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# Do GPOs Promote or Stifle Competition in Healthcare-Product Supply Chains?

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This paper uses economic modeling to examine the controversial role that Group Purchasing Organizations (GPOs) play in the supply chains for healthcare products. Among the controversies, perhaps the most fundamental one is whether or not GPO-contracted prices are the lowest available. However, the fiercest controversy is around the "Contract Administration Fees (CAFs)" that GPOs charge to manufacturers. We examine these and other controversies using a Hotelling duopoly model. Among our conclusions: GPOs increase competition between manufacturers and lower prices for healthcare providers. However, GPOs reduce manufacturers' incentives to innovate. We also demonstrate that the existence of lower off-contract prices is not, per se, evidence of anticompetitive behavior on the part of GPOs. Indeed, we demonstrate that, under certain circumstances, the presence of a GPO lowers off-contract prices. We also examine the consequences of eliminating the "safe harbor" provisions, and conclude that it would not affect any party's profits or costs.

## 1. Introduction

GPOs play a very significant - and very controversial - role in the supply chains for healthcare products. A 2005 study conducted for the Health Industry Group Purchasing Association (HIGPA) reported that 72-80% of every healthcare dollar (in an acute care setting) is acquired through group purchasing.<sup>1</sup> More recently, Burns and Lee (2008) reported that nearly 85% of hospitals route 50% or more of their commodity-item spending through GPOs, and 80% of hospitals route 50% or more of their pharmaceutical spending through GPOs.

Moreover, GPO purchasing power is highly concentrated: According to a 2003 GAO study<sup>2</sup>, the seven largest GPOs account for over 85% of hospital purchases made through GPO contracts, and the two largest GPOs account for approximately two-thirds of total

 $<sup>^1\</sup>mathrm{Muse}$  & Associates: "A Cost Savings and Market place Analysis of the Healthcare Group Purchasing Industry."

<sup>&</sup>lt;sup>2</sup>GPO Report (GAO-03-998T, July 16, 2003) Statement for the Record by Marjorie Kanof, Director, Health care-Clinical and Military Health Care Issues.

GPO purchasing volume for all medical products. In 2007, *Modern Healthcare* reported that the largest GPO, Novation, contracted for over 2,400 hospitals and 30,000 alternative sites, with 2006 purchasing volume of over \$ 33 Billion.

What makes the role of GPOs controversial is neither the significance of the role they play in healthcare-product supply chains nor the concentration of their purchasing power, per se. Instead, the controversies involve the fees they charge to manufacturers, some of the business practices they employ, and, ultimately, whether GPOs promote or stifle competition in the markets for healthcare products.

In this paper we briefly describe the role of GPOs in healthcare-product supply chains and summarize some of the criticisms about them. Then, we examine these criticisms using a Hotelling model. Our analysis concludes that healthcare GPOs promote competition in some ways but stifle competition in others.

Group purchasing organizations (GPOs) negotiate the prices that their "provider-members" pay for products they purchase "on contract", either direct from manufacturers or through healthcare-product distributors. The rationale for healthcare providers to belonging to a GPO is that they will incur lower total cost of ownership (TCOO) by purchasing "on contract" through a GPO than they might obtain for themselves. In our analysis, we represent the TCOO as the purchasing costs of product plus the overhead costs, i.e., the "contracting" costs associated with their procurement. GPOs position themselves to offer lower TCOO through a combination of product expertise over a wide range of products and the combined buying power of their members.

GPOs earn revenue from several sources: Contract Administration Fees (CAFs) charged to manufacturers, membership fees charged to provider-members, administrative fees charged to distributors authorized to distribute products to provider-members on-contract, and miscellaneous fees for services. The most common, most significant, and most controversial source of GPO revenue is the Contract Administration Fee (CAF). This is a revenue-sharing mechanism, nominally set at 3% of each manufacturer's contracted sales.

Although revenue-sharing contracts are commonly used elsewhere (e.g., real estate, mutual funds), such revenue-sharing in healthcare had been specifically outlawed under the "anti-kickback" statute of the Social Security Act. However, in 1987, partly to facilitate the growth of GPOs, the Social Security Act was amended to create "safe-harbor provisions" that protect healthcare GPOs from prosecution under the anti-kickback statute. In brief, these provisions require GPOs to limit CAFs to an average of 3% or, in the case of exceptions, to inform members of the amount or percentage of any CAFs in excess of 3%, the products to which they apply, and the manufacturers who receive them.

Many of the criticisms about healthcare GPOs are linked to CAFs. For example, manufacturers complain that they are forced to charge higher prices for all products - whether they are sold on or off contract - in order to recover the CAFs they pay to GPOs for on-contract sales. Others assert that the elimination of the "safe-harbor" provisions, which allow GPOs to charge CAFs to manufacturers, would either yield large cost savings to providers and/or payers. Here are two excerpts.

"The elimination of the safe harbor would be revenue neutral under the most conservative assumptions; and would generate large savings for the federal government under more realistic assumptions."<sup>3</sup>

According to Sethi (2006),

"Based on our analysis of the total revenue generated by the GPOs, their operating margins, and a careful assessment of their expenses, it is estimated that GPOs generate excess annual revenue in the range of \$5 billion to \$6 billion, which legitimately belongs to their member hospitals since they are the ones who actually paid for it."

Another criticism about GPOs revolves around whether or not GPOs' on-contract prices are, in fact, the lowest prices available. A pilot study on GPO<sup>4</sup> prices conducted for the US Senate Subcommittee on Antitrust, Competition, and Business and Consumer Rights concluded that a hospital's use of a GPO contract did not guarantee that the hospital saved money: GPOs' prices were not always lower but often higher than prices paid by hospitals negotiating with vendors directly.

Another criticism about GPOs is that they pose a barrier to entry for small firms.<sup>5</sup> Yet another is about product innovation and quality; i.e., that the contract relationship between GPOs and manufacturers blocks or slows the introduction of newer, better products. One of many such examples is the Masimo case. Masimo, a maker of pulse oximeters did not have contracts with Premier ro Novation (two of the largest GPOs) because both have awarded

<sup>&</sup>lt;sup>3</sup>www.criterioneconomics.com/pubs

<sup>&</sup>lt;sup>4</sup>GAO report (GAO-02-690T, April 30,2002) Group Purchasing Organizations: Pilot Study Suggests Large Buying Groups Do Not Always Offer Hospitals Lower Prices.

 $<sup>^5{\</sup>rm GAO}$  report (GAP-03-998T, July 16,2003) Group Purchasing Organizations: Use of Contracting Processes and Strategies to Award Contracts for Medical-Surgical Products.

"sole source" contract to Necllor. Thus hospitals were given strong incentives to purchase from Nellcor although Masimo's product was considered by doctors to be a better product than Nellcor's. In March 2005, a jury awarded Masimo Corp. \$140 million in damages in a dispute over a loyalty discount offered by the leading manufacturer of pulse oximeters, Nellcor, although the case remains in litigation.<sup>6</sup>

The GPO industry takes these criticisms seriously, and has responded with a series of commissioned reports and white papers, arguing that GPOs reduce prices and are procompetitive. More recently, Burns and Lee (2008) conducted an independent survey of GPO members and conclude that GPOs do help contain rising health care costs by reducing product prices in two ways: (1) through pooled purchasing leverage of hospitals buying products on nationwide contracts and (2) through the establishment of price ceilings in these contracts beneath which hospitals negotiate on their own.

