Group Purchasing, Nonlinear Tariffs, and Oligopoly

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Abstract

Loyalty discounts are nonlinear tariffs that condition rebates or marginal prices on meeting aggregate purchase or market share targets. These discounts are widespread, and are often the impetus for consumers to form buying groups, or group purchase organizations (GPOs). This paper models the competitive effects of the introduction of a GPO to a market for which the GPO's member preferences are horizontally differentiated. We show that although in a monopoly setting, nonlinear tariffs are an effective way to extract consumer surplus, when suppliers compete using such schedules, the results are far more competitive than simple Bertrand-Nash competition with linear tariffs. In our model, the nonlinear schedule puts all customers "in play" to a degree that contrasts sharply with the competition at the margin characteristic of constant per-unit prices. We demonstrate that asymmetry in preferences does not disturb the efficiency or the price advantage for consumers of our results, but that with asymmetrical preferences, market shares for the preferred supplier are higher than under constant per-unit prices. Finally, we examine the effects of bundling discount schedules across product categories when oligopolists compete with nonlinear tariffs.

Keywords: nonlinear pricing, loyalty discounts, competition, GPO

JEL L13, L42, D43

1 Introduction

This paper presents a model of the effect of nonlinear tariffs on competition among oligopolists. Tariff schedules that condition rebates or discounts on the volume or share of a consumer's purchases are commonplace when buying groups of retailers such as grocers, hardware stores, and auto parts dealers deal with suppliers. These conditional tariff schedules are often referred to as loyalty discounts. In recent years, they have attracted considerable attention as emergent group purchasing organizations (GPOs) have come to dominate the purchases of medical supplies. The popularity of such arrangements appears to stem from their claim to reduce the acquisition costs of the products in question. Indeed, purchasing groups often form to extract such discounts by pitting rival suppliers against one another. This paper models the effect of aggregating consumers into a buying group on the competitiveness of suppliers of differentiated products. The role of group purchasing in our model is simply to enable suppliers to compete with rivals by means of nonlinear tariffs. Our model illustrates the impact of these tariffs on both the prices paid by group members and the efficiency of allocation of the products in question among group members.

Nonlinear tariff schedules of the sort we model are both widespread and controversial. U.S. courts have typically refused to condemn such schedules under the antitrust laws, at least so long as the discounts are not "bundled" across products. European policy has been to outlaw such discount schedules whenever a supplier offering the schedule is deemed to be dominant. But neither the law nor the economics analysis of such discounts is settled. Indeed, the American antitrust authorities recently recommended that the U.S. Supreme Court defer taking up the question of the appropriate law governing bundled rebates, a complex form of nonlinear tariff, "… to allow … economic analysis to develop further…"[1]

[1] Antitrust Division, U.S. Department of Justice and Federal Trade Commission, "Brief for the United States as Amicus Curiae," *3M v. LePage's, Inc.*, http://www.usdoj.gov/atr/cases/f203900/203900.pdf, page 19. For more on the bundled discounts in the *LePage's* case, see Marvel and Peck (2006).

In monopoly settings, nonlinear tariffs are an effective way to extract consumer surplus. But the existence of rebates conditioned on share targets, as is common in healthcare, means that the relevant setting is oligopoly. We show that when suppliers compete using such schedules, the results are far more competitive than simple Bertrand-Nash competition with linear tariffs. In our model, a nonlinear schedule puts all customers "in play" to a degree that contrasts sharply with the competition at the margin characteristic of constant per-unit prices. Consumers who face oligopoly suppliers thus have a strong incentive to form GPOs when doing so can induce competition through nonlinear tariffs.

We extend our model to deal with asymmetrical preferences, showing that with asymmetry, consumers continue to benefit from the lower prices that nonlinear tariffs generate. In addition, nonlinear tariffs lead to efficient allocation in contrast to the inefficiency in consumption that results from a single-price tariff. Moreover, the market share for the preferred firm is higher than under constant per-unit prices and the less preferred firm is always worse off compared to the simple linear tariff competition that would prevail in the absence of the GPO. Nonlinear tariffs raise the return to promotional or innovative activities designed to sharpen the advantage of a particular supplier's product over those of rivals, again in comparison to the linear benchmark. We then demonstrate that bundled discounts arise as a profitable strategy for a supplier that is active in multiple markets. By offering a bundled discount, a supplier is able to price discriminate different GPOs or buyers more effectively, combining nonlinear tariffs with second-degree price discrimination.

Not surprisingly, given the widespread use of such schedules and the controversy that surrounds them, we are not the first to take up this issue. Section 2 surveys the relevant economics literature and outlines briefly the governing case law, and provides a description of the stylized facts of medical GPOs that motivate our model. Section 3 presents our model for what we term the symmetric case. Section 4 allows for consumer preferences to be shifted in favor of one supplier. Section 5 analyzes

bundled discounts. Finally, section 6 summarizes and concludes the analysis.

2 Nonlinear Tariffs with Oligopoly in Economics and Law

2.1 Group Purchasing and Nonlinear Discounts in Economics

Several papers have suggested that GPOs are a way for buyers to amass bargaining power (Chipty and Snyder, 1999; Inderst and Wey, 2003, 2006). When the supplier has a increasing unit costs, buyer groups can capture a larger share of surplus than individual consumers do. In a multiple seller/multiple buyer setting, Snyder (1996, 1998) shows that, as the size of a buyer increases, sellers' ability to tacitly coordinate on price decreases, which leads to lower average prices. There is some reason to doubt that sheer size, as opposed to the ability to move business among suppliers, is the source a GPO's low prices. In the market for healthcare supplies, GPO contracts often include purchase targets which require that a GPO be able to shift consumers between suppliers. Large pharmacy chains, unable to shift purchases among suppliers, do not obtain similar discounts (Ellison and Snyder, 2001). It thus appears that nonlinear tariffs, and not their size-driven bargaining power, determines the GPOs' ability to deliver lower prices to members.

A second strand of literature considers the effect of competition among sellers when a buyer or GPO can commit to purchase exclusively from one of the sellers. O'Brien and Shaffer (1997) show that the buyer can obtain a lower price through an exclusive commitment. The exclusive commitment comes with inefficiency in that the buyer does not receive its desired allocation of the suppliers' goods. For consumers, this inefficiency is justified by intensified competition between the rival suppliers.

Dana (2003) extends O'Brien and Shaffer by endogenizing the decisions of buyers to form groups. He shows that when buyers form groups that commit to buy exclusively from one supplier, they ob-

tain a lower price equal to their supplier's marginal cost. Buyers thus have a powerful incentive to form groups and to enter into exclusive purchase commitments, though as in O'Brien and Shaffer, the resulting allocation is inefficient. But Dana assumes that sellers are able to identify the preferences of each individual customer, and thus supplier price discrimination is feasible even without GPOs. contrast, suppliers in our model are unable to observe preferences of individual consumers, rendering price discrimination infeasible. The formation of a GPO makes nonlinear tariffs (price discrimination) feasible. It is this move to nonlinear tariffs that intensifies competition and yields lower prices, a very different mechanism from the one posited by Dana.

