

BUYER ALLIANCES AND MANAGED COMPETITION

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In a health insurance market, a large employer or an organized “buyer alliance” is in a position to influence the design of plans offered to its members. We study how the sponsors of buyer alliances manage competition among insurance firms by focusing on their choices of the format of competition, the number of firms allowed to compete, and the quality of care offered by the firms. We find deviations from optimality in all three dimensions. Specifically, we find a tendency toward too many firms and too much quality, and a bias toward a format involving the prescreening of insurance plans by the sponsor.

1. INTRODUCTION

A major feature of the evolving market for health insurance is the coalescing of buyers into groups who purchase insurance jointly. The grouping of consumers into large buyer alliances can give consumers the strength to negotiate effectively with health-care providers. It can also give them a wide selection of plans that they could not otherwise

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achieve as individuals or as small employee groups. For these and other benefits,¹ most large employers already offer group insurance plans, which account for the bulk of private insurance for people under 65.² More recently, the notion of buyer alliances has emerged in many health reform proposals as a vehicle for expanding health coverage to small businesses and individuals. The idea is to encourage or require small employers and individuals to join a large insurance unit to spread consumer risk and to increase bargaining power. While varying in their terms and in the vision of how they will be organized and managed, most of the health reform plans call for some form of buyer alliance.³ Independent of such movements at the federal level, numerous private health cooperatives have emerged voluntarily, aided by state legislation.⁴

Despite the increasing significance of buyer alliances, little is known about exactly how the buyer alliances will influence the nature of competition among providers and the plans that they will offer. Although the increased bargaining power that accrues to alliances should intensify price competition, concerns remain. On the one hand, there are fears that quality of care and patients' freedom of choice may be subordinated to the goal of cost containment. On the other hand, there are concerns that the alliances may not put enough competitive discipline on the providers. A related issue is the role that the sponsors of health alliances should play. Should the sponsors simply pass along price quotes and let individual members provide market discipline through their choices at sign-up time? Or should they be allowed to negotiate the terms of the plans for their members?

The current paper studies these questions. Specifically, we shall

1. The other benefits include scale economies associated with the spreading of the fixed administration costs and the tax exemption of the employees' health benefits.

2. In 1980, individual (nongroup) insurance premiums were about 10 percent of total private insurance premiums for both commercial and Blue Cross insurers; the rest was almost all group insurance provided at the workplace (Pauly, 1986).

3. For example, Enthoven's health insurance purchasing cooperative (HIPC) refers to employers, governmental entities, or purchasing cooperatives, which, acting on behalf of a large group of subscribers, structure and adjust the market to increase price competition (see Enthoven, 1993). The original Clinton plan calls for mandatory participation of small businesses (with fewer than 5000 employees) in regional alliances run by public agencies ("Fewer Employers to Be Put Into Regional Alliances," *Wall Street Journal*, January 24, 1994). At the other end of the spectrum, the House Republican leadership supports a plan that will simply override state laws that bar companies in unrelated industries from joining together solely to buy coverage ("Getting Health Alliances Right," *Fortune*, May 16, 1994).

4. Eight states, including Ohio and California, have passed laws establishing or allowing cooperatives to purchase health coverage, as of 1994 ("Getting Health Alliances Right," *Fortune*, May 16, 1994).

ask what format of competition a sponsor of an alliance will choose, how many providers she will allow to compete, in what way she will subsidize the members, and what kinds of health plans will be offered to consumers in different circumstances. Much of the recent theoretical work on health-care markets focuses on contracting between health-care providers and insurance companies or governments. Examples of such research include Glazer and McGuire (1994), Ma (1994), Rogerson (1994), Chalkley and Malcomson (1995), and Gal-Or (1995), who focus on the merits of prospective payment systems. The buyer side of the market, in particular the behavior of buyer alliances, has not been studied. We begin to fill this gap.

The basic model builds on the location model employed by Ma and Burgess (1993) and Wolinsky (1994). Many health-care providers (HMO-hospital coalitions, henceforth “firms”) can offer health insurance plans that are horizontally and vertically differentiated. The horizontal characteristics of a plan are the fixed attributes of the health services provided under that plan, such as the physical location of the affiliated hospitals and their treatment specialties. For modeling simplicity, the horizontal element is metaphorically represented as a location in a unit circle, as in Salop (1979). Quality represents the vertical element of the plans. It includes the benefits covered by the plans, but could also include the level of care, the number of accessible doctors, the treatment methods, the presence of modern medical facilities, expected waiting time, and other amenities. Consumers have identical preferences for quality and price but have heterogeneous preferences over characteristics, with their ideal characteristics distributed uniformly over the product space. The firms compete in quality and premiums. How they compete in these terms—the format of competition—is what buyer alliances seek to influence.

The sponsor of a buyer alliance selects one of two formats of competition: sponsor-driven competition or individual-driven competition. The two formats are mainly distinguished by the extent to which the sponsor is involved in the selection of the firms. In individual-driven competition, the sponsor chooses firms solely according to the horizontal characteristics of the plans that they offer. The sponsor takes a passive role in the determination of quality and premium, which the chosen firms offer directly to the consumers. In this format, the individual choices of consumers therefore generate the main competitive pressure on the firms. In sponsor-driven competition, the sponsor plays a more active role in negotiating with the firms over terms of their plans. Specifically, the sponsor selects the firms according to their quality-premium terms and their horizontal characteristics. While individuals have a choice of plans in this regime, the sponsor fundamen-

tally influences the terms of the plans through the initial selection process.

These two formats may represent different ideals about how managed competition can be best structured, with views differing with respect to the roles of the sponsors. Examples of individual-driven competition include the Federal Employee Health Benefit Program and Florida's 11 regional Community Health Purchasing Alliances, whose sponsors' main function is to release price quotes on standardized packages. Meanwhile, the sponsor-driven competition captures the spirit of managed competition, as defined in Enthoven (1993).⁵ In the real world, the sponsor may actually have a choice between the two formats, or one format may arise naturally. As an example of the latter, individual-driven competition arises naturally once plans gain persistent market shares, since the sponsors cannot credibly use the threat of exclusion.

Within each format, the sponsor determines the rule for subsidizing its members. In practice, employer subsidization may be motivated by the current tax system, which exempts the employer's contribution to employees' health-care expenses.⁶ We focus on two other important roles that sponsor subsidization plays. First, subsidization provides the sponsor with leverage in restricting the consumers' access to plans. Clearly, consumers are given monetary incentives to choose subsidized plans. As will be seen, restricting consumers to a limited number of plans can be a good way to induce high-quality services from firms. Second, the way the subsidization rule is structured can have ramifications for the intensity of firms' competition. Specifically, the extent to which the sponsor absorbs premium differences determines the price sensitivity of consumers, which influences the intensity of price and quality competition in the individual-driven competition. (For example, a contribution rule that absorbs part of the premium difference between plans will make members less price-sensitive, which reduces the intensity of price competition.) When firms have market power, for example, the sponsor can use the contribution rule to counteract the market power.