To date, the "cases" either for and against GPOs have been based either on surveys or macro-economic scenario analysis. Using these as background, in what follows we develop and analyze several economic duopoly models involving GPOs, manufacturers, and providers to address the controversial roles of the GPO. Our analysis leads to the following insights into the controversial roles of the GPOs:

- The existence of a GPO increases competition between the manufacturers and lowers prices for healthcare providers.
- Asymmetry in providers' preference for similar products does not affect the results summarized above;.
- The GPO lowers the manufacturers' incentive to innovate their products.
- If the manufacturers could choose to sell on-contract or off-contract, then at equilibrium, two cases can arise: both sell on-contract, or one manufacturer sells on-contract and the other sells off-contract. In the latter case, the off-contract price might be lower than the on-contract price.
- Eliminating CAFs and having providers pay for GPOs' contracting services would have no effect on any party's profit or costs.

<sup>&</sup>lt;sup>6</sup>http://www.nellcor.com/legal/antitrust.aspx

The remainder of this paper is organized as follows: §2 introduces related literature, §3 presents the basic model, §4 studies whether the presence of the GPO lowers the prices, §5 endogenizes the manufacturers' decision on whether to sell off-contract or on-contract. §6 explores whether the presence of GPO promotes or hinders product innovation, and §7 examines whether removing the "safe harbor" provisions improves' any party's, profits or costs. Finally, §8 summarizes and concludes.

## 2. Literature

By forming a purchasing group, the dispersed buyers can act strategically in negotiating with manufacturers and therefore achieve better prices. The forming of the GPO enables the GPOs or the manufacturers to employ three types of common contracts: exclusive dealing, nonlinear pricing, or revenue sharing.

One strand of economics literature examines the effects of competition among manufacturers when buyers form a GPO to commit to purchasing exclusively from one of the manufacturers. O'Brien and Shaffer (1997) show that buyers can obtain lower prices through both nonlinear pricing and sole sourcing, which intensify competition between the rival suppliers. Dana (2003) extends O'Brien and Shaffer (1997) by endogenizing the decisions of buyers to form groups. He shows that if the GPO commits to purchasing exclusively from one supplier, then the buyers obtain a lower price, one that is equal to the suppliers' marginal costs. Marvel and Yang (2008) study a similar problem, assuming that: (1) the GPO's interests are aligned with the buyers and thus seeks to minimize the buyers' total purchasing costs; and, that (2) the sellers have the bargaining power, offering take-or-leave it nonlinear pricing tariffs to the GPO. Different from Dana (2003), their GPO cannot identify individual providers' utility value. They demonstrate that the competition-intensifying effect of the nonlinear tariff, not the GPO's bargaining power, lowers the GPO's purchasing price since the sellers have the bargaining power in their model.

However, none of the above papers address the CAFs, i.e., the revenue-sharing contracts that are used by healthcare GPOs. Our models include CAFs, and one of the questions we examine is whether or not the "safe harbor" provisions that allow them, should be eliminated.

Like Marvel and Yang (2008), we employ the Hotelling model. However, in recognition of the purchasing power of healthcare GPOs, we model the GPO as the Stackelberg leader. Like Marvel and Yang (2008), we show that the GPO intensifies the competition between the rival manufacturers, and, therefore, lowers prices. In addition, our model captures the transaction efficiency enabled by GPOs: an important rationale for the existence of GPOs in U.S. healthcare supply chain. As Marvel and Yang (2008), we prove that asymmetry in preferences doe not affect the price advantage of the GPO. However, because of the bargaining power is in the GPO instead of in the manufacturers, the manufacturers' profits in our models are smaller than those in Marvel and Yang (2008); and as a result, the providers' costs in our model are smaller than those in Marvel and Yang (2008).

We draw the opposite conclusion from Marvel and Yang (2008) on the effect of the GPOs on innovation: we conclude that the presence of the GPO stifles the manufacturers' incentives to innovate. This contrasting result is caused by the different power structurer that we assume. In Marvel and Yang (2008), the manufacturers employ nonlinear pricing to negotiate with the GPO, thereby acting as the Stackelberg leader. O'Brien and Shaffer (1997) and Dana (2003) also model the GPO as the leader.

The scope of GPOs is not limited to healthcare supply chain. For example, grocery, furniture retailers and hospitality all purchase through GPOs to improve their bargaining powers and thereby to save purchasing costs. However, different from healthcare industry where demand is inelastic to prices, members of these GPOs compete with each other, and therefore, the total market size depends on competing members' prices. As a result, whether forming a GPO benefits its member also depends on the demand price elasticity. Assuming that a monopoly manufacturer who offers a linear quantity discount to competing retailers, Chen and Roma (2008) identify the conditions under which a GPO will form.

Wang, Jiang and Shen (2004), who study channel performance under revenue-sharingbased consignment selling, is loosely related to our paper. In a single manufacturer-retailer setting, the manufacturer determines selling price and quantity, and the retailer who incurs partial channel distribution costs charges a share of sales revenue. They characterize channel performance under multiplicative and additive demand functions.

## 3. The Model

We employ the Hotelling model of horizontal differentiation. Two manufacturers offer competing but not identical products. A continuum of healthcare providers are distributed uniformly with density 1 along the interval [0, 1], with manufacturer 1 located at the 0 point and manufacturer 2 located at the 1 point. All providers are assumed to be willing to pay v > 0 for a single unit of the product if that product exactly matches the provider's preferred variety. This willingness to pay is reduced by t > 0 per unit distance for a product whose characteristics does not match the provider's preference. We assume the distribution of the providers are common knowledge, but the manufacturers cannot identify any individual provider's preference. This constraint on information prevents manufacturers from engaging in price discrimination when selling directly to the providers.

Let  $p_i$  be manufacturer *i*'s price and  $c_m$  be the manufacturers' common unit contracting cost if selling directly to the providers. Their unit production costs are normalized to zero. The results of this paper will not change if the production costs are positive. Let the providers have common unit contracting cost,  $c_p$ , if they purchase directly from the manufacturers. Let  $c = c_m + c_p$ .

GPOs reduce contracting costs for both providers and manufacturers. For providers, GPO membership reduces or eliminates the purchasing staff who would otherwise be engaged in finding or contracting with suppliers. According to Schneller (2005), the average cost avoidance per contract is \$1,367. For manufacturers, GPOs mean fewer contracts, thus reducing administrative costs. Hence, we assume that if products are sold through a GPO, then the total unit contracting cost is  $c - \Delta$  where  $0 \leq \Delta < c$ , and they are borne by the GPO. The reduced unit contracting cost,  $c - \Delta$ , represents economies of scale or scope only available to the GPO. For simplicity, the contracting costs of the manufacturers and the providers are normalized to zero.