Economists have long understood that "perfect" (first-degree) price discrimination made possible through the use of nonlinear tariffs will yield a more efficient outcome than that possible with simple linear pricing.[2] Consumers are unlikely to be pleased with this increased efficiency, however, as all of their surplus is extracted by means of the tariff. But our approach allows suppliers to discriminate by means of take-it-or-leave it offers of nonlinear tariff schedules, thereby combining first-degree price discrimination with oligopoly but without introducing any scope for bargaining. Previous efforts to integrate price discrimination into oligopoly have addressed how the advent of third-degree price discrimination affects prices and firm profitability. Holmes (1989) shows that under oligopoly, third-degree price discrimination may decrease firms' profits. This point is illustrated more explicitly by Corts (1998), who demonstrates that if two sellers rank consumer groups differently (or two sellers have different "strong markets"), then allowing third-degree price discrimination can yield lower prices in all markets. In our duopoly model, allowing price discrimination in the form of a nonlinear tariff unambiguously leads to lower prices, while in both Holmes and Corts this result holds only under certain conditions that are likely to prove unusual.

Several other papers consider settings that loosely resemble ours. Kolay et al. (2004) study an

[2] See Varian (1989) for a survey.

all-units discount in a setting with a single buyer facing a single seller. Greenlee and Reitman (2005) study firms competing by offering loyalty discounts. Neither of these papers considers the possibility that buyers may form groups, which is the central topic of the current paper.

2.2 Antitrust Policy for Nonlinear Discounts

Loyalty and bundled discounts have also featured prominently in case law. *Concord Boat Corp. v. Brunswick Corp.,* 207 F.3d 1039 (8th Cir. 2000), and *Virgin Atlantic Airways, Ltd. v. British Airways PLC.,* 60 F.Supp. 571 (S.D.N.Y. 1999), *aff'd*, 257 F.3d 256 (2d Cir. 2001), each involved nonlinear tariff discount structures that awarded consumers according to market share. In each case, the courts ultimately declined to rule that the tariff schedules were anticompetitive.[3]

The principal exception to this pattern comes from Microsoft's abandonment of its tariff schedule that tied payments by personal computer manufacturers (OEMs) to the total number of processors (at that time, computers) shipped, rather than to the number of computers that shipped with Microsoft's operating system installed. This tariff structure resulted in marginal cost (zero) pricing for additional copies of the operating system, but imposed a fixed fee for each OEM based upon its size. Microsoft agreed to settle charges that its tariff had the effect of excluding rivals by reverting to per-unit pricing of its software.[4]

The situation is very different in Europe. A judgment referred to as *Michelin II* has placed a

[3] Brunswick, whose MerCruiser stern drives were preferred by many customers to those of its principal rival, Volvo, offered discounts to boatbuilders according to the share of its stern drives they installed in their boats. Volvo countered with discounts of its own. The *Concord Boat* court concluded that this represented competition on the merits, and overturned a lower court award of in excess of $140 million to boatbuilder customers of Brunswick. The Court of Appeals determined that the discounts were themselves the products of competition and that since they were not shown to represent below cost pricing, they were not predatory.

In *Virgin Atlantic,* an attempt was made to show that the discounts that British Airways offered travel agents for making customer-specific sales targets resulted in below-cost pricing on transatlantic routes. The court rejected the proffered evidence on below-cost pricing, and thereby upheld the loyalty program.

[4] The complaint in this case, known as the "licensing case," is available from the United States Department of Justice Antitrust Division web site, http://www.usdoj.gov/atr/cases/f0000/0046.htm. The same web site also contains a number of additional documents including a Court of Appeals decision upholding the settlement reached by DOJ and Microsoft, *United States v. Microsoft,* 56 F.3d 1148 (D.C. Cir 1995).

nearly insurmountable burden of proof of efficiencies onto supposedly dominant firms wishing to adopt loyalty rebates.[5] The position of European antitrust authorities appears to be that there are no positive effects of such discounts, and therefore that they are "abusive" unless adopted in response to competition from others. Accordingly, loyalty discounts are nearly, though not completely, per se illegal.[6]

2.3 Healthcare GPOs

In the United States, nonlinear tariffs are perhaps most controversial in markets for medical supplies. In 2003, Hillenbrand Industries agreed to pay $250 million to Kinetic Concepts, a rival manufacturer of specialty hospital beds, to settle a dispute over a discount schedule that awarded hospitals discounts on their bundled purchases of hospital beds of all types.[7] More recently, in March 2005, a jury awarded Masimo Corp. $140 million (before trebling) in damages in a dispute over a loyalty discount offered by the leading manufacturer of pulse oximeters, Nellcor,[8] though that case remains in litigation. Johnson & Johnson has sued Amgen for bundled discounts that lower the marginal price of its popular drug Aranesp when combined with purchases of related drugs.[9]

Our analysis is applicable to any oligopoly whose rival suppliers face purchasing aggregation sufficient to make nonlinear tariff competition feasible. But for purposes of exposition, we concentrate on medical supply purchasing because of the rising importance of GPOs in such markets and the controversy they have generated. There are hundreds of GPOs, and most hospitals belong to at least one. About 30 of the GPOs negotiate "sizeable contracts on behalf of their members."[10] Overall, it is

[5] Manufacture française des pneumatiques Michelin v. Commission [2003] ECR II-4071.

[6] See European Commission, DG Competition, "DG Competition discussion paper on the application of Article 82 of the Treaty to exclusionary abuses," Brussels, December 2005, http://europa.eu.int/comm/competition/antitrust/others/discpaper2005.pdf.

[7] See *Kinetic Concepts, Inc. v. Hillenbrand Industries, Inc.,* 262 F. Supp. 2d 722 (W.D. Texas, 2003).

[8] http://www.nellcor.com/legal/antitrust.aspx

[9] The complaint against Amgen is similar to the loyalty discounts the Supreme Court struck down in *SmithKline Corp. v. Eli Lilly & Co.,* 575 F.3d 1056 (3d Cir. 1978).

[10] The description in this paragraph is derived from a Unites States General Accounting Office report, "Group Purchas-

estimated that "about 72 percent of purchases that hospitals make are done using GPO contracts,"[11] and that almost all (96 to 98 percent of) hospitals use GPOs for at least some of their purchasing.[12] Finally, GPO contracts fit our characterization of such contracts as nonlinear tariffs.[13]

The competitive concern most closely associated with the rise of GPOs appears to be one of agency failure (U.S. Department of Justice and Federal Trade Commission, 2004). GPOs could collude with suppliers to deny rival suppliers access to the healthcare market, pocketing fees from incumbent suppliers in return. We assume that the GPOs serve their members, and accordingly we do not introduce supplier/GPO collusion in our framework.

