsilon$$
$$= \frac{2c(r-6t)^2 + t\left(5r^2 + 90t^2 + 36t\beta - 2\beta^2 - 4r(12t+\beta)\right)}{2(r-6t)^2}.$$

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

$$U_1^{\mathrm{PER2}}(x) := V - p_1 - tx$$

and

$$U_2^{\mathrm{PER2}}(x) := V - p_2 - t(1-x) + r(1-x) - \beta.$$

Simultaneous maximization of firms' profits leads to prices in equilibrium of $p_1^{\mathrm{PER2}} = \frac{c(r-6t)+(r-2t)(3t+\beta)}{r-6t}$ and $p_2^{\mathrm{PER2}} = \frac{c(r-6t)+(r+2t)(r-3t+\beta)}{r-6t}$, with the indifferent consumer at $\frac{3t+\beta}{6t-r}$. Firms' profits are $\pi_1^{\mathrm{PER2}} = \frac{(2t-r)(3t+\beta)^2}{(r-6t)^2}$ and $\pi_2^{\mathrm{PER2}} = \frac{2t(r-3t+\beta)^2}{(r-6t)^2}$. Prices and quantities in equilibrium cause total costs of

$$C_{\mathrm{PER2}} = \int_0^x (p_1 + t\epsilon)\mathrm{d}\epsilon + \int_0^{1-x} (p_2 + t\epsilon + \beta)\mathrm{d}\epsilon - r(1-x)^2$$
$$= \frac{2c(r-6t)^2 + r^2(5t+2\beta) - 4rt(12t+5\beta) + 2t\left(45t^2 + 18t\beta - \beta^2\right)}{2(r-6t)^2}.$$

and total expenditures of $E_{\mathrm{PER2}} = \frac{c(r-6t)^2+2r^2t+4t\left(9t^2+\beta^2\right)-r\left(21t^2+2t\beta+\beta^2\right)}{(r-6t)^2}$.

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

Comparison of the rebate schemes

Evaluating the alternative rebate concepts, we find that the introduction of rebate contracts lowers total costs where two firms serve the market. Where one firm serves the market, rebates do not affect total costs for the consumers, irrespective of the affiliate.

Comparing the findings regarding multiple, exclusive and partially exclusive rebate contracts, two cases have to be distinguished: The perception of the members of the GPO based on total costs and the view of the GPO based on expenditures.

Proposition 1 *From the point of view of* ***the members of the GPO*** *the ranking of the different rebate contract forms is given by:*

(1) *For* $0<\beta<\frac{-(r-3t)^2+\sqrt{(r-6t)(r-3t)^2(r-2t)}}{t}$: $C_{\mathrm{ER1}}<C_{\mathrm{ER2}}<C_{\mathrm{MR}}<C_{\mathrm{PER2}}<C_{\mathrm{PER1}}$.

(2) *For* $\frac{-(r-3t)^2+\sqrt{(r-6t)(r-3t)^2(r-2t)}}{t}<\beta<r+\sqrt{3}\sqrt{(r-6t)^2}-9t$: $C_{\mathrm{ER1}}<C_{\mathrm{MR}}<C_{\mathrm{ER2}}<C_{\mathrm{PER2}}<C_{\mathrm{PER1}}$.

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

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

Irrespective of quality differences, exclusive rebate contracts with manufacturer 1 always yield the lowest total costs. Negotiating with firm 1, it is cost minimizing for the members of the GPO to opt for exclusive rebate contracts instead of partially exclusive rebate contracts, irrespective of quality differences. The reason for this is twofold; under partially exclusive rebate contracts, total rebates are strictly lower than under exclusive rebate contracts, as complete compliance is not realized. Additionally, firm 1 charges higher prices under partially exclusive rebate contracts than under exclusive rebate contracts.

For quality differences smaller than $r+\sqrt{3}\sqrt{(r-6t)^2}-9t$ this holds true also for rebate contracts with manufacturer 2. For sufficiently large quality differences, it is cost minimizing to opt for the moderate form of partially exclusive rebate contracts.

Comparing partially exclusive rebate contracts, it minimizes total costs to select the low-quality firm, manufacturer 2, as a rebate partner. Being a partner, firm 1 profits from the possibility of granting rebates and the quality advantage. Both aspects render manufacturer 1 more attractive than firm 2 and make it charge rather high prices. When it is not selected, firm 1 decreases prices to compensate the members of the GPO for the rebate loss. Firm 2 can increases prices only moderately, making partially exclusive rebate contracts with the low-quality firm more attractive.

