WORKING

PAPERS

"COOPERATION VS. RIVALRY:

PRICE-COST MARGINS BY LINE OF BUSINESS"

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"Cooperation vs. Rivalry:

Price-Cost Margins by Line of Business"

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Federal Trade Commission

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The views expressed here are our own and not necessarily
those of the Federal Trade Commission or any of its members. A review has been conducted to ensure that the data in this paper do not identify individual company line of business data.
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Much of the recent literature on oligopoly price determination
has drawn on Cowling and Waterson's (1976) seminal work. Their contribution w~s to show that ~ general oligopoly model could be used to motivate cross-sectional studies of industry price-cost margins, employing the Herfindahl-Hirschman (H) index of concentration, the conjectural variation, and demand elasticity. More recently, Clarke and Davies (1982) have shown" that the H index is an implication of cost asymmetries, and they propose to parameterize a range of non-competitive behavior among firms in a Cowling-Waterson type model. The present paper is an effort to take that exercise an addi-
tional step forward. In particular, we draw on insights from recent empirical literature to further generalize these oligopoly models,
test some of the distinctive features of each, and explore some new implications using data far more disaggregated than previously avail-able. The relevant empirical developments are found in Kwoka (1979)
and Ravenscraft (1983). The former work examined the ,Tj 13.7284653.6624 0 0

important specific results, we find that leading firms' margins in each industry are lower when non-leaders are larger, and non-leaders' margins are diminished in industries where scale economies dictate more dominant leading firms. Despite exceptions, the pervasiveness of this rivalry phenomenon contradicts the traditional presumption that performance levels are shared by all firms in an industry. To that extent, the results are in the spirit of Demsetz's (1973) and Porter's (1979) findings. Further implications of these results for the theoretical model and empirical work are discussed in the last section.

I. Cooperation Models In this section, we contrast three major approaches to modeling cooperation/collusion: Cowling-Waterson, Clarke-Davies and the "shared asset" model. Our detailed data, described below, permit testing among these alternatives. The results of this testing also constitute the point

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The Lerner index can be derived from equation (1) and is given by:
(2) Lij = MSij(1 + Aij)/Tlj'
w her eMS l' J' is the fir m 's mar k e t s h are, A, . = t: ax k . I ax,

tive specifications. For example, they assume a static environment with a fixed number of firms, a homogeneous product, constant marginal costs and an exogenously determined conjectural variation. 4 A more traditional approach to oligopoly modeling, which has been called the "shared asset" model, acknowledges the difficulty of explicitly spe-cifying the correct functional form and elects a more direct but less rigorous path. It assumes that all firms share in the higher price that results from cooperation. Therefore, profits are assumed to be some positive function of industry-wide concentration. As with the previous models, the functional form is assumed to be linear.5 Market share is also included to capture scale economies and other possible size-related advantages. Hence, the Lerner index of the ith firm in the jth industry is:
(6) Lij = e~Sij + YCij.
While the role of demand elasticity is acknowledged in this model, no specific interpretation along those lines is given to the estimated coefficients in (6).
Equations (3), (5) and (6) therefore represent three related but different models of oligopoly pricing. They also can be viewed as subsets of the following equation:
(7) L i j = 61 M S i j + ~ C j + 63 C j M S i j .
All three theories suggest that 61 will be positive. In addition,
the Cowling-Waterson and Clarke-Davies models indicate that it should equal the inverse of the elasticity of demand. Each theory differs with respect to its prediction about the cooperation related para-meters 32 and 63' The Cowling-Waterson model predicts 62 = a and 63 > O. Clark-Davies model predicts 62 = -63 or equivalently that the two