5. The original architects of managed competition favored the passive approach where individual choices provide all the market discipline, much as under individual-driven competition. The Clinton plan envisions a regulatory approach whereby sponsors set the prices. This latter approach appears to impose a greater informational burden on sponsors than the sponsor-driven competition, as we remark in Section 4.

6. Employer payments for health insurance provided as a fringe benefit are a tax-deductible business expense for the firms, and are not treated as employee income for tax purposes. The tax expenditures associated with this type of exclusion amounted to more than \$20 billion in 1982, or about 8 percent of private health insurance expenditures (Pauly, 1986).

Our main results are as follows. First, the sponsor's active screening role generates more effective price competition, as sponsor-driven competition results in a fuller extraction of rents than individual-driven competition. Individual choices in the latter format place competitive pressure on the firms, but this is limited by consumer heterogeneity. Hence, firms enjoy strictly positive profits. By contrast, the heterogeneity plays no role in the sponsor-driven competition, since the firms wage all-or-nothing competition for the right to serve a given segment of the market. This result suggests that a sponsor would prefer such an active screening role, even when it may not be socially desirable.

Second, there is a potential for excessive quality in both formats. In individual-driven competition, the sponsor may induce excessive quality (through the design of the subsidization rule) in order to squeeze the firms' rents. In our model, the fixed costs associated with a quality increase are not reflected in the price, so an increase in quality can squeeze rents when consumer heterogeneity is small. Excessive quality also arises in sponsor-driven competition if the sponsor picks more than one firm. Firms have an incentive to increase quality to steal consumers away from their "neighboring" firms (in the product space), which in turn enables them to offer a (relatively) good premium deal, due to the presence of the fixed costs. Such opportunistic behavior does not succeed in equilibrium, but it induces too much quality. The tendency for excessive quality is consistent with the perception that the rate of inflation for health-care services has been largely unchecked by the spread of HMOs. Manheim et al. (1994) find service competition rather than price competition, and no significant change in total market competition, between 1983 and 1988, a period of rapid growth for HMOs.

Third, the sponsor has a tendency to choose too many firms in the individual-driven competition. Such a tendency arises from the sponsor's desire to extract rents from the firms, since increasing their number intensifies price competition. The same is not true with the sponsor-driven competition, however. The sponsor extracts full rents from the firms in the latter format, so she chooses the socially optimal number of firms.

The current paper is related to different strands of literature. As mentioned earlier, Ma and Burgess (1993) and Wolinsky (1994) examine a spatial duopoly with a vertical quality dimension. (In both cases, there are two firms located at the ends of an interval.) Our paper differs in that we incorporate the hierarchical decision process involving the sponsor and consumers and we also endogenize the number of firms and the format of competition. Furthermore, the tendency toward over-provision of quality that we find contrasts with Ma and Burgess (1993)

and Wolinsky (1994), who find no bias if firms choose price and quality simultaneously. Also closely related is the literature on optimal market design [see, for example, Auriol and Laffont (1993), Dana and Spier (1992), and McGuire and Riordan (1995)].⁷ Unlike these papers, we focus on a buyer alliance that acts to maximize consumers' welfare. Finally, recent work by Mathewson and Winter (1995) examines the effect of buyer groups in a monopolistically competitive market, but its focus is on the parties excluded from the groups.

The rest of the paper is organized as follows. The next section describes our model and characterizes the social optimum. Section 3 analyzes individual-driven competition, and Section 4 examines sponsor-driven competition using two different criteria for the sponsor. The comparison across regimes is in Section 5. Section 6 makes concluding remarks.

2. THE MODEL

We consider a model of group health plans offered through a buyer alliance. The actors are a sponsor, consumers, and health insurance firms. Each firm is affiliated with hospitals, which actually provide health-care services.⁸ Consumers purchase a health plan and receive health care. The sponsor of the buyer alliance offers the consumers access to a set of health plans provided by the firms.

A *health plan* yields an array of services that are offered by affiliated hospitals under that plan. Each plan can be characterized by the *quality* of these services, their *characteristics*, and the *premium* that is charged for the plan. Specifically, quality is the *vertical* element of the services, which encompasses the number of accessible doctors, the treatment methods, the presence of modern medical facilities, and the amenities. For simplicity, we represent quality as a one-dimensional variable, $q \geq 0$. The quality is observable once it is chosen, but it is not verifiable, so it cannot be contracted upon a priori. It is also irreversible once a firm chooses it.⁹

7. Those papers differ from ours in several other respects. In particular, they focus on incomplete information on the regulator's part, and they do not address the possibility of differences in quality.

8. Since our focus is on the hierarchical relationship in a buyer alliance, we abstract from the possible agency problem that exists between an insurance firm and member hospitals. As mentioned in the Introduction, the latter relationship has been the subject of many recent studies.

9. In practice, the quality choices are made when insurance firms sign contracts with hospitals and when the hospitals make their investments for medical facilities and equipment. These investments are often sunk and cannot easily be reversed.

The characteristic of a plan captures a *horizontal* element of the services, such as the geographic locations of the affiliated hospitals, their specialities, their practice style, or their religious denomination, for example. It is simply modeled as a *location*, $x \in [0, 1]$ (measured clockwise) on a unit circle. Note that the terms such as “location” and “circle” can be interpreted in a number of different ways depending on the underlying product space. Finally, the premium $p \geq 0$ represents a single up-front payment for the plan. (As will be clear subsequently, this assumption involves no loss of generality.) In sum, plan i is characterized by a triple (q_i, x_i, p_i) .

Consumers’ preferences are described as follows. Consumers are heterogeneous in their tastes for the horizontal characteristic. They may prefer different plans according to their own geographic locations or health conditions. For example, one plan may support hospitals that feature unconventional treatment techniques, and consumers may differ in their tastes for such treatment techniques. Alternatively, one plan may sponsor a single large hospital in a downtown location while another plan may support many small clinics scattered all over a suburban area. Suburban consumers may then prefer the latter plan, while downtown residents prefer the former. Here, we simply model preferences for plan characteristics by indexing each consumer by his ideal location on the unit circle, $\theta \in [0, 1]$, again measured clockwise. We assume that consumers’ ideal locations are uniformly distributed, with density μ . If a consumer located at $\theta \in [0, 1]$ purchases plan i with characteristic $x_i \in [0, 1]$, he incurs a disutility of $g(\theta, x_i) \equiv t \min \{(\theta - x_i)^2, (1 - |\theta - x_i|)^2\}$, where $t > 0$ parametrizes the importance of the horizontal element.

The consumers are identical in their valuation of quality. This vertical homogeneity implies that there is no significant adverse selection problem. Nor is there a moral-hazard problem on the part of the consumers. While these two phenomena are important in the health-care market, they are beyond the scope of the current paper. Absent adverse selection and moral hazard, we can focus on health plans that offer full insurance without loss of generality. This assumption is consistent with many HMO plans, since they often do not impose deductibles (Sullivan et al., 1993).