A provider located at x on the interval receives a utility of  $v - tx - p_1 - c_p$  if purchasing directly from manufacturer 1, and a utility of  $v - (1 - x)t - p_2 - c_p$  if purchasing directly from manufacturer 2. Given  $p_1$  and  $p_2$ , in the absence of a GPO, the manufacturers' demand  $D_i$  can be obtained by solving

$$v - tx - p_1 - c_p = v - (1 - x)t - p_2 - c_p$$

So,

$$D_1 = x = \frac{1}{2} + \frac{p_2 - p_1}{2t}; \qquad D_2 = \frac{1}{2} + \frac{p_1 - p_2}{2t}$$
(1)

Note that the manufacturers' market shares do not depend on the providers' contracting cost  $c_p$  but only on the preference characteristic parameter t and the prices. Therefore, the market- share distribution remains the same if the goods are sold through the GPO.

Suppose that providers in the market have the option to form a single GPO. If it forms, it possesses the same information as the manufacturers. That is, it knows the distribution of

its members' preference but does not know each member's individual preference. The GPO incurs unit contracting cost  $c - \Delta$ , described above; and it is in a position to offer a takeor-leave-it contract to each manufacturer. The contract stipulates a contract administrative fee (CAF): for each unit of product that is sold at price  $p_i$ , manufacturer i receives  $\lambda_i p_i$  and the GPO receives  $(1 - \lambda_i)p_i$  where  $0 < \lambda_i < 1$ . If the manufacturers decline the offer, the game is over, and they receive zero profit. If they accept the offer, then they engage in a pricing game, each getting a share of the market and sales revenue. We assume that the GPO's interest is aligned with the providers' interest, thus expecting revenue just enough to cover its costs. If the GPO expects a certain level of return on its costs, we indicate, later in the analysis, how it can be accommodated.

If the providers do not form a GPO and purchase directly from the manufacturers, then the contracting costs  $c_m$  and  $c_p$  are borne by the manufactures and the providers, respectively. The manufacturers engage in pricing game and receive 100 % of the revenues from their respective share of market.

## 4. Do GPOs Yield Lower Prices?

#### 4.1 Symmetric Preference

We first assume that two identical manufacturers compete for business from the providers, each located at the two end points of the interval [0, 1] of the Hotelling model. We will examine and compare the equilibrium prices with and without the GPO.

#### 4.1.1 Direct Purchase

In the absence of the GPO, manufacturer i chooses  $p_i$  to maximize its profit,

$$(p_i - c_m)D_i = (p_i - c_m)(\frac{1}{2} + \frac{p_j - p_i}{2t}) \quad (i, j = 1, 2; i \neq j)$$

The FOC (first order condition) of above equation with respect to  $p_i$  yields

$$t + (p_j - p_i) - (p_i - c_m) = 0$$

Therefore, at equilibrium,  $p_{1*} = p_{2*} = p_* = t + c_m$ ,  $D_1 = D_2 = 1/2$ , and each manufacturer earns  $\pi_{1*} = \pi_{2*} = \pi_* = t/2$ . In order to ensure full market coverage, the provider located at the center of the unit interval must have a nonnegative utility at the equilibrium. That is,  $v - p_* - c_p - t/2 \ge 0$ , which is equivalent to  $v \ge 3t/2 + c$ . Let  $s_*$  be the providers' total costs under direct purchase. Then

$$s_* = \int_0^x (p_1 + c_p - v + t\epsilon) d\epsilon + \int_0^{1-x} (p_2 + c_p - v + t\epsilon) d\epsilon$$
$$= 2 \int_0^{1/2} (t + c + t\epsilon) d\epsilon$$
$$= 5t/4 + c - v$$

The first component represents the utility loss of buying a less desirable product, the second term is the total channel contracting costs, and the last term is the utility gain of obtaining the products. So the contracting costs are all borne by the providers in the absence of the GPO. The total channel surplus is

$$-s_* + 2\pi_* = v - t/4 - c$$

The following lemma summarizes the result.

Lemma 1. In the absence of the GPO, at equilibrium,

- (a) Each manufacturer sells to 1/2 of the market at price  $t + c_m$  and earns t/2.
- (b) The providers total costs are 5t/4 + c v.
- (c) The total channel surplus is v t/4 c.

The selling price is increasing in  $c_m$ , a well-known result that unit production costs soften Betrand-Nash competition under linear pricing.

#### 4.1.2 Purchase Through the GPO

We now show that if the providers form a GPO who offers a contract to each manufacturer, all the channel contracting costs are transferred to the manufacturers; and so the manufacturers compete with each other as if their contracting costs were zero. Let superscript 'G' represent that products are sold through the GPO. Let  $\lambda_i$  the manufacturer i's CAF, and  $\pi_i^G$  be manufacturer i's profit from selling its product through the GPO. In the duopoly game, manufacturer i chooses  $p_i$  to maximize

$$\pi_i^G = \lambda_i p_i D_i = \lambda_i p_i \left(\frac{1}{2} + \frac{p_j - p_i}{2t}\right) \tag{2}$$

The FOC of (2) with respect to  $p_i$  yields

 $t + p_j - 2p_i = 0$ 

So  $p_{1*} = p_{2*} = p_*^G = t$  and  $D_1 = D_2 = 1/2$ .

In order for the GPO to break-even,

$$p_*^G(1-\lambda) - (c_m + c_p - \Delta) = 0$$
(3)

must hold. So

$$\lambda_{i} = [p_{*}^{G} - (c_{m} + c_{p} - \Delta)]/p_{*}^{G} = [t - c + \Delta)]/t$$

Note that if the GPO requires a return of r on its costs,  $c - \Delta$ , then  $\lambda_i = [t - (1+r)(c - \Delta)]/t$ .

Note that in order to ensure  $\lambda_i > 0$ , which guarantees a nonnegative profit for each manufacturer,  $t > c - \Delta$ . Substituting  $\lambda_i$  into (2) yields

$$\pi_{1*}^G = \pi_{2*}^G = \pi_{*}^G = \frac{p_1 \lambda_i}{2} = [t - (c - \Delta)]/2$$

The providers' aggregated costs are

$$s_*^G = \int_0^x (p_1 + t\epsilon - v)d\epsilon + \int_0^{1-x} (p_2 + t\epsilon - v)d\epsilon = 2\int_0^{1/2} (t + t\epsilon)d\epsilon = 5t/4 - v$$

The total channel surplus is

$$-s^G_*+2\pi^G_*=v-t/4-(c-\Delta)$$

Let  $\theta = c - \Delta$ . The result are summarized as follows.

Lemma 2. In the presence of the GPO, at equilibrium,

- (a) Each manufacturer sells to 1/2 of the market at the price t and earns  $(t \theta)/2$ .
- (b) The providers' total purchasing costs are 5t/4 v.
- (c) The total channel profit is  $v t/4 \theta$ .