3 The Model

Consider a standard Hotelling model of horizontal differentiation. Two suppliers offer competing, but not identical products. A consumer's location in product space is given by x, with supplier 1's location given by by $x = 0$, and the location of supplier 2 by $x = 1$. Consumers are assumed to be uniformly distributed with density 1 along the interval $[0,1]$.[14] All consumers are assumed to be willing to pay $v > 0$ for a single unit of the good if that good's characteristic exactly matches the consumer's position on the interval. Willingness to pay is reduced by a factor $k > 0$ per unit distance for a product whose characteristic does not match the consumer's preferred variety. Thus

ing Organization: Pilot Study Suggests Large Buying Groups Do Not Always Offer Hospitals Lower Prices," GAO-03-998T, July 16, 2003. The quotation is from page 6 of this report.

For a survey of the role of GPOs and the potential competition problems they pose, see U.S. Department of Justice and Federal Trade Commission (2004).

[11] Background data on health care GPOs are available from their trade association, HIGPA, https://www.higpa.org/about/about_faqs.asp.

[12] *Id.* GPO Entry appears easy, with new GPOs such as Broadlane—formed in 1999 and a top seven GPO by 2002—able to grow rapidly. GPO members typically retain the outside option of dealing directly with suppliers. Many belong to multiple GPOs.

[13] The General Accounting Office (*Id.,* p. 9.) notes that GPO contracts have the characteristic that product prices fall as volume and share commitments are met.

[14] The uniform distribution is not essential for the qualitative results of the paper. At this point, we require only that the distribution of consumer preferences is symmetric with respect to 1/2.

if the prices of the two firm's are denoted by p_1, p_2, a consumer at x receives utility of $v - kx - p_1$ if the product is purchased from supplier 1, and utility of $v - (1 - x)k - p_2$ when purchasing from supplier 2.[15]

We assume that the distribution of customers is common knowledge, but that suppliers cannot identify the preferences of any individual customer. This limit on information prevents suppliers from engaging in price discrimination when dealing directly with consumers.[16] Suppliers are assumed to have a common constant marginal cost, c. Assuming that the interval is covered (v is large relative to k), given p_1 and p_2 the demand functions are

$$D_i(p_i, p_j) = \frac{p_j - p_i + k}{2k},$$

The best-response functions are easily obtained and solved to yield the unique Bertrand-Nash equilibrium. Each firm offers a constant per unit price, $p_1 = p_2 = k + c$.

Thus far we have nothing more than a standard Hotelling model. Price competition does not lead to marginal cost pricing because each firm recognizes that when it cuts price, the lower price flows not only to consumers at the margin, but to every consumer. It would appear, then, that there are opportunities for lower prices if consumers can force the suppliers to compete for the business of all consumers, not just those at the margin.

[15] Alternatively, we could assume a continuum of consumers with valuations v_1 and v_2 for products 1 and 2, respectively, described by a cumulative distribution function $F(v_1, v_2)$. For our purposes, the essential distribution function is $G(v_1 - v_2)$. This function can be translated into a Hotelling model with an appropriate normalization.

[16] The restriction of suppliers to constant per unit prices also depends on the utility function we have assumed, namely that each consumer has unit demand. If consumers have elastic demands and a single crossing property is satisfied with respect to demand and type (x), then firms are able to use nonlinear tariffs to screen consumers (that is, to practice second-degree price discrimination). See Spulber (1981) for the details.

3.1 Duopoly with the Possibility of a GPO

Suppose that initially, all consumers in our market have the opportunity to form a single or universal GPO (cases with multiple GPOs are considered below). Should it form, the GPO is assumed to possess the same information as its suppliers. That is, the GPO knows the distribution of its members' preferences but cannot identify each consumer's individual preference. Given the prices offered by the suppliers, the GPO chooses to buy a proportion x of its needs from supplier 1, obtaining the remaining $1 - x$ from supplier 2, $x \in [0,1]$.[17] The decision variable of the GPO, x, becomes a continuous variable. With the GPO in place, suppliers can offer nonlinear tariffs to influence the GPO's choice of x. As will be shown below, this change in feasible tariff schedules changes the nature of competition.

The timing of the game is as follows. First, consumers decide whether to form a universal GPO. Second, upon observing whether a universal GPO is formed, if a GPO is present, each supplier offers simultaneously and non-cooperatively a nonlinear tariff schedule mapping from x to total payment, which we denote $r_i(\cdot),\ i = 1, 2.$. If no GPO is present, each supplier offers a single price p_i. Next, the GPO, if present, allocates of its purchases by choosing x. Note that no bargaining occurs, as the schedules offered by suppliers to the GPO are on a take-it-or-leave-it basis. Alternatively, without a GPO, individual consumers choose their supplier. Finally, if present, the GPO allocates its purchases among its members. Note that in the first stage of the game, the decision whether to form the GPO is endogenous. To proceed, we first characterize the equilibria of the subgame where the GPO is formed in the first stage.

The GPO (a non-profit organization) has as its objective the maximization of the surplus of its consumer members. Though the GPO, like the suppliers, cannot identify the preferences of individual members, it can allocate its purchases efficiently for any given x. To see this, suppose that

[17] The total purchase of the GPO is guaranteed to be 1, since v is assumed to be large relative to k.

the GPO sets a price $p + k(1 - 2x)$ for good 1 and p for good 2. By means of this mechanism, all consumers located to the left of x select firm 1's product and the remaining consumers pick firm 2's product. These choices result in the efficient allocation of the products purchased by the GPO among its members. Moreover, the GPO has the flexibility to set p to balance its budget.

Given this efficient allocation mechanism, the GPO's objective of maximizing the surplus of its members is equivalent to minimizing the sum of the payments to suppliers and the lost surplus that results from purchasing products that do not match consumer preferences. Thus the GPO's problem is

$$\max_x \left[-r_1(x) - r_2(1-x) - \int_0^x k\xi d\xi - \int_0^{1-x} k\xi d\xi \right].$$

which is equivalent to the following problem:

$$\min_x \left[r_1(x) + r_2(1-x) + k\left(\frac{x^2}{2} + \frac{(1-x)^2}{2} \right) \right]. \tag{1}$$

The GPO thus includes the welfare of all of its members in its computation, which changes the situation from the single-price case, where the firms compete over the marginal customers. If the GPO is indifferent between $x = \frac{1}{2}$ and $x' \neq \frac{1}{2}$, we assume that the GPO always picks $x = \frac{1}{2}$.

Now denote the marginal price schedule for each supplier by $a_i(\cdot)$,

$$\begin{aligned} r_1(x) &= \int_0^x a_1(t)dt, \text{ and} \\ r_1'(x) &= a_1(x), \end{aligned}$$

with the equivalent holding for $a_2(1-x)$. Then the first-order condition for the GPO's problem is

$$a_1(x) - a_2(1-x) + k(2x-1) = 0 \tag{2}$$

Note that (2) is necessary but may not be sufficient, since the objective function in (1) may not be convex.