The consumers’ preferences are specified as follows. If a consumer located at $\theta \in [0, 1]$ pays T_i for plan i characterized by quality q_i and characteristic x_i , then his utility is

$$U(q_i, p_i; \theta) \equiv q_i - g(\theta, x_i) - T_i + S,$$

where S is a constant. If the consumer has no insurance, his utility is

zero. We assume that S is sufficiently large that each consumer will always choose a plan. If the consumers have access to more than one plan, they pick their preferred plan.

There exists a pool of many firms sponsoring plans with different characteristics. All plans that a given firm can offer are based on the same group of hospitals, so their horizontal characteristics are the same. We therefore assume without loss of generality that each firm offers a single plan. For simplicity, there is a continuum of firms, whose characteristics cover the entire product space.¹⁰ Each firm is an expected-profit maximizer. The cost of managing a health plan for a firm is the anticipated cost of providing services to the consumers who purchase the plan. The cost has both variable and fixed components (with respect to the number of consumers), and each component depends on the quality of services that the firm has chosen. Suppose that firm i has offered a plan with quality q_i and a premium p_i and that D_i consumers have chosen the plan. Then firm i 's profit from offering that plan is

$$\pi_i \equiv D_i[p_i - c(q_i)] - F(q_i),$$

where $c(\cdot)$ and $F(\cdot)$ are the marginal and fixed costs of providing the anticipated services. The following technical assumptions are used throughout the remainder of the paper.

ASSUMPTION 1: For all $q > 0$, $c(\cdot)$ is increasing and convex, and $\lim_{q \downarrow 0} c'(q) = 0$.

ASSUMPTION 2: For all $q > 0$, $F(\cdot)$ and $F'(\cdot)/F(\cdot)$ are increasing, $F(0) = 0$, $\lim_{q \downarrow 0} F'(q) = 0$, and $\lim_{q \uparrow \infty} F'(q) = \infty$.

Assumption 2 guarantees that $F(\cdot)$ is convex.

The sponsor makes several decisions for the consumers. She first decides the format of competition. Either there is individual-driven competition, in which case the sponsor picks firms according to their locations (in the product space) and then the firms choose their prices and qualities, or there is sponsor-driven competition, in which case the firms make quality and price offers and then the sponsor selects firms according to their terms as well as their locations. In either case, each consumer selects his own plan from among the plans that the sponsor selected. Such a restriction on consumer choice can also arise from exclusive contracting, but it can arise from the sponsor's subsidization of the chosen plans, to which we now turn.

10. This assumption is used to make it possible to pick n equally spaced firms around the circle. It plays no decisive role in obtaining the results of this paper.

The sponsor specifies a rule for subsidizing consumers within each format. The subsidization rule that we use is the following: For all selected plans, the sponsor gives the consumers a subsidy equal to the lowest premium among the plans. She can also provide an additional subsidy for plans with higher premiums. Specifically, the sponsor pays a fraction $1 - \beta$ of the amount by which a premium exceeds the lowest premium, $0 \leq \beta \leq 1$.¹¹ Under this scheme, a consumer's payment is $T_i = \beta(p_i - \min_j\{p_j\})$ when choosing plan i . For example, if plan A has a yearly premium of \$2000 and plan B has the lowest premium of \$1200, then a consumer who selects plan A pays $\$800 \cdot \beta$ out of his own pocket. This cost-sharing scheme encompasses some that have been implemented already, as well as some proposed schemes.¹² Furthermore, the scheme can yield the same outcome as any linear cost-sharing scheme or two-part tariff scheme.¹³ As will become clear, the choice of β determines consumers' price sensitivity and will influence the equilibrium prices in the individual-driven competition regime.

The sponsor maximizes her expected profit. Since utility is transferable, any Pareto-optimal outcome maximizes the sum of the sponsor's and consumers' utilities (see Milgrom and Roberts, 1992, pp. 35–39). This means that the sponsor maximizes the consumers' net health benefits, less her contribution.¹⁴ To see this, suppose that the employees' total compensation is fixed at the value of the long-run marginal product, for example. When an employer raises the dollar value of employees' net health benefits, fixing her contribution, it enables her to reduce the wages by that amount. Hence, the employer has the incentive to maximize the net health benefits minus her contribution. Suppose that the sponsor selects firms (plans) $i = 0, 1, \dots, n - 1$. If

11. That is, overcompensation is disallowed. Given the tax-exempt status of employers' contribution, allowing overcompensation can lead to an undesirable arbitrage opportunity.

12. The idea of pegging contributions to the low-cost benchmark plan appears in both Enthoven's and Clinton's versions of managed competition. In particular, they promote the particular scheme with $\beta = 1$, i.e., consumers pay the entire premium difference. See Enthoven (1993) and Starr and Zelman (1993).

13. As will be clear, the key factor that influences the choice of consumers is the fraction of premium differences borne by the consumers. Any linear (affine) sharing rule therefore results in the same outcome.

14. We do not consider side payments between the sponsor and the firms. With the sponsor internalizing the consumers' utility, however, introducing side payments should not change the results fundamentally. If the sponsor selects the firms according to the lump-sum payments she collects, she can extract the entire rent as in sponsor-driven competition. Yet, a quality distortion may still arise. See Section 4 for more details.

plan i is characterized by (q_i, x_i, p_i) , and a consumer at location θ picks plan $i(\theta) \in \{0, 1, \dots, n - 1\}$, then the sponsor's payoff is

$$V \equiv \mu \int_0^1 [q_{i(\theta)} - g(\theta, x_{i(\theta)}) - p_{i(\theta)}] d\theta.$$

Note that the sponsor internalizes consumers' health benefits and the total cost borne by her and the consumers.

Before analyzing the sponsor's problem, it is useful to consider the social planner's problem. The social planner chooses the set of firms, as well as their quality levels and the set of consumers they serve, to maximize the health benefits less the cost of providing them. Clearly, consumers' total travel costs (i.e., the disutility of not choosing their ideal characteristics in the product space) are minimized when a set of equally spaced firms are chosen. We assume that the social planner indeed prefers a set of equally spaced firms that choose the identical quality.¹⁵ This restriction facilitates our analysis substantially.

Given our assumptions, the socially optimal level of quality, \bar{q}^n , is the same for all chosen firms, satisfying

$$\mu[1 - c'(\bar{q}^n)] - nF'(\bar{q}^n) = 0. \quad (1)$$

The associated social welfare level can be written

$$W^n(t, \mu) \equiv \mu \left[\bar{q}^n - c(\bar{q}^n) - \frac{t}{12n^2} \right] - nF(\bar{q}^n). \quad (2)$$

The social planner chooses n to maximize $W^n(t, \mu)$. There is a clear tradeoff from raising the number of firms. The presence of fixed costs, by itself, favors fewer firms (ideally, one) serving the market. Consumers' diversity of preferences favors more firms. At one extreme, infinitely many firms could be selected, which would minimize consumers' travel costs, since they will choose the plans with their ideal characteristics. But, as can be seen from (1), the presence of infinitely many firms implies that the quality level will be zero. Throughout the paper, we rule out such an extreme case by assuming that zero quality is sufficiently unattractive to consumers.¹⁶

A comparative statics exercise sheds further light on the determinants of the socially optimal number of firms. An increased preference

15. General sufficient conditions for equal spacing to be socially optimal are not available, but equal spacing is optimal for large and small t . Placing firms too close together drives quality down to zero, which we assume to be undesirable.

16. Alternatively, the sponsor may face an arbitrarily small fixed cost of transacting with each of the chosen firms. In such a case, the optimal number of firms is finite.

for product diversity (i.e., larger t) favors raising the number. At the same time, if preference diversity is sufficiently unimportant (small t), the social optimum requires only one firm to serve the entire group. It is not immediately clear, however, how the size of the group, μ , affects the net gain from increasing the number of firms, since the optimal quality changes with the number of firms. The following proposition makes a relevant observation.

PROPOSITION 1: *The socially optimal number of firms increases with t and μ .*

Proof: See the Appendix. □

We now analyze the equilibrium choices of the sponsor in two formats.

3. INDIVIDUAL-DRIVEN COMPETITION

In individual-driven competition, the sponsor first picks $n \geq 2$ firms to compete for her subscribers. (Optimality requires that n be at least two, since an *ex post* monopolist could extract all surplus from the sponsor.) Throughout the paper, we focus on a symmetric equilibrium where the sponsor picks equally spaced firms. Without loss of generality, we take the locations to be $x_i = i/n$ for $i = 0, \dots, n - 1$. The selected firms next offer their individual plans, (q_i, p_i) , to the consumers, each of whom then chooses his preferred plan. We focus on a symmetric equilibrium where all firms choose the same pair, (q^n, p^n) .

Suppose that all firms except the firm at location 0 choose the pair (q^n, p^n) and that firm 0 offers (q, p) . A consumer located at θ picks plan 0 if $U(q, p; \theta) > U(q_i, p_i; \theta)$ for all $i = 1, 2, \dots, n - 1$. Thus, firm 0 attracts all consumers who strictly prefer its plan to their next-best plan. Formally, firm 0 faces demand $D_0(q, p, q^n, p^n) = \max\{0, \min\{\mu, 2\mu \theta\}\}$, where θ solves

$$\begin{aligned}
 q - \beta(p - \min\{p, p^n\}) - t \hat{\theta}^2 &= q^n - \beta(p^n - \min\{p, p^n\}) \\
 - t \min_{k \in N \cap \{k \leq n/2\}} \left(\frac{k}{n} - \hat{\theta} \right)^2 & \tag{3}
 \end{aligned}$$

The left-hand side represents a type- θ consumer's utility when he selects plan 0, while the right-hand side represents his utility when he selects the best alternative plan. (Recall that the consumer pays the unsubsidized portion of the premium.) $D_0(q, p, q^n, p^n)$ is continuous in

all four arguments¹⁷ and is increasing in $(q, -p, -q^n, p^n)$, with all cross-partial derivatives (or subdifferentials) being zero. It follows that firm 0's profit,

$$\pi_0(q, p, q^n, p^n) \equiv D_0(q, p, q^n, p^n)[p - c(q)] - F(q),$$

is continuous in all four arguments, is supermodular in (q, p) , and exhibits increasing differences in $(q, p; -q^n, p^n)$. The game is therefore *supermodular*, and a pure-strategy Nash equilibrium exists (see Fudenberg and Tirole, 1991, pp. 489–493).

The necessary conditions for the symmetric equilibrium are obtained by setting the derivatives of the profit function equal to zero when $(q, p) = (q^n, p^n)$:

$$\left. \frac{\partial \pi_0(q, p, q^n, p^n)}{\partial q} \right|_{(q,p)=(q^n,p^n)} = \frac{\mu n}{t} [p^n - c(q^n)] - \frac{\mu}{n} c'(q^n) - F'(q^n) = 0, \quad (4)$$

$$\left. \frac{\partial \pi_0(q, p, q^n, p^n)}{\partial p} \right|_{(q,p)=(q^n,p^n)} = \frac{\mu}{n} - \frac{\mu \beta n}{t} [p^n - c(q^n)] = 0. \quad (5)$$

Equation (5) shows that the equilibrium profit margin of each firm is

$$p^n - c(q^n) = \frac{t}{\beta n^2}. \quad (6)$$

To understand the equilibrium quality, substitute (6) into (4) to get

$$\mu \left[\frac{1}{\beta} - c'(q^n) \right] - nF'(q^n) = 0. \quad (7)$$

Comparing (7) with (1) reveals that $q^n \geq \bar{q}^n$, and q^n is decreasing in β . That is, given n , quality is excessive if $\beta < 1$. As β increases, however, the consumers become more sensitive to the premium, as can be seen in (3). In particular, if the sponsor does not absorb any of the premium differential ($\beta = 1$), then $q^n = \bar{q}^n$, which is socially optimal. This last result is in keeping with the insight of Spence (1975): Firms extract all of the marginal type's utility and hence care about that type's gross benefit from quality. Since the marginal benefit of quality is the same for all types in our model, and since consumers face the entire premium

17. This property fails to hold when the travel costs are linear. If firm 0 lowers its price or raises its quality sufficiently, it can increase the quantity demanded in a discontinuous fashion. The discontinuity can upset the existence of a pure-strategy equilibrium.

at the margin when $\beta = 1$, the firms have the correct social incentive for quality in that case.

The real question here is whether the sponsor's private incentive is aligned with the social incentive regarding the choice of β . That is, will the sponsor choose $\beta = 1$, thereby inducing the socially optimal quality level? We address this question next, followed by an examination of the sponsor's choice of the number of firms.

For a given n , the sponsor's utility is

$$v^n(t, \mu; \beta) \equiv \mu \left[q^n - \frac{t}{12n^2} - p^n \right].$$

Substituting (6), the utility can be written as

$$v^n(t, \mu; \beta) \equiv \mu \left[q^n - \frac{t}{12n^2} - \left(c(q^n) + \frac{t}{\beta n^2} \right) \right]. \quad (8)$$

The sponsor maximizes $v^n(t, \mu; \beta)$ by choosing the subsidization parameter β . The intuition for the sponsor's choice can be clearly seen when $\beta = 1$. Differentiating (8) with respect to β , substituting in (7), and evaluating at $\beta = 1$ yields

$$\left. \frac{\partial v^n(t, \mu; \beta)}{\partial \beta} \right|_{\beta=1} = \frac{\mu t}{n^2} + nF'(q^n) \frac{\partial q^n}{\partial \beta}. \quad (9)$$

The sponsor will choose $\beta < 1$, thereby inducing excessive quality, if and only if (9) is negative. The terms in (9) can be explained as follows. The first term accounts for the sponsor's "rent extraction" motive. The sponsor has an incentive to raise the consumers' price sensitivity (i.e., raise β) so as to squeeze the rents accruing to the firms. As is clear from (6), raising β reduces the firms' profit margin. The second term suggests that the sponsor may have the opposite incentive, that is, to raise consumers' (relative) quality sensitivity by lowering β . Additional fixed costs associated with a quality increase does not translate into a price increase. For instance, if the firms all increase quality by one unit, they do not pass on the additional fixed costs to the consumers. So, inducing high quality from the firms (by lowering β) may result in a transfer of surplus to consumers. The second term, which is negative, captures this effect.