It is well known that production costs, here contracting costs, soften the Bertrand-Nash competition with linear prices. The CAF contract, under which the manufactures obtain  $\lambda_*$  share of revenue, induces the manufacturers to compete as if their contracting costs were zero, thus lowering the equilibrium price to t/2.

#### 4.1.3 Comparison

Comparing the equilibrium points with GPO and without GPO leads to the following conclusions.

**Proposition 1.** In the presence of the GPO, at equilibrium,

- (a) Each manufacturer's price decreases by  $c_m$ , and its profit decreases by  $\theta/2$ ;
- (b) The providers' total costs decrease by c;
- (c) The total channel surplus increases by  $\Delta$ .

We have assumed that the GPO's interests are completely aligned with the providers', thus expecting zero return. If the GPO expects some level of profit, our model can accommodate this change in two ways. First, the right side of (3) can be replaced by a positive number as aforementioned. In other words, the GPO would charge each manufacturer a larger CAF. The equilibrium price will not change since it is independent of  $\lambda_i$ . Neither will the providers' purchasing costs. Second, because the GPO reduces the providers' cost by c, the GPO could charge the providers a fixed fee in the form of membership fee. Some GPOs do so. As long as the total membership fees are lower than c, the providers still benefit from the presence of the GPO. Thus they have incentives to form the GPO.

#### 4.2 Asymmetric Preference

In many setting, providers' preferences for the products are asymmetric. Physicians may prefer one manufacturer's product to the other's. Some established manufacturers may have longer relationship with providers, thus having "brand" advantage over its competitors. Manufacturers may also employ marketing strategies to shift or reshape providers' preferences. To capture such situations, we now generalize our models to deal with cases wherein providers' preferences are shifted in favor of one of the two competing manufacturers.

As in §4.1, the providers remain uniformly distributed over the unit interval, but their willingness to pay for the product of one of the manufacturers, taken arbitrarily to be manufacturer 1, is increased by a factor  $\delta > 0$ . Manufacturer 1 can be seen as the more established firm, while manufacturer 2 is a new entrant. So  $v + \delta$  is the reservation price for manufacturer 1's product for a provider located at x = 0.

As in the previous subsection, the market share can be derived as follows: a provider located at x on the unit interval is indifferent to buying a product from either manufacturer,

$$v + \delta - tx - c_p - p_1 = v - (1 - x)t - c_p - p_2 \tag{4}$$

 $\mathbf{SO}$ 

$$D_1(p_1, p_2) = x = \frac{1}{2} + \frac{p_2 - p_1 + \delta}{2t}$$
$$D_2(p_1, p_2) = 1 - x = \frac{1}{2} + \frac{p_1 - p_2 - \delta}{2t}$$

If the providers purchase through a GPO, then  $c_p$  disappears from both sides of (4). Hence, the market-share distribution remains the same.

#### 4.2.1 Direct Purchase

If the providers purchase directly from the manufacturers, each manufacturer i chooses  $p_i$  to maximize its expected profit.

$$\pi_1 = D_1(p_1 - c_m) = \left(\frac{1}{2} + \frac{p_2 - p_1 + \delta}{2t}\right)(p_1 - c_m)$$
(5)

$$\pi_2 = D_2(p_2 - c_m) = \left(\frac{1}{2} + \frac{p_1 - p_2 - \delta}{2t}\right)(p_2 - c_m) \tag{6}$$

Solving the FOCs of above equations with respect to  $p_1$  and  $p_2$ , respectively, yields equilibrium prices

$$p_{1*} = t + c_m + \delta/3$$
  $p_{2*} = t + c_m - \delta/3$  (7)

So the equilibrium market shares are

$$D_1 = x = \frac{1}{2} + \frac{\delta}{6t}$$
  $D_2 = 1 - x = \frac{1}{2} - \frac{\delta}{6t}$  (8)

Hence, for manufacturer 2 to obtain a market share,  $\delta < 3t$ . The manufacturers' expected profits at equilibrium are

$$\pi_{1*} = \frac{(3t+\delta)^2}{18t} \qquad \pi_{2*} = \frac{(3t-\delta)^2}{18t}$$

The favored manufacturer charges a higher price and obtains a larger market share and, therefore, makes greater profit than its rival. The manufacturers' total profits are

$$t + \frac{\delta^2}{9t}$$

The providers' total costs are

$$s_* = \int_0^x (p_1 + t\epsilon + c_p - v - \delta) d\epsilon + \int_0^{1-x} (p_2 + t\epsilon + c_p - v) d\epsilon$$
$$= \int_0^{\frac{1}{2} + \frac{\delta}{6t}} (t + c + \frac{\delta}{3} + t\epsilon) d\epsilon + \int_0^{\frac{1}{2} - \frac{\delta}{6t}} (t + c - \frac{\delta}{3} + t\epsilon) d\epsilon$$
$$= \frac{5t}{4} + \frac{5\delta^2}{36t} + c - v$$

The total channel surplus is

$$\pi_{1*} + \pi_{2*} - s_* = v - \frac{t}{4} - \frac{\delta^2}{36t} - c$$

The results are summarized as follows.

Lemma 3. In the absence of the GPO, at equilibrium,

- (a) Manufacturer 1 sells to  $\frac{1}{2} + \frac{\delta}{6t}$  of the market at the price  $t + c_m + \delta/3$  and earns  $\frac{(3t+\delta)^2}{18t}$ .
- (b) Manufacturer 2 sells to  $\frac{1}{2} \frac{\delta}{6t}$  of the market at the price  $t + c_m \delta/3$  and earns  $\frac{(3t-\delta)^2}{18t}$ .
- (c) The providers' total costs are  $\frac{5t}{4} + \frac{5\delta^2}{36t} + c v$ .
- (d) The channel total surplus are  $v \frac{t}{4} \frac{\delta^2}{36t} c$ .

Compared with the symmetric game without GPO, the providers' costs increase by  $5\delta^2/(36t)$ , manufacturer 1's profit increases by  $\delta/3 + \delta^2/(18t)$ , and manufacturer 2's profit decreases by  $\delta/3 - \delta^2/(18t)$ . The profit gain of manufacturer 1 is due to its competitive advantage against manufacturer 2 because of the increase of the providers' willingness to pay for its product. Surprisingly, the total channel surplus decreases by  $\delta^2/(36t)$  compared with the symmetric game without the GPO.

#### 4.2.2 Purchase Through the GPO

Suppose that the providers form a GPO, who offers a take-or-leave-it CAF contract to each manufacturer. Let  $\lambda_i$  be manufacturer i's share of its own sales revenue. Then the manufacture's expected profits are

$$\pi_1^G = \lambda_1 p_1 \left( \frac{1}{2} + \frac{p_2 - p_1 + \delta}{2t} \right)$$
(9)

$$\pi_2^G = \lambda_2 p_2 \left( \frac{1}{2} + \frac{p_1 - p_2 - \delta}{2t} \right) \tag{10}$$

Solving the FOCs with respect to  $p_i$  yields

$$p_{1*}^G = t + \delta/3 \qquad p_{2*}^G = t - \delta/3$$
(11)

So the equilibrium prices do not depend on the revenue shares but only on t and  $\delta$ . The market share distribution remains the same as (8).

For the GPO to break-even, the following equation must hold

$$[(1 - \lambda_1)p_{1*}^G - \theta]D_1 + [(1 - \lambda_2)p_{2*}^G - \theta]D_2 = 0$$
(12)

Since under  $\delta < 3t$ , each manufacturer takes a positive share of the market. The GPO can offer a different or the same share of revenue to the manufacturers. We will first assume that the GPO offers a different revenue share to the manufacturers.

In addition, as in §4.1.2, if the GPO expects a certain level of return, (12) implies that it can raise  $\lambda_1$  and  $\lambda_2$  to extract profit from the manufacturers, provided that each manufacturer continues to earn a profit. The equilibrium prices and the providers' purchasing costs will not be affected. Additionally, as we will show below, the GPO reduces the providers' purchasing costs. Therefore, the GPO can earn a profit by charging the providers' fixed fees that are smaller than the cost savings.

#### Different CAFs

Here we assume that the GPO charges different CAFs on the manufacturers. Since under  $\delta < 3t$ , each manufacturer takes a positive market share, i.e.,  $D_1 > 0$  and  $D_2 > 0$ . Thus for (12) to hold, the following must also hold

$$\lambda_1 = \frac{p_{1*}^G - \theta}{p_{1*}^G} = 1 - \frac{3\theta}{3t + \delta}$$
$$\lambda_2 = \frac{p_{2*}^G - \theta}{p_{2*}^G} = 1 - \frac{3\theta}{3t - \delta}$$

Observe that

$$\frac{1 - \lambda_1}{1 - \lambda_2} = \frac{p_{2*}}{p_{1*}}$$

So the proportion of the GPO's revenue shares from the manufacturers' revenue is the reciprocal of their selling prices. That is, the GPO collects a lower share of revenues from the favored manufacturer who sells at a higher price. Moreover, for  $\lambda_2 > 0$ ,  $3(t - \theta) > \delta$ .

The manufacturers' expected profits at equilibrium are

$$\pi_{1*}^{G} = \frac{(3t+\delta)^2}{18t} \left(1 - \frac{3\theta}{3t+\delta}\right)$$
(13)

$$\pi_{2*}^G = \frac{(3t-\delta)^2}{18t} \left(1 - \frac{3\theta}{3t-\delta}\right)$$
(14)

Each manufacturer makes less profit than if the GPO is not formed. The two manufacturers' total expected profits are

$$\pi^G_{1*} + \pi^G_{2*} = t + \frac{\delta^2}{9t} - \theta$$

which decreases by  $\theta$  than that without the GPO.

#### Uniform CAFs

Here we assume that the GPO offers the same CAF to each manufacturer. Since the equilibrium prices and market-share distribution are independent of the revenue shares, letting  $\lambda_1 = \lambda_2 = \lambda$  in (12) leads to

$$1 - \lambda = \frac{9t\theta}{9t^2 + \delta^2}$$

Therefore, the manufacturers' expect profits at equilibrium are

$$\tilde{\pi_1}^G = \frac{(3t+\delta)^2}{18t}\lambda = \frac{(3t+\delta)^2}{18t}\left(1 - \frac{9t\theta}{9t^2 + \delta^2}\right)$$
(15)

$$\tilde{\pi_2}^G = \frac{(3t-\delta)^2}{18t}\lambda = \frac{(3t-\delta)^2}{18t}\left(1 - \frac{9t\theta}{9t^2 + \delta^2}\right)$$
(16)

#### Comparison

Interestingly, the total profits of the manufacturers are the same under each CAF scheme proposed above.

$$ilde{\pi_1}^G + ilde{\pi_2}^G = \pi_{1*}^G + \pi_{2*}^G = t + rac{\delta^2}{9t} - heta$$

To compare  $\tilde{\pi}_1^G$  and  $\pi_{1*}^G$ , one only needs to compare the second term in the square brackets of (13) and (15).

$$\frac{9t\theta}{9t^2+\delta^2}\frac{3t+\delta}{3\theta} = \frac{9t^2+3t\delta}{9t^2+\delta^2} > 1$$

because  $3t > \delta$ . Therefore,  $\tilde{\pi}_1^G < \pi_{1*}^G$ . Since the total profit of the manufacturers' profits are the same, manufacturer 1 is worse off under the uniform CAFs, manufacturer 2 must be better off. Hence, if the manufacturers have options to choose between the two schemes, manufacturer 1 would favor the differentiated CAF scheme over the uniform CAF scheme. Under the differentiated CAFs, manufacturer 1 obtains a larger share of the revenue than its competitor. However, the uniform CAF scheme forces manufacturer 1 to share the gain from its more favorable product with its competitor.

Because the manufacturers' total profits and the selling prices are the same under either

scheme, the providers' total purchasing costs are also the same.

$$s_*^G = \int_0^x (p_1 + t\epsilon - v - \delta) d\epsilon + \int_0^{1-x} (p_2 + t\epsilon - v) d\epsilon$$
  
=  $\int_0^{\frac{1}{2} + \frac{\delta}{6t}} (t - \frac{\delta}{3} - v - \delta + t\epsilon) d\epsilon + \int_0^{\frac{1}{2} + \frac{\delta}{6t}} (t - \frac{\delta}{3} + t\epsilon - v) d\epsilon$   
=  $\frac{5t}{4} - \frac{\delta}{2} - \frac{\delta^2}{36t} - v$ 

The providers' traveling costs are the same as those without the GPO. However, the providers who purchase from manufacturer 1 obtain an additional utility of  $\frac{\delta}{2} + \frac{\delta^2}{36t}$  because manufacturer 1's product is more appealing.

The total channel surplus under either CAF scheme is

$$\pi^G_{1*} + \pi^G_{2*} - s^G_* = v - \frac{t}{4} + \frac{5\delta^2}{36t} - \theta + \frac{\delta}{2}$$

Thus, in the absence of the GPO, the channel surplus decreases as  $\delta$  increases. Our results are summarized as follows.

**Lemma 4.** If the providers purchase products through the GPO, the asymmetric duopoly has the following equilibrium.

- (a) Under either CAF scheme, manufacturer 1 sells to  $\frac{1}{2} + \frac{\delta}{6t}$  of the market at the price  $t + \frac{\delta}{3}$ , manufacture 2 sells to  $\frac{1}{2} \frac{\delta}{6t}$  of the market at the price  $t \frac{\delta}{3}$ .
- (b) Under the differentiated CAF scheme, manufacturer 1's profit is  $\frac{(3t+\delta)^2}{18t}(1-\frac{3\theta}{3t+\delta})$  and manufacturer 2's profit is  $\frac{(3t-\delta)^2}{18t}(1-\frac{3\theta}{3t-\delta})$ ; under the uniform CAF scheme, manufacturer 1's profit is  $\frac{(3t+\delta)^2}{18t}(1-\frac{9t\theta}{9t^2+\delta^2})$  and manufacturer 2's profit is  $\frac{(3t-\delta)^2}{18t}(1-\frac{9t\theta}{9t^2+\delta^2})$ ;

(c) The providers' total cost is  $\frac{5t}{4} - \frac{\delta}{2} - \frac{\delta^2}{36t} - v$  under either scheme;

(d) The channel's total surplus under either scheme is  $v - \frac{t}{4} + \frac{5\delta^2}{36t} + \frac{\delta}{2} - \theta$ .

