

A PROPERTY RIGHTS THEORY OF THE FIRM AND MIXED COMPETITION: A COUNTER-EXAMPLE REVISITED

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ABSTRACT

The property rights theory of the firm argues that nonproprietary firms operate inefficiently and can not successfully compete against for profit firms without subsidies, government enforced protection, or some other intervention. Friesner and Rosenman (2001) provided an alternative explanation for the persistence of mixed competition, basing it on preferences of the administrators of nonproprietary firms. If the management of a nonproprietary firm is willing to trade profit and compensation for other goals, the firm can effectively compete in a mixed market. In this note we show that, in general, their model is unstable, thus making it an inadequate explanation for the persistence of mixed competition markets. However, we offer a pair of simple changes to their model that we believe may better reflect market reality, that provides the necessary stability for mixed competition to persist, and discuss how this change alters the policy implications of their original work.

INTRODUCTION

The early analysis of mixed competition generally showed that managers of nonproprietary firms, without a residual claim on the firm's net revenue, instead procure non-pecuniary benefits for themselves or their co-workers in excess of that normally procured by managers of their profit-maximizing counterparts. This re-allocation of resources made nonproprietary firms inefficient, and consequently unable to effectively compete against for-profit firms. Empirical studies of different sectors of the US health care market tended to support this view, including analyses of hospitals (Clarkson, 1972; Friedman and Pauly, 1981;

Bruning and Register, 1989; and Register, Williams and Bruning, 1991), nursing homes (Frech, 1985; Tuckman and Chang, 1988;) and health insurance (Frech, 1976). But Friesner and Rosenman (2001) – henceforth referred to as FR – proposed a model of nonproprietary firm behavior that allowed nonproprietary firms to compete effectively against proprietary firms without subsidy, tax advantage, or other government protection. FR find that, without any protection or subsidies, nonproprietary providers can compete directly with profit-maximizing firms if the nonproprietary management is willing to sacrifice economic profit (or monetary compensation) for other objectives, including higher output, lower prices (to non-government-insured patients) and/or higher quality. That is, the management must be willing to trade monetary compensation for specific types of non-monetary compensation (referred to as an “internal donation” by FR).

In this note we show that, in general, the FR model is unstable because of the second order conditions, thus making it an inadequate explanation for the persistence of mixed competition markets. However, we offer a pair of simple changes to their model that we believe may better reflect market reality, that provides the necessary stability for mixed competition to persist, and discuss how this change alters the policy implications of their original work.

The remainder of this paper proceeds in four steps. First, we briefly review FR's

original model and its solutions. Next, we show that the original model does not generally satisfy stability conditions. Third, we present some possible approaches that provide stable solutions, yet retain the original model's general findings. We conclude the paper by discussing the policy implications of our corrected models, particularly with regard to mixed competition in health care.

THE ORIGINAL FR (2001) MODEL¹

FR describe a health care market that consists of one purely profit-maximizing firm and one nonproprietary firm that values quality and output in addition to profit. These firms compete by treating two distinct groups of patients: insurers for the first group (group i patients) pay the price (or some predetermined portion of the price) charged by providers, while insurers for the second (group j patients) reimburse providers a fixed fee for each service rendered.² Each group has a distinct demand curve which is based on the differences between the prices and qualities offered by each firm. Thus, a firm can increase the demand for its products by either charging a lower price and/or higher quality relative to its competitor. Consequently, the market is fixed – if one firm experiences an increase in the demand for its services, the other must necessarily suffer a decline.

The primary difference between the two patient groups is the provider's ability to control price. Because a provider is reimbursed a fixed payment for treating group j patients, it cannot influence demand by altering its price to these patients.

¹ Our intent in this section is only to briefly sketch FR's (2001) setup. We refer the reader to the original paper for a complete description of the model.

² In their paper, FR (2001) also show that their model can be extended to include multiple firms and multiple patient groups with little loss of generality.

Instead, group j demand is responsive only to changes (relative to its competitor) in quality. On the other hand, the provider can change the price it charges group i patients, making group i's demand a function of both relative prices and qualities. FR assume that consumers, on average, appreciate higher quality. A key aspect of the model is that nonproprietary managers also appreciate higher quality, which enhances the organizational prestige of the firm. As such, management's non-pecuniary benefits are, in part, determined by the quality and quantity of services a nonproprietary firm provides.