How the sponsor will set β depends on the relative magnitudes of the above effects. If t is very high, then the firms' profit margin is high [see (6)], so it pays to make the consumers price-sensitive. In this case, β is likely to equal one, by contrast, if t is very small, the profit margin is already small, so the firms' rents are more effectively

squeezed by making the consumers quality-sensitive. In this case, β is likely to be less than one. The result is formally shown as follows.

PROPOSITION 2: For a given $n \geq 2$, there exists $\hat{t} > 0$ such that quality is excessive if and only if $t < \hat{t}$.

Proof: It follows from (7) that t has no effect on q^n . Therefore, the second term in (9) is negative and does not depend on t . Meanwhile, the first term in (9) is monotonically decreasing in t , and gets arbitrarily small as t goes to zero and arbitrarily large as t goes to infinity. Therefore, when t is sufficiently small, the right-hand side of (9) is negative, so the sponsor picks $\beta < 1$, which entails excessive quality, as argued earlier. \square

We now explore the sponsor's incentives regarding the number of firms. Of special interest is whether the sponsor would pick the number that is (constrained) socially optimal (given that the equilibrium quality results from each choice of n). Such a social criterion is meaningful if the firms cannot be regulated to choose the efficient quality level, as we assume here. Let β^n denote the optimal choice of β for the sponsor. Her utility from choosing n firms is

$$v^n(t, \mu) \equiv \mu \left[q^n - \frac{t}{12n^2} - \left(c(q^n) + \frac{t}{\beta^n n^2} \right) \right]. \quad (10)$$

The associated social welfare level is

$$w^n(t, \mu) \equiv \mu \left[q^n - \frac{t}{12n^2} - c(q^n) \right] - nF(q^n). \quad (11)$$

We now establish that the sponsor has an incentive to select too many firms. The result uses an additional assumption (that is not used elsewhere).

ASSUMPTION 3: $c''(q) - F'(q)/F(q) + n/\mu F''(q) \geq 0$ for all $q \geq 0$.

It holds if either $c(\cdot)$ or $F(\cdot)$ is sufficiently convex.

PROPOSITION 3: Given Assumption 3 (in addition to Assumptions 1 and 2), the sponsor chooses (weakly) more firms than is socially optimal in the individual-driven competition regime.

Proof: In the Appendix. \square

This result shows an important bias that arises when buyers are organized. Since consumers are heterogeneous, competition among the firms does not fully dissipate the rents. These rents decrease as the sponsor increases the number of plans (firms) to compete for the con-

sumers. Therefore, whenever the social planner favors increasing the number of firms, so does the sponsor. In fact, even when social welfare decreases with increasing number of firms, the sponsor may increase the number of firms because the resulting decrease in rents accruing to the firms may outweigh the welfare loss.

4. SPONSOR-DRIVEN COMPETITION

The lack of competitive pressure under individual-driven competition points to the potential desirability of a sponsor who actively negotiates on behalf of members. This section examines the implications of such an increased bargaining ability on the part of the sponsor. Here, we allow the sponsor to screen a set of firms, *based on the plans that they offer*. Specifically, after firms have chosen the terms of their plans, the sponsor picks $n \geq 1$ equally spaced plans to maximize his utility, which equals aggregate gross consumer surplus minus the total payments.

Alternatively, one could imagine a format in which the sponsor simply mandates the desired levels of price and quality from the firms. Such a regulatory approach may not be feasible in practice, however. As we assume, quality comprises various aspects of health services, not all of which are easy to measure objectively, so it is difficult for the sponsor to commit to a level of quality *ex ante*. While price may be easier to regulate *ex ante*, its optimal level may not be known until after the firms actually propose all the terms. Besides, our decentralized mechanism is consistent with the way managed care and managed competition work. We will later point out how such an ability to regulate price can implement the efficient outcome.

The case where the sponsor picks one firm entails a winner-take-all auction, much as under *managed care*, whereas the case where more than one firm is chosen corresponds to *managed competition*.¹⁸ As will be seen, the nature of an equilibrium is qualitatively different for the two cases, so we consider the two cases separately.

4.1 MANAGED CARE: CHOICE OF A SINGLE FIRM

In this regime, all firms offer their plans, and then the sponsor selects a single plan to serve all consumers exclusively. (In case of indifference, the winner is selected randomly.) To determine a subgame perfect equi-

18. While the latter format resembles the individual-driven competition, it is qualitatively distinct in that the *ex ante* selection competition now determines the terms of the plans.

librium, we begin with the last stage. Given the plans, $\{(q_i, p_i)\}$, if the sponsor chooses plan i , she receives utility

$$\begin{aligned} v(q_i, p_i) &\equiv \mu \int_0^1 [q_i - g(\theta, x_i) - p_i] d\theta \\ &= \mu \left[q_i - \frac{t}{12} - p_i \right]. \end{aligned}$$

Note that the location of the winning firm does not matter since the aggregate disutility for consumers is the same no matter which firm is selected. Also, β is irrelevant here, since only one firm is selected. The sponsor picks plan i if $v(q_i, p_i) > v(q_j, p_j)$, for all $j \neq i$.

We now characterize the equilibrium strategy for the winning firm. First, the winning firm must earn zero profit in equilibrium, so if firm i wins, then

$$\mu[p_i - c(q_i)] - F(q_i) = 0.$$

Suppose, to the contrary, that firm i wins with $\mu[p_i - c(q_i)] - F(q_i) > 0$. Firm $j \neq i$ could win by offering the same quality but a slightly lower premium and earn a strictly positive profit, which gives a contradiction. Therefore, profit must be zero in an equilibrium. This zero-profit result differs from the outcome in individual-driven competition, where the heterogeneity of individual preferences gave firms strictly positive rents. The heterogeneity of individual preferences plays no role under the winner-take-all competition that results from managed care.

Next, we show that the winning firm's quality, q , maximizes the sponsor's utility,

$$v\left(q, c(q) + \frac{F(q)}{\mu}\right) = \mu \left[q - \frac{t}{12} - c(q) \right] - F(q), \quad (12)$$

in equilibrium. If the winning firm chooses any other quality, then another firm can offer the utility-maximizing quality, set the premium slightly above its cost, and still win.

Thus, the equilibrium quality satisfies

$$\mu[1 - c'(q^1)] - F'(q^1) = 0. \quad (13)$$

The quality level is clearly efficient: $q^1 = \bar{q}^1$. The sponsor has utility

$$v^{*1}(t, \mu) \equiv \mu \left[\bar{q}^1 - \frac{t}{12} - c(\bar{q}^1) \right] - F(\bar{q}^1). \quad (14)$$

The resulting social welfare level is

$$w^{*1}(t, \mu) = v^{*1}(t, \mu), \quad (15)$$

since the sponsor extracts firms' rents completely.

4.2 MANAGED COMPETITION: CHOICE OF MULTIPLE FIRMS

Here, the sponsor picks $n \geq 2$ equally spaced firms on the basis of their plans. Specifically, the sponsor picks, at each location, a plan that maximizes her utility, given the plans offered by the winning firms at the other $n - 1$ locations.

