Vertical Market Organization
and the
Structure-Profits Relationship

by

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Market structure research has concentrated substantial analysis on the relationship of market structure and profitability (Bain 1957, Weiss, and Federal Trade Commission for example). These analyses have generally relied heavily on seller concentration as the major explanatory variable for differences in industry rate of return. In some cases barriers to entry have also been considered. This study adds measures of market structure in vertically related input and output markets in order to improve the explanation of industry profit variability.

Introduction

A traditional hypothesis of market structure research is that higher levels of concentration lead to higher profit levels. Research in Industrial Organization has tended to focus this hypothesis on the firms relationship to its output market (Bain 1959, Caves, and Scherer). The result has been limited attention to input market effects on industry profit levels. The exclusion of vertical market structure from empirical analysis of structure-profit models may limit their explanatory power. A theory of profitability and vertical market structure is available. Singer (p. 208) concludes that "...the same amount of profit will be earned by a monopolist in the following market structures: (1) where a monopoly over a final product exists and the related input industries are purely competitive; (2) where a monopoly exists over both the final product industry and related input industries; and finally, (3) where a monopoly exists over an input industry and the necessary remaining inputs and final product are produced in purely competitive industries."

Between the extreme cases set out above price, output, and distribution of profit are unclear. However, these extreme cases do lend
credibility to certain hypotheses relating an industries vertical market structure to its rate of return. These hypotheses are:

1. Industries facing concentrated markets will have lower rates of return where they face either concentrated input markets or concentrated markets for their output.

2. Barriers to entry in an industry will result in increased rates of return, and

3. Barriers to entry in input industries will result in higher profits in the input industry and thus higher costs and lower profits to industries purchasing from them.

An earlier analysis (Brooks) has examined the impact of buyer concentration on industry rate of return finding significant linear relationship. Further, the addition of buyer concentration facing an industry improved the statistical relation of rate of return, seller concentration and barriers to entry.

The objectives of this paper are:

1. To extend the analysis of rate of return and vertical market structure to include structural measures for input markets.

2. To test the explanatory ability of these measures at two points in time.

Procedure

This study extends rate of return-concentration analysis by adding additional exogenous variables to control for the structure of input markets. Gambles and Levinson have shown that the relationship between rate of return and market structure is not a constant one through time. This study therefore applies the analysis to two different time periods.
Vertical market structure relationships being considered are illustrated in Figure 1. Hypothesized relationships with respect to X's rate of return for the variables identified are set forth as follows:

Assuming that the share of X's inputs purchased from I effects the ability of I to use monopoly power to exploit X then:

1. Seller concentration in I is negatively related to rate of return in X, and the larger the share of X's inputs coming from I the greater the impact of seller concentration on rate of return in X.

2. Barriers to entry in I is negatively related to rate of return in X.

Assuming that the share of I's shipments going to X effect X's ability to use monopsony power to exploit I then:

3. Buyer concentration in X is positively related to rate of return in X, and the larger the share of I's output purchased by X the greater the impact of buyer concentration on X's rate of return.

Assuming that seller concentration and barriers to entry are indicators of monopoly power then:

4. Seller concentration in X is positively related to rate of return in X;

5. Barriers to entry in X is positively related to rate of return in X.

Assuming that the share O's shipments from X limits O's ability to use buyer concentration to exploit X then:
Figure 1
Simple Model of Industry Vertical Relationships

VERTICAL INTERRELATIONSHIPS

I_1

I_2

I_3

X

0_1

0_2

0_3

Seller Concentration
In I

Share of X's Inputs
From I

Impact of I on X

Impact of X on I

Share of I's Shipments
Going to X

Buyer Concentration in X

Seller Concentration
In X

Impact of X on O

Impact of O on X

Share of X's Shipments
to O

Buyer Concentration in O

X = Industry whose rate of return is effected.
I's = Industries from whom X purchases inputs.
O's = Industries who buy output from X.
6. Buyer concentration in 0 is negatively related to rate of return in X, and the higher the share of X's output going to 0 the greater the impact of buyer concentration in X's rate of return.

Development of the output and input variables is consistent with the theory of vertical market structures. This is not to suggest that all the relevant market structure variables have been included. But rather that the effects of an analysis that goes beyond traditional variables of seller concentration and barriers to entry needs to be examined.

The weighting process implied by the assumptions above requires comprehensive data on interindustry shipments. These data are generally available for specific time periods from *Input-Output Structure of the U.S. Economy* published by the U.S. Department of Commerce. The two most recent dates for which input-output statistics are available are 1963 and 1967. These years were chosen as the time periods for comparison.

The 2-digit SIC level of aggregation for manufacturing industries was selected. The 2-digit level is the only level at which comparable data for all measures are readily available and it provides comparability with Brook's study. These data are available for 1963 and 1967 from three sources: U.S. Census Bureau, Internal Revenue Service, and Department of Commerce.

Operationalizing Variables

These variables are calculated and presented in Appendix Tables 1 and 2.

Endogenous Variable. Rate of return (R) is operationally defined as net income (less deficit) before taxes plus interest paid as a percent of
total assets. The data are from Table 3, 1963 and 1967, Statistics of Income: Corporation Income Tax Returns, Internal Revenue Service.