More formally the group i demand curve facing each firm is:

$$X_{iN} = a + b(q_{iN} - q_{i.}) - c(P_{iN} - P_{i.}) \quad (1)$$

$$X_{i.} = a - b(q_{iN} - q_{i.}) + c(P_{iN} - P_{i.}) \quad (2)$$

where:

$a > 0$; $b > 0$; $c > 0$

i indexes group i patients;

N indexes the not-for-profit provider;

π indexes the profit-maximizing provider;

q (which is normalized to the nonnegative segment of the real line) represents quality;

P represents the price charged to patients.

The parameter a represents the baseline level of group i demand in the market, while b and c depict how sensitive consumers are to relative changes in price and quality, respectively. Group j demand equations for each firm are defined similarly; except that price is not an argument in these functions:

$$X_{jN} = \alpha + d(q_{jN} - q_{j.}) \quad (3)$$

$$X_{j.} = \alpha - d(q_{jN} - q_{j.}) \quad (4)$$

where:

j indexes the second patient group;

$\alpha > 0$; $d > 0$.

Nonproprietary managers derive benefits from diverting resources away from productive activities. These can be in the form of enhanced quality, greater benefits for employees, or for their own, personal consumption. Since these resources generally do not contribute to a firm's productivity, they are termed "excess, non-productive, non-pecuniary expenditures" and are treated separately from total productive (variable) costs. FR make no constraints on what constitutes non-productive costs. As such, a firm's total (variable) costs can be specified as:

$$TVC_k = TPC_k + TNP_k \quad (5)$$

Or more explicitly as

$$TVC_k = \phi q_{ik} X_{ik} + \psi q_{jk} X_{jk} + \theta q_{ik} q_{jk} + TNP_k \quad (6)$$

where:

$k = N, \pi$;
 $\phi > 0$; $\psi > 0$; $\theta > 0$;
 TPC_k is total expenditures related to production;
 TNP_k represents excess non-productive, non-pecuniary expenses.

Substituting the demand equations into (6) makes it clear that the cost function is quadratic in quality for both patient groups. The positive signs for ϕ , ψ and θ implicitly assume that the firm experiences diseconomies of scale and scope in quality (arising only from productive activities) for each patient group (Panzar and Willig 1977).

The for-profit manager chooses q_i , q_j and P_i to maximize profit:

$$\Pi = P_i X_i + P_j X_j - TPC \quad (7)$$

By definition the for-profit manager automatically sets $TNP_s = 0$. The nonproprietary manager, however, is not concerned solely with profit, and chooses

TNP_N , q_{iN} , q_{jN} and P_{iN} to maximize her utility. The managers utility is a weighted average of quality, output and total excess, non-productive, non-pecuniary spending (or "cash flow"):

$$U = z_1 X_{iN} + z_2 X_{jN} + z_3 q_{iN} + z_4 q_{jN} + (1 - z_1 - z_2 - z_3 - z_4) TNP_N \quad (8)$$

subject to

$$P_{iN} X_{iN} + P_j X_{jN} - TPC_N - TNP_N = 0 \quad (9)$$

where:

z_i , $i = 1, \dots, 4$ are the weights for each argument in the utility function ($0 \leq z_i \leq 1$);
 P_j is the price the provider receives for treating group j patients.

By substitution, decision-maker chooses q_{iN} , q_{jN} and P_{iN} to maximize the following function:

$$U = z_1 X_{iN} + z_2 X_{jN} + z_3 q_{iN} + z_4 q_{jN} + (1 - z_1 - z_2 - z_3 - z_4) (P_{iN} X_{iN} + P_j X_{jN} - TPC_N) \quad (10)$$

A critical assumption is that TNP_N is non-negative. The firm may or may not earn positive economic profit but it always earns enough cash flow to cover its expenses, including TNP_N .

The model eliminates the traditional explanations of mixed competition – targeting a market residual for a customer base, subsidies from government or other sources, differential cost structures, a nonproprietary firm that fully mimics a for-profit entity (which would in fact be the case if $z_1 = z_2 = z_3 = z_4 = 0$), or collusion between the two firms.

