GAMES OF SURVIVAL IN THE NEWSPAPER INDUSTRY

by

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1. Introduction.

Since 1958 the number of United States cities with competing central-city newspapers had dwindled from 70 to 19. This evident drift toward monopoly has provoked public concern over the loss of independent editorial voices. Economically, it raises important questions about what cost structures can mandate a "natural monopoly" and how rival firms in small-numbers markets behave when structural conditions favor a monopoly equilibrium in the long run. The general properties of newspapers' cost structures are well known from Rosse's important research.[1] What has not been explored systematically is the rivalrous behavior of two or three sellers in a market where monopoly profits may substantially exceed those of duopoly or triopoly.

A newspaper is an economically complex firm that sells information to readers and readers' attention to advertisers. (In the second section of this paper we set forth the formal optimizing conditions for a single newspaper.) In each of these roles the central-city newspaper faces many competitors, and monopolistic competition is clearly the general model applicable to the markets both for media of information and entertainment and for advertising messages. However, central-city newspapers are in what Rosse (1967) called "isolated competition" within these general market structures. Most readers and advertisers, we assume, regard competing central-city newspapers as better substitutes for each other than for other media. Therefore, newspapers' rivalry can be assumed to take place in a distinct market segment. In the third section of this paper we model this rivalry in terms of a seller's choice between sharing duopoly profits and investing resources to make a rival leave the market. Then we present an econometric model of the demand for and pricing of central-city newspaper advertisements and circulation, to test the implications of our models of decision-making by the single newspaper and games of survival among small-numbers rivals.

2. The Single Newspaper Firm.

In this section we derive the first-order conditions for profit-maximization by a single newspaper making use of the several instruments at its command. The resulting first-order conditions give rise to the system of estimating equations used in Section 4. The newspaper firm is modeled here as a monopolistic competitor that faces downward sloping ceteris paribus demand curves for both circulation and advertising. Our model is developed from Corden's (1952-53; also Reddaway, 1963) pioneering exposition of the unusual relationship between the newspaper's circulation and advertising functions, which stands out most clearly if we initially assume that the newspaper's circulation price per copy is fixed (by convention, perhaps) while its other policy instruments are adjusted to optimal values. Then we set out the first-order conditions that result when the circulation price is also variable.

2.1 Circulation and Editorial Quality

We define the following variables:

R_c = revenue generated from circulation

q_c = circulation or quantity of copies

p_c = price per copy (assumed fixed).

Then $R_c = p_c q_c$. Let the demand for newspapers q_c^d depend on the quality of the paper, where "quality" is determined solely by monetary expenditures on reporting, editorial staff, etc. The usual assumption of diminishing marginal returns to expenditures is made. Denoting these expenditures on quality by e, we have:

$$q_c^d = q_c^d(e), \quad e > 0, \quad .. \quad q_c^d(0) = 0$$

(A1)

$$\frac{d}{de}(q_c^d) > 0, \qquad \frac{d^2}{de^2}(q_c^d) < 0 .$$

The costs due to circulation may be broken down into three components: a fixed cost, F_c; a cost that increases in proportion to circulation, $V_c q_c$; and expenditures e which affect circulation demand. Let f denote the inverse demand function for circulation. Then total costs as a function of circulation are:

$$TC_c = F_c + V_c q_c + f(q_c) . \tag{1}$$

From assumption (A1), we have the fact that f' > 0 and f" > 0 thus f is convex and monotonically increasing. Average costs are:

$$AC_c = \frac{F_c}{q_c} + V_c + \frac{f(q_c)}{q_c} . \tag{2}$$

The slope of the average cost curve is then:

$$\frac{d}{dq_c}(AC_c) = \frac{1}{q_c^2}\left[(q_c f' - f) - F_c\right] . \tag{3}$$

Since f is convex we know that $f' > f/q_c$ or $q_c f' - f > 0$ so that the sign of the average cost curve's slope depends on how large the fixed cost F_c is relative to $(q_c f' - f)$. Note that for relatively large fixed costs, the average cost curve is initially downward-sloping, but as q_c increases the slope will become positive since $(q_c f' - f)$ is strictly increasing in q_c and unbounded from above. This then gives us the usual U-shaped average cost curve.

If circulation were the only activity of the newspaper firm, profit-maximization would yield:

$$p_c - V_c = f'(q_c^*) \tag{4a}$$

and

$$e^* = f(q_c^*) \; . \tag{4b}$$

If the average-cost curve is assumed to be U-shaped, we have the equilibrium shown in Figure 1.

INSERT FIGURE 1 HERE.

2.2 Advertising Demand and Price.

We now incorporate the newspaper's pricing of advertising messages, defining the following variables:

R_a = revenue generated from advertising

q_a = quantity of lines of advertisement per copy

p_a = price per line of advertisement.

Because the firm has some monopoly power in this market, we let q_a^d be a function of price p_a. We also suppose that advertising demand is related to the newspaper's circulation, q_c, a higher circulation inducing a larger demand for advertising linage. Thus we assume:

$$\text{(A2)} \qquad q_a^d = q_a^d(p_a,\ q_c),\ \frac{d}{dq_c}\,(q_a^d) > 0,\ \frac{d}{dp_a}\,(q_a^d) < 0 \; .$$

Advertising revenues R_a are then $p_a q_a(p_a,\ q_c)$.

The cost associated with any level of advertisement is a combination of some fixed costs F_a and a charge V_a that is proportional to the lines of advertisement per copy. Total and average costs are then:

$$TC_a = F_a + V_a q_a q_c \tag{5a}$$

$$AC_a = \frac{F_a}{q_a} + V_a q_c \tag{5b}$$

The behavior of average costs of advertising for increasing levels of circulation are shown in Figure 2.[2]

INSERT FIGURE 2 HERE.

2.3 Profit Maximization.

The firm's problem of maximizing the profits accruing from both advertising and circulation gives rise to the following objective function:

$$\Pi(q_c, p_a) = p_c q_c + p_a q_a - \left[F_c + F_a + (V_c + V_a q_a) q_c + f(q_c)\right] . \tag{6}$$

The firm chooses an optimal p_a and an optimal q_c (hence e). The first-order conditions for such an optimum are:

$$\frac{\partial \Pi}{\partial q_c} = p_c + p_a \frac{\partial q_a}{\partial q_c} - (V_c + V_a q_a) - V_a q_c \frac{\partial q_a}{\partial q_c} - \frac{\partial f}{\partial q_c} = 0 \tag{7a}$$

$$\frac{\partial \Pi}{\partial p_c} = q_a + p_a \frac{\partial q_a}{\partial p_a} - V_a q_c \frac{\partial q_a}{\partial p_a} = 0 . \tag{7b}$$

These two equations may be rewritten as:

$$p_c + p_a \frac{\partial q_a}{\partial q_c} = V_c + V_a q_a + V_a q_c \frac{\partial q_a}{\partial q_c} + \frac{\partial f}{\partial q_c} \tag{8a}$$

$$q_a + p_a \frac{\partial q_a}{\partial p_a} = V_a q_c \frac{\partial q_c}{\partial p_a} . \tag{8b}$$

Equation (8a) states that at the optimum, the marginal revenue accruing from increasing circulation one unit (the price of the additional copy plus the increase in advertising revenue due to higher circulation-induced demand) should be equated to the marginal cost of an additional copy (advertising and circulation expenditures). Equation (8b) may be more easily interpreted by first defining the price-elasticity of advertising demand as $\psi(p_a, q_a, q_c) = (p_a/q_a)(\partial q_a/\partial p_a)$ and then rewriting the equation as:

$$p_a\left(1 + [\tfrac{1}{\psi}]\right) = V_a q_c \ . \tag{9}$$

Equation (9) is the familiar price-markup relation for a monopolist. The two first-order conditions may then be solved simultaneously for the optimal advertising price and level of circulation (which implies a unique level of expenditures on editorial quality).

These conditions show how the optimal circulation price depends upon the ability of additional circulation to induce additional advertising, which feeds back positively to the increase in total revenue resulting from any decrease in the circulation price. They also indicate the joint vulnerability of these revenue streams to exogenous shifts in either advertising demand (say, due to the arrival of television) or circulation demand (say, due to the movement of households from the central city to the suburbs). As Rosse (1978) stressed, an adverse shift in either demand function shrivels both revenue streams.[3]

Although these factors stand out more clearly when circulation price is not included as an instrument, we need to allow its optimal adjustment (along with e and P_a) in a full set of first-order conditions. Suppose that newspaper demand depends on both circulation price p_c and editorial expenditures e, i.e., $q_c^d = q_c^d(e, p_c)$ and assume that:

(A3) For any fixed p_c, $\frac{\partial q_c^d}{\partial e} \geq 0$, $\frac{\partial^2 q_c^d}{\partial e^2} < 0$.