Firm 1's problem can now be expressed as choosing its revenue schedule $r_1(\cdot)$ to maximize its profits constrained by the GPO's optimization problem, given $r_2(\cdot)$:

$$\max_{r_1(\cdot)} r_1(x) - cx$$

subject to (2). The problem can also be expressed in terms of the marginal price schedules:

$$\max_{a_1(\cdot)} \int_0^x (a_1(t) - c)dt$$

subject to the requirement that the GPO's choice of x solves (1). We know that neither supplier will lower its marginal price strictly below c. Therefore, $a_i(\cdot) \geq c$.

Lemma 1 *The equilibrium outcome must be symmetric. That is, in equilibrium each supplier must obtain the same profit and each sells* $\frac{1}{2}$.

Proof Suppose that in a candidate equilibrium, the market share of supplier 1, denoted x^* is such that $x^* \neq \frac{1}{2}$. Without loss of generality, suppose $x^* > \frac{1}{2}$. Now fix supplier 1's tariff, and consider the following deviation by supplier 2. Supplier 2 retains its original tariff, $a_2(1-t)$, for $t \in [x^*, 1]$, and charges $a_2(1-t) = c + \varepsilon$ for $t \in [\frac{1}{2}, x^*]$, with $\varepsilon > 0$ but small. Since $a_1(\cdot) \geq c$, the GPO will prefer to buy at least $\frac{1}{2}$ from firm 2. This deviation is profitable since supplier 2 obtains a margin ε from additional sales, $x^* - \frac{1}{2}$, and thus results in a contradiction. Therefore, $x^* = \frac{1}{2}$. It is immediate that the two suppliers must have the same equilibrium profit, for otherwise the supplier with the lower profit can mimic its rival's tariff, thereby obtaining the same profit. ∎

By lemma 1, in seeking equilibria, we can focus without loss of generality on tariff profiles such that

both profits and market shares are symmetric.

Lemma 2 *In any equilibrium, neither supplier can earn a profit strictly greater than* $\frac{k}{4}$, $a_1(x) = c$ *for* $x \in [\frac{1}{2}, 1]$, *and* $a_2(1-x) = c$ *for* $x \in [0, \frac{1}{2}]$ *almost everywhere.*

Proof Consider a tariff profile that results in a symmetric market outcome, and each supplier earns a profit $\pi > \frac{k}{4}$. Consider the following deviation by supplier 2: Supplier 2 offers $a_2(1-x) = c + \varepsilon$ for $x \in [0, \frac{1}{2}]$, with ε very small. Then the GPO has incentive to set $x^* = 0$ (The GPO purchases nothing from supplier 1). To see this, compared to $x^* = \frac{1}{2}$, the GPO saves $\pi - \frac{k}{4} - \frac{1}{2}\varepsilon > 0$ ($\frac{k}{4}$ is the increase in total transportation cost) by setting $x^* = 0$. This is a profitable deviation, which means that in any equilibrium each supplier cannot earn a profit strictly greater than $\frac{k}{4}$.

Suppose there is an interval $(x_1, x_2) \in [\frac{1}{2}, 1]$ such that $a_1(x) > c$ for any $x \in (x_1, x_2)$. Now consider the following tariff of supplier 2: Supplier 2 charges an up-front fee of $\frac{k}{4} + \int_{x_1}^{x_2} [a_1(t) - c]dt - \varepsilon$ with ε very small, and charges c for each additional unit. Then the GPO will buy at least $1/2$ from supplier 2, since its total cost of acquiring the additional $1/2$ from supplier 1 is $\frac{k}{4} + \int_{\frac{1}{2}}^{1} a_1(t)dt \geq \frac{k}{4} + \frac{1}{2}c + \int_{x_1}^{x_2} [a_1(t) - c]dt$. But now supplier 2's profit becomes $\frac{k}{4} + \int_{x_1}^{x_2} [a_1(t) - c]dt - \varepsilon > \frac{k}{4}$, a contradiction. Therefore, in any equilibrium $a_1(x) = c$ for $x \in [\frac{1}{2}, 1]$ almost everywhere. Similarly, we can show that $a_2(1-x) = c$ for $x \in [0, \frac{1}{2}]$ almost everywhere. ∎

In what follows, we first find an equilibrium, which will serve as a benchmark for other equilibria.

Lemma 3 *The following tariff profile is an equilibrium, with each firm selling* $1/2$ *and earning profit*

$\frac{k}{4}$:

$$a_1(x) = \begin{cases} c + k(1-2x), & x \leq \frac{1}{2} \\ c, & x > \frac{1}{2} \end{cases} \tag{3}$$

$$a_2(1-x) = \begin{cases} c + k(2x-1), & x \geq \frac{1}{2} \\ c, & x < \frac{1}{2} \end{cases} \tag{4}$$

Proof Under this tariff profile, the GPO is indifferent among all $x \in [0,1]$ since (2) is satisfied everywhere. It will set $x^* = \frac{1}{2}$. By lemma 2, there is no unilateral deviation that can increase a firm's profit. Thus it is an equilibrium. ∎

As an alternative to the equilibrium specified in lemma 3, we can construct another equilibrium with each firm adopting the following two-part tariff schedule. Each supplier requires an up-front fee of $k/4$ and offers to sell additional units at a price of c per unit. Lemmas 2 and 3 imply that in any equilibrium, each supplier must earn a profit of $k/4$, for otherwise a supplier can always earn this much by unilaterally deviating to the tariff specified in lemma 3. The following proposition summarizes the results obtained in these lemmas.

Proposition 1 *There are multiple equilibria. However, all equilibria have the same equilibrium outcome. Each supplier sells $\frac{1}{2}$ and earns a profit of $k/4$.*

Generally, any tariff profile with each supplier offering one of the tariffs in the following class

consists an equilibrium:

$$a_i(x) = \begin{cases} a_i(x) \text{ with } \int_0^{\frac{1}{2}} a_i(t)dt = \frac{c}{2} + \frac{k}{4} \text{ and} \\ \int_x^{\frac{1}{2}} a_i(t)dt \leq \int_x^{\frac{1}{2}} [c + k(1-2t)]dt & \text{for any } x \leq \frac{1}{2} \\ \qquad = (c+k)(\frac{1}{2} - x) - k(\frac{1}{4} - x^2), \\ c, & x > \frac{1}{2} \end{cases}$$

The inequality ensures that the GPO has no incentive to set $x^* \neq \frac{1}{2}$. Note that equilibrium tariff schedules can be asymmetric.

Without the GPO, each firm gets an equilibrium profit of $k/2$, and each consumer pays $c + k$ getting his preferred good. But with the GPO, each firm's equilibrium profit becomes $k/4$, and each consumer pays $c + k/2$ getting his preferred good. Thus we have the following proposition.

Proposition 2 *Compared to the case without the GPO, each firm's equilibrium profit decreases by* $\frac{k}{4}$ *with the presence of the GPO, and consumers obtain their desired good at a reduced price.*

Thus consumers have incentives to form the GPO in the first stage. Doing so yields their preferred good at a reduced price. Note that the role of the GPO is not to increase the bargaining power, since it just accepts the tariffs offered by each firm. The only change under the presence of GPO is that firms are able to employ nonlinear tariffs. However, the presence of the GPO changes the nature of supplier competition. Without the GPO, two firms are simply compete for the marginal consumer located at 1/2. When facing the GPO, suppliers can compete for *all* consumers, leading to fierce competition and lower average prices.