4

concentration terms reduce to B2Cj(1 - MSij). The shared asset model hypothesizes that B2 > 0 and B3 = O.
Equation (7) is estimated using an unusually rich data source consisting of 3186 line of business (LB) observations on 258 Federal Trade Commission industry categories for the year 1975. 6 Each "line of business" denotes a firm's operation in one of its industries. The dependent variable is the LB's operating income divided by sales (Le., a LB's price-cost margin), where operating income is defined to be sales minus materials, payroll, advertising, other selling expenses, R&D, administrative expenses, and depreciation. In addi-tion to the variables in equation (7), the following control variable are included together with a constant term and are assumed to enter the model additively.
MES.; = 1977 industry minimum efficient scale: market share
of average plant size in top half of distribution;
G ROW j = in d u s,t r y g row t h : 1 9 76 d i v ide d by 1 97 2 val u e 0 f s hip men t s ;
DS.i = industry distance shipped (in thousands of miles):
radius within which 80 percent of shipments occurred;
I~Pj = 1975 industry

elasticity of demand between

II. Models of Rivalry
The above results support the Clarke-Davies model with one major exception -- the coefficient which estimates the degree of coopera-tion is negative. 9 To further understand this apparent anomaly, two assumptions employed by Clarke-Davies are relaxed.
First, single summary indexes of market structure, such as the four-firm concentration index and the Herfindahl-Hirschman index, are generalized to allow for the possibility of intraindustry rivalry. Second, the assumption that the aj's are identical for all firms in an industry is dropped. These changes yield significant insights into the interpretation of the negative coefficient on concentration. Clarke and Davies offer no theory of oligopoly in the sense of deriving the structural determinants of aj (or more directly, of ~ij). While most research has used the four-firm concentration ratio, they -- like Cowling and Waterson before them -- prefer the Y index, but for reasons that lay outside their theory. As Kwoka has noted, such summary indexes of market structure impose a variety of restric-tions on the role of individual market shares and, by implication, on interfirm behavior. For example, the four-firm concentration ratio adds up the top four market shares with equal weight, and ignores

possibility of a negative, rivalry effect from any firm.
Thus, our first modification will be to relax to some degree
these restrictions by letting industry-wide <::tj be a simple, linear function of the ordered sequence of market shares in that industry. That is:
k

(8) <::tj = m~1 BmSmj
where k is an empirically determined variable, 1 ~ k ~ N, represent-ing the subset of firms whose shares "matter", in the sense of having a significant impact on margins. Smj equals the mth firm share in the industry, ranked from largest to

changes undetected than would larger firms," i.e., smaller firm's conjectures may be closer to Cournot or rivalry. The empirical consequences of such different behavior are suggested by equation (8). That expression assumes identical interactions for all firms with respect to one other, whereas a number of oligopoly theories (domi-nant firm, price leadership, limit pricing, "strategic groups") would suggest important differences between leading and nonleading firms. We shall test empirically for such differences in aj'S between leaders and followers, along the lines suggested by Clarke and Davies. Furthermore, the role played by leaders can be expected to
differ depending on a number of factors conditioning the firms' environments. Prominent among these in the literature is the degree of scale economies. When economies are great, the price preferences of large leading firms may compress non-leaders' price-cost margins since the latter suffer cost disadvantages. By contrast, in low-scale industries, larger leaders are likely to have a less adverse effect on non-leaders' margins, cet. ~ For these reasons, too, the aj'S are predicted to be different, and we shall examine differ-ences between high and low-scale industries.

III. Empirical Evidence
We begin by first exploring the simplest case where the aj,s
are identical for all firms in an industry, but aj depends on k shares according to equation (8). To illustrate the implications,
let k = 2, i.e., only S1 and S2 are important to cooperation or rivalry. Then aj = S1S1j + are

control variables discussed above. From theory and earlier work it is apparent that we must include own share MSij plus a term inter-acting S1 j with one-minuS-MSij. The cooperation hypothesis implies that &t > 0; rivalry, that 61 < 0; and "independent" behavior, that
61 = O. In fact, our estimation procedure involves first the examina-tion of the effect of S1j by itself (in the form specified by the Clarke-Davies model, i.e., interacted with one minus market share). Next, S2j is added to the equation with S1j, then S3j is added, and
so forth, as long as s ignifican t (posi t i ve or nega t i ve) e ffec ts emerge. Thus, we will be performing two-tail tests on ordered sequence of 6's. Table II reports estimates of equation (9) using all 3186 line
of business observations, thus far without distinction between

value of 3.00. The addition of S4DMS ij to this group raises the F statistic slightly to 0.27, but still well below the critical F value of 2.60. The market shares of nonleading firms do not, in general, seem to affect the price-cost margins of firms in the industry, while the leading firm acts as a strong rival to the smaller firms. Thus, it is the negative effect of S1 which underlies and explains the negative impact of CR4 observed in Table I.

Under this definition, the empirical results on the leader
sample are presented in Table III. This model is entirely analogous

to that in Table II, with the proviso that MS ij now captures the leader's own share directly. The results, however, are quite dis-tinct. The crucial difference, in terms of the cooperation-rivalry theory, is the change in sign and significance of SlDMSij and
S2DMSij. The coefficient on SlDMSijwas negative and significant in Table II while it is positive and insignificant in Table III. This confirms the proposition that leaders are not lowering their own profitability through their rivalrous behavior. The coefficient on S2DMSij, which was insignificant in Table II, has a large significantly negative la28 985.9in

Similar, but statistically weaker, results were found for subsam-pIes consisting of leaders in consumer goods industries and producer goods industries. An important exception to this pattern emerges in the Food and Kindred Product group (industries in two-digit SIC 20). For this group, a positive and significant coefficient on the second share appears, suggesting cooperation between the top two firms.
This result corresponds to other empirical findings of stronger coordination in both food retailing and food manufacturing. 13
With respect to the follower group, the hypothesized importance
of scale economies (see Section II) leads us to split the group according to whether the firms are in the top or bottom half of the MES distribution. 14 In particular, we expect that larger leaders are likely to compress follower margins where the latter are disadvan-taged by scale considerations, but in low-scale industries the impact of larger leaders is ambiguous. Table IV confirms these predictions.

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In high-MES coordinatio1d

in the role of leaders' market shares is due to colinear factors (see footnote 12). It is also possible that other dimensions of struc-ture, like

try regressions (see Kwoka (1979) and Lamm (1981)) may be due to aggregation: Larger leading firms comprise more of the weighted average industry price-cost margin. Hence, the positive effect of S1

Footnotes

1Cowling and Waterson's aggregation of (3) gives industry mar-gins as: Lj = Hj(1 +)1j)/llj where)1j =

city utilization variable,

Table III -- Leading Firm Analysis

Dependent Variable - LB Operating Income/Sales

Independent
Variables

S1DMSij

S2DMSij

S4DMS· . lJ

MES· J

GROWj

DS· J

IMPj

ADVj

RDj

CA.Pj

CONSTI\NT

- .0904

(-1.33)

. 0231

(0.51)

. 3145

(2.81)

. 0525

(3.54)

- .0079

(-0.57)

- .0917

(-1.79)

. 7176

(4.08)

. 3428

(1 .07)

. 0493

(2.27)

. 1210

(2.42)

- .1413

(-2.62)

. 2056

(6.39)

2

. 0167

(0.20)

- .3015

(-2.23)

. 0288

(0.64)

. 3113

(2 • 8 1)

. 0507

(3.44)

- .0081

(-0.59)

- .0920

(-1.81)

. 7122

(4.08)

. 2865

(0.90)

. 0473

(2.19)

. 1246

(2.51)

-.1322

(-2.47)

. 2214

(6.36)

3

. 0136

(0.16)

-.4175

(-2.16)

. 2462

(0.84)

. 0301

(0.67)

. 2995

(2.68)

. 0500

(3.38)

- .0080

(-0.58)

-.0915

(-1.80)

. 7163

(4.10)

. 3092

(0.96)

. 0438

(1.99)

. 1256

(2.53)

-.1336

(-2.49)

. 2236

(5.88)

4

. 0155

(0.18)

-.4157

(-2.14)

. 2192

(0.58)

. 0455

(0.11)

. 0302

(0.67)

. 2974

(2.62)

. 0498

(3.35)

-.0079

(-0.57)

-.0918

(-1.80)

. 7150

(4.07)

. 3112

(0.97)

. 0435

(1 .96)

. 1262

(2.52)

-.1344

(-2.48)

. 2237

(5.41)

Notes: t statistics are in parentheses, except in R2 column which contains F statistics testing for the0 0 11.9

Table IV -- Follower Firm Analysis
Dependent Variable - LB Operating Income/Sales Independent
Variables