The firm then chooses p_c, p_a, and e in order to maximize profits Π where:

$$\Pi(e, p_c, p_a) = p_c q_c(e, p_c) + p_a q_a - \left(F_c + F_a + [V_c + V_a q_a] q_c(e, p_c) + e\right) . \quad (10)$$

The first-order conditions are then:

$$\frac{\partial \Pi}{\partial p_a} = (p_a - V_a q_c) \frac{\partial q_a}{\partial q_a} + q_a = 0 \quad (11a)$$

$$\frac{\partial \Pi}{\partial p_c} = \left[p_c + (p_a - V_a q_c) \frac{\partial q_a}{\partial q_c} - (V_c + V_a q_a)\right] \frac{\partial q_c}{\partial p_c} + q_c = 0 \quad (11b)$$

$$\frac{\partial \Pi}{\partial e} = \left[p_c + (p_a - V_a q_c) \frac{\partial q_a}{\partial q_c} - (V_c + V_a q_a)\right] \frac{\partial q_c}{\partial e} - 1 = 0 . \quad (11c)$$

Define the quantity A as:

$$A \equiv \left[p_c + (p_a - q_c V_a) \frac{\partial q_a}{\partial q_c} - (V_c + V_a q_a)\right] \quad (12)$$

and let $\eta(p_a, q_a, q_c) \equiv \frac{\partial \ln q_a}{\partial \ln p_a}$ be the price elasticity of advertising demand.
Then rearranging equations (11) yields:

$$p_a(1 + \frac{1}{\eta}) = V_a q_c \quad (13a)$$

$$A \frac{\partial q_c}{\partial p_c} = - q_c \quad (13b)$$

$$A \frac{\partial q_c}{\partial e} = 1 \quad (13c)$$

Combining equations (13b) and (13c) gives the familiar Dorfman-Steiner relation. Hence, the first-order conditions (13) imply the following two equalities:

$$p_a(1 + \frac{1}{\eta}) = v_a q_c \tag{14a}$$

$$\frac{p_c q_c}{e} = - \frac{\varepsilon}{\gamma} \tag{14b}$$

where $\varepsilon \equiv \frac{\partial \ln q_c}{\partial \ln p_c}$ and $\gamma \equiv \frac{\partial \ln q_c}{\partial \ln e}$ are the price-elasticity of circulation demand and the editorial expenditure-elasticity of circulation demand respectively.

3. A Simple Model of Ruin.

In this section, the basis for games of survival is considered in the context of a simple infinite-horizon two-firm model. A complete theory of ruinous competition is well beyond the scope of this study.[4] Our more modest goal is to derive conditions under which ruin might be a more likely outcome than other standard oligopolistic competitive equilibria. Unfortunately, the multi-market nature of the newspaper firm complicates the analysis considerably. Therefore, we first examine in fairly general terms the case in which firms compete in a single market only and then explore the implications of the model for newspaper firms in particular. A further simplification employed is the assumption of stationarity. That is, while the two firms compete over an infinite number of periods, each firm's per-period profit functions are independent of time. In the terminology of game theory, the two firms are playing a supergame in which all the constituent games are identical. The stationarity assumption is of considerable value since it allows us to study an essentially dynamic phenomenon such as ruin through the use of more tractable static models of oligopoly. Given these simplifying assumptions, our approach in this section is to first define some notation and preliminary concepts, then provide a specific (if ad hoc) definition of ruin, and finally propose conditions under which ruin may be a plausible outcome of competition.

Consider then two firms X and Y which produce an undifferentiated product in each period. Denote by (x_t, y_t) the vector of outputs of X and Y respectively in period t. Since all the constituent games are identical, time subscripts will usually be dropped. Let $p(Q)$ denote the market inverse demand function where $Q \equiv x + y$. The following assumption is made:

(B1) $p(\cdot)$ is continuous and is twice continuously differentiable for all $Q \geq 0$; $p' < 0$; there exists some $Q^+ > 0$ such that $p(Q^+) = 0$ for $Q \geq Q^+$ and $p(Q) > 0$ for $Q \varepsilon [0, Q^+)$; and $p(0) = p_0 > 0$.

Let $C_X(x)$ and $C_Y(y)$ denote the cost functions of X and Y respectively and assume that:

(B2) C_X is the continuous and is twice continuously differentiable for all $x \geq 0$; $C_X(0) \geq 0$; $C_X' > 0$, $C_X'' \geq 0$; and similarly for C_Y.

Given the market inverse demand function $p(Q)$ and the cost functions C_X and C_Y, the profits for X and Y may then be expressed as:

$$\Pi^X(x, y) = p(x + y)x - C_X(x) \tag{15a}$$

$$\Pi^Y(x, y) = p(x + y)y - C_Y(y) \tag{15b}$$

The market value of X and Y are then simply the present discounted value of all future profits. Letting V_X and V_Y denote the current market values of x and Y, we have:

$$V_X = \sum_{t=1}^{\infty} \beta_X^{t-1} \Pi^X(x_t, y_t) \tag{16a}$$

$$V_Y = \sum_{t=1}^{\infty} \beta_Y^{t-1} \Pi^Y(x_t, y_t) \tag{16b}$$

where $\beta_J = \frac{1}{1 + R_J} \in (0, 1)$ is the appropriate discount factor for firm J and R_J is firm J's appropriate cost of capital, J = X, Y. It is assumed throughout that firms seek to maximize their market value.

For later reference, we define the output combinations (x^M, y^M) and (x^C, y^C) as those corresponding to a joint monopoly and a Cournot equilibrium respectively for the constituent game. More formally, let

$$(x^M, y^M) = \arg \max_{(x,y)} \{\Pi^X(x, y) + \Pi^Y(x, y)\} \tag{17}$$

and let (x^C, y^C) simultaneously solve the following two equations:

$$x^C = \arg \max_{x} \Pi^X(x, y^C) \tag{18a}$$

$$y^C = \arg \max_{y} \Pi^Y(x^C, y) \tag{18b}$$

Note that, due to the time-additive-separable nature of firms' market values, the repeated play of the Cournot output levels in each constituent game is a noncooperative equilibrium (N.E.) for the supergame. Indeed, any sequence of N.E. for the constituent games forms a N.E. for the supergame when stationarity obtains.[5]

The Cournot equilibrium may be defined alternatively in terms of reaction functions. Specifically, let $\mathbf{X}(y)$ and $\mathbf{Y}(x)$ denote the reaction functions of X and Y respectively, where:

$$\mathbf{X}(y) \equiv \arg \max_{x} \Pi^X(x, y) \tag{19a}$$

$$\mathbf{Y}(x) \equiv \arg \max_{y} \Pi^Y(x, y) \tag{19b}$$

Then the Cournot equilibrium output plans (x^C, y^C) simultaneously solve the two equations:

$$\mathbf{X}(y^C) = x^C \tag{20a}$$

$$\mathbf{Y}(x^C) = y^C \tag{20b}$$

In addition to assumptions (B1) and (B2), we require two further assumptions which insure the existence and stability of the Cournot equilibrium:

(B3) For all (x, y) such that $x > 0$, $y > 0$ and $x + y \varepsilon [0, Q^+)$, $\frac{\partial^2}{\partial x^2} \Pi^X(x, y) < 0$, $\frac{\partial^2}{\partial y^2} \Pi^Y(x, y) < 0$.

(B4) For all (x, y) such that $x > 0$, $y > 0$ and $x + y \varepsilon [0, Q^+)$

$$\frac{\partial^2}{\partial x^2} \Pi^X + \left| \frac{\partial^2}{\partial x \partial y} \Pi^X \right| < 0$$

$$\frac{\partial^2}{\partial y^2} \Pi^Y + \left| \frac{\partial^2}{\partial x \partial y} \Pi^Y \right| < 0$$

3.1 A Definition of Ruin.

In the interest of brevity the following definitions will be given for firm X only, since the corresponding definitions for firm Y will then be obvious.

<u>Definition 1</u>: A firm X is said to be <u>ruined</u> if its profits are nonpositive for all feasible output levels $x \varepsilon [0, Q^+)$. In the event of ruin, the firm suffers its losses and shuts down permanently thereafter.

Implicit in this definition of ruin is the presumption that the firm is perfectly capital-constrained so that the victim of predation cannot borrow to finance continued losses.[6] If X is ruined, Y then enjoys monopoly profits in all subsequent periods.

Let x* denote the output level of X which is required to ruin Y. More formally, define x* as the solution to the following equation:

$$\underset{Y}{\text{Max}}\ \Pi^{Y}(x^*, y) = 0 \qquad (21a)$$

or

$$\Pi^{Y}\big(x^*, Y(x^*)\big) = 0 \qquad (21b)$$

If X produces x*, then Y's best response yields zero profit by definition. Any other output response by Y is clearly inferior. Defining y* similarly, the critical output values of ruin may be displayed graphically as in Figure 3.

INSERT FIGURE 3 HERE.

By letting $f(X) = \Pi^{Y}\big(x, Y(x)\big)$ and using the envelope theorem, it can be shown that $\frac{df}{dx} < 0$ under (B1) - (B4) so that any level of output greater than x* also results in ruin for Y.

Although X can in principle always ruin Y by producing a sufficiently large quantity of output, it may ruin itself in the process. This motivates the next definition.

<u>Definition 2</u>: Ruin is said to be a <u>feasible</u> strategy for X if

$$\Pi^{X}\big(x^*, Y(x^*)\big) > 0 .$$

If ruin is feasible for X, this simply means that X's threat of ruining Y is credible. Note that in this definition X is implicitly taken to be the Stackelberg leader and Y the follower and vice-versa in the definition of Y's feasibility of ruining X. Now if ruin is feasible for only one of the two firms, then this leader-follower choice is a natural one. If, however, ruin is feasible for both firms then the usual Stackelberg disequilibrium in which both X and Y wish to lead may arise. Note that if both firms attempt to ruin each other, the resulting Stackelberg disequilibrium is mutually suicidal.[7] That is:

$$\Pi^X(x^*, y^*) < 0 \ , \quad \Pi^Y(x^*, y^*) < 0 \tag{22}$$

In order to evaluate the importance of such indeterminacies, the nature of equilibria for this game must be explored and we return to this issue in the following section.