Allowing both firms to be active in the market, that is multiple rebate contracts, guarantees fairly moderate total costs for all possible values of β.

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

Proposition 2 *From the point of view of* ***the GPO*** *the ranking of the different rebate contract forms is given by:* $E_{\mathrm{ER1}}=E_{\mathrm{ER2}}<E_{\mathrm{MR}}<E_{\mathrm{PER2}}<E_{\mathrm{PER1}}\quad\forall\beta$.

The evaluation of the members of the GPO and the GPO itself differs. The GPO is likely to opt for the cost-minimizing alternative of exclusive rebate contracts irrespective of the manufacturer. In the case of exclusive rebate contracts with firm 1, this is in line with the choice of the members of the GPO. However, exclusive rebate contracts with manufacturer 2 yield strictly higher total costs. Partially exclusive rebate contracts cause strictly higher total expenditures than exclusive rebate contracts, irrespective of the rebate partner. Considering total cost, this only holds true in case of rebate contracts with firm 1. These different evaluations may give rise to possible delegation problems.

Furthermore, we analyze the impact of the different rebate contract forms on firms' profits.

Proposition 3 *The ranking of firms' profits partially depends on quality differences:*

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

- *For* $\beta<\sqrt{4t^2-2rt}-t$: $\pi_1^{\mathrm{ER1}}=\pi_1^{\mathrm{ER2}}<\pi_1^{\mathrm{MR}}<\pi_1^{\mathrm{PER1}}<\pi_1^{\mathrm{PER2}}$.
- *For* $\sqrt{4t^2-2rt}-t<\beta$: $\pi_1^{\mathrm{ER1}}=\pi_1^{\mathrm{ER2}}<\pi_1^{\mathrm{MR}}<\pi_1^{\mathrm{PER2}}<\pi_1^{\mathrm{PER1}}$.

(2) *For firm 2, it is given by:* $\pi_2^{\mathrm{ER2}}=\pi_2^{\mathrm{ER1}}<\pi_2^{\mathrm{MR}}<\pi_2^{\mathrm{PER2}}<\pi_2^{\mathrm{PER1}}\quad\forall\beta$.

Both manufacturers profit from partially exclusive rebate contracts, as they lead to higher profits than exclusive rebate contracts or multiple rebate contracts. For sufficiently small quality differences, manufacturer 1 profits from partially exclusive rebate contracts with manufacturer 2. The same holds true for firm 2 irrespective of quality differences. This is due to the fact that not being a partner of partially exclusive rebate contracts still guarantees positive quantities without the obligation to grant rebates. For increasing quality differences, manufacturer 1 prefers being a partner of partially exclusive rebate contracts, instead of partially exclusive rebate contracts with manufacturer 2.

In order 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 an additional decision variable. Total welfare adds up consumer surplus and profits of the two manufacturers for all possible rebate contract forms, while M stands for the specific rebate contract:

$W_M = V - C_M + \pi_1^M + \pi_2^M.$

Comparing the total welfare for all five possible regimes gives a ranking of the different rebate contract forms of:

Proposition 4 *The welfare ranking of the different rebate contract forms depends on quality differences:*

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

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

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

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

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

From a welfare perspective, exclusive rebate contracts with manufacturer 2 yield the 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 sufficiently small 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 quality differences because of the comparative advantage from the lowest total cost for the consumers.

Discussion

In our article we analyze the effects of different rebate contract forms on consumer surplus, firms' profits and total welfare. We answer the question whether a rebate form exists that is superior under horizontal and vertical differentiation.

According to the number of rebate contract partners, we differentiate between exclusive (one affiliate) and multiple (two affiliates) rebate contracts.

Partially exclusive rebate contracts constitute a third, hybrid alternative, with the GPOs conducting rebate contracts with one of the manufacturers. However, consumers are not obliged to buy the pharmaceutical product under contract, although by not doing so they possibly forgo rebates.

Taking vertical differentiation into account as well, neither multiple nor exclusive nor partially exclusive rebate contracts are favorable in all cases, from the point of view of consumer surplus and total welfare.

Irrespective of quality differences, exclusive rebate contracts with the manufacturer offering the high-quality drug 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.