Because quantity demanded depends on the relative nature of the model, FR solve it by taking the first order conditions for

both firms and using that information to solve for the optimal differences between each firm's price (to group i patients) and qualities. The firm that offers a lower price and/or higher quality to each group dominates that segment of the market, along with the net revenue gained from treating those patients. As shown in the appendix, FR derive the following equilibrium values:

$$(P_{iN} - P_{i\pi})^* = - \left[\frac{c\theta^2}{\psi d(2b + \phi c)} + \frac{2(b - \phi c)^2}{2b + \phi c} \right]^{-1} \left(\frac{2z_1 b(b - \phi c)}{(2b + \phi c)z_5} + \frac{z_1 c \theta^2}{3\psi d(2b + \phi c)z_5} + \frac{z_3}{z_5} - \frac{\theta(z_2 d + z_4)}{3\psi d z_5} \right) \quad (11)$$

$$(q_{iN} - q_{i\pi})^* = - \left[\frac{\theta^2}{3\psi d} + \frac{2(b - \phi c)^2}{3c} \right]^{-1} \left(\frac{2z_1(b - \phi c)}{3z_5} + \frac{z_3}{z_5} - \frac{\theta(z_2 d + z_4)}{3\psi d z_5} \right) \quad (12)$$

$$(q_{jN} - q_{j\pi})^* = \left[\frac{2\psi d(b - \phi c)^2}{c\theta} + \theta \right]^{-1} \left(\frac{2z_1(b - \phi c)}{3z_5} + \frac{z_3}{z_5} + \frac{2(b - \phi c)^2(z_2 d + z_4)}{3c\theta z_5} \right) \quad (13)$$

where: $z_5 = 1 - z_1 - z_2 - z_3 - z_4$

Clearly, which firm charges a lower price and offers higher quality to each patient group depends on the relative weights of the nonproprietary, as well as the marginal

profitability of treating group i patients ($b - \phi c$).

CHECKING THE GENERALIZABILITY OF THE FR (2001) MODEL

At issue is whether FR's model violates second-order stability conditions. Taking the second order partial derivatives for the for-profit firm (noting that the second-order partials for the nonproprietary firm are identical to the ones presented below) we find that:

$$\begin{aligned} \frac{\partial^2 \Pi}{\partial P_{i\pi}^2} &= -2c < 0; \\ \frac{\partial^2 \Pi}{\partial P_{i\pi} \partial q_{i\pi}} &= b + \phi c > 0; \\ \frac{\partial^2 \Pi}{\partial P_{i\pi} \partial q_{j\pi}} &= 0; \end{aligned}$$

$$\begin{aligned} \frac{\partial^2 \Pi}{\partial q_{i\pi} \partial P_{i\pi}} &= b + \phi c > 0; \\ \frac{\partial^2 \Pi}{\partial q_{i\pi}^2} &= -2\phi b < 0; \\ \frac{\partial^2 \Pi}{\partial q_{i\pi} \partial q_{j\pi}} &= -\theta < 0; \\ \frac{\partial^2 \Pi}{\partial q_{j\pi} \partial P_{i\pi}} &= 0; \end{aligned}$$

$$\begin{aligned} \frac{\partial^2 \Pi}{\partial q_{j\pi} \partial q_{i\pi}} &= -\theta < 0; \\ \frac{\partial^2 \Pi}{\partial q_{j\pi}^2} &= -2\psi d < 0 \end{aligned}$$

which, in matrix form is given by:

$$\begin{bmatrix} -2c & b + \phi c & 0 \\ b + \phi c & -2\phi b & -\theta \\ 0 & -\theta & -2\psi d \end{bmatrix} \quad (14)$$

For each firm's problem to represent a maximum, this matrix must be negative semi-definite. This implies that the determinants of the first, second and third principle minors of (14) must be negative, positive, and negative, respectively. These principal minors are given by:

$$D^1 = -2c < 0 \quad (15)$$

$$D^2 = 4\phi bc - (b + \phi c)^2 = -(b - \phi c)^2 < 0 \quad (16)$$

$$D^3 = -8\phi b\psi dc + 2\psi d(b + \phi c)^2 + 2c\theta^2 = 2\psi d(b - \phi c)^2 + 2c\theta^2 > 0 \quad (17)$$

Clearly, the determinants for two of the three principal minors do not satisfy the second order conditions for a maximum. The instability of the model's solutions come from two sources. The first, as evidenced by (16), is that there is an unstable feedback between group i price and quality. Most likely, this is due to the fact that the demand curves are linear and separable in price and quality for this group. The second, as evidenced by (17), is that there is a lack of feedback between group i price and group j quality.

A PROPOSED CORRECTION

Having demonstrated the shortcomings in the original model, it is interesting to consider how to correct the original model, yet retain the model's parsimony and its policy implications. One obvious way to do so would be to allow for feedback between the demand curves, particularly between group i price and both qualities. However, in all likelihood, this would destroy any parsimony in the model, as the demand curves would become quadratic, while cost curves and utilities would be cubic. In addition, the first order conditions would be quadratic, and thus much more difficult (if not impossible) to solve. As a result, we ignore this possibility,

since doing so would require a major reconfiguration of the original model.

A simpler and possibly more realistic way to proceed is to make the assumption that neither firm quality discriminates, so $q_i = q_j$. Under this assumption, the demand conditions reduce to:

$$X_{iN} = a + b(q_N - q_i) - c(P_N - P_i) \quad (1a)$$

$$X_i = a - b(q_N - q_i) + c(P_N - P_i) \quad (2a)$$

$$X_{jN} = \alpha + d(q_N - q_j) \quad (3a)$$

$$X_j = \alpha - d(q_N - q_j); \quad (4a)$$

where all previous definitions and parameter restrictions apply. Similarly, the cost functions reduce to:

$$TVC_k = \phi q_k X_{ik} + \psi q_k X_{jk} + TNP_k \quad (6a)$$

where $k = N, \pi$; $\phi > 0$; $\psi > 0$.

Since firms do not quality discriminate, scope issues are irrelevant and the term involving θ has been removed from (6a). Thus, the nonproprietary firm's utility function reduces to

$$U = z_1 X_{iN} + z_2 X_{jN} + z_3 q_N + (1 - z_1 - z_2 - z_3)(P_{iN} X_{iN} + P_j X_{jN} - TPC_N) \quad (10a)$$

The first order conditions of the for-profit's utility function are:

$$\begin{aligned} \frac{\partial \Pi}{\partial P_{i\pi}} &= a + bq_{\pi} - bq_N \\ &+ cP_{iN} - 2cP_{i\pi} + \phi cq_{\pi} = 0 \end{aligned} \quad (18)$$

$$\begin{aligned} \frac{\partial \Pi}{\partial q_\pi} &= bP_{i\pi} - \phi a - 2\phi b q_\pi + \phi b q_N \\ &- \phi c P_{iN} + \phi c P_{i\pi} + dP_j - \psi \alpha \\ &- 2\psi d q_\pi + \psi d q_N = 0 \end{aligned} \quad (19)$$

The first order conditions for the nonproprietary provider are:

$$\begin{aligned} \frac{\partial U}{\partial P_{i\pi}} &= -z_1 c + (1 - z_1 - z_2 - z_3) \\ (a + b q_\pi - b q_N + c P_{iN} - 2c P_{i\pi} + \phi c q_\pi) &= 0 \end{aligned} \quad (20)$$

$$\frac{\partial U}{\partial q_\pi} = z_1 b + z_2 d + z_3$$

The second order conditions for this new, profit-maximizing problem (again, the NFP's problem is identical) are given by:

$$\frac{\partial^2 \Pi}{\partial P_{i\pi}^2} = -2c < 0;$$

$$\frac{\partial^2 \Pi}{\partial P_{i\pi} \partial q_\pi} = b + \phi c > 0;$$

$$\begin{aligned} \frac{\partial^2 \Pi}{\partial q_\pi^2} &= b + \phi c > 0; \\ \frac{\partial^2 \Pi}{\partial q_\pi^2} &= -2(\phi b + \psi d) < 0; \end{aligned}$$

while the stability condition is given by:

$$\begin{aligned} D &= 4(\phi b + \psi d) - (b + \phi c)^2 \\ &= 4c\psi d - (b - \phi c)^2 \end{aligned} \quad (22)$$

which is positive (thus, along with the negative own-second partials guaranteeing a maximum) so long as the first term is larger in magnitude than the second term.