We now characterize the plan offered in a symmetric equilibrium with n firms. Suppose that all winning firms at locations other than 0 offer the plan (q^n, p^n) and that firm i at location 0 offers (q', p') and is selected in equilibrium. Let θ be the consumer who is indifferent between the firms selected at location 0 and location 1 in equilibrium. Here, we consider a necessary condition for an equilibrium where all n firms are active. Sufficiency of the equilibrium is then straightforward.

We first argue that the sponsor picks a firm that offers the highest index, $\phi(q, p) \equiv q - p$, among all firms in the neighborhood of each location. That is, at each location, the firm that offers the highest quality-premium differential is selected. This can be shown as follows. By assumption, there are many firms arbitrarily close to location zero. Bertrand competition among these firms implies that the winning plan $(q', p') = (q^n, p^n)$ must maximize the sponsor's utility, which equals¹⁹

$$2\mu \int_0^{\hat{\theta}} [q' - p' - t\theta^2] d\theta + 2\mu \int_{\hat{\theta}}^{\min\{3/2n, 1/2\}} \left[q^n - p^n - t \left(\frac{1}{n} - \theta \right)^2 \right] \times d\theta + \text{constant},$$

subject to the constraint that the plan yields at least zero profit:

$$2\hat{\theta}\mu[p' - c(q')] - F(q') \geq 0, \quad (16)$$

where $\hat{\theta}$ is given by equation (3). Any marginal change of (q', p') in the neighborhood of (q, p) may influence θ , but it has no first-order effect on the sponsor's utility. Therefore, the selected plan must maximize $\phi(q', p') = q' - p'$, subject to (16). Substituting in for p' from (16), q' must maximize

19. The first two terms represent the sponsor's utility from the winning plan at location 0 and her utility from the winning plans from the two neighboring locations, respectively. The constant terms represent her utility from winning plans elsewhere, which are fixed when (q', p') are changed slightly.

$$\phi\left(q', c(q') + \frac{F(q')}{2\theta\mu}\right) = q' - c(q') - \frac{F(q')}{2\theta\mu}. \quad (17)$$

In the symmetric equilibrium, $\hat{\theta} = 1/(2n)$, and $d\hat{\theta}/dq = n/(2t)$ from equation (3). Using these results, and differentiating (17) and setting it equal to zero, we find that the equilibrium quality, q^n , satisfies

$$\mu[1 - c'(q^n)] - nF'(q^n) + \frac{n^3}{t}F(q^n) = 0. \quad (18)$$

The first two terms are the same as the left-hand side of (1). The third term is new here. It represents the firm's incentive to steal customers from the neighboring firms. Such opportunistic behavior on the part of the firms is reminiscent of the opportunism found in the context of franchising relationships (O'Brien and Shaffer, 1992; McAfee and Schwartz, 1994). In these models, a single franchiser contracts with a new franchisee in a way that steals customers away from the existing franchisees. Since the contract terms with those existing franchisees were already fixed, the franchiser has an incentive to foster such opportunistic behavior by the new franchisee. A similar opportunism arises here, with the fixed costs as its conduit. The intuition can be explained by Figure 1.

In the figure, the sponsor's indifference curves are represented by 45-degree straight lines (since the sponsor cares about the quality premium differential). The convex curve starting at the origin is the zero-profit, isoprofit curve of the firm located at zero, when *all the other winning firms choose the same quality-premium pair*. A symmetric equilibrium must occur on this curve, since zero profit must hold with all firms offering the same pair. The tangent point E between the isoprofit and the sponsor's indifference curves yields the socially optimal quality level \bar{q}^n , but it cannot be sustained as an equilibrium. The thin curve through E is the firm's isoprofit curve, *when all other firms stick with E* . This new isoprofit curve is flatter, since the premium needed to support a quality above \bar{q}^n is smaller when only that firm raises quality than when all other firms simultaneously raise quality. The reason is that with higher quality, the firm attracts consumers away from neighboring firms, which spreads the fixed cost. Thus, raising quality above \bar{q}^n enables the firm to keep its average cost at a relatively low level, which in turn enables it to offer a relatively attractive premium deal. In particular, the firm can offer a pair A that yields a strictly positive profit for the firm but is also strictly preferable to E for the sponsor. Such an offering creates losses for the neighboring firms, since their average costs must rise. Yet, the sponsor does not internalize such

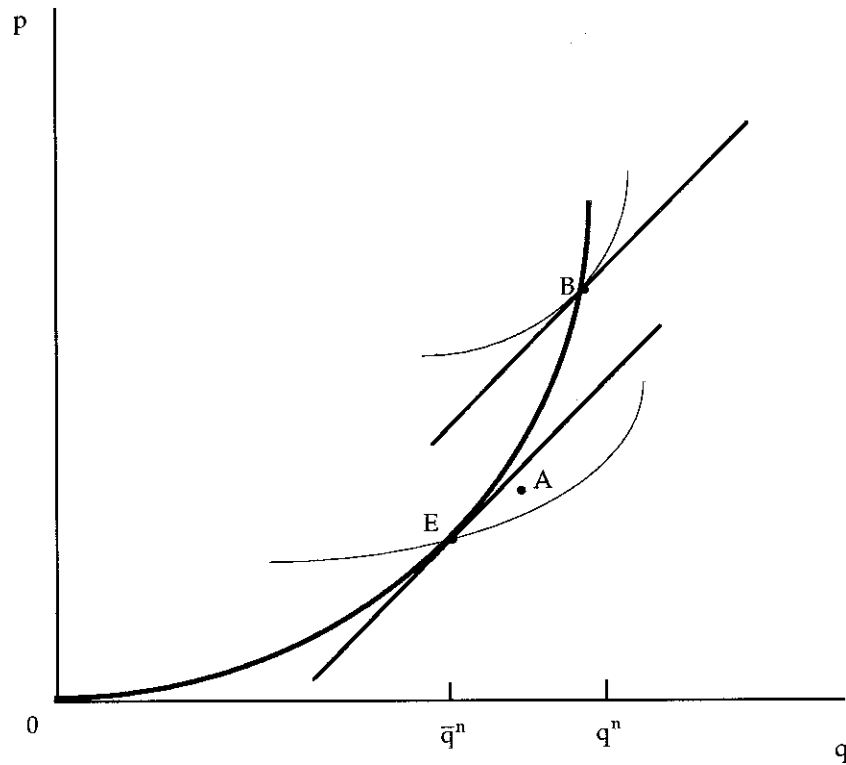


FIGURE 1.

losses, so she simply welcomes the offer. In the symmetric equilibrium, all firms behave in this opportunistic way, so they attract equal shares of the market, but the opportunism results in excessive quality ($q^n > \bar{q}^n$). In the figure, the equilibrium occurs when no additional quality increase is privately beneficial for the firm, i.e., at B, where the associated thin curve is tangent to the sponsor's indifference curve.

The presence of this quality bias means that the sponsor would like to commit to a criterion that penalizes such an opportunistic quality increase. This more sophisticated criterion is difficult to communicate to the firms *ex ante*, and it also requires the sponsor to have the ability to commit *ex ante*. Another way to eliminate excessive quality is for the sponsor to mandate a regulatory price

$$p^R = c(\bar{q}^n) - \frac{nF(\bar{q}^n)}{\mu},$$

which will induce the efficient level of quality \bar{q}^n . As mentioned earlier, such an approach requires that the sponsor know the optimal quality level, which may be difficult in practice. Such an informational requirement is not needed for the managed competition that we considered.

In the symmetric equilibrium, the sponsor's utility is

$$v^{*n}(t, \mu) \equiv \mu \left[q^n - \frac{t}{12n^2} - c(q^n) \right] - nF(q^n).$$

The sharing parameter β has no effect on either the equilibrium quality or the sponsor's utility, so we again set $\beta = 0$. The associated social welfare is $w^{*n}(t, \mu) = v^{*n}(t, \mu)$, so the sponsor picks the socially optimal number of firms, given the equilibrium quality choice. Since the equilibrium quality choice involves a distortion when $n \geq 2$, but not when $n = 1$, the former is less likely to be used than the latter, relative to the first-best environment considered in Section 2. The following proposition summarizes the results.

PROPOSITION 4: *Sponsor-driven competition entails excessive quality under managed competition ($n \geq 2$) but efficient quality under managed care ($n = 1$). Given such quality choices, the sponsor chooses the socially optimal number of plans. Relative to the first-best environment without the quality distortion, managed competition is less often used than managed care.*

5. INDIVIDUAL VS. SPONSOR-DRIVEN COMPETITION

The previous sections have studied the equilibrium quality levels and the number of firms chosen in each format. In particular, excessive quality is shown for sponsor-driven competition with $n \geq 2$, and the possibility is shown for individual-driven competition. We now study the sponsor's preferences for the alternative formats. The following proposition establishes that there exists a bias in favor of sponsor-driven competition.

PROPOSITION 5: *Whenever sponsor-driven competition (with the privately optimal number of firms) is socially preferred to individual-driven competition (with the privately optimal number of firms), the former is chosen by the sponsor.*

Proof: It suffices to show that whenever $w^{*k}(t, \mu) > w^n(t, \mu)$, we have $v^{*k}(t, \mu) > v^n(t, \mu)$. Recall that $v^{*k}(t, \mu) = w^{*k}(t, \mu)$. By contrast, $v^n(t, \mu) \leq w^n(t, \mu)$, since profits are nonnegative in the individual-driven competition regime. The result follows immediately, since

$$v^{*k}(t, \mu) - v^n(t, \mu) \geq w^{*k}(t, \mu) - w^n(t, \mu). \quad \square$$

The intuition behind the result is straightforward. While sponsor-driven competition results in full extraction of rents by the sponsor, individual-driven competition does not. Therefore, whenever the former is socially preferred, it is also privately preferred. Conversely, a socially preferable individual-driven competition regime may not be selected because of the sponsor's failure to capture the firms' profits.²⁰

For instance, it can be shown that the sponsor always prefers sponsor-driven competition with one firm (managed care) to individual-driven competition with two or three firms, regardless of the value of t .²¹ If t is sufficiently large, then the latter outcome is socially preferred to the former outcome (if the quality bias associated with the latter outcome is not too large). Yet, the sponsor always prefers managed care. Inasmuch as a large t favors providing choices to consumers, it means a low price sensitivity and a high profit for the firms in individual-driven competition. In fact, the increased profit margin outweighs the social value of providing choices to the consumers. This argument shows why exclusive dealing can be privately optimal for the sponsor of a buyer alliance but may not be socially desirable. In this situation, it may be socially desirable to limit the sponsor's exclusive contracting ability.²²

6. CONCLUSION

We have studied how the presence of buyer alliances will influence the design of health plans and the structure of competition in the health-care market. An important finding is the effect of the sponsors' role. With sponsors playing a passive role, individual choices alone were shown to place insufficient competitive pressure on the providers, whereas the sponsors' active involvement in the screening of health plans can result in complete extraction of the providers' rents. This finding implies that buyer alliances with active sponsor involvement can indeed make health plans affordable and thus be a vehicle for

20. The individual-driven competition regime can be socially preferable, since quality is excessive under sponsor-driven competition. Quality can also be excessive under individual-driven competition, but not if t is high (see Proposition 2). In this latter circumstance, if the bias in the number of chosen firms is not too big under individual-driven competition, it can be socially preferable to sponsor-driven competition.

21. This point is formally proved in the original version of this paper (see Che and Gale, 1995).

22. The "any willing provider" legislation, for example, permits any health-care provider who is willing to accept the terms of managed care and who can meet specified credentialing criteria to be admitted into the panel. See Simon (1995) for the economic implications of this legislation.

expanding health coverage to a wider segment of the society. At the same time, we recognize that buyer alliances may bring about possible distortions in the quality of health care as well as the intensity of price competition. Specifically, we have identified biases in the choice of sponsors toward too many firms and too much quality.

Our study of buyer alliances represents a first step into an important area of study. For a more comprehensive understanding of their importance in the health-care market, our model must be extended in several areas.

1. *The effects of the tax exemption of employers' contributions.* We have abstracted from the tax-exempt status of employer contributions to employees' health expenses. (Consumers can also pay for health care out of pretax income.) Including the tax-saving effect would make the sponsor face less than the true social cost of raising quality, since purchasing an additional dollar's worth of health care would cost less than a dollar. (Recall that demand for quantity is perfectly inelastic.) Thus, there is a tendency for socially excessive quality, which reinforces the other effects. This tendency is present with both individual-driven and sponsor-driven competition.²³
2. *Persistence in the choice of health plans.* We have studied static competition among plans. In reality, competition is dynamic. Subscribers can switch plans, and firms can change the terms of their plans, as well as the mix of services, over time. As Neipp and Zeckhauser (1985) point out, there could be substantial switching costs associated with reestablishing the patient's medical history and building a new patient-doctor relationship. The presence of switching costs will result in muted competition in the renewal periods. It will also alter the nature of competition among firms. Under individual-driven competition, the marginal consumer's switching costs will determine the intensity of competition. Under sponsor-driven competition, the switching costs of inframarginal consumers will also be important (because competitive pressure comes from the threat of replacement). Our results may therefore be affected if consumers have different switching costs (for example, with marginal consumers having lower switching costs). Also of interest is the validity of the well-known hypothesis of a low introductory price coupled with eventual "price-gouging" (see Klemperer, 1987).
3. *Adverse selection, cream skimming, and dumping.* We abstracted from

23. The working-paper version analyzes the effect of tax exemption and demonstrates the further tendency toward excessive quality choices. See Che and Gale (1995).

the adverse-selection issue in this paper, by assuming that consumers have identical risk. In practice, different consumers have different risks and impose (often dramatically) different costs of health care on the providers. In this situation, providers will have incentives to choose only healthy consumers and to dump high-risk consumers.²⁴ An important benefit from organizing buyer alliances is to circumvent such cream skimming by the providers. By committing to treat all members of alliances the same regardless of their risk types, sponsors of large alliances can make it difficult for the providers to attract only healthy patients. Their success in circumventing cream skimming appears to depend on specific ways in which alliances are organized, however. For example, how many alliances are allowed to exist in a given region, as well as whether enrolment is voluntary or mandatory, will have ramifications for the providers' risk selection abilities.