3.2 Conditions Affecting the Likelihood of Ruin.

Since it is a necessary condition, the feasibility criterion provides a trivial indication of the likelihood of ruin. In order to derive other conditions under which ruinous competition is likely to ensue, we explore its profitability relative to an alternative. In choosing a benchmark equilibrium to compare to the ruin outcome, the Cournot equilibrium has one serious drawback: given assumptions (B1) - (B4), it can readily be shown that the Cournot equilibrium is not Pareto optimal.[8] It may therefore be a less useful benchmark since in a dynamic context there are significant incentives for all players to reach a more profitable equilibrium. In particular, the joint monopoly outcome (J-M) is (with suitable side-payments) Pareto-superior and Pareto optimal.[9] However, although the J-M outcome is Pareto optimal, it is not necessarily a N.E. for the constituent games therefore the sequence of J-M output levels may not be a N.E. for the supergame. Nevertheless, if the discount factors are not too large, it is possible to obtain the J-M outcome as a N.E. for the supergame by employing more sophisticated strategies. Suppose, for example, both firms agree to produce at the collusive optimum until one firm deviates after which they revert to the less profitable Cournot outputs permanently thereafter. If the discount factors are not too large then certainly both firms would prefer the collusive outcome; the threat of returning to a N.E. is a credible one which enforces the collusive outcome effectively.[10] Although such strategies (known as "grim-trigger" strategies) yield many Pareto optimal N.E., for purposes of comparison we focus on the J-M outcome in the remainder of this paper.

Given the possibility of ruin, it is conceivable that a strategy which eliminates competitors may dominate even collusive equilibria. Although substantial losses may be suffered in driving out the competition, they may be significantly outweighed by the subsequent monopoly profits accruing to the surviving firm. This gives rise to a simple condition for profitability:

Proposition 1: Ruin is profitable for firm X if the following inequality is satisfied:

$$\beta_X > \frac{\Pi^X(X^M, y^M) - \Pi^X(x^*, \mathbf{Y}(x^*))}{\Pi^X(x^P, 0) - \Pi^X(x^*, \mathbf{Y}(x^*))} \equiv I_R^X \tag{23}$$

where x^P is the profit-maximizing level for X as a pure monopolist (Note, $x^P = \mathbf{X}(0)$).

Proof: See Appendix A.

Note that the profitability condition may be re-expressed as an upper bound on the discount rate R_X:

$$R_X < 1 - \frac{1}{I_R^X} \equiv \hat{R}_X \ . \tag{24}$$

Table 1 summarizes plausible equilibria for the various possibilities. If for example, ruin is infeasible for both firms then the J-M outcome is a viable noncooperative equilibrium for the supergame (there are of course many others). Even if ruin is feasible for one firm but not the other, the J-M equilibrium will still obtain as long as ruin is not profitable. The only indeterminacy is the case where ruin is profitable for both firms, in which case neither ruin nor the J-M outcome are N.E. Although in principle mutual ruin is possible, in practice this does not seem likely since in such circumstances both firms have sizable incentives to bind themselves to alternate strategies. For our purposes, the cases in which the threat of ruin is asymmetric are of more immediate interest and are explored in the next section for firms with quadratic profit functions facing a linear market demand function.

INSERT TABLE 1 HERE.

3.3 The Symmetric Linear-Quadratic Case.

Let the profit and market inverse demand functions be given by:

$$p(Q) = a - bQ \tag{25a}$$

$$\Pi^X = px - F_X - \frac{1}{2} G_X x^2 \tag{25b}$$

$$\Pi^Y = py - F_Y - \frac{1}{2} G_Y y^2 \tag{25c}$$

where a, b, F_X, G_X, F_Y, and G_Y are all positive constants. The reaction functions for X and Y are then:

$$X(y) = \frac{a}{2b + G_X} - \frac{b}{2b + G_X} y \tag{26a}$$

$$Y(x) = \frac{a}{2b + G_Y} - \frac{b}{2b + G_Y} x \tag{26b}$$

Given the profit and reaction functions, the ruin levels x* and y* may be calculated to be:

$$x^* = \frac{a}{b} - \frac{1}{b}\sqrt{2F_Y(2b + G_Y)} \tag{27a}$$

$$y^* = \frac{a}{b} - \frac{1}{b}\sqrt{2F_X(2b + G_X)} \tag{27b}$$

Note that as long as the Cournot equilibrium profits are positive, the ruin levels exist and lie between the Cournot output levels and a/b.[11] From equations (27) it is clear that the ruin level for X is a decreasing function of the fixed and marginal costs of Y. Let $\hat{x}$ denote that level of output which solves the equation $\Pi^X(x, \mathbf{Y}(x)) = 0$. Then, by virtue of the fact that $\Pi^X(x, \mathbf{Y}(x))$ is strictly positive on the interval $[x^C, \hat{x})$ and strictly negative on the interval $[\hat{x}, \infty)$, ruin is feasible if and only if the ruin level x^* falls below this critical value $\hat{x}$.

To investigate the role of fixed costs in facilitating ruin, suppose that $G_X = G_Y = G$ so that except for fixed costs, the two firms are symmetric. Intuitively, if X has much lower fixed costs than Y, the excess output over the Cournot level required to ruin should be less for X than for Y. Even if ruin were still feasible for both firms, X would suffer lower losses since its ruin level is less than Y's. In order to evaluate the profitability of ruin, we compare it to the J-M equilibrium. For the joint monopoly to be a N.E. for the supergame, the following inequalities must be satisfied:[12]

$$\beta_X > \frac{\Pi^X(\mathbf{X}(y^M), y^M) - \Pi^X(x^M, y^M)}{\Pi^X(\mathbf{X}(y^M), y^M) - \Pi^X(x^C, y^C)} \equiv I_B^X \tag{28a}$$

$$\beta_Y > \frac{\Pi^Y(x^M, \mathbf{Y}(x^M)) - \Pi^Y(x^M, y^M)}{\Pi^Y(x^M, \mathbf{Y}(x^M)) - \Pi^Y(x^C, y^C)} \equiv I_B^Y \tag{28b}$$

or, in terms of the returns R_J,

$$R_J < \frac{1}{I_B^J} - 1 \equiv \overline{R}_J^M , \quad J = X, Y .$$

Assuming that these obtain, the profitability condition in Proposition 1 may then be checked. Analytic expressions for these various conditions are given in Appendix A, and in Table 2 some illustrative numerical examples are given. Consider the first row in Table 2. The two firms' fixed costs are identical and relatively low, hence the ruin level exceeds the sustainable level of output. This implies that ruin is not feasible for either firm. Note that in this case, the upper bound for the firms' cost of capital which insures that the grim-trigger strategy described above yields a N.E. is 94.5 percent. That is, as long as the firms' discount rate is less than 94.5 percent, the trigger strategy involving the threat of reverting to the Cournot point constitutes a N.E. for the supergame. Entries for the upper bound of the discount rate which insures profitability are omitted when ruin is infeasible. As we move down the first set of rows in Table 2, the fixed cost for Y increases in increments of 100. When Y's fixed cost reaches 450, ruin becomes feasible for X, but is still infeasible for Y. Furthermore, the profitability condition will clearly be satisfied for almost any reasonable discount rate (upper bound = 106.4 percent). The asymmetric costs have clearly induced ruinous competition.

In the second half of Table 2, the two firms' fixed costs are identical but relatively high, starting out at 650. In this case, ruin is feasible and probably profitable for both firms resulting in an indeterminacy. However, as the fixed costs of X decline relative to Y's, ruin becomes feasible for X but not for Y, and predation results once again.

INSERT TABLE 2 HERE.

3.4. Predation in the Newspaper Industry.

Although the previous sections have outlined a simple model of predation in an infinitely-repeated single-product duopoly, its extension to the case of a two-product duopoly is considerably more involved (see Bulow et. al. (1985) for example). Nevertheless, the results of the single-product case may serve as useful "first-order" guidelines for analyzing ruin in the newspaper industry. In particular, it is not unreasonable to suppose that fixed costs play a quite similar role in the two-product duopoly. In fact, the existence of fixed costs for each newspaper guarantees that the minimum total cost for a monopoly paper to provide any given quantity of circulation (and advertising) is less than that for duopolists producing the same total outputs. If tastes were identical, the total net revenues available to a monopolist would exceed those available for division by cooperating duopolists.

Telser (1966) pointed out that predation may be a bad investment relative to buying out a rival, and that under some conditions outside lenders can expect a positive return from helping the potential victim survive an attack. We note that the role of reputation and various other factors may make predation a superior investment. One other factor is antitrust policy hostile to horizontal mergers; some forms of predatory behavior in the newspaper industry, such as increases in editorial expenditures, probably are quite difficult for regulatory agents to detect. The higher these fixed costs, the higher are future monopoly profits for the successful predator relative to duopoly profits. Wagner's (1981) review of the evidence indicated that for mass-circulation papers first-copy costs are about half of total costs, and Rosse's (1978) figure for smaller-circulation dailies was 40 percent.

Several aspects of the newspaper industry not incorporated into our model seem similarly to influence the likelihood of predation:

1. In Section 1 it was observed that because the demand for advertising depends upon circulation as well as price, there are two channels through which a change in circulation may affect revenues. To the extent that this dependence amplifies the effect of changes in output upon profits, predation will be more likely since such linkages will have a tendency of decreasing the levels of ruin (x^*, y^*) ceteris paribus, hence lowering the costs of predation.

2. The elasticities of the advertising and circulation demand functions are clearly relevant since the lower they are in absolute value, the larger are monopoly profits relative to the profits of noncooperative duopoly.

3. Random disturbances may affect the preferences of advertisers and readers for one newspaper relative to another, so that the division of duopoly profits between them may differ substantially among states of nature. A sufficient reason for this is that the effect on circulation of outlays on editorial quality contains a random component, so that a paper's editorial-expenditure policy that was optimized ex ante may prove unsuccessful ex post. As a result, in any given state of nature, one paper may be earning higher profits (from larger circulation and/or higher advertising) than it expected, the other one lower profits. The effect of this on the incentive to "prey" is that the former firm needs to sacrifice less profit in order to produce losses for the latter. Therefore, the greater this randomness in newspapers' fortunes, the greater the chances that one paper will find itself in a situation where predation is profitable.[13]

Also, given that there is uncertainty in the newspapers' profitability, the newspaper firm's discount factor (or equivalently, its cost of capital) reflects the particular risk-class to which the firm belongs. If the profitability condition (24) and the equilibrium conditions (28) may be re-interpreted as "certainty equivalence" relations under uncertainty, then it is apparent that the more "risk" present (i.e., the higher the cost of capital), the less likely is ruinous competition.

4. The payout to predation is less, the more the subsequent monopoly profits are constrained by the threat of entry. Easy exit is a necessary condition for contestability and easy entry. However, it may not be sufficient to the extent that goodwill assets belonging to incumbents require entrants to incur shakedown losses or sunk promotional outlays (with uncertain returns). To the extent that habituation and custom determine newspaper readership, the compensation required by the typical reader of newspaper B to shift to incumbent paper A may be substantially less than that required to shift to a new and unfamiliar paper.[14] Newspapers do not seem to be among the class of goods for which buyers have a taste for variety, rotating their purchases among "acceptable" varieties and therefore requiring a relatively small inducement to try a new one.

5. The strategy of predation is more likely to be profitable, the shorter the period for which losses are endured before the victim exists. That period is shorter, the greater the degree to which the firm's fixed (first copy) costs are not also sunk. Although in most industries fixed and sunk costs are highly correlated,[15] significant parts of newspapers' fixed costs are sunk only for short periods. Editorial personnel are not

employed on long-term contracts, and buildings and the equipment used in the distribution system have alternative uses. Presses and related specialized equipment, however, may have limited salvage value. Thus, as industries go, newspapers represent one in which the losing firm's exit is relatively unhampered by fixed costs that are sunk or contractually unavoidable. A countervailing factor, however, is negative salvage value due to pension and severance-pay liabilities to pressmen and printers.

4. An Econometric Model.

The models considered in Sections 2 and 3 suggest that cost structures may dispose central-city newspapers toward monopoly status, and that in rivalrous markets some incumbents may choose policies that promote the monopoly outcome. With structural changes toward monopoly occurring frequently in major U.S. cities, it becomes attractive to test these implications statistically. We took as a sample 50 major newspapers in 30 metropolitan areas. Although the main component of the analysis is a cross-section model fitted to data for the year 1980, we do not proceed in the usual spirit of assuming that these newspaper markets are in (or randomly displaced from) long-run equilibrium. Because games of survival are necessarily transient states, we test the hypothesis that at least some rivalrous markets in 1980 were not in long-run equilibrium--for example, that newspapers which have exited since 1980, or are widely expected to exit, were behaving differently from their surviving (or favored) rivals.

The estimating equations are based on the model of Section 2, chiefly the first-order conditions for determining the newspaper's circulation and advertising prices and its outlays on editorial quality (Equations 13a, 13b, and 13c). The advertising price is in fact a vector of prices for national, retail, and classified ads respectively, because their demands are expected to differ in elasticity. We also estimate demand functions for advertising and circulation that correspond to Assumptions (A1) - (A3) in the model. These prove useful to test auxiliary hypotheses. The quantities demanded and the instrument settings chosen by the newspapers are of course jointly determined, so the model is estimated by two-stage least squares.

4.1 Demand Equations.

The estimated equations for total 1980 advertising lineage (national--ADN, retail and other local--ADR, classified--ADC) and circulation (CIRC) are conveniently reported first. Their inclusion is necessary to complete the simultaneous model, but they also provide the chance to evaluate several relationships that are significant for rivalry in the newspaper industry. Variables are defined briefly in the text, more precisely in an appendix table that gives their sources.

The quantity demanded of each class of advertising should be negatively related to its price, expressed as a weighted average of standardized line rates for weekday and Sunday editions, with total advertising lineage used as weights. These are denoted PADN (national), PADR (retail), and PADC (classified), and all are list prices quoted in trade sources or by the newspapers themselves. We were unable to ascertain to what extent bargaining depresses transaction prices below those quoted rates (the discrepancy may be significant for local retail advertising).[16] The price variables as defined ignore the favorable combined rates offered to advertisers who place the same ads in separate morning and evening editions. Therefore, we included as a regressor a dummy variable indicating that a newspaper offers a combined rate (DCMB). The "bundling" strategy of a combined rate implies that the effective price of advertising lies below that measured by the line-rate variables, and so DCMB's coefficient should be positive. What the advertiser demands is of course messages delivered to individual newspaper readers, and so combined daily and Sunday circulation (CIRC) is included as a separate regressor expected to wield a positive influence.

Various terms can serve to test whether the demand for advertising in a particular paper is affected by the availability of substitute advertising media such as suburban daily papers, television and radio stations. We obtained numbers of TV and radio stations in each newspaper's metropolitan area. We also calculated the share of daily-newspaper circulation in each metropolitan area held by the largest two suburban dailies, weighted by the fraction of population in the metropolitan area residing outside of the central city. This variable (SUBCON) should be negatively related to the demand for advertising lineage in the metropolitan daily if SUBCON succeeds in capturing the degree to which the suburban papers provide an effectively differentiated alternative medium. Finally, we noted the proposition commonplace in newspaper circles that national and retail advertisers have a preference for the leading newspaper in a metropolitan area and therefore will *ceteris paribus* place a lesser volume of advertising in follower papers. We were concerned to test this conjecture because of its importance for the viability of rivalry, and so included a dummy variable (DFOL) set equal to one for each newspaper that ranks second or third in circulation in its metropolitan area.

Table 3 presents logarithmic regressions[17] of lineage for the three types of advertising on the variables just defined. Because the price variables are endogenous in the system, these equations were estimated by the method of two-stage least squares. The coefficients of the price variables can be read directly as elasticities and exhibit reasonable values for each class of advertising. They are statistically significant, as are values of the combination-rate dummy (DCMB) and weighted circulation (CIRC). The variable indicating the strength of suburban dailies (SUBCON) takes the expected sign but is significant only for retail advertising. The dummy for newspapers lower-ranked in circulation (DFOL) is weakly significant for retail advertising but not for national advertising. The dummies DCMB and DFOL were omitted from the equation for classified advertising, where they are deemed inappropriate, and the equation for ADC exhibit substantially less explanatory power than the others.[18] We thought that the logarithmic relation of advertising lineage to circulation might be nonlinear (compare Ferguson, 1983). Addition of a quadratic term indicated no such nonlinearity for ADN or ADR, but it did prove significant and considerably improve the fit of the equation for ADC. The numbers of TV and radio stations are omitted; these variables' coefficients exhibited incorrect positive signs and t-statistics that were substantial although not statistically significant. We decided that they did not belong in the model,[19] and their presence makes little difference to the coefficients of other variables.

INSERT TABLE 3 HERE.

The other demand equation pertains to circulation (CIRC), which should be negatively related to its price (PCIRC--weighted average of daily and Sunday single-copy prices). CIRC should increase with the number of households in the metropolitan area and with household disposable income; a degree of freedom is preserved and a superior fit results when we employ the product of these two variables (INCOME). Circulation should increase with the quality of the paper and decrease with the availability of good substitutes. We assumed that the quality of a newspaper for household readers increases with its number of personnel in editorial positions (QUAL), which we take to indicate the extent and quality of local news coverage; and with the volume of retail and classified advertising (ADR, ADC).[20] Newspaper circulation is assumed to decrease with the number of television stations in the metropolitan area (TV), because they substitute for newspapers as sources of news and local retail advertising. We also expect it to decrease with extent of substantial competition from suburban dailies (SUBCON). Finally, shifts in households' leisure-time activities have tended to reduce the demand for evening papers relative to those delivered in the morning, so that evening papers (dummy DEVE) should have lower circulation.

This model of the determinants of circulation was estimated in logarithmic form by two-stage least squares, as with the advertising-demand equations. It exhibited some instability in key coefficients, so we quote a representative result and then describe the consequences of shifting the specification:

$$\begin{aligned} \text{CIRC} = &\underset{(3.52)}{-8.188^{a}} - \underset{(0.96)}{0.557}\ \text{PCIRC} + \underset{(6.465)}{0.895^{a}}\ \text{INCOME} + \underset{(3.62)}{0.756^{a}}\ \text{QUAL} + \underset{(1.94)}{0.272^{b}}\ \text{ADR} \\ &+\underset{(1.50)}{0.080}\ \text{SUBCON} - \underset{(2.87)}{0.770^{a}}\ \text{TV}. \end{aligned}$$

In this version of the model the signs of INCOME, QUAL, ADR, and TV are correct and their coefficients are significant. The price elasticity is negative but not significant. The coefficient of the suburban-press substitute (SUBCON) is unexpectedly positive and moderately significant, suggesting that metropolitan and suburban dailies may compete less for circulation than for retail advertising (compare the equation for ADR in Table 3). This equation omits ADC; when included, it obtains an insignificant coefficient with the wrong sign. It also omits DEVE; when that variable is included, the coefficient of ADR becomes significant only at 19 percent while the coefficient of DEVE is negative and significant; those two variables are correlated, and we cannot distinguish whether evening papers are eschewed because of when they appear or because they offer less useful information. Finally, the coefficient of the circulation price is smaller in other specifications, ranging down to -0.26 from the -0.55 shown above, but the coefficient does come to exceed its standard error. These magnitudes are similar to Reekie's (1976) estimates.

4.2 Equations for Price and Editorial Quality.

We now turn to the core of the model, which consists of equations for five decision variables available to the newspaper--line rates for the various classes of advertising (PADN, PADR, PADC), the circulation price (PCIRC), and editorial quality (QUAL). We showed in Section 2 that the determinants of each price variable include the levels of those costs that vary with advertising and circulation and the factors that determine the elasticity of market demand (and its position) for each of them. Pricing should also be influenced by the strategic considerations discussed in Section 3. The determinants of editorial quality should be explored in the form of the familiar Dorfman-Steiner relationship.

The data available on newspapers' costs are fragmentary and not well adapted to estimating a fully specified cost function. Furthermore, the distinction between advertising and circulation costs made in Section 2 cannot be preserved. The best we can do to control for differences in newspapers' variable costs is to measure three components that should contribute to explaining variations in the costs of both circulation and advertising.[21] One of these is a measure of the composite hourly costs of labor to each newspaper (LABOR), calculated as a weighted average of labor costs in each of the newspapers' five major departments. The second cost indicator is a measure of the population density of the central city in the metropolitan area (CCDENS). The newspaper's distribution costs certainly increase with central-city congestion, and other costs (both variable and fixed) probably are affected adversely as well.[22] Finally, evening papers (DEVE) experience higher costs of distribution because newspapers must be delivered through the congested afternoon rush hour. Thus, the prices of advertising and circulation should increase with LABOR, CCDENS, and DEVE. The newspaper's circulation volume (CIRC) also belongs in the model to control for the number of copies in which the advertising line appears.

The influence of competitive conditions on advertising line rates needs to be modeled with care. The sample includes both monopoly newspapers and those in diverse situations of small-group rivalry. Although the data base is not rich enough to let us compare each paper's own actual line rates to a custom-made contrafactual, we can observe numerous differences in market structure, its changes, and the observed paper's position in its market. Because a game of survival is necessarily a transitory event, a cross-section research design must allow for the possibility that different types of rivalrous conditions prevail in different markets. We define the variables that were used to make these distinctions, then explain their joint interpretation in conjunction with the models that are estimated.

We distinguish, first of all, between cities with monopoly central-city newspapers (DMONOP) and others. Where rivalry exists, we focus on the price-setting behavior of papers with differing market shares or ranks. The variable SHARE is defined as circulation of the newspaper in question as a fraction of the copies circulated of all metropolitan-area daily newspapers (including suburban); we utilized the variable for all newspapers, for only those with central-city rivals (SHAREC), or we allowed SHARE to take a different coefficient for papers with and without central-city rivals (SHAREC and SHAREM). A simpler strategy was to trichotomize papers in the sample into central-city monopolists (DMONOP), followers (DFOL), and leading circulation papers with central-city rivals (the residual category). Finally, because data are available on the circulation of individual daily papers in each area, we could calculate any of the conventional measures of concentration.

We employed several dummies to incorporate independent information on competitive behavior and states of structural transition in these markets. Assume that a newspaper whose rival has exited cannot, for reasons of goodwill, immediately make any upward adjustment of its prices to a steady-state level appropriate to the new, more concentrated structure. Assume also that the existence of a competitor is associated with advertising rates depressed to reflect aggressive rivalry. Then a paper that had recently (during 1970-1980) lost a central-city rival should have been charging rates that were low for the market structure in which it found itself in 1980. DLOSS, indicating the recent exit of a rival, should therefore receive a negative coefficient. Public information on newspaper markets frequently includes comments that recognize the occurrence of "warfare" conditions in certain markets. The dummy DWARF was set equal to one for papers in the Dallas, Denver, and Detroit markets, deemed from this information to exhibit warfare conditions during 1980. A third source of information on competitive conditions is the subsequent demise of a paper in the 1980 sample, or widespread reports appearing after 1980 but by 1984 that its survival was in doubt. The dummy DSICK was assigned a value of one for such papers, which we expected might be quoting high line rates in 1980 in an attempt to harvest what they could of their goodwill assets. Two other measures were used to describe the concentration of the observed newspaper's competitors. SUBCON, already defined, represents the combined share of the largest two suburban dailies in the metropolitan area multiplied by the suburban portion's share of the metropolitan area's population. HERFM is the Herfindahl concentration measure computed over all daily newspapers in the metropolitan-area market (including suburban) minus the square of the observed paper's own share.

These variables could be logically grouped in several ways into models for estimation. SHAREC is a strategic variable to distinguish between passive (Cournot-type) behavior and predatory strategies, because in the former case an oligopolist holding a larger share of a market tends to prefer higher price (by the rule of elasticity of derived demand). Conversely, a large-share predator in a game of survival would set a lower price. A competing specification relies on DFOL on the logic that a newspaper's position in a game of survival depends not on its own share of circulation but on whether it enjoys an advantage in market share over any central-city rival.[23] The transitory-state variables DLOSS, DWARF, and DSICK, as well as DMONOP, can be employed with either SHARE or DFOL to make additional discriminations among states of rivalry.

Because formulations utilizing SHAREC and DFOL yield very similar results, we report in Table 4 only the models employing DFOL. Following the functional form derived in Section 2, we converted all continuous variables to logarithms and estimated equations determining PADB, PADR, and PADC by the method of two-stage least squares. The basic results, appearing in Table 4, are somewhat mixed. The cost variables (LABOR, CCDENS, DEVE) are correctly signed except for LABOR in the equation for classified advertising, but their significance levels are quite low; we cannot claim that the components of incremental cost that underlie advertising line rates are accurately measured. Because we believe that our labor-cost variable is quite an accurate measure of each newspaper's actual costs, we suspect that its failure throughout the model to control effectively for variable-cost differences may reflect the inclusion of significant rent components in wages. See Wagner's (1981) discussion of union power in newspapers. Circulation (CIRC) is a highly significant variable, with line rates rising a bit less than proportionally with circulation.[24] DFOL, indicating a newspaper with a larger-share central-city rival, takes the positive coefficient which implies that followers charge higher prices; it is significant for classified advertising but not for national or retail advertising (in the appropriate two-tail test). If the equations in Table 4 are re-estimated with DFOL replaced by SHAREC the same interpretation emerges: SHAREC's coefficient is negative, supporting a "games of survival" interpretation, but is significant only for classified advertising rates. Of the other market-structure dummies, the coefficients of DLOSS confirm that newspapers which recently lost a competitor quoted line rates in 1980 that were below what their market structures otherwise indicated: DLOSS's coefficient is significant for retail and classified advertising. This finding is interesting in the context of DMONOP's coefficient, which fails to indicate that monopoly central-city papers charge higher advertising rates than those who retain one or more rivals. Our lack of difference between monopoly and rivalrous markets overall agrees with Ferguson (1983) but not with several other studies--Landon (1971), Kerton (1973; but compare Mathewson (1972)), Owen (1983), Thompson (1984). Newspapers engaged in widely noted warfare (DWARF) were charging significantly lower rates (except for classified advertising), and newspapers that later existed (or seemed likely to) were charging higher national and retail advertising rates (but not to a highly significant extent, and not for classified advertising).[25]

INSERT TABLE 4 HERE.

The results do not indicate that games of survival were occurring in all rivalrous central-city newspaper markets. However, the performance of DLOSS and DWARF implies that they do take place, as does DSICK's performance and the failure of DFOL (or SHARE) to indicate the alternative pattern of Cournot rivalry. These results must be strongly qualified by the lack of evidence that monopoly papers (in steady state) charge higher rates and our inability to secure good controls for differences in newspapers' variable costs. We did not obtain any significant relations of advertising rates to numbers of radio or TV stations, although Ferguson (1983) did in a larger sample that included much smaller cities than ours.