Using the same methodology outlined in the original version of the paper, the model's (differenced) solution is:

$$\begin{aligned} (P_{iN} - P_{i\pi})^* &= - \left(\frac{z_1}{1 - z_1 - z_2 - z_3} \right) \\ &\left(\frac{2b(b - \phi c) - \psi dc}{2(b - \phi c)^2 - 3\psi dc} \right) - \left(\frac{z_2 d + z_3}{1 - z_1 - z_2 - z_3} \right) \\ &\left(\frac{2b + \phi c}{2(b - \phi c)^2 - 3\psi dc} \right) \end{aligned} \quad (23)$$

$$(q_N - q_\pi)^* = - \left(\frac{3c}{2(b - \phi c)^2 - 3\psi dc} \right) \left[\left(\frac{z_1}{1 - z_1 - z_2 - z_3} \right) \left(\frac{2(b - \phi c)}{3} \right) + \left(\frac{z_2 d + z_3}{1 - z_1 - z_2 - z_3} \right) \right] \quad (24)$$

These solutions are similar to FR's, with two exceptions. First, with no quality discrimination, economies of scope are irrelevant, so any term from the original solution containing θ is no longer present in the new solution. Second, and unlike the original model, our restriction creates a tradeoff between each of the patient groups (as well as between group i price and group i quality). Specifically, if a provider uses a higher group i price to finance higher group i quality, it must now offer that same high quality to group j patients as well. This implies that group i patients are subsidizing

group j patients, thereby increasing (since firms are experiencing diseconomies of scale) costs in a disproportionate fashion.³ The disproportionate increase in costs from this price increase is represented by the $-3\psi dc$ term in the denominator of (23), as well as the presence of $-\psi dc$ in the numerator of the first term in this expression. The net result is a decrease in the marginal profitability of using group i prices to capture more group i patients. More importantly, it is this feedback that makes the corrected model's solution stable.

Equations (23) and (24) also allow us to make some inferences about the outcome of mixed competition. In general, the signs of these equations are ambiguous, and depend on the relative magnitudes of the model's parameters. However, we can identify some conditions under which the nonproprietary firm is either successful or unsuccessful at dominating the market (or portions of the market). First, suppose that the term $2(b - \phi c)^2 - 3\psi dc$ is negative. Then if the firm values group j output and quality (so that z_2 and z_3 are disproportionately large and z_1 is close to zero), then (23) and (24) are both positive, indicating that the nonproprietary firm survives by charging a higher price and offering a higher quality than its competitor, thus segmented the market. Similarly, if $2(b - \phi c)^2 - 3\psi dc$ is positive and the firm values z_2 and z_3 sufficiently more than z_1 , then the (23) and (24) are negative, and the nonproprietary serves the low price, low quality end of the market (and the profit maximizing firm serves the higher end of the market).⁴

³ The health economics literature has defined this activity as "cost adjusting". See Friesner (2002) or Friesner and Rosenman (2004) for a discussion of this issue.

⁴ We follow FR (2001) and assume that, if there is market segmentation, that the market segments are large enough to allow both firms to earn zero economic profit, so that both firms continue operations.

Concomitantly, suppose that the nonproprietary values group i output sufficiently more than quality or group j 's output (so that z_1 carries a very high value compared to z_2 and z_3). In this case market dominance becomes much more ambiguous, since it also depends on the sign of $b - \phi c$ (the marginal profitability of treating group i patients without accounting for quality subsidization), as well as the sign of $2b(b - \phi c) - \psi dc$ (the same marginal probability accounting for this subsidization). The intuition behind this finding is that, when competing for group i patients, the magnitude of the marginal profitability of treating group i patients compared to the magnitude of the quality subsidization "drain" on group i profitability becomes much more important in determining the outcome of competition.

The proposed correction makes only one additional assumption, which many health care experts would argue is appropriate and, thus, innocuous. However, a drawback is that eliminates the inclusion of (dis)economies of scope in quality. If one were interested in adapting the model to incorporate diseconomies of scope, one can instead make firms price takers in the private payer market as well as in the government market. It is not necessary that $P_{iN} = P_{i}$, only that they are exogenous to the firm. As shown in Appendix B, the results of this modification are behavioral solutions such that:

$$(q_{iN} - q_{i\pi})^* = \left(\frac{z_1 b + z_3}{1 - z_1 - z_2 - z_3 - z_4} \right) \left(\frac{3\psi d}{9\phi b \psi d - \theta^2} \right) - \left(\frac{z_2 d + z_4}{1 - z_1 - z_2 - z_3 - z_4} \right) \left(\frac{\theta}{9\phi b \psi d - \theta^2} \right) \quad (25)$$

and

$$(q_{jN} - q_{j\pi})^* = - \left(\frac{z_1 b + z_3}{1 - z_1 - z_2 - z_3 - z_4} \right) \left(\frac{\theta}{9\phi b \psi d - \theta^2} \right) + \left(\frac{z_2 d + z_4}{1 - z_1 - z_2 - z_3 - z_4} \right) \left(\frac{3\phi b}{9\phi b \psi d - \theta^2} \right) \quad (26)$$