APPENDIX

We first establish a preliminary lemma.

LEMMA A1: *If $n > k$, then $nF(\bar{q}^n) > kF(\bar{q}^k)$.*

Proof: We show that, for any q such that $nF(q) \leq kF(\bar{q}^k)$, we have $nF'(q) < kF'(\bar{q}^k)$, which will imply that

$$\mu[1 - c'(q)] - nF'(q) > \mu[1 - c'(\bar{q}^k)] - kF'(\bar{q}^k) > 0,$$

since $q < \bar{q}^k$. The above inequality then implies that $nF(\bar{q}^n) > kF(\bar{q}^k)$. To prove the initial hypothesis, suppose, to the contrary, that $nF'(q) \geq kF'(\bar{q}^k)$. Then

$$\frac{F'(q)}{F(q)} \geq \frac{F'(\bar{q}^k)}{F(\bar{q}^k)},$$

which contradicts Assumption 2, since $q < \bar{q}^k$. Thus, we conclude that $nF'(q) < kF'(\bar{q}^k)$, from which the desired result follows. \square

Proof of Proposition 1: Let $n^*(t, \mu)$ denote the socially optimal number of firms, given (t, μ) . First note that t has no effect on the optimal qualities, by (1). Therefore, for all $n > k$, $W^n(t, \mu) - W^n(t, \mu)$ is increasing in t . This shows that $n^*(\cdot, \mu)$ is nondecreasing.

24. For a detailed discussion of cream skimming and dumping, see Ellis (1993), for example.

We now show that $n^*(t, \mu') \geq n^*(t, \mu)$ for $\mu' > \mu$. Let $n \equiv n^*(t, \mu)$. It suffices to show that, for any $k < n$, $W^n(t, \mu) - W^k(t, \mu)$ is increasing in μ , since this implies that $W^n(t, \mu') - W^k(t, \mu') \geq W^n(t, \mu) - W^k(t, \mu) > 0$, implying that $n^*(t, \mu') \geq n$. Using the envelope theorem, we get

$$\frac{\partial[W^n(t, \mu) - W^k(t, \mu)]}{\partial \mu} = \left(\bar{q}^n - c(\bar{q}^n) - \frac{t}{12n^2} \right) - \left(\bar{q}^k - c(\bar{q}^k) - \frac{t}{12k^2} \right).$$

If this expression is nonpositive for any $k < n$, then, by Lemma A1,

$$\begin{aligned} W^n(t, \mu) - W^k(t, \mu) &= \mu \left[\bar{q}^n - c(\bar{q}^n) - \frac{t}{12n^2} \right] - 2F(\bar{q}^n) \\ &\quad - \left\{ \mu \left[\bar{q}^k - c(\bar{q}^k) - \frac{t}{12k^2} \right] - F(\bar{q}^k) \right\} < 0, \end{aligned}$$

contradicting the hypothesis that $n = n^*(t, \mu)$. \square

Proof of Proposition 3: We prove that if $w^n(t, \mu) > w^k(t, \mu)$, then $v^n(t, \mu) > v^k(t, \mu)$, for $n > k$. Suppose, to the contrary, that

$$\begin{aligned} v^n(t, \mu) &= w^n(t, \mu) - \left(\frac{t}{\beta^n n^2} - nF(q^n) \right) \\ &\leq w^k(t, \mu) - \left(\frac{t}{\beta^k k^2} - kF(q^k) \right) \\ &= v^k(t, \mu). \end{aligned}$$

Then, given the hypothesis,

$$\frac{t}{\beta^n n^2} - nF(q^n) > \frac{t}{\beta^k k^2} - kF(q^k). \quad (\text{A1})$$

We consider two cases:

Case 1: $\beta^n \geq \beta^k$. Let q_k^n be the equilibrium quality under the n -firm regime, when the sponsor uses β^k instead of β^n . Then, given Assumption 3, $\beta^n F(q^n) \geq \beta^k F(q_k^n)$ from (7). Now, we show that $nF(q_k^n) \geq kF(q^k)$. For any q such that $nF(q) \geq kF(q^k)$, we have $nF'(q) \leq kF'(q^k)$. Otherwise, $F'(q)/F(q) > F'(q^k)/F(q^k)$, which contradicts Assumption 2, since $q < q^k$. But then, for such q ,

$$\mu \left[\frac{1}{\beta^k} - c'(q) \right] - nF'(q) < \mu \left[\frac{1}{\beta^k} - c'(q^k) \right] - kF'(q^k) = 0,$$

which proves that $nF(q_k^n) \geq kF(q^k)$. Combining the two inequalities, we get

$$\begin{aligned}
\frac{t}{\beta^n n^2} - nF(q^n) &= \frac{1}{\beta^n} \left[\frac{t}{n^2} - \beta^n nF(q^n) \right] \leq \frac{1}{\beta^n} \left[\frac{t}{n^2} - \beta^k nF(q_k^n) \right] \\
&< \frac{1}{\beta^n} \left[\frac{t}{n^2} - \beta^k kF(q^k) \right] < \frac{1}{\beta^n} \left[\frac{t}{k^2} - \beta^k kF(q^k) \right] \\
&\leq \frac{1}{\beta^k} \left[\frac{t}{k^2} - \beta^k kF(q^k) \right] = \frac{t}{\beta^k k^2} - kF(q^k),
\end{aligned}$$

where the first inequality follows from $\beta^n F(q^n) \geq \beta^k F(q_k^n)$, the second from $nF(q_k^n) \geq kF(q^k)$, the third from $n > k$, and the fourth from $\beta^n \geq \beta^k$ and the factor in square brackets is nonnegative, since the expression on the right in the first line represents the industry profits, which are nonnegative in equilibrium. The above result contradicts (A1).

Case 2: $\beta^n < \beta^k$. Suppose that the sponsor chooses β^k instead of β^n in the n -firm regime. Let q_k^n and $w_k^n(t, \mu)$ be the resulting quality and social welfare, respectively. Recall that raising β increases social welfare, so $w_k^n(t, \mu) > w^n(t, \mu)$. Since β^k is not the optimal choice for the sponsor,

$$\begin{aligned}
v^n(t, \mu) &\geq w_k^n(t, \mu) - \left(\frac{t}{\beta^k n^2} - nF(q_k^n) \right) \\
&> w^k(t, \mu) - \left(\frac{t}{\beta^k k^2} - kF(q^k) \right) \\
&= v^k(t, \mu),
\end{aligned}$$

where the second inequality holds because $w_k^n(t, \mu) > w^n(t, \mu) > w^k(t, \mu)$, $n > k$, and $nF(q_k^n) > kF(q^k)$, as shown above. The above inequality contradicts the original hypothesis. \square

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