#### 4.2.3 Comparison

So, purchasing through the GPO reduces the providers' total purchasing cost by  $\delta/2 + \delta^2/(6t) + c$ . In contrast, in the symmetric game, the GPO reduces the providers' costs by c. Hence, the preference difference between the manufacturers' products further intensifies the competition between the manufacturers and, therefore, further reduces the providers'

purchasing costs in the presence of the GPO. The presence of the GPO improves the channel surplus by

$$\pi_{1*}^G + \pi_{2*}^G - s_*^G - (\pi_{1*} + \pi_{2*} - s_*) = \frac{\delta^2}{6t} + \frac{\delta}{2} + \Delta$$

Hence, even if  $\Delta = 0$ , the channel surplus is greater with the GPO than without it. The increasing rate of the surplus increases as  $\delta$  increases. If  $\delta = 0$ , then the channel profit is improved by  $\Delta$ , the same as that in the symmetric duopoly. Hence, the symmetric duopoly can be treated as a special case of the asymmetric one. The results are summarized as follows.

#### **Proposition 2.** Compared to the equilibrium without the GPO,

- (a) Under either CAF scheme, the manufacturers' market shares are the same as those without the GPO. However, selling price decreases by c<sub>m</sub>;
- (b) Under the differentiated CAF scheme, manufacturer 1's profit decreases by  $\frac{\theta}{2} + \frac{\theta\delta}{6t}$ , and manufacturer 2's profit decreases by  $\frac{\theta}{2} \frac{\theta\delta}{6t}$ ;
- (c) Under the uniform CAF scheme, manufacturer 1's profit decreases by  $\frac{\theta}{2} + \frac{3t\delta\theta}{9t^2+\delta^2}$ , and manufacturer 2's decreases by  $\frac{\theta}{2} \frac{3t\delta\theta}{9t^2+\delta^2}$ ;
- (d) The manufacturers' total profits decrease by  $\theta$  under either scheme.
- (e) Manufacturer 1 prefers the differentiated CAF scheme to the uniform one, while the opposite holds for manufacturer 2. The providers are indifferent between the two schemes;
- (f) The providers' costs decrease by  $c + \frac{\delta}{2} + \frac{\delta^2}{36t}$  under either scheme;
- (g) The total channel surplus increases by  $\frac{\delta^2}{6t} + \frac{\delta}{2} + \Delta$  under either scheme.

Whether the GPO is present or not, the manufacturers' total profits increase at the rate  $\frac{2\delta}{9t}$  as  $\delta$  increases. Although the increase of utility of manufacturer 1's product allows it to charge a higher price for those providers who favor its product, the presence of the GPO unambiguously lowers the providers' purchasing prices and each manufacturer's profit. The favored manufacturer's profit decreases by a smaller margin than those of less favored competitor.

The comparison of the manufacturers' profits also implies that the GPO makes the prospect of an entry less attractive, assuming that manufacturer 2 is a new entrant who is still building preferences for its product. As the weaker rival in the market, it charges a lower price and obtains a smaller market share. And the introduction of the GPO further reduces its profit, thus creating a more intimidating environment than in the symmetric case analyzed in  $\S4.1$ .

The presence of the GPO lowers the manufacturers' total profits by  $\theta$ , a constant independent of  $\delta$ . Thus, one may conjecture that if  $\delta$  is endogenized, the presence of the GPO at best will not change, if not lower, the value of  $\delta$  at equilibrium. This conjecture leads us to examine the innovation game in §6.

## 5. Sell On or Off Contract?

Suppose now that each manufacturer is , first, able to choose to sell through the GPO or directly to the providers. Then, at the second stage, the manufacturers engage in pricing competition. Three cases arise: both sell off-contract; both sell on-contract, or one of the manufacturers, taken arbitrarily to be manufacturer 1, sells off-contract and manufacturer 2 sells on-contract. The first two cases have been examined in §4.1. We now examine the third case: manufacturer 1 sells off-contract and manufacturer 2 sells on-contract.

The market-share distribution is obtained by solving

$$v - p_1 - tx - c_p = v - p_2 - (1 - x)t$$

The left side of above equation is the surplus of the provider located at x if buying from manufacturer 1 and its right side is its surplus if buying from manufacturer 2. Note that buying directly from manufacturer 1 incurs unit contracting costs  $c_p$ , while buying through the GPO does not. So

$$D_1 = x = \frac{1}{2} + \frac{p_2 - p_1 - c_p}{2t} \qquad D_2 = 1 - x = \frac{1}{2} - \frac{p_2 - p_1 - c_p}{2t}$$
(17)

Manufacturer 1's profit is

$$\pi_1 = (p_1 - c_m) \left(\frac{1}{2} + \frac{p_2 - p_1 - c_p}{2t}\right)$$

Manufacturer 2's profit is

$$\pi_2^G = (p_2 - \theta) \left(\frac{1}{2} - \frac{p_2 - p_1 - c_p}{2t}\right)$$

#### 5.1 Off-Contract Price v.s. On-Contract Price

The FOCs of the profit functions with respect to the prices yield

$$p_{1*} = t + \frac{2c_m - c_p}{3}$$
$$p_{2*}^G = t + \frac{c}{3}$$

Recall that in the case in which both manufacturers sell through the GPO, each manufacturer charges price t. Here, manufacturer 1's decision to sell direct results in manufacturer 2' price unambiguously increasing by  $\frac{c}{3}$ , while manufacturer 1's price is lower than t if and only if  $2c_m < c_p$ . Moreover, the off-contract price  $p_{1*}$  is lower than the on-contract price  $p_{2*}$ if  $c_m < 2c_p$ .

A comparison of the equilibrium prices is very revealing. If both manufacturers sell through the GPO, then the manufacturers are forced to compete as if their contracting costs were zero, which lowers the equilibrium prices to t (which is independent of the unit contracting costs,  $c_m$  and  $c_p$ ). However, if one manufacturer sells directly, both  $c_m$  and  $c_p$  affect the equilibrium prices. Manufacturer 1's contracting costs soften the pricing competition, with manufacturer 1's price increasing at the constant rate 2/3 relative to  $c_m$  and its rival's price increasing at the lower rate, 1/3. The provider's contracting cost  $c_p$  drives manufacturer 1 to lower its price at the constant rate 1/3. Responding strategically, manufacturer 2 raises its price at the rate 1/3 with respect to  $c_p$ .