To identify the force that amplifies competition, suppose that suppliers can commit to charging

only one price in the presence of the GPO. Given p_1 and p_2, the GPO will set $x^* = \frac{1}{2} + \frac{p_2 - p_1}{2k}$.[18] Thus the demand functions are identical to those in the benchmark case without the GPO, yielding the equilibrium price $p_1 = p_2 = c+k$. This implies that when facing the GPO, the rival suppliers are better off if they can commit to charging a single per unit price. But for the suppliers, this commitment is not credible. Given that one supplier offers a single price $c + k$, its rival has an incentive to offer a nonlinear tariff to increase its market share and thereby its profit.

The above discussion implies that it is the availability of nonlinear tariff, which is made possible with the presence of the GPO, that strengthens competition. The benefit of the GPO to its members comes directly from the ability of the GPO to pit suppliers against one another to a greater degree than occurs with simple per unit prices. There is no reason for the GPO to exist apart from its ability to induce suppliers to compete in offering nonlinear tariff schedules. The implications for antitrust policy are clear. If nonlinear prices were to be banned, so that each supplier was restricted to a single price, firms would be better off and consumers worse off. The total social surplus will not change as long as the interval is covered. However, if policy-makers value consumers' welfare more than suppliers' profits, then nonlinear tariffs should be allowed. This is the opposite of the conclusion for nonlinear tariffs under monopoly, where such tariffs increase efficiency at the expense of reducing consumers' surplus.

More formally, suppose that supplier 1 is a monopolist. In the absence of a GPO, this supplier will set $p = \max\{\frac{v+c}{2}, v - k\}$, so that it covers the market as long as c is small in relation to the valuation of the consumers who least value firm 1's product. Firm 1's share of the potential market is $x = \min\{\frac{v-c}{2k}, 1\}$. The addition of the GPO ensures that the market is covered as long as $v - k > c$, but it also permits the supplier to set the marginal price $a(x) = v - kx$ and extract all consumer surplus.

Moving to duopoly, a nonlinear tariff provides the same opportunity to extract surplus as in the

[18] The objective function (1) is convex in this case, so that the first order condition is sufficient.

monopoly case. But with duopoly, this is only one part of the story. With a nonlinear tariff, a firm can compete for any consumer, without worrying about that such competition reduces the price charged for its inframarginal consumers. However, if both suppliers engage in these attempts to augment share through low prices at their margins, each supplier's ability to extract surplus is now limited by its rival's aggressive pricing. Suppliers are induced to defend all of their customers. This effect of nonlinear tariffs in intensifying competition always dominates the impact of the ability to extract surplus, yielding lower profits and higher consumer surplus.

It is a surprising result that the introduction of oligopoly reverses the impact of nonlinear pricing compared to the monopoly case. Holmes (1989) shows that under oligopoly, third-degree price discrimination can decrease firms' profits. Holmes' result, however, like that of Corts (1998) holds only for particular parameter values. In our setting the reversal is always present.

3.2 Multiple GPOs

As section 2 shows, the healthcare market is stocked with multiple GPOs whose membership can overlap. Thus far, we have assumed that any GPO that arises must represent all consumers. We now relax this assumption. Suppose for exogenous reasons, a positive measure ε of consumers, which is uniform on $[0,1]$, are barred from joining any GPO. Suppliers thus set $p = c + k$ for such individual customers. This constant unit pricing also provides an outside option for consumers in the complement of this group.

Now consider the remaining consumers' incentives to form GPOs. If every GPO consists of a positive measure of consumers and the distribution is uniform on $[0,1]$, then firms will offer each GPO the same nonlinear tariffs as those under a universal GPO, no matter how many GPOs there are. We employ the term "uniform GPO" to describe these GPOs. As demonstrated above, with one group forming a uniform GPO, the remaining consumers have an incentive to form such GPOs

as well. For GPOs, the composition of consumer preferences and willingness to substitute among suppliers matters. Thus we expect tariff schedules tied to market share targets, not simply to total purchases. If purchase targets are employed, they should be expected to vary across GPOs of different sizes.

Alternatively, consumers could choose to affiliate with others holding similar preferences, so that uniformity would be lost. Suppose customers located close to 1/2 form a GPO of their own, which we term a marginal GPO. Assume that such consumers are able to identify one another and to convince suppliers that their preferences are indeed concentrated around $\frac{1}{2}$. A credible marginal GPO can obtain average prices very close to the suppliers' marginal cost, c. Thus, if feasible, consumers located in the vicinity of $\frac{1}{2}$ have an incentive to form a marginal GPO. However, informational difficulties are likely to limit severely the role of marginal GPO. Any GPO claiming to represent marginal consumers is likely to attract consumers who misrepresent their preferences in order to join. Even if consumers can identify the preferences of one another, it is difficult to convince firms that their GPO is marginal GPO, since every GPO has an incentive to claim as a marginal GPO and get a lower price. A true marginal GPO will thus be difficult for suppliers to identify. In the presence of such informational issues, it is likely that suppliers will treat GPOs uniformly.[19] The resulting equal treatment in turn makes consumers indifferent among joining different GPOs and form GPOs randomly, which justifies suppliers' belief that each GPO is uniform.

3.3 Entry

GPOs, by obtaining lower prices from suppliers and limiting their ability to extract surplus, have the side effect of rendering entry by new rival suppliers more difficult. To see this, suppose initially only firm 1 is present in the market. Firm 2, then, is a potential entrant with a irreversible entry cost

[19] Note that many healthcare providers can and do join multiple GPOs, further homogenizing them in appearance to suppliers.

that we denote by f. When only firm 1 is present, there is no benefit for customers to form a GPO. Should firm 2 enter, however, consumers will form a GPO, with the result that each firm gets a lower profit $k/4$ compared to $k/2$ in the absence of the GPO. Therefore, if $f \in (k/4, k/2]$, entry occurs without GPO, but firm 2 is deterred given that consumers will form a GPO on the event of entry.

4 Asymmetry

In many settings, consumer preferences for the products in their choice sets will not reflect the preference symmetry assumed in our simple model. Incumbent suppliers may have established themselves as known commodities. Suppliers can invest in marketing strategies designed to shift or shape consumer preferences. To deal with such situations, we now generalize our results to deal with cases in which consumer preferences are shifted in favor of the product of one of our two competing suppliers.

Suppose that consumers remain uniformly distributed over the unit interval as before, but that their willingness to pay for the product of one of the suppliers, taken arbitrarily to be supplier 1, is increased by a factor $\Delta v = v' - v > 0$. Thus v' is the reservation price for supplier 1's product for a consumer located at $x = 0$. In order that some customers prefer supplier 2's product, we assume that $\Delta v < k$.