Exogenous Variables Output Market. Seller concentration in an industries output market (SCO) is an average of the component industry 4-digit SIC four-firm concentration ratios, weighted by the value of shipments from each industry, and is expressed as a percent. Data are from Concentration Ratios In Manufacturing Industry, 1963, Department of Commerce and Census of Manufacturing, 1967, Department of Commerce.

Barriers to entry in the output industries (BEO) is the advertising to sales ratio in an industry adjusted for the proportion of sales going to personal consumption. Adjustment of the advertising to sales ratio is made because the barrier to entry created by product differentiation through advertising is a more significant factor in consumer than producer goods markets (Brooks, p. 158-159). Advertising and sales (business receipts) data are obtained from Table 3 of 1963 and 1967 Statistics of Income: Internal Revenue Service, Corporation Income Tax Returns.

Industry SIC 33, Primary Metals, has almost no output to personal consumption (Appendix Tables 3 and 4) and has the lowest advertising to sales ratio (Appendix Tables 1 and 2). This advertising to sales ratio in primary metals is therefore assumed to be the advertising to sales ratio in each industry's producer goods market. This ratio is then weighted by the intermediate output for each industry. THE BEO measure is obtained by subtracting the weighted advertising to sales ratio for producer goods from the industry's overall advertising to sales ratio and dividing by industry' shipments to personal consumption:
\[
\text{BEO}_i = \frac{(A/S)_i (Sf_i + Sp_i) - (A/S)p \ (Sp_i)}{Sf_i}
\]

where \( \text{BEO}_i \) = the measured barriers to entry in an output industry

\( A/S_i \) = the measured advertising to sales ratio in an output industry

\( (A/S)p \) = the measure of advertising to sales in producers goods markets (Primary Metals)

\( Sf_i \) = value of shipments to personal consumption for an industry

\( Sp_i \) = value of shipments to intermediate output for an industry.

The following terms are defined as elements used in constructing the remaining measures of vertical market structure:

\( SCO_i \) = seller concentration in industry \( i \) (see above).

\( Sf_i \) = personal consumption for industry \( i \) (see above).

\( S_{ij} \) = shipments from industry \( i \) to industry \( j \). See appendix tables 1 and 2 where for example, \( S_{20j} \) = the row vector indicating shipments from the food industry to other industries and \( S_{120} \) = the column vector indicating shipments from other industries to food.

For any \( j \), \[ \sum_{i=20}^{39} S_{ij} = \text{total input shipments}. \]

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For purposes of this study, all distributions of output other than to the twenty manufacturing industries used in the study and to personal consumption are ignored. These shipments represent about 70 percent of total manufacturing output. It is assumed that further refinements to the data would not significantly alter the relationships examined.
Buyer concentration of an industries output (BCO) is obtained by first assuming that the purchasing concentration in an industry is the same as the selling concentration in that industry. This would mean that every firm in an industry buys inputs in the same proportions as its share of total output. Each industry's buyer concentration is initially measured by SCO. A portion of total output is purchased for personal consumption, and the concentration of this market is assumed to be zero. Furthermore, it is necessary to exclude an industries purchases from itself (i=j). A model relating rate of return to input and output market structure is at a loss to predict what will happen when an industry sells to itself.

The BCO measure for industry i is the weighted sum of buyer concentration for the j industries buying from i. The weighting factor is the share of i's shipments to j over shipments to intermediate goods plus personal consumption.

\[
BCO_i = \sum_{j=20}^{39} \left( SCO_j \left( \frac{S_{ij}}{\sum_{j=20}^{39} S_{ij} = Sf_i} \right) \right)
\]

**Exogenous Variables Input Market.** The measure of structure on the input side of a vertical market system has received little attention. Industry rate of return may be influenced by market structure on either or both the input and output sides of the market. Input measures considered are defined below, analogous to the market output structure measures.

The buyer concentration of industry j as an input buyer (BCI) is defined as the seller concentration in output (SCOj) of that industry weighted by the proportion of each input industry's shipments (i to j) (intermediate and personal consumption) going to j.
\[
\text{BCI}_j = \frac{39}{\sum_{i=20}^{39} \text{SCO}_j \left( \frac{39}{\sum_{i=20}^{39} S_{ij} + S_{j1}} \right)}
\]

The input industry seller concentration (SCI) impact on industry \( j \) is measured by the SCO for each industry \( i \) weighted by the proportion of \( j \)'s inputs from each \( i \):

\[
\text{SCI}_j = \frac{39}{\sum_{i=20}^{39} \text{SCO}_i \left( \frac{39}{\sum_{i=20}^{39} S_{ij}} \right)}
\]

Barriers to entry in input industries (BEI) impacting on \( j \) is the sum of BEO\(_i\) weighted by the share of \( j \)'s inputs from \( i \):

\[
\text{BEI}_j = \frac{39}{\sum_{i=20}^{39} \text{BEO}_i \left( \frac{39}{\sum_{i=20}^{39} S_{ij}} \right)}
\]

Models. The models used in the analysis assume linear relationships. Multiple regression analysis was used to estimate the relationships between rate of return and selected structural variables. The initial model used was that presented by Brooks which related to the output market:

\[ R = a + b_1 (\text{SCO}) + b_2 (\text{BCO}) + b_3 (\text{BEO}). \]

This model represented Brooks attempt to add buyer concentