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Tobin's q Ratio and Industrial Organization: Further Results

THIRD DRAFT

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I. Introduction

A recent article by Lindenberg and Ross (1981) analyzed the use of Tobin's q as a measure of the upper bound of monopoly rents earned by firms.1/ Tobin's q is defined to be the ratio of a firm's market value to the replacement cost of the firm's assets. Lindenberg and Ross (LR) provide statistical evidence that suggests the value of Tobin's q is positively and significantly related to the firm's monopoly power as measured by an estimate of the Lerner index. In contrast, Tobin's q was positively, but insignificantly related to a weighted average of the 4-firm concentration ratios for the industries in which the firm competes. They stress, however, that their "results are subject to the usual caveats concerning data availability and quality, and improvements in these areas would greatly aid future research."2/

The evidence reported here suggests that the 4-firm concentration ratio, when measured more accurately, gains in statistical significance. More importantly, measures of intangible capital and market share are significant determinants of Tobin's q, but a measure of risk is not significantly related to q.

II. Analysis

LR were constrained in their analysis by the inadequacies of the available data. In particular, the method used by LR to assign an average industry concentration ratio to each firm is likely to result in significant measurement error. In their words:

Included on the COMPUSTAT tapes are the four-digit SIC codes, but, in some cases, adjustments were made on the tapes to account for a firm doing significant business in several industries with, say, the same three-digit code. For example, if a firm was significantly involved in industries 2011, 2012, 2013, ..., the recorded SIC code would read 2010. Consequently, it was necessary to construct averages (weighted by value of shipments) for all three-digit codes, two- digit codes, and so forth. For each firm, there is an associated concentration ratio representing the share of value of shipments in 1972 of the four largest firms in its 'industry.' (p. 27)

When firms are highly diversified, the SIC code assigned by COMPUSTAT reflects an increased level of aggregation. In addition, any assigned code undoubtedly encompasses markets in which the firm does not compete and excludes markets in which the firm does compete. Furthermore, it is not clear how LR were able to obtain meaningful 4-firm concentration ratios for their reconstructed 'industries.' In general, when two four-digit SIC industries are combined to form an aggregated industry, the four-firm concentration ratio of the aggregated industry will not equal a weighted average of the concentration ratios of the two four-digit industries. For these reasons, the concentration ratios used by LR are likely to be unreliable.

By using firm-level data which were unavailable to LR, the present study is relatively free of measurement error and permits the construction of additional explanatory variables and the testing of alternative hypotheses. Previous research indicates that market share is a better determinant of firm profitability than market concentration. As a predictor of profitability, however, market share can reflect both the efficiency advantages of relative firm size and

the price-increasing ability of larger firms. Monte Carlo estimates by Ravenscraft (1981) suggest that, when explaining firm profitability in the presence of scale economies, both concentration and market share variables are required to capture the industry price-increasing effects of concentration and the cost-reducing benefits of relative firm size, respectively. While Ravenscraft modeled only the cost-reducing effects of market share, a positive relationship between profit and market share could be viewed as a result of a firm-specific price-increasing effect rather than a cost-reducing effect of market share.3/ The market share variable does not, by itself, distinguish between these two interpretations, but rather captures a firm-specific advantage associated with market share.

If a positive profit-market share relationship is the result of a firm-specific price-increasing effect, it is still uncertain whether the higher firm prices reflect some monopoly power associated with market share, or some product quality and differentiation advantage which is correlated with market share. In that we include variables measuring advertising and research and development intensity, the market share variable may be more indicative of a firm-specific price effect resulting from monopoly power or a relative cost advantage enjoyed by firms with larger market share.

Since increased profitability will be reflected in an increased value of q, as higher profits are capitalized into greater market value, it should be possible to use concentration and market share variables to distinguish between collusion and firm-specific effects of market share when explaining Tobin's q. Accordingly, a weighted

average of the firm's market shares will be added to a measure of market concentration to capture any firm specific effects.

A variable not considered by LR is a measure of risk. It is expected that for any given level of profitability, investors will value the earnings stream less highly as the level of risk increases. Hence, a measure of risk will be added to the regression with the expectation that it will be negatively correlated with Tobin's q.

LR note that their estimates of q did not account for stocks of intangible capital which result from expenditures on advertising and research and development. This means that replacement costs may be biased downward and the value of q may be biased upward.4/ There is some question, however, concerning the extent to which the effects of advertising are long-lived, thereby creating intangible capital. Clarke (1976) presents evidence which suggests that the effects of most advertising are exhausted within a year. To the extent that Clarke is correct, the significance of an advertising variable would not be due to a correlation between the presence of advertising and an upwardly biased measure of q. Accordingly, measures of advertising and research and development activity will be added to the equation, in part to adjust for elements of intangible capital, to control for differences in product quality and differentiation, and to reflect enhanced control over price.