If each supplier is restricted to a simple per-unit price tariff—our benchmark case—this change in preferences causes supplier 1 to increase its market share and to sell at a higher price, while supplier 2 lowers its price in order to staunch the loss of market share. The demand schedules for the two firms become

$$\begin{aligned} D_1(p_1, p_2) &= x = \frac{p_2 - p_1 + k + \Delta v}{2k}, \text{ and} \\ D_2(p_2, p_2) &= 1 - x = \frac{p_1 - p_2 + k - \Delta v}{2k}. \end{aligned}$$

Computing the best-response functions and solving yields the prices,

$$\begin{aligned} p_1 &= k + c + \frac{\Delta v}{3}, \text{ and} \\ p_2 &= k + c - \frac{\Delta v}{3}. \end{aligned}$$

Suppliers 1 and 2 have equilibrium profits given by

$$\begin{aligned} \pi_1 &= \frac{1}{2}k + \frac{\Delta v}{3} + \frac{(\Delta v)^2}{18k}, \text{ and} \\ \pi_2 &= \frac{1}{2}k - \frac{\Delta v}{3} + \frac{(\Delta v)^2}{18k}. \end{aligned}$$

The equilibrium market share for supplier 1 is $\frac{1}{2} + \frac{\Delta v}{6k}$, which is different from the efficient market share $x^E = \frac{1}{2} + \frac{\Delta v}{2k}$.

If we introduce a GPO to the problem and accordingly consider suppliers able to compete with nonlinear tariffs, then the GPO's optimization problem must be modified to include the extra surplus that sales of the customer-preferred product generate:

$$\max_x \left[\Delta v \cdot x - r_1(x) - r_2(1-x) - \int_0^x k\xi d\xi - \int_0^{1-x} k\xi d\xi \right].$$

The first-order condition for this problem is

$$\Delta v - r_1'(x) + r_2'(1-x) - k(2x-1) = 0.$$

Notice that if $r_1' = r_2' = \bar{a}$, so that the firms match each other's marginal prices, the GPO will shift customers to firm 1 so that $x^* = \dfrac{1}{2} + \dfrac{\Delta v}{2k}$.

We can solve for the equilibrium as in the symmetry case. This process yields the following

proposition:

Proposition 3 *There are multiple equilibria. However, all equilibria share the same equilibrium outcome:*

i) the profit of firm 1 is given by $\pi_1^{GPO} = \frac{1}{2}\Delta v + \frac{k}{4} + \frac{(\Delta v)^2}{4k}$,

ii) the profit of firm 2 is given by $\pi_2^{GPO} = -\frac{1}{2}\Delta v + \frac{k}{4} + \frac{(\Delta v)^2}{4k}$,

iii) the market shares of the rivals are given by $x^* = \frac{1}{2} + \frac{\Delta v}{2k}$ *and* $1 - x^* = \frac{1}{2} - \frac{\Delta v}{2k}$,

iv) firm 1 offers $a_1(t) = c$ *almost everywhere for* $t \in [x^*, 1]$, *and*

v) firm 2 offers $a_2(t) = c$ *almost everywhere for* $t \in [1 - x^*, 1]$.

Proof By an argument similar to the proof of lemma 1, we can show that the equilibrium market share must be $x^* = \frac{1}{2} + \frac{\Delta v}{2k}$. Next, analogously to lemma 2, we can establish that the equilibrium profits of firm 1 and firm 2 cannot exceed π_1^{GPO} and π_2^{GPO}, respectively. Moreover, each firm must offer marginal cost c almost everywhere in the other firm's territory. Finally, we can find an equilibrium which yields π_1^{GPO} and π_2^{GPO} for firms 1 and 2, respectively (the equilibrium is shown below). ∎

The following nonlinear tariff profile constitutes an equilibrium, which has the property that the GPO is indifferent among all the $x \in [0, 1]$

Supplier 1:

$$\text{If } x \geq \frac{1}{2} + \frac{\Delta v}{2k}, \quad \text{offer: } a_1(x) = c.$$

$$\text{If } x < \frac{1}{2} + \frac{\Delta v}{2k}, \quad \text{offer: } a_1(x) = c + \Delta v + k(1 - 2x)$$

Supplier 2:

$$\text{If } x < \frac{1}{2} + \frac{\Delta v}{2k}, \quad \text{offer: } a_2(1 - x) = c.$$

$$\text{If } x \geq \frac{1}{2} + \frac{\Delta v}{2k}, \quad \text{offer: } a_2(1 - x) = c - \Delta v + k(2x - 1)$$

An alternative equilibrium involves each firm setting a two-part tariff in which the firms set different up-front fees, F_1 and F_2, but then sell at marginal cost, c. Given the marginal cost pricing, we see that these fees are the respective profits of the two firms when facing a GPO, $\pi_i^{GPO} = F_i,\ i \in \{1, 2\}$.

Our previous results allow us to compare profits between the fixed price per unit case and that of the firms facing a GPO. The results of this comparison are

$$\begin{aligned}\Delta\pi_1 &= \pi_1^{GPO} - \pi_1 = -\frac{k}{4} + \frac{\Delta v}{6} + \frac{7(\Delta v)^2}{36k} \\ \Delta\pi_2 &= \pi_2^{GPO} - \pi_2 = -\frac{k}{4} - \frac{\Delta v}{6} + \frac{7(\Delta v)^2}{36k} < 0.\end{aligned}$$

This comparison is instructive. Firm 2 provides a useful check on the pricing of its rival, even if the rival's products are widely preferred. The addition of a GPO to the problem always makes firm 2 worse off, because it must defend all of its customers against the marginal cost pricing that firm 1 offers to the GPO. Firm 1, on the other hand, in its own territory faces the competition of marginal cost pricing from firm 2, so that its profits fall when firm 2 is a close rival. But the introduction of a nonlinear tariff also permits firm 1 to price aggressively and efficiently, gathering more of the market to itself. It attracts customers from firm 2 that it can serve more efficiently than its rivals, but who would otherwise have cost too much inframarginal profit in the single price, no GPO case. This benefit from a nonlinear schedule is most telling if firm 1 is able thereby to cut substantially into sales that firm 2 would otherwise have made. Hence introduction of a GPO cuts firm 1's profits if Δv is small, but raises firm 1's profits when Δv is close to k. But the GPO always benefits its members—consumers are unambiguously better off, since $\Delta\pi_1 + \Delta\pi_2 = -\frac{k}{2} + \frac{7(\Delta v)^2}{18k} < 0$. Moreover, consumers now obtain efficient allocations of goods, $x^* = x^E$. This efficiency results from the fact that nonlinear tariffs eliminate the price distortions under single-price competition.

Notice also that once again, the presence of a GPO makes the prospect of entry less attractive, assuming that the entrant anticipates a period during which it must build consumer preferences for its alternative product. As the smaller rival in the market, the entrant sees a profit drop due to the GPO that is larger in absolute terms than that of its incumbent rival. Thus the competition that the

GPO induces is even more intimidating here than in the symmetric case analyzed previously.