Substituting  $p_{1*}$  and  $p_{2*}$  into (17) yields

$$D_1 = x^* = \frac{1}{2} - \frac{c}{6t}$$
  $D_2 = 1 - x^* = \frac{1}{2} + \frac{c}{6t}$ 

Note that manufacturer 1's market share shrinks compared with the case in which each manufacturer sells through the GPO or the case in which neither does. To ensure manufacturer 1 a positive market share requires that 3t > c. The manufacturers' profits at equilibrium are

$$\pi_{1*} = \frac{(3t-c)^2}{18t} \tag{18}$$

$$\pi_{2*}^G = \frac{1}{18t}(3t + \Delta)(3t + c) > \frac{t}{2}$$
(19)

The providers' total costs are

$$\int_{0}^{x} (p_{1} + c_{p} - v + t\epsilon) d\epsilon + \int_{0}^{1-x} (p_{2} - v + t\epsilon) d\epsilon$$
  
= 
$$\int_{0}^{\frac{1}{2} - \frac{c}{6t}} \left( t + \frac{2}{3}c + t\epsilon - v \right) d\epsilon + \int_{0}^{\frac{1}{2} + \frac{c}{6t}} \left( t + \frac{1}{3}c + t\epsilon - v \right) d\epsilon$$
  
= 
$$\frac{5t}{4} + \frac{1}{2}c - \frac{1}{36t}c^{2} - v$$

The total channel surplus is

$$\pi_{1*} + \pi_{2*}^G - \left(\frac{5t}{4} + \frac{1}{2}c - \frac{1}{36t}c^2 - v\right)$$
$$= v - \frac{t}{4} - \frac{2c}{3} + \frac{c^2}{12t} + \frac{\Delta}{6} + \frac{\Delta c}{18t}$$

Recall, from Lemma 2 that if both manufacturers sell on-contract, the total channel surplus is  $v - \frac{t}{4} - \theta$ .

By Lemma 1, the equilibrium prices without the GPO are  $p_1 = p_2 = t + c_m$ , and the providers' total costs are  $5t/4 + c_m + c_p - v$ . Hence, the GPO lowers the providers' purchasing costs if and only if

$$\frac{t}{4} - \frac{c}{2} - \frac{c^2}{36t} = \frac{1}{36t} [3(t-c)^2 - 10c^2] < 0$$

where  $c = c_m + c_p$ . Solving the inequality yields  $t < (\frac{\sqrt{10}}{3} + 1)c$ . The conclusions are summarized as follows.

**Proposition 3.** If one manufacturer sells directly, while its competitor sells through the GPO, then at equilibrium,

- (a) The off-contract price is lower than the on-contract price if  $c_m < 2c_p$ .
- (b) The presence of the GPO lowers the providers' total purchasing costs if and only if  $\frac{t}{c} < \frac{\sqrt{10}}{3}$ .

Recall that the criticism about GPO pricing is bolstered by the evidence that on-contract prices are not necessarily the lowest available; indeed, off-contract prices are sometimes lower. We have shown here that off-contract price could be lower than on-contract price. However, if so, this is because of the GPO. Without the GPO, the off-contract price would be higher.

		Manufacturer 2		
		On contract	Off contract	
Manufacturer 1	On contract	$\left(\frac{t-\theta}{2}, \frac{t-\theta}{2}\right)$	$\left(\frac{(3t+c)(3t+\Delta)}{18t},\frac{(3t-c)^2}{18t}\right)$	
	Off contract	$\left(\frac{(3t-c)^2}{18t},\frac{(3t+c)(3t+\Delta)}{18t}\right)$	$\left(\frac{t}{2}, \frac{t}{2}\right)$	

Table 1: Selling on-contract or off-contract

## 5.2 Is Selling On-Contract Better?

In this subsection we demonstrate that if the manufacturers are able to choose to sell on or off contract, then only two equilibria exist: Either both sell on-contract or one sells on-contract and the other sells off-contract. We also show that the total profits of the manufacturers are larger in the latter case.

Using Lemmas 1 and 2 an Proposition 4, the first stage game: selling off contract or on-contract can be expressed by a  $2 \times 2$  matrix where  $c = c_m + c_p$ .

If, for each manufacturer, selling on-contract is the best response, given that the competing manufacturer sells on-contract, then the symmetric equilibrium arises: both manufacturers sell on-contract. Equivalently, using Table 1, the following inequality must hold.

$$\frac{t-\theta}{2} > (\frac{t}{2} + \frac{c^2}{18t} - \frac{c}{3})$$

which can be simplified as

$$\Delta > \frac{c^2}{18t} + \frac{2c}{3} \tag{20}$$

For the asymmetric equilibrium to arise, the following two equalities must hold:

$$\Delta < \frac{c^2}{18t} + \frac{2c}{3} \tag{21}$$

and

$$\frac{(3t+c)(3t+\Delta)}{18t} > \frac{t-\theta}{2}$$

which always holds.

The equilibrium in which both manufacturers sell off-contract cannot arise because

$$\frac{(3t-c)^2}{18t} - \frac{t}{2} < 0$$

due to c < 3t. Above inequality also implies that the direct selling manufacturer 1's profit is lower when its competitor sells on-contract than when the competitor also sells off-contract. Using (18) and (19), the manufacturers' total profits in the asymmetric equilibrium are

$$t-\frac{c}{6}+\frac{\Delta}{6}=t-\frac{\theta}{6}$$

From Lemma 2, in the equilibrium at which both manufacturers sell on-contract, their total profits are  $t - \theta$ . Hence, the manufacturers' total profit is greater in the asymmetric equilibrium than in the symmetric one.

Note that Since  $\Delta < c$  and t > c/3, so it is more likely that (20) will not hold. In particular, if  $\Delta < 2c/3$ , then (20) does not hold for certainty. And as a result, only the asymmetric equilibrium can arise.

**Proposition 4.** If each manufacturer can choose to sell off-contract or on-contract, at equilibrium,

- (a) If  $\Delta > \frac{c^2}{18t} + \frac{2c}{3}$ , the asymmetric equilibrium arises in which one manufacturer sells on-contract, the other sells off-contract.
- (b) Otherwise, both manufacturers will choose to sell through the GPO.
- (c) The total profits of the manufacturers are greater in the asymmetric equilibrium than those in the symmetric equilibrium in which both sell on-contract.

The results provide the following insights into the controversies about on and off contract buying. First, the presence of GPOs lowers off-contract price. Second, off-contract buying is not, in and of itself, evidence that GPOs are anti-competitive. Instead, this represents an equilibrium that maximizes the manufacturers' total profits.

## 6. Do GPOs Help Or Hinder Innovation?

One of the charges against GPOs is that they stifle innovation by putting new products in a disadvantaged competitive position. Here we will examine whether the presence of GPO promotes or stifles innovation.

Our analysis proceeds as in §4.2 except here we endogenize  $v_1$  and  $v_2$ . Suppose that the base value of both manufacturer's product to a provider is v, but each manufacturer can choose to increase the base value by  $\delta_i$  at a cost  $c(\delta_i)$ , where  $c(\cdot)$  is increasing and strictly convex. So  $v_i = v + \delta_i$ . Each manufacturer chooses  $\delta_i$  first and then sets its price.