It should be noted that the estimate of Lerner's index used by LR [(sales-operating expenses)/sales] may be viewed more properly as an estimate of the gross sales margin than of the price-cost margin. As

such, the Lerner index measures actual performance, regardless of whether such performance is a consequence of market power or greater efficiencies. Accordingly, Lerner's index should be expected to outperform measures of market structure and firm market share.

III. Data and Variable Descriptions

Most of the data used in the present research are drawn from the 1972 Corporate Patterns Report (CPR) of the Federal Trade Commission, the 1973 Survey of Manufacturers, the concentration ratios published in the 1972 Census of Manufacturers, as adjusted by Weiss and Pascoe (1982), the COMPUSTAT data base and the CRSP data base. The 1972 CPR sample consists of 1239 of the largest manufacturing firms.5/ Because some of the 246 firms in the LR sample were non-manufacturing firms, only 200 firms could be matched with the CPR sample.

In the CPR sample, the value of shipments for each firm is provided according to 5-digit product classes. Following Weiss and Pascoe, the 5-digit product classes were either retained as meaningful economic markets, or aggregated to the 4-digit industry level. In some cases, two or more 4-digit industries were combined to reflect the inter-industry competition. According to these market definitions, the adjusted CPR data were used to compute the proportion (a_{ij}) of firm i's total value of shipments (s_i) in market j: That is:

$s_i = \sum_{j=1}^{n_i} s_{ij}$, $a_{ij} = s_{ij}/s_i$, $\sum_{j=1}^{n_i} a_{ij} = 1$, where s_{ij} is the value of shipments of firm i in market j, and n is the number of markets served by firm i.

By using the total value of shipments (S_j) of all firms in market

j, as provided in the 1973 Survey of Manufacturers,6/ it is possible to compute each firm's market share: $m_{ij} = s_{ij}/S_j$. A weighted average of a firm's market shares can be calculated as

$$\sum_{j=1}^{n_i} a_{ij}\, m_{ij} = \text{MKTSHR}_i .$$

By using the values of a_{ij} for each firm, it is possible to calculate weighted averages of various market-wide statistics. In addition to adjusting the 1972 concentration ratios to reflect more meaningful product market definitions, Weiss and Pascoe adjusted the 4-firm concentration ratios to reflect imports, exports and regional markets created by transportation costs. By using their adjusted 4-firm concentration ratio (cr4w), a weighted average can be calculated for each firm:

$$\sum_{j=1}^{n_i} a_{ij}\, (\text{cr4w}_j) = \text{CR4W}_i .$$

A Herfindahl measure of market concentration (herf_j) was calculated for each market using the CPR data:

$$\sum_{i=1}^{q_j} m_{ij} = \text{herf}_j ,$$

where q_j is the number of CPR firms in market j. Since the CPR sample does not contain all firms, the value of herf is biased downward. The weighted average of the Herfindahl indexes for the markets in which a firm participates is

$$\sum_{j=1}^{n_i} a_{ij}\, \text{herf}_j = \text{HERF}_i .$$

Two variables have been computed to measure the importance of advertising and research and development in the firm's market(s). The value of the firm's advertising variable (AD) was computed as a weighted average of IRS industry advertising-sales ratios, where the

weights were the fraction of a firm's sales in each industry. The patent variable (RD) was computed in the same way using data from Science Indicators (NSF).7/ Both these variables should be viewed as proxies, the accuracy of which depends on the stability of the industry averages over time and the uniformity of advertising and research and development activity across firms within each industry.

A measure of risk, BETA72$_i$, is calculated according to the capital asset pricing model using monthly security returns over the period of 1968-1972. The data are drawn from the CRSP data file. It was also possible to obtain an average risk measure, ABETA$_i$, over the 1960-1977 period. (For regressions using the BETA72, ABETA, AD and RD variables, insufficient data required that the sample be reduced to 155 observations.) And finally, following LR, the Lerner index of monopoly power, LER72$_i$, is approximated by the ratio of (sales-operating expenses)/sales for 1972.

The explanatory variables described above were used to explain Tobin's q as of 1972: TOBIN72$_i$. Although the CPR data are for 1972, the fact that market structure variables change slowly over time suggests that the average of the q ratio over the period of 1960-77, TOBINQA$_i$, may also exhibit a systematic relation with the explanatory variables. When explaining TOBINQA$_i$, the average of Lerner's index from 1960 to 1977, AVELER$_i$, was used in place of LER72$_i$.8/

IV. The Empirical Results

The weighted average of the adjusted 4-firm concentration ratios, CR4W, appears to be a significant determinant of the average value of q over the 1960-77 period, TOBINQA. See Table 1. However, the improved measurement of concentration does not produce statistically significant results in explaining TOBIN72, the value of q in a single year.8/ The estimated value of the Herfindahl measure of concentration, although biased, does provide a notable statistical improvement over the 4-firm measure of concentration. Further improvements are obtained by market share and the estimated Lerner index.