Negotiating with the high-quality firm, the GPO minimizes costs to decide for exclusive rebate contracts instead of partially exclusive rebate contracts, irrespective of the quality differences. Under partially exclusive rebate contracts, total rebates are strictly lower than under exclusive rebate contracts. In addition, the manufacturer charges higher prices under partially exclusive rebate contracts than under exclusive rebate contracts.

For sufficiently small quality differences this holds true for rebate contracts with the low-quality firm as well. For sufficiently large quality differences, it is cost minimizing to choose the moderate form of partially exclusive rebate contracts.

Comparing partially exclusive rebate contracts with the two alternative firms, it minimizes total costs to select the low-quality firm as rebate partner.

Analyzing total welfare, we find that the ranking of the different rebate schemes clearly depends on the degree of vertical differentiation. For fairly low quality differences, partially exclusive rebate contracts are superior to exclusive rebate contracts and multiple rebate contracts lead to the highest welfare. With increasing quality differences, exclusive rebate contracts with the high-quality firm become more attractive, while multiple rebate contracts become less attractive.

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

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 take only unit prices into consideration. Hence, they evaluate exclusive rebate contracts as equivalent irrespective of the rebate partner. Depending on the magnitude of the quality differences, the harm to consumers changes. Besides, the GPOs tend to ignore the advantages of partially exclusive rebate contracts.

These insights of our article are important as they contribute to ongoing 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, either on the level of total costs for the members of the GPOs or 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 these should therefore be considered carefully.

With the introduction of the Act for Restructuring the Drug Market (Arzneimittelneuordnungsgesetz, AMNOG), partially exclusive rebate contracts came into effect in Germany. Under vertical differentiation they may increase consumer surplus and total welfare, and hence they should be regarded as a third alternative. This is also in line with the practice of the Blue Cross and Blue Shield companies. They restrict their members' choice to the drugs listed on the prescription list, but members are allowed to get a prescription drug that is not listed by paying a higher copayment.

Perceived quality differences also play a part in which rebate form induces the highest consumer surplus. From the point of view of the consumers, there may be a correlation between (perceived) quality of pharmaceutical products and certain characteristics such as age, pre-existing conditions or interactions with other drugs. Analyzing the distribution of its members helps the GPOs to select the cost-minimizing rebate form.

As well as different cases that have to be distinguished mathematically, the results have to be interpreted against the background of the complex real world. There are very limited data available concerning evidence on the rebate negotiations between GPOs and manufacturers. Both parties tend to keep the details secret, thus making it difficult to model them. Therefore, we make some simplifying assumptions which are discussed below.

One simplification of our model is that in the case of exclusive rebate contracts, prices go down until the zero-profit condition is reached. However, in reality this might not be fulfilled and higher prices may be realized. Due to bargaining power, the manufacturers might be able to force the GPOs to accept even higher prices. However, we also show that even for higher prices, exclusive rebate contracts often yield the lowest 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 well be non-linear and differing between the two manufacturers. This argument is especially relevant when comparing partially exclusive and exclusive rebate contracts. Manufacturers are supposed to grant higher rebates when 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. Further analysis is required in order to establish which form fits real-world discount negotiations best.

Furthermore, our model also assumes that members of GPOs buy at most one unit of pharmaceutical products. In reality, hospitals, for instance, buy thousands of different products. Manufacturers may take advantage of this fact by grouping different products into bundles.

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Appendix

Proof Multiple Rebate Contracts: For the indifferent consumer

$$V - p_1 - tx + \frac{rx^2}{x} = V - p_2 - t(1-x) + \frac{r(1-x)^2}{(1-x)} - \beta$$

has to hold, which yields the position of the indifferent consumer at $\frac{p_2 - p_1 + t + \beta - r}{2t - 2r}$. Firm i's maximization problem is given by

$$\max_{p_i} = (p_i - c)D_i(p_i, p_j) - rD_i(p_i, p_j))^2.$$

The first order condition is

$$\frac{\partial \pi_i^{\mathrm{MR}}}{\partial p_i} = \frac{p_i(r-2t) + c(-r+t) + t(p_j - r + t + \beta)}{2(r-t)^2} = 0.$$

This yields the solutions of $p_2^{\mathrm{MR}} = c + t - \frac{t\beta}{3t-r}$ and $c + t + \frac{t\beta}{3t-r} = p_1^{\mathrm{MR}}$.

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