Two more decision variables remain for analysis--the circulation price and the level of editorial quality. We were able to explain little or nothing of the interfirm variation in circulation prices. This fact is consistent with a theoretical consideration established in Section 2. The optimized circulation price is set with regard not just to the incremental costs and demand elasticity for circulation, but also for the incremental advertising revenue that is obtainable when circulation increases; the available data are not rich enough to model that indirect connection properly. Furthermore, empirical evidence suggests that circulation prices are quite sticky and changed only infrequently (Merrilees, 1983), so that the variable cannot be assumed subject to continuous optimization. Therefore, we do not report the results in detail. The models that we estimated closely resembled those for advertising line rates except that total advertising lineage was included as an independent variable to capture costs associated with variations in the number of pages per copy. However, the theoretical model implies that the optimal circulation price need not increase with either this variable or total circulation, because of the interdependence between circulation and advertising revenue. In fact, neither variable has a significant influence on the circulation price. We observed only two robust influences on the circulation price: evening newspapers charge less per copy (probably a reflection of demand elasticity), and duopolistic warfare (DWARF) did depress the circulation price.

The model's final equation explains QUAL, the total number of editorial positions. The theoretical form of the equation (14b) in Section 2 indicates that it should depend logarithmically on total revenue from circulation (REV) and factors determining the responsiveness of the quantity bought to editorial quality and to circulation price. The price-elasticity variables related to demand and competitive conditions are the same ones employed in Table 4 (determinants of advertising price). Variables determining the responsiveness of circulation to editorial quality are not easily devised, but we did employ a measure of the intensity of newspaper readership in the metropolitan area, namely the total circulation of all daily newspapers divided by the number of households in the metropolitan area (PEN). We also used SUBCON, the variable describing the extent of suburbanization and the concentration of suburban dailies. LABOR is included as a cost-based determinant of editorial quality, with a negative coefficient expected. Taking logarithms of the continuous variables, we estimated by two-stage least squares. The following equation represents the results:

$$QUAL = \underset{(6.60)}{2.854} + \underset{(2.61)}{0.229^{a}} REV - \underset{(1.26)}{0.059} SUBCON + \underset{(2.78)}{0.307^{a}} DMONOP + \underset{(2.17)}{0.247^{b}} DFOL$$

$$-\underset{(1.55)}{0.221^{c}} DWARF - \underset{(0.48)}{0.062} DSICK + \underset{(1.46)}{0.148^{c}} DLOSS$$

The model reveals something about competitive influences, although it did not capture response elasticities well. REV behaves appropriately to normalize QUAL, but both PEN and LABOR proved entirely insignificant (they were dropped from this model). Central-city papers tend to reduce quality in the face of concentrated suburban competition, but the significance level of SUBCON's coefficient is low. Monopoly newspapers offer significantly higher editorial quality, perhaps reflecting the interaction of readers' positive preferences for quality with the fixed ("first copy") cost of providing editorial quality.[26] Editorial quality tends to suffer in "warfare" conditions, but (unlike advertising rates) it seems to be restored promptly after the loss of a competitor (perhaps an optimal response to capture readers loyal to the competitor). There is a weak tendency for "sick" newspapers to sacrifice editorial quality, although followers in fact offer higher quality in markets that are rivalrous but not warring.

5. Summary and Conclusions.

Central-city newspaper markets in the United States have trended rapidly toward monopoly status, not surprisingly in light of their cost and demand characteristics. In order to understand this process, we have modeled formally the optimizing decisions of the single newspaper, which sets three instruments (advertising and circulation prices, editorial quality) in selling to interrelated markets for circulation and advertising. We also developed a model of the conditions under which it may pay a duopolistic seller to invest in ruining a rival, showing formally how this incentive increases with the importance of fixed costs. Less formally, we argued that a series of documented characteristics of newspaper markets are capable of making a strategy of ruining a rival superior to other duopolistic equilibria.

We estimated an econometric model of advertising and circulation demands and prices and editorial quality for a sample of 50 newspapers in 1980. The sample included both monopoly and rivalrous markets. The model was designed both to test for the conditions likely to make ruin a profitable option and to use extraneous information to determine whether it was in fact being pursued in some markets. The statistical results broadly confirm the hypothesis, revealing behavior in some markets consistent with games of ruin occurring or having occurred. The evidence does not so much indict particular predators as it fails to reject the hypothesis that games of ruin were under way in some markets, and that some papers seemed to behave (the evidence is weak on this point) as if they were "harvesting" in anticipation of their own exit or making the best of a rival's previous exit. Overall, Rosse's characterization of central-city newspapers as isolated competitors is supported, as is his diagnosis (Rosse, 1978) of the slide toward monopoly status.

Appendix A

Proof of Proposition 1:

Let $\Pi^M \equiv \Pi^X(x^M, y^M)$, $\Pi^R \equiv \Pi^X\big(x^*, Y(x^*)\big)$, and $\Pi^P \equiv \Pi^X(x^P, 0)$ denote firm X's profits under joint monopoly, ruinous competition, and pure monopoly respectively. The condition for profitability of the ruin strategy is simply that the present discounted value of all future profits from ruinous competition exceeds that of the joint monopoly equilibrium, i.e.,

$$\Pi^R + \beta\Pi^P + \beta^2\Pi^P + \ldots > \Pi^M + \beta\Pi^M + \beta^2\Pi^M + \ldots \tag{A1}$$

But

$$\Pi^R + \sum_{j=1}^{\infty} \beta^j\Pi^P = \Pi^R + \frac{\beta}{1-\beta}\Pi^P \tag{A2a}$$

$$\sum_{j=0}^{\infty} \beta^j\Pi^M = \frac{\Pi^M}{1-\beta}\,. \tag{A2b}$$

Using (A2), (A1) may be rewritten as

$$\Pi^R + \frac{\beta}{1-\beta}\Pi^P > \frac{\Pi^M}{1-\beta} \tag{A3}$$

or

$$\beta > \frac{\Pi^M - \Pi^R}{\Pi^P - \Pi^R}\,. \tag{A4}$$

QED

Miscellaneous Results for the Linear-Quadratic Example:

(1) Note that the condition for stability in this example is

$$\frac{2b + G_X}{b} > \frac{b}{2b + G_Y} \tag{A5}$$

which is clearly always satisfied.

(2) Cournot and J-M output levels:

$$x^C = \frac{a(b + G_Y)}{(2b + G_X)(2b + G_Y) - b^2} \tag{A6a}$$

$$y^C = \frac{a(b + G_X)}{(2b + G_X)(2b + G_Y) - b^2} \tag{A6b}$$

$$x^M = \frac{aG_Y}{2b(G_X + G_Y) + G_X G_Y} \tag{A7a}$$

$$y^M = \frac{aG_X}{2b(G_X + G_Y) + G_X G_Y} \; . \tag{A7b}$$

(3) Critical value $\hat{x}$ for ruin:

$$\hat{x} = \frac{a(b + G_Y)}{H} + \frac{1}{H}\sqrt{a^2(b + G_Y)^2 - 4F_X H(2b + G_Y)}$$

$$H \equiv (b + G_X)(b + G_Y) - \tfrac{1}{2} G_X G_Y \; . \tag{A8b}$$

(4) Profits for firm X under Cournot and J-M strategies:

$$\Pi^X(x^C, y^C) = \frac{\tfrac{1}{2} a^2 (b + G_X)^2 (2b + G_Y)}{\left[(2b + G_X)(2b + G_Y) - b^2\right]^2} - F_Y \tag{A9}$$

$$\Pi^X(x^M, y^M) = \frac{\tfrac{1}{2} aG_X}{\left[2b(G_X + G_Y) + G_X G_Y\right]} - F_Y \; . \tag{A10}$$

Appendix B. Definitions and sources of variables used in statistical analysis

Variable	Definition	Source
ADN	Total number of lines of national advertising published by each newspaper during calendar 1980.	"Annual Survey of Advertising Linage," Editor and Publisher, May 1981
ADR	Total number of lines of retail advertising published by each newspaper during calendar 1980.	See ADN.
ADC	Total number of lines of classified advertising published by each newspaper during calendar 1980.	See ADN.
CIRC	Weighted average of daily and Sunday circulation volume for each newspaper in September 1980.	Standard Rate and Data Service, Newspaper Circulation Analysis (Skokie, IL: Standard Rate and Data Service, September 1980).
PADN	List price per line quoted to national advertisers by each newspaper in September 1980.	See CIRC.
PADR	List price per line quoted to retail advertisers by each newspaper at end of 1980.	Pinpoint Marketing, Inc., Retail Rates of U.S. Newspapers (New York, 1981).
PADC	List price per line quoted to classified advertisers by each newspaper at end of 1980.	Published line rates from each newspaper or direct telephone inquiry to each paper.
QUAL	Total number of titled editorial positions at each newspaper, end of 1980.	Editor and Publisher, Editor and Publisher International Yearbook, 1981.
CCDENS	Central City population divided by land area (square miles), 1980	U.S. Bureau of the Census, State and Metropolitan Area Data Book, 1982, Tables A, B

DFOL	Dummy variable set equal to 1 for newspapers that faced rival central-city papers and did not have the largest circulation in September 1980, 0 otherwise.	See CIRC.
DMONOP	Dummy variable set equal to 1 for newspaper that faced no central-city rivals in September 1980, 0 otherwise.	See CIRC.
SHARE	Circulation of the newspaper divided by total circulation of all daily newspapers in the metropolitan area (including suburban).	See CIRC.
HERFM	Herfindahl concentration measure calculated over circulation shares of all daily newspapers in the metropolitan area, minus square of SHARE.	See CIRC.
SUBCON	Combined shares of metropolitan-area daily newspaper circulation held by the largest two suburban daily papers, weighted by the fraction of metropolitan area population residing outside the central city.	See CIRC and CCDENS.
DCMB	Dummy variable set equal to 1 if the newspaper offered a combined advertising rate for morning and evening editions, 0 otherwise.	See CIRC.
LABOR	Weighted average of wage scales in five departments, editorial, printing, pressroom, mailroom, and drivers, January-June 1981.	American Newspaper Publishers' Association, Semi-Annual Report on Wage Scales, July 1981.

Appendix B (continued)

PEN	Percentage of households in the Area of Dominant Influence (ADI) subscribing to one or more daily newspapers. The ADI general coincides with the Census definition of Standard Metropolitan Statistical Area, but is adjusted where necessary to reflect the reach of the central city's television stations.	See CIRC.
INCOME	Number of households in the Area of Dominant Influence (See PEN) multiplied by average household income.	See CIRC.
TV	Number of television stations serving the Area of Dominant Influence (see PEN).	See CIRC.
DSICK	Dummy variable set equal to 1 for a newspaper that ceased publication between 1980 and 1985 or was reported to be running sustained losses, 0 otherwise.	Articles in Editor and Publisher and general business periodicals such as Business Week, Wall Street Journal.
DWARF	Dummy variable set equal to 1 if trade press reported "warfare" conditions among central-city newspapers in the metropolitan area during 1980.	See DSICK.
DLOSS	Dummy variable set equal to 1 for metropolitan areas in which a central-city daily newspaper ceased publication during 1970-1980.	See CIRC.

Footnotes

[1]See Rosse (1967, 1970) and also his series of unpublished working papers--Rosse (1977, 1978), Rosse, Owen, and Dertouzos (1975), Rosse and Panzar (1977), and Rosse and Dertouzos (1978).

[2]Rosse (1967, 1970) concluded that, with product quality held constant, scale economies exist in advertising and news space per issue of the newspaper--especially when these functions are taken together, not so significantly when they are analyzed separately. He did not find such substantial scale economies for circulation itself. An indirect cost study based on newspapers' national advertising rates and total advertising outputs led to the finding that the elasticity of unit costs with respect to total advertising output (column-inches per subscriber) is negative and highly significant statistically.

[3]This tendency for disturbances to cumulate is further amplified when we recognize that the demand for circulation may depend positively on the amount of advertising carried by the newspaper. This relation is incorporated in our empirical work below.

[4]In addition to the classic reference on games of survival by Shubik (1959), more recent references include Maskin and Tirole (1983) and Fudenberg and Tirole (1984).

[5]See Friedman (1977) Lemma 8.1.

[6]An economically more meaningful criterion for ruin would be the situation in which the firm's current obligations exceed the present discounted value of all future profits. This, however, renders the problem of ruin substantially more complicated since the decision to ruin a competitor today depends upon future profits whereas future profits depends upon whether ruin occurs today. Although in principle the existence of a "fixed point"

strategy may be demonstrated, deriving a tractable closed-form solution is considerably more difficult.

[7]To see this, simply note that:

$$\underset{x}{\text{Max}}\ \Pi^{X}(x, y^{*}) = \Pi^{X}(\mathbf{X}(y^{*}), y^{*}) = 0$$

so that any other output level other than $\mathbf{X}(y^{*})$, such as x^{*}, is sub-optimal hence yields a negative profit level (subject to the strict monotonicity conditions implicit in assumptions (B1) - (B4)).

[8]See Friedman (1977) Theorem 2.2.

[9]By definition, the total profits resulting from the J-M outcome must exceed those of the Cournot outcome. Let π be the excess total profits of J-M over Cournot and let firms X and Y agree that at the J-M outcome, X receives profits equal to its Cournot profits plus $\alpha\pi$ and Y receives its Cournot profits plus $(1 - \alpha)\pi$, $\alpha \in (0, 1)$. The J-M outcome under this re-distribution scheme is always Pareto-superior.

[10]See Friedman (1983) chapter 5.4 for a numerical example of a grim-trigger strategy equilibrium.

[11]To see this, note that $\Pi^{Y}(x, \mathbf{Y}(x))$ is continuous, is negative at $x = a/b$ since $\mathbf{Y}(a/b) = 0$, and is positive at the Cournot point $x = x^{C}$ by assumption.

[12]See Friedman (1983) chapter 5.4. Note that in this case, the resulting equilibrium is the balanced temptation equilibrium proposed in Friedman (1971, 1973).

[13]This case bears an important relation to our formal model of advantages stemming from lower fixed costs. Because the newspaper's fixed inputs affect its differentiation, the paper that enjoys random superiority in its fixed assets is observed to hold a disproportionate market share; in terms of our

model, it can be thought of as enjoying lower fixed costs than its rival for attaining any given market share. See Rosse's (1978) discussion.

[14]Accordingly, Glazer (1985, p. 474) found that first entrants into daily newspaper markets tend significantly to outlive second entrants.

[15]Baumol and Willig (1981) to the contrary notwithstanding.

[16]Ferguson (1963) found that retail advertisers enjoy lower scheduled rates than national advertisers and get volume discounts as well.

[17]That is, logarithms were taken of all variables other than those taking the forms of dummies.

[18]For the corresponding ordinary least squares equations the adjusted R^2 value for ADC is zero, while it is 0.29 for ADN and 0.47 for ADR.

[19]We hypothesize that they pick up on balance not the abundance of substitute advertising media but otherwise unobserved traits determining the volume of advertising demanded in the metropolitan area. This hypothesis is strengthened by the consideration that the numbers of TV and radio stations obviously increase with the size and commercial importance of a metropolitan area.

[20]National advertising, available to households inexpensively or free of charge via other media, is assumed not to influence the household's demand for newspapers.

[21]Important material inputs--paper and ink--are traded in national markets, and their costs should not vary substantially among newspapers.

[22]We also considered whether population densities in the metropolitan area's suburban portions might have the opposite effect, with distribution costs increasing due to suburban sprawl. When that measure was used in the models estimated in Table 4, its coefficient was signed as expected but quite insignificant.

[23]The presence of competing theoretical predictions indicates that two-tail tests are appropriate for both SHARE and DFOL.

[24]The coefficients on CIRC of the national and classified advertising rates are not significantly less than unity, but that of the crucial retail advertising is less than one at the 5 percent confidence level in a two-tail test.

[25]Bucklin (1982, chapter 4) developed a simple time-series analysis of selected newspaper markets for the period 1969-1980. Although it was seriously hampered by data limitations, it did yield the conclusion that a newspaper gaining market share tended to lower its national advertising rate per thousand circulation while papers losing share tended to raise theirs.

[26]Other possible explanations come to mind, such as greater technical inefficiency and overstaffing in monopoly papers.

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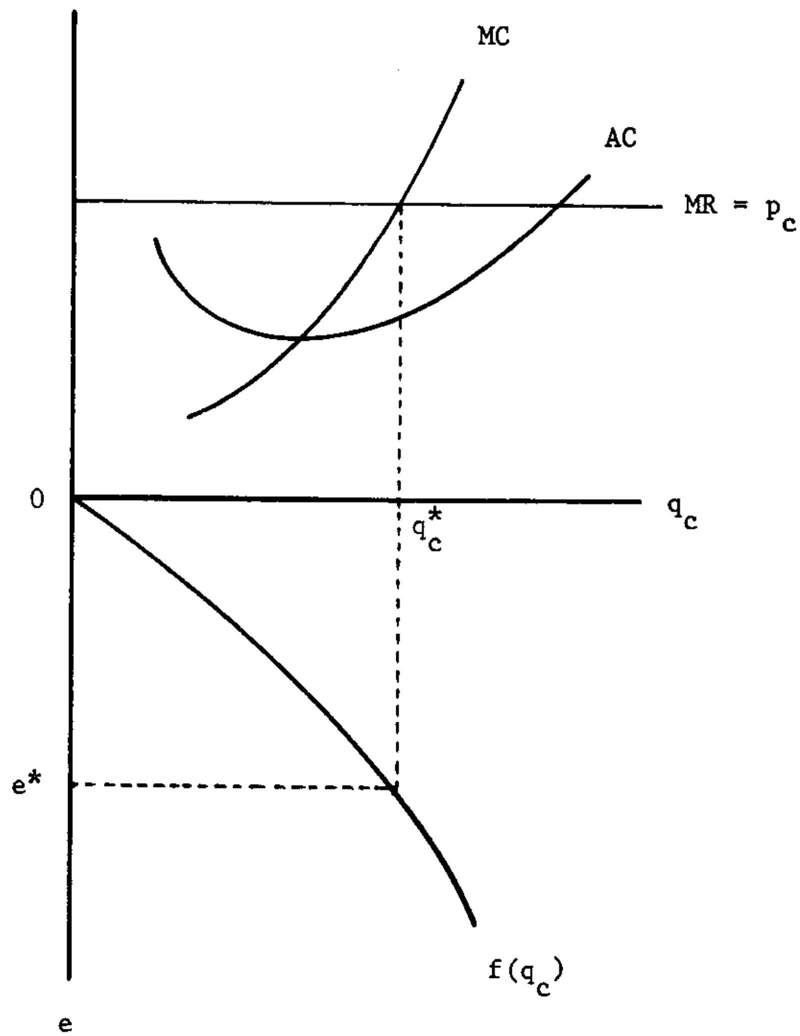

Figure 1.