The Herfindahl measure of concentration is combined with market share to distinguish between the collusion and market share effects. Equations 5 and 10 in Table 1 fail to reveal any evidence of collusion. The significance of the market share variable could be due to relative efficiency or firm-specific attributes associated with market share which permit firms to increase profits.

TABLE 1

Dependent Variable: TOBINQA

Reg. #	Variable	Estimated Coefficient	t-ratio	R-squared
1	INTERCEPT	0.82	3.06	
	CR4W	1.57	2.89	.04
2	INTERCEPT	1.10	8.77	
	HERF	4.79	4.62	.10
3	INTERCEPT	1.14	11.01	
	MKTSHR	4.22	5.69	.14
4	INTERCEPT	0.13	0.77	
	AVELER	9.62	9.42	.31
5	INTERCEPT	1.13	9.12	
	MKTSHR	3.92	3.17	
	HERF	0.51	0.03	.14

Dependent Variable: TOBIN72

6	INTERCEPT	1.13	3.15	
	CR4W	0.92	1.29	.01
7	INTERCEPT	1.27	7.47	
	HERF	3.02	2.15	.02
8	INTERCEPT	1.25	8.77	
	MKTSHR	3.13	3.09	.05
9	INTERCEPT	0.37	1.85	
	LER72	8.29	6.49	.18
10	INTERCEPT	1.29	7.66	
	MKTSHR	3.78	2.23	
	HERF	1.10	0.48	.05

200 observations

One factor which may be related to market share and which may give firms greater control over price is differentiation and product quality arising from advertising and research and development. The inclusion of advertising and research and development variables should not only

help compensate for the measurement problems noted by LR in their estimates of q, but help determine whether MKTSHR's significance reflects a potential correlation between market share and product characteristics.

TABLE 2

Dependent Variable: TOBINQA

INTERCEPT	AVELER	MKTSHR	AD	RD	ABETA	R-Sq.	Obs.
0.07 (0.28)	8.42 (8.12)	2.54 (3.76)				.36	200
-0.01 (-0.05)	6.70 (7.29)	1.68 (2.77)	0.17 (5.63)	0.17 (1.41)		.45	155
0.05 (0.25)	6.65 (7.17)	1.67 (2.74)	0.17 (5.47)	0.18 (1.45)	-0.07 (-0.50)	.45	155

Dependent Variable: TOBIN72

INTERCEPT	LER72	MKTSHR	AD	RD	BETA72	R-Sq.	Obs.
0.29 (1.40)	7.71 (5.85)	1.63 (1.68)				.19	200
0.13 (0.62)	5.90 (5.00)	0.72 (0.81)	0.21 (4.85)	0.21 (0.94)		.28	155
0.61 (0.68)	5.10 (4.01)	0.71 (0.81)	0.20 (4.35)	0.20 (1.14)	-0.43 (-1.61)	.29	155

t-values in ()

Because the Lerner index captures actual performance and market share reflects only the potential for superior performance, MKTSHR should be insignificant when included along with the Lerner index (AVELER or LER72). It is clear from Table 2, however, that MKTSHR is significant in explaining TOBINQA, although it does lose significance in the TOBIN72 equation. MKTSHR retains its significance in the TOBINQA equation when AD and RD are added, suggesting the MKTSHR is not reflecting product characteristics. The measure of risk has the anticipated sign, but is insignificant.

V. Conclusion

The empirical results reported here reflect more accurate measures of market structure than available to LR, the use of market share and risk variables, and adjustments to account for intangible capital and product characteristics. The evidence indicates that while the estimates of Lerner's index remain the strongest determinant of Tobin's q, market share continues to play a significant role in explaining the average value of q, even after the advertising, research and development, and risk have been made. Whether market share reflects relative efficiency, firm-specific market power, or only reflects misspecification and remaining measurement error, remains to be determined.

Footnotes

1/ The paper by Lindenberg and Ross is the most rigorous analysis of Tobin's q in the context of industrial organization research.

2/ Lindenberg and Ross (1981), p. 30.

3/ Ravenscraft (1981), p. 7.

4/ Lindenberg and Ross (1981), p. 17.

5/ The FTC CPR does not include 64 firms which reported value of shipments by 5-digit product classes, but had a total value of shipments below 50 million. Those 64 firms are included in the data base used in this study.

6/ The 1973 Survey of Manufactureres contains corrections to the total value of shipments published in the 1972 Census of Manufacturers.

7/ The variables for advertising and research and development were supplied by Dennis C. Mueller.

8/ The values of q for 1972 were kindly supplied by Stephen Ross. The average values of q over the 1960-77 period were published in Lindenberg and Ross (1981).

9/ The LR results which are comparable to equation #5 are $q = 1.46 + .27(CR4)$, with a t-ratio for concentration (CR4) of 0.63 and an R-squared of 0.01.

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