The second order conditions indicate that the expression $9\phi b \psi d - \theta^2$ must be positive for a solution to exist. This implies that (25) and (26) are likely of opposite sign, so that the two firms again likely segment the market.⁵ Depending on the nonproprietary firm's utility weights, one firm dominates the group i portion of the market offering higher quality to these patients, and one firm dominates the group j portion market by offering a higher value for q_j .

While the price for treating each patient group does not determine how the market is segmented, prices do determine the gains from segmenting the market. That is, the revenue (or cash flow) generated from treating a segment of the market is determined in part by the price the firm receives for its services. So if different payers reimburse different amounts, the financial success of the nonproprietary firm is determined by its utility weights. A nonproprietary firm that places more weight on group i patients (represented by the utility weights z_1 and z_3) will capture the majority of group i patients in the market. If the group i insurer reimburses more generously than the group j insurer (holding all else constant), the firm will obtain a

⁵ We cannot make this statement with perfect certainty because we have not specified the relative sizes of the utility weights (or the demand and cost parameters). However, if the nonproprietary's utility weights are sufficiently skewed toward one group or another, then one can say with perfect certainty that market segmentation occurs.

higher utility than if the firm places more weight on group j patients (z_2 and z_4).

Similarly, the parameters a and α do not affect which market segment each firm takes, but they do impact the gains received from capturing a particular market segment. Holding other factors constant (including price), these parameters represent the size of the market for each patient group. Larger values for either parameter indicate that there are more patients that the firm is able to treat, and thus more revenue than can be generated from that market segment. Thus, firms that cater to (or capture) a larger segment of the market will be more successful at increasing either profit or utility.

CONCLUSIONS AND POLICY IMPLICATIONS

We provide a corrected model that supports the primary conclusions FR found – that in the absence of barriers to entry, outside revenue or economies of scope or scale it is still possible for not-for-profit firms to compete in the same market as for-profit firms. We preserve the two necessary conditions that FR found for mixed competition; that not-for-profit firms need to make a positive cash flow while earning a below normal return to investment and that the goals of the not-for-profit firm with respect to the mix of price and quality, as represented by the manager's objective, needs to closely match those of the consumers in the market. In the absence of this match, if facing increased competition by for-profit firms a non-for-profit will need to put more emphasis on profit (to match the efficiency of production and costs) or increase quality to attract a greater share of the market.

These last two points are significant. Not-for-profit hospitals often have community boards appointed specifically to represent the interests of the service population, contrasted to for-profit boards who represent the interests of the shareholders. If a not-for-profit is to thrive, it is important that the community board provide a fair representation of the demand side of the market.

rights alone will not drive out not-for-profit firms.

Another important finding is that mixed competition should result in market-segmentation. With two types of patients (government and non-government insured), for-profit firms end up being the primary service provider for one group, while not-for-profits are the primary service provider of the other – which serving which depends on the elasticity of demands for quality. For example, the managed care market is almost evenly split between for-profit (53% of the market) and not-for-profit firms (AIS, 2004). But as shown in Table 1, the Medicare managed care market is dominated by for-profit companies. Excluding the Kaiser Foundation Health Plan, which popularized HMOs in the post-WWII era, only two of the top ten Medicare Managed Care firms are not-for-profit, and both of the not-for-profit firms are in Pennsylvania. Meanwhile seven of the largest firms in the commercial managed care market are non-profit. And Kaiser Foundation Health Plan, the largest managed care in both groups, is the only firm common to both lists.