We summarize these findings in the following proposition.

Proposition 4 *In the presence of the GPO, the less attractive firm is always worse off, consumers are always better off, but the GPO's impact on the profitability of the advantaged firm is ambiguous, with profits falling when Δv is small or possibly rising when Δv is close to k. The advantaged firm increases its market share at the expense of its rival in the presence of a GPO. Products are allocated efficiently among GPO members.*

4.1 GPOs, Promotion, and Innovation

One of the charges against GPOs is that they stifle innovation by disadvantaging new products. Prospective medical device manufacturers claim to be at a disadvantage because of the stiff rebates that established rivals offer. Some theoretical models also have the feature that innovation is suppressed by buyer power. Inderst and Wey (2003) argue that a seller's incentive to innovate is dampened when buyers form groups, though in a later paper (Inderst and Wey, 2005) they obtain the reverse relationship. In our model, though suppliers face heightened competition due to nonlinear tariffs, nonlinear tariffs increase incentives to promote and innovate.

To see this, we endogenize v_1 and v_2. Suppose the basic value of each good to a consumer is v, but each firm i can increase v_i by $\Delta v_i = v_i - v$ if it promotes its product at a cost $C(\Delta v_i)$, where $C(\cdot)$ is increasing and strictly convex (enough). Suppose firms make their promotional decisions (choose Δv_i) before they set prices. We compare two settings: without and with a GPO.

In the absence of a GPO, firm i chooses Δv_i (given Δv_j) to maximize its profit

$$\max_{\Delta v_i} \frac{1}{2}k + \frac{\Delta v_i - \Delta v_j}{3} + \frac{(\Delta v_i - \Delta v_j)^2}{18k} - C(\Delta v_i)$$

We assume that the objective functions are concave in Δv_i ($C(\Delta v_i)$ is convex enough). Then the first order conditions are sufficient:

$$\frac{1}{3} + \frac{\Delta v_i^* - \Delta v_j^*}{9k} - C'(\Delta v_i^*) = 0$$

In the symmetric equilibrium $\Delta v_1^* = \Delta v_2^*$, which are characterized by

$$\frac{1}{3} = C'(\Delta v_i^*)$$

With a GPO and associated nonlinear tariffs, the maximization problem becomes:

$$\max_{\Delta v_i} \frac{1}{4}k + \frac{\Delta v_i - \Delta v_j}{2} + \frac{(\Delta v_i - \Delta v_j)^2}{4k} - C(\Delta v_i)$$

Recall that we assume that the objective functions are concave in Δv_i.[20] In the symmetric equilibrium, $\Delta v_1^{*G} = \Delta v_2^{*G}$ are characterized by

$$\frac{1}{2} = C'(\Delta v_i^{*G})$$

It can be easily seen that $\Delta v_i^{*G} > \Delta v_i^*$, since $C(\cdot)$ is increasing and convex. Therefore, the introduction of a GPO leads to a higher level of demand-increasing activity, whether promotion or product improvement. The GPO increases the return on investment in demand-enhancing activities, since the exploitation of any preference advantage that results is not hindered by any distortion in prices.

[20] One sufficient condition is that $C''(\cdot) > \frac{1}{2k}$.

5 Bundled Discounts with Nonlinear Tariffs

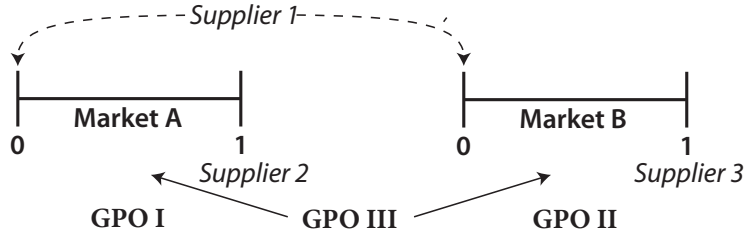
Bundled rebates allow customers to combine their purchases across markets in order to qualify for loyalty discounts or other rebates conditional on purchases. When confronted by a discount schedule that bundles purchases in this manner, suppliers that operate in a single market often claim that they are unable to compete with the rival whose product span permits it to combine nonlinear tariffs across markets. We now turn to the analysis of bundled rebate schemes in the presence of GPOs with their associated nonlinear tariffs. In order to extend our model to such cases, we must add both an additional market and we must assume GPOs of different types.

Suppose, then, that we consider two separate markets, A and B, and that within each market, products are differentiated as in our previous analysis. We assume that the participation of a supplier in a market is determined exogenously. We suppose that supplier 1 participates in each market, but that supplier 2 participates only in market A and supplier 3 participates only in market B. Each of the two markets can be described as in our previous analysis. In each, the product is differentiated, consumers are uniformly distributed on $[0,1]$, and suppliers are located at the endpoints of the interval. For simplicity, we will assume that the same degree of differentiation parameter, k, applies to each of the markets. Note that only supplier 1 is in a position to offer a bundled discount.

We continue to assume that a GPO is a consumer aggregation device that enables suppliers to compete by means of nonlinear tariffs. Let consumers who are active only in market A be represented by a GPO, which we label GPO I. Consumers active only in market B are represented by a different GPO, which we label GPO II. Finally, consumers active in both markets have the option of forming a new GPO to represent their interests, denoted GPO III. Alternatively, they can simply affiliate separately with the two market-specific GPOs, I and II. The situation is illustrated schematically in figure 1. As before, the role of a GPO is simply to make purchases on behalf of its members.

We assume that consumer preferences for GPOs I and II are symmetric, so that in our earlier

Figure 1: Bundled Discounts: Markets with Supplier and Customer Overlap



notation,

$$\begin{aligned} \Delta v_I^A &= v_1^A - v_2^A = 0, \text{ and} \\ \Delta v_{II}^B &= v_1^B - v_3^B = 0, \end{aligned}$$

where the roman subscripts denote the customers who comprise the GPO in question. Finally, we assume that consumers who demand the two products (those represented by GPO III) have preferences shifted in favor of either supplier 1's or supplier 2's product in market A, but have symmetric preference between the products available in market B. That is, $\Delta v_{III}^A \neq 0$ and $\Delta v_{III}^B = 0$.[21] We further assume that in market A, the ratio of GPO III's total demand to that of GPO I is $\varepsilon > 0$, which is very small.[22] In market B, since members of GPOs II and III have the identical symmetric preferences, their relative size is unimportant. We assume that suppliers confront the GPOs without the ability to identify the customers they represent, though all the other information is common knowledge.

Suppose initially that supplier 1 does not offer a bundled discount. It will then offer a nonlinear tariff in each market conditional on its share in each market. The equilibrium outcome in market B is straightforward. Suppliers 1 and 3 each earn $k/4$ and get a market share $1/2$ from both GPO II

[21] This set of assumptions can be relaxed. What we require is that $\Delta v_I^A \neq \Delta v_{III}^A$, and $\Delta v_{II}^B = \Delta v_{III}^B$.