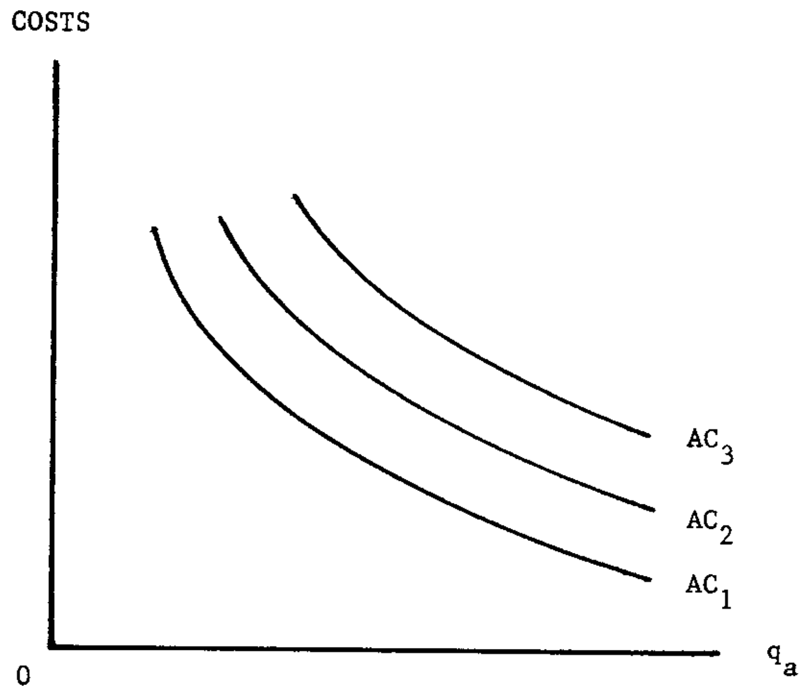

Figure 2.

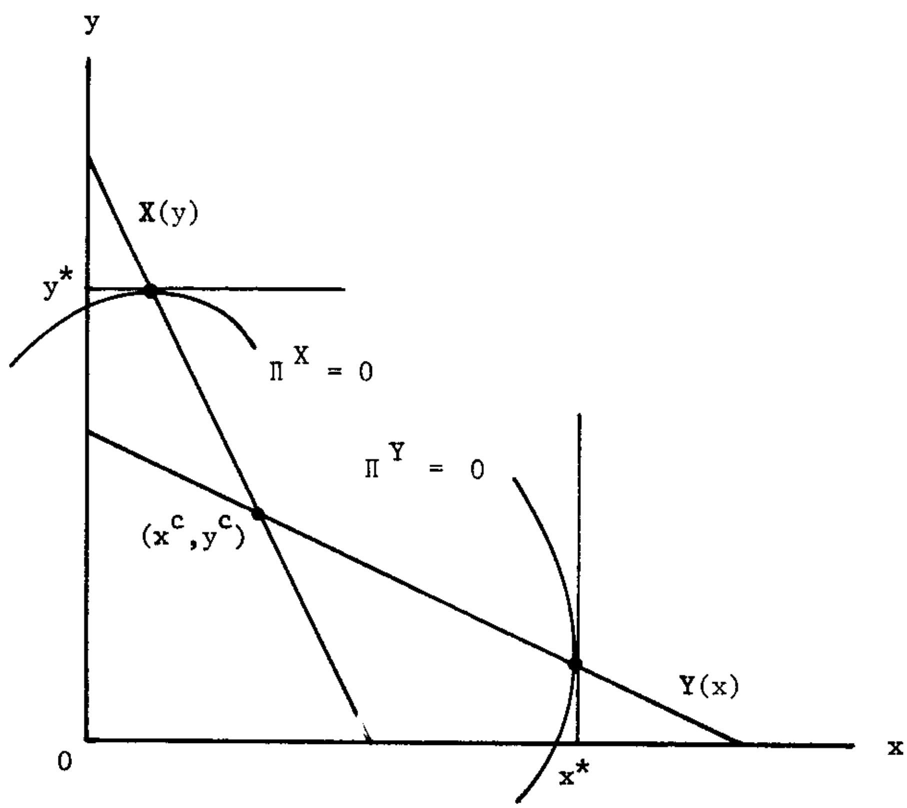

Figure 3.

		Y		
		Infeasible	Feasible Unprofitable	Feasible Profitable
	Infeasible	J-M	J-M	Ruin
X	Feasible Unprofitable	J-M	J-M	Ruin
	Feasible Profitable	Ruin	Ruin	?

Table 1. Plausible Equilibria For Various Feasibility/Profitability Combinations.

Table 2. Analysis of Games of Survival for the Symmetric Linear-Quadratic Case.

F_X	F_Y	x^*	$\hat{x}$	$\Pi^X(x^*, \mathbf{Y}(x^*))$	$\bar{R}^M_X$	$\hat{R}_X$	y^*	$\hat{y}$	$\Pi^Y(\mathbf{X}(y^*), y^*)$	$\bar{R}^M_Y$	$\hat{R}_Y$
50.00	50.00	40.99	25.91	-3226.58	94.46	--	40.99	25.91	-3226.58	94.46	--
50.00	150.00	34.39	25.91	-1519.52	94.46	--	40.99	25.15	-3326.58	94.46	--
50.00	250.00	29.84	25.91	-610.93	94.46	--	40.99	24.33	-3426.58	94.46	--
50.00	350.00	26.15	25.91	-32.66	94.46	--	40.99	23.44	-3526.58	94.46	--
50.00	450.00	22.96	25.91	351.51	94.46	106.39	40.99	22.48	-3626.58	94.46	--
50.00	550.00	20.10	25.91	603.94	94.46	196.38	40.99	21.40	-3726.58	94.45	--
50.00	650.00	17.50	25.91	759.38	94.46	409.83	40.99	20.16	-3826.58	94.46	--
650.00	650.00	17.50	20.16	159.38	94.46	409.83	17.50	20.16	159.38	94.46	409.83
550.00	650.00	17.50	21.40	259.38	94.46	409.83	20.10	20.16	3.94	94.46	196.38
450.00	650.00	17.50	22.48	359.38	94.46	409.83	22.96	20.16	-248.49	94.46	--
350.00	650.00	17.50	23.44	459.38	94.46	409.83	26.15	20.16	-632.66	94.46	--
250.00	650.00	17.50	24.33	559.38	94.46	409.83	29.84	20.16	-1210.93	94.46	--
150.00	650.00	17.50	25.15	659.38	94.46	409.83	34.39	20.16	-2119.52	94.46	--
50.00	650.00	17.50	25.91	759.38	94.46	409.83	40.99	20.16	-3826.58	94.46	--

Table 3. Determinants of Demand for Advertising Lineage.[1]

Independent Variables	Dependent Variable		
	ADN	ADR	ADC
PAD[2]	-0.716[b] (1.86)	-1.509[a] (3.35)	-1.054[b] (1.68)
DCMB	0.309[a] (2.59)	0.464[a] (3.35)	--
CIRC	1.050[a] (2.71)	1.549[a] (3.57)	1.054[a] (1.96)
SUBCON	-0.026 (0.44)	-0.113[b] (1.69)	-0.185 (1.24)
DFOL	-0.018 (0.13)	-0.212[c] (1.33)	--
Constant	3.159[c] (1.65)	2.271 (0.96)	4.570[c] (1.67)

[1]t-statistics appear in parentheses below the regression coefficients. Levels of significance (one-tail tests) are: a = 1 percent; b = 5 percent; c = 10 percent.

[2]PADN, PADR, PADC in the equations for ADN, ADR, and ADC respectively.

Table 4: Determinants of Advertising Lines Rates.[1]

Independent Variables	Dependent Variable		
	PADN	PADR	PADC
LABOR	0.076 (0.35)	0.088 (0.48)	-0.712[b] (2.02)
CCDENS	0.061[c] (1.42)	0.088[a] (2.46)	0.074 (1.07)
DEVE	0.052 (0.63)	0.026 (0.37)	0.042 (0.31)
CIRC	0.913[a] (11.58)	0.850[a] (12.94)	0.987[a] (7.74)
DFOL	0.030 (1.36)	0.027 (0.40)	0.371[a] (2.80)
DMONOP	-0.098 (1.22)	-0.041 (0.60)	-0.030 (0.23)
DLOSS	-0.096 (1.21)	-0.185[a] (2.80)	-0.291[b] (2.26)
DWARF	-0.199[b] (1.96)	-0.217[a] (2.56)	-0.147 (0.89)
DSICK	0.138[c] (1.34)	0.075 (0.88)	-0.053 (0.32)
Constant	-4.575[a] (9.42)	-4.815[a] (11.92)	-3.601[a] (4.58)

[1] t-statistics appear in parentheses below the regression coefficients. Levels of significance (one-tail tests except as noted in text) are: a = 1 percent; b = 5 percent; c = 10 percent.