At the same time, the same cautions that applied to FR should apply here. Our model uses a very simplified structure of costs and demand. We remove the possibility of any philanthropic effort and tax benefits when in fact those do exist. Similarly, we do not allow for economies of scope and scale, both of which may be facts in the health care industries. These reasons alone may explain mixed competition, despite our ability to show that property

Appendix A: Derivation of the FONC from the FR Model

The necessary first order conditions for the profit-maximizing firm are:

$$\begin{aligned} \frac{\partial \Pi}{\partial P_{i\pi}} &= a + bq_{i\pi} - bq_{iN} + cP_{iN} \\ -2cP_{i\pi} + \phi cq_{i\pi} &= 0 \end{aligned} \quad (A1)$$

$$\begin{aligned} \frac{\partial \Pi}{\partial q_{i\pi}} &= bP_{i\pi} - \phi a - 2\phi bq_{i\pi} + \phi bq_{iN} \\ -\phi cP_{iN} + \phi cP_{i\pi} - \theta q_{j\pi} &= 0 \end{aligned} \quad (A2)$$

$$\begin{aligned} \frac{\partial \Pi}{\partial q_{j\pi}} &= dP_j - \psi \alpha - 2\psi dq_{j\pi} \\ +\psi dq_{jN} - \theta q_{i\pi} &= 0 \end{aligned} \quad (A3)$$

The nonproprietary's first order conditions are:

$$\begin{aligned} \frac{\partial U}{\partial P_{iN}} &= -z_1 c + (1 - z_1 - z_2 - z_3 - z_4) \\ (a + bq_{iN} - bq_{i\pi} + cP_{i\pi} \\ -2cP_{iN} + \phi cq_{iN}) &= 0 \end{aligned} \quad (A4)$$

$$\begin{aligned} \frac{\partial U}{\partial q_{iN}} &= z_1 b + z_3 + (1 - z_1 - z_2 - z_3 - z_4) \\ (bP_{iN} - \phi a - 2\phi bq_{iN} + \phi bq_{i\pi} \\ -\phi cP_{i\pi} + \phi cP_{iN} - \theta q_{jN}) &= 0 \end{aligned} \quad (A5)$$

$$\begin{aligned} \frac{\partial U}{\partial q_{jN}} &= z_2 d + z_4 + (1 - z_1 - z_2 - z_3 - z_4) \\ (dP_j - \psi \alpha - 2\psi dq_{jN} + \psi dq_{j\pi} - \theta q_{iN}) &= 0 \end{aligned} \quad (A6)$$

Combining and solving these conditions for the optimal differences yields:

$$(P_{iN} - P_{i\pi})^* = - \left[\frac{c\theta^2}{\psi d(2b + \phi c)} + \frac{2(b - \phi c)^2}{2b + \phi c} \right]^{-1} \left(\frac{2z_1 b(b - \phi c)}{(2b + \phi c)z_5} + \frac{z_1 c\theta^2}{3\psi d(2b + \phi c)z_5} + \frac{z_3}{z_5} - \frac{\theta(z_2 d + z_4)}{3\psi d z_5} \right) \quad (A7)$$

$$(q_{iN} - q_{i\pi})^* = - \left[\frac{\theta^2}{3\psi d} + \frac{2(b - \phi c)^2}{3c} \right]^{-1} \left(\frac{2z_1(b - \phi c)}{3z_5} + \frac{z_3}{z_5} - \frac{\theta(z_2 d + z_4)}{3\psi d z_5} \right) \quad (A8)$$

$$(q_{jN} - q_{j\pi})^* = \left[\frac{2\psi d(b - \phi c)^2}{c\theta} + \theta \right]^{-1} \left(\frac{2z_1(b - \phi c)}{3z_5} + \frac{z_3}{z_5} + \frac{2(b - \phi c)^2(z_2 d + z_4)}{3c\theta z_5} \right) \quad (A9)$$

where: $\frac{z_3}{z_5} = 1 - z_1 - z_2 - z_3 - z_4$

Clearly, which firm charges a lower price and offers higher quality to each patient group depends on the relative weights of the the nonproprietary, as well as the marginal profitability of treating group i patients ($b - \phi c$).

Appendix B: Solution to the Price Taker Model

The result of this modification is also market segmentation. For convenience we retain the notation from the original paper, except that P_{iN} and $P_{i\pi}$ are now treated as exogenous. The first order conditions for profit-maximization are:

$$\frac{\partial \Pi}{\partial q_{i\pi}} = bP_{i\pi} - \phi\alpha - 2\phi b q_{i\pi} + \phi b q_{iN} \quad (B1)$$

$$-\phi c P_{iN} + \phi c P_{i\pi} - \theta q_{j\pi} = 0$$

$$\frac{\partial \Pi}{\partial q_{j\pi}} = dP_j - \psi\alpha - 2\psi d q_{j\pi} \quad (B2)$$