#### 6.1 Direct Purchase

Working backward, we will first obtain the pricing subgame, and then the equilibrium of the innovation game. The equilibrium prices are similar to (7), with  $\delta$  being replaced by  $\delta_1 - \delta_2$  for  $p_1$  and  $-\delta$  being replaced by  $\delta_2 - \delta_1$ ,

$$p_i = t + c_m + \frac{\delta_i - \delta_j}{3}$$
  $(i, j = 1, 2; i \neq j)$ 

and using (8), manufacturer i's market share is

$$D_i(p_i, p_j) = \frac{1}{2} + \frac{p_j - p_i + \delta_i - \delta_j}{2t} = \frac{1}{2} + \frac{\delta_i - \delta_j}{6t} \quad (i, j = 1, 2; i \neq j)$$

Using (5) and (6), manufacturer i's expected profit is

$$\pi^{i} = \frac{(3t + \delta_{i} - \delta_{j})^{2}}{18t} - c(\delta_{i}) \quad (i, j = 1, 2; i \neq j)$$
(22)

The FOC of (22) with respect to  $\delta_i$  yields

$$\frac{1}{3} + \frac{\delta_i - \delta_j}{9t} = c'(\delta_i) \tag{23}$$

In the symmetric equilibrium,  $\delta_1^* = \delta_2^* = \delta^*$ . So at the equilibrium of the innovation game,

$$\frac{1}{3} = c'(\delta^*)$$

### 6.2 Purchase Through the GPO

Using (9) and (10), the equilibrium prices are

$$p_i = t + \frac{\delta_i - \delta_j}{3}$$

and the market shares do not change with the presence of the GPO. So

$$D_i = \frac{1}{2} + \frac{\delta_i - \delta_j}{6t}$$

We have proved that in §4.2 that the manufacturer whose product is more appealing prefers the differentiated CAFs to the uniform CAFs. For the GPO to break-even,

$$\lambda_i = 1 - \frac{\theta}{t + \frac{\delta_i - \delta_j}{3}}$$

So manufacturer i's expected profit is

$$\pi_i^G = \lambda_i p_i \left( \frac{1}{2} + \frac{p_j - p_i + \delta_i - \delta_j}{2t} \right) - c(\delta_i)$$
$$= \lambda_i \left( t + \frac{\delta_i - \delta_j}{3} \right) \left( \frac{1}{2} + \frac{\delta_i - \delta_j}{6t} \right) - c(\delta_i)$$
$$= \left( t + \frac{\delta_i - \delta_j}{3} - \theta \right) \left( \frac{1}{2} + \frac{\delta_i - \delta_j}{6t} \right) - c(\delta_i)$$

The FOC of  $\pi_i^G$  with respect to  $\delta_i$  yields

$$\frac{1}{3} + \frac{\delta_i - \delta_j}{9t} - \frac{\theta}{6t} = c'(\delta_i)$$

In a symmetric equilibrium,  $\delta^G_{1*} = \delta^G_{2*} = \delta^G_*$ , where  $\delta^G_*$  satisfies

$$\frac{1}{3} - \frac{\theta}{6t} = c'(\delta^G_*)$$

So  $c'(\delta^G_*) \leq c'(\delta_*)$ .

The strict convexity of  $c(\cdot)$  yields  $\delta^G_* \leq \delta_*$ . For the symmetric equilibrium, the same  $\delta^G_*$  can be achieved if the GPO employs the uniform CAF scheme. Therefore, the introduction of a GPO does dampen demand-enhancing activities, whether it is promotion or product innovation.

**Proposition 5.** Selling through the GPO lowers the manufacturers' incentives to innovate.

Some theoretical models concur with our results. Inderst and Wey (2003) argue that buyers' purchase group dampens a seller's incentive to innovate, although in a later paper, Inderst and Wey (2005), the authors obtain the opposite conclusion.

## 7. Should "Safe Harbor" Provisions for GPOs be Eliminated?

In this section we examine the most controversial issue of all: whether or not the "safe harbor" provisions, which permit GPOs to charge CAFs should be withdrawn, thereby eliminating CAFs.

We assume that GPOs would continue to exist because of the contracting efficiencies they provide, but that their providers member would pay the CAFs. Let  $\lambda$  be the CAF charged to the providers. All other settings are the same as in §4.1. Then the market- share distribution can be determined as follows:

$$p_1 + \lambda_1 p_1 + tx = p_2 + \lambda p_2 + t(1 - x)$$

Hence,

$$D_1 = x = \frac{1}{2} + \frac{(1+\lambda)(p_2 - p_1)}{2t} \qquad D_2 = 1 - x = \frac{1}{2} - \frac{(1+\lambda)(p_2 - p_1)}{2t}$$

And manufacturer 1's profit is

$$p_1 x = p_1 \left[ \frac{1}{2} + \frac{(1+\lambda)(p_2 - p_1)}{2t} \right]$$

Its FOC condition is

$$\frac{1}{2} + \frac{(1+\lambda)(p_2 - p_1)}{2t} - p_1 \frac{1+\lambda}{2t} = 0$$

Let  $p_0^G$  be the equilibrium price, then

$$p_0^G = \frac{t}{1+\lambda} = \frac{t}{1+\frac{\theta}{p_0^G}} < t$$

if  $\lambda > 0$ . Solving above equation leads to

$$p_0^G = t - \theta \qquad \lambda = \frac{\theta}{t - \theta}$$

For  $\lambda < 1$ ,  $t > 2\theta$ . Note that for every unit of the product that the providers purchase, their actual unit costs are  $(1 + \lambda)p = t$ .

Hence, the providers' total purchasing costs are the same as those in §4.2, i.e., 5t/4 - v.

Each manufacturer sells to one half of the market at the price  $t - \theta$ , but it does not need to pay the CAFs to the GPO. As a result, it also earns  $(t - \theta)/2$ , the same as its counterpart in §4.2. One can also verify that shifting the CAF from the manufacturers to the providers will induce a lower level of innovation-promotion than if the CAF is charged to the manufacturers. Hence, merely shifting the CAF does not alter any party's profit or costs.

## 8. Summary

Our models have demonstrated that purchasing through GPOs lower prices for providers. The price advantage generated by the GPO for the providers arises from two sources: the buying power of the GPO and the intensified competition between the manufacturers created by the CAFs. Asymmetry in preference does not alter the price advantage, with the manufacturer whose product is more appealing obtaining a larger market share and selling at a higher price. It is worth noting that if the manufacturers' costs are asymmetric, the conclusions above remain valid because by Lemma 4, neither the equilibrium prices nor the market share distribution depends on the manufacturers' costs.

In addition, we have demonstrated that if the manufacturers could choose to sell through a GPO or directly, then at equilibrium, two cases occur: both sell through the GPO, or one sells through the GPO and the other sells directly. Moreover, we find that the presence of the GPO can cause the off-contract price to be lower than on-contract price.

Despite its price advantages, the presence of the GPO lowers the manufacturers' incentives to innovate.

Moreover, eliminating "Safe Harbor" provision will not change any party's profit or cost. Neither will it resolved the innovation dampening effect of the GPO.

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