[22] This assumption is not essential, but simplifies our analysis.

and GPO III. The equilibrium in market A is more complicated. Since the customers who buy from both markets are relatively unimportant, the equilibrium outcome will be (or very close to) that in which GPO I buys 1/2 from each supplier, and each supplier earns $k/4$ from GPO I. For GPO III's behavior in market A, we distinguish two cases.

Case 1: $\Delta v_{III}^{A} > 0$. In this case, supplier 1's product A is more appealing to GPO III. Under any set of equilibrium tariff schedules that results in equal market share allocation for GPO I, GPO III will buy solely from supplier 1. GPO III pays c/2+k/4 for 1/2 of its customers who prefer supplier 1's product, and it pays marginal cost for supplier 1's product for its remaining customers. Note that the remaining customers are willing to pay less of a premium for supplier 2's product than are the customers of GPO I, from whom supplier 2's tariff schedule extracts the amount of their preference over marginal cost. Hence the members of GPO III who prefer supplier 2's product are nonetheless unwilling to pay the premium demanded by supplier 2, and so all purchases come from supplier 1. The additional purchases do not benefit supplier 1, however, since it charges marginal cost at that range.

Case 2: $\Delta v_{III}^{A} < 0$. In this case, supplier 2's product A is more appealing to potential members of GPO III. Under any tariff schedule that results in equal market share for GPO I, GPO III will buy solely from supplier 2. Supplier 1 earns zero profit from members of GPO III.

Thus far, we have no reason for GPO III to form, as its members simply affiliate with both GPO I and GPO II, obtaining their supplies of the products according to the respective tariff schedules. How does the outcome change if supplier 1 is able to offer a bundled discount? Suppose that supplier 1 can condition its tariff schedule in market A on the purchases made in market B. The ability to line the markets allows supplier 1 effectively to distinguish the potential members of GPO III from GPO I in market A. Once again, we consider two cases.

Case 1: $\Delta v^A_{III} > 0$. Recall that when supplier 1 does not employ a bundled discount, it obtains no advantage from the preference of GPO III's members for its product. The customers with the strongest preference for its product, including customers in $[0, \frac{1}{2}]$ pay according to the tariff schedule set for the customers of GPO I. Though sales rise as supplier 1 captures *all* customers from the remainder of the interval, it gains nothing from the additional sales. Given $\Delta v^A_{III} > 0$, supplier 1 could potentially increase its profit by charging higher marginal prices for GPO III that reflect its members preference for its products. These customers are those who are also active in market B, and so can be identified. But once identified, firm 1 wished to charge them a higher tariff—the bundled "discount" is a premium. Such a premium is unlikely to be feasible. GPO III can easily mimic GPO I thereby avoiding the premium, or put differently, the potential members of GPO III have no reason to form the GPO in the first place. Prospective members of GPO III can simply join both GPO I and II to obtain lower prices.

Case 2: $-k < \Delta v^A_{III} < 0$. Recall that when supplier 1 does not employ a bundled discount, supplier 1 does not sell to potential members of GPO III. But if bundled discount is permitted, supplier 1 can offer a separate nonlinear tariff directed at prospective GPO III members. Under this tariff, if a GPO buys $1/2$ in market B from supplier 1, then the GPO qualifies for lower marginal prices in market A. These lower marginal prices are identical to those of the schedule offered in asymmetric case with $\Delta v^A_{III} < 0$. Confronted with this offer, GPO III will form to buy a positive portion of its market A purchase from supplier 1. Consequently, supplier 1 earns a positive profit from GPO III in market A, selling its product to customers whose preferences most closely match the characteristic of its offering. Under this bundled discount, GPO III has an incentive to form. Its customers obtain a more desirable allocation of goods in market A at lower prices. Though GPO I also wants to mimic GPO III to obtain the resulting lower average

price for its members, it is unable to do so since it does not value good B. [23] Thus a GPO III will form to obtain a bundled discount in equilibrium. Moreover, the introduction of this bundled discount leads to more a efficient allocation of goods in market A. The requirement is that consumers continue to differ in their assessments of the relative merits of the market A products of suppliers 1 and 2, but that for those who purchase products from both market A and market B, their preferences are shifted in favor of the product of the supplier that operates only in market A.

Without the ability to offer a bundled discount, supplier 1 simply sacrifices all potential GPO III member customers, yielding inefficiency in market A in the allocation of goods for GPO III. The bundled discount allows these customers to be separated effectively, and the associated nonlinear tariff schedule provides them with lower prices.

Our analysis of GPOs show that they operate by replacing simple per unit pricing with more competitive nonlinear tariffs. In this section, we have shown that bundled discount permits finer nonlinear discounts to emerge. Bundled discounts are sometimes interpreted as an extension of tying or bundling (Whinston, 1990). But they are quite different: while tying or bundling is restricted to per-unit pricing, bundled discounts are closely associated with nonlinear tariffs.

6 Summary and Conclusions

GPOs have captured a large and increasing share of healthcare supply purchasing. They have attracted healthcare providers as members by obtaining lower average prices from suppliers. The price advantage that they generate for their members is not merely the consequence of buying power arising from the size of aggregated purchasing groups. Ellison and Snyder (2001) provide evidence that

[23] We assume that GPO II can be prevented from purchasing in market A to qualify for a bundled discount, reselling its market A purchases to GPO I.

"price discounts depend more on the ability to substitute among alternative suppliers than on sheer buyer size. In particular, hospitals and HMOs, which can use restrictive formularies to enhance their substitution opportunities beyond those available for drugstores, obtain substantially lower prices. Chain drugstores only receive a small size discount relative to independents, at most two percent on average, and then only for products for which drugstores have some substitution opportunities (i.e., not for on-patent branded drugs)." Our model demonstrates why this is so. We show that the same nonlinear tariffs that allow monopolists to extract all available surplus have a very different impact under oligopoly. By enabling rival suppliers to compete in nonlinear tariffs, GPOs yielding efficient product allocations that nonetheless leave substantial surplus in the pockets of consumers.[24]

Nonlinear tariffs increase the degree of competition very substantially in comparison to the already competitive alternative of Bertrand-Nash pricing in markets populated by heterogeneous consumers. Nonlinear pricing places all—not just marginal—consumers in play. By inducing tariff schedules that squeeze surplus out of suppliers, GPOs reduce the profits available to potential entrants. They also increase the returns to promotion and innovation that strengthen consumer preferences for a supplier's product, an effect that encourages promotion and innovation. But the effects on entry and market dominance come in the context of greatly enhanced competition that GPOs and their associated nonlinear tariffs facilitate. Accordingly, any attempt to limit use of such discount schedules is likely to impose substantial costs on consumers together with inefficiency in consumption.

[24]Evidence on GPO behavior suggests that commitment programs that tie prices to share levels are used most intensively by the largest and most successful of GPOs. See United States General Accounting Office, "Group Purchasing Organization: Use of Contracting Processes and Strategies to Award Contracts for Medical-Surgical Products," Study GAO-03-998T, July 16, 2003.

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