$$+\psi d q_{jN} - \theta q_{i\pi} = 0$$

The first order conditions for the not-for-profit provider are:

$$\frac{\partial U}{\partial q_{iN}} = z_1 b + z_3 + (1 - z_1 - z_2 - z_3 - z_4)(bP_{iN} - \phi\alpha - 2\phi b q_{iN} + \phi b q_{i\pi} - \phi c P_{i\pi} + \phi c P_{iN} - \theta q_{jN}) = 0 \quad (B3)$$

$$\frac{\partial U}{\partial q_{jN}} = z_2 d + z_4 + (1 - z_1 - z_2 - z_3 - z_4)(dP_j - \psi\alpha - 2\psi d q_{jN} + \psi d q_{j\pi} - \theta q_{iN}) = 0 \quad (B7)$$

The second order conditions for this new, profit-maximizing problem (again, the NFP's problem is identical) are given by:

$$\frac{\partial^2 \Pi}{\partial q_{i\pi}^2} = -2\phi b < 0;$$

$$\frac{\partial^2 \Pi}{\partial q_{i\pi} \partial q_{j\pi}} = -\theta < 0;$$

$$\frac{\partial^2 \Pi}{\partial q_{j\pi}^2} = -2\psi d < 0;$$

$$\frac{\partial^2 \Pi}{\partial q_{i\pi}^2} = -2\psi d < 0$$

while the stability condition is given by:

$$D = 4\phi b \psi d - \theta^2 \quad (B5)$$

which is positive (thus, along with the negative own-second partials guaranteeing a maximum) so long as the first term is larger in magnitude than the second term.

Thus, the optimal, differenced solutions are given by:

$$(q_{iN} - q_{i\pi})^* = \left(\frac{z_1 b + z_3}{1 - z_1 - z_2 - z_3 - z_4} \right) \left(\frac{3\psi d}{9\phi b \psi d - \theta^2} \right) - \left(\frac{z_2 d + z_4}{1 - z_1 - z_2 - z_3 - z_4} \right) \left(\frac{\theta}{9\phi b \psi d - \theta^2} \right) \quad (B6)$$

$$(q_{jN} - q_{j\pi})^* = - \left(\frac{z_1 b + z_3}{1 - z_1 - z_2 - z_3 - z_4} \right) \left(\frac{3\phi b}{9\phi b \psi d - \theta^2} \right) + \left(\frac{z_2 d + z_4}{1 - z_1 - z_2 - z_3 - z_4} \right) \left(\frac{\theta}{9\phi b \psi d - \theta^2} \right)$$

The second order conditions indicate that the expression $9\phi b \psi d - \theta^2$ must be positive for a solution to exist. This implies that (30) and (31) are likely of opposite sign, so that the two firms again likely segment the market.⁶ Depending on the nonproprietary firm's utility weights, one firm dominates the group i portion of the market offering higher quality to these patients, and one firm dominates the group j portion market by offering a higher value for q_j .

⁶ See footnote 5 for a caveat to this discussion.

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Table 1: Managed Care Enrollments

Managed Care Organization	Medicare Enrollment		Managed Care Organization	Commercial Enrollment	
Kaiser Foundation Health Plan, Inc.	641,494	non-profit	Kaiser Foundation Health Plan, Inc.	5,701,562	non-profit
PacifiCare of California, Inc.	386,100	for-profit	Blue Cross of California	1,358,244	for-profit
Humana Medical Plan of Florida, Inc.	225,148	for-profit	PacifiCare of California, Inc.	1,330,000	for-profit
Highmark Blue Cross Blue Shield	188,639	non-profit	Blue Cross Blue Shield of Massachusetts	970,000	non-profit
Independence Blue Cross	160,733	non-profit	Blue Cross and Blue Shield of Illinois	905,000	non-profit
CIGNA HealthCare of Arizona, Inc.	116,457	for-profit	Blue Cross and Blue Shield of Florida, Inc.	693,441	non-profit
HIP Health Plan of New York, Inc.	105,419	for-profit	Harvard Pilgrim Health Care, Inc.	677,201	non-profit
Health Net of California, Inc.	101,000	for-profit	Blue Shield of California	609,909	non-profit
PacifiCare of Texas, Inc.	100,400	for-profit	Independence Blue Cross	539,792	non-profit
PacifiCare of Arizona, Inc.	88,400	for-profit	Blue Cross Blue Shield of Georgia	527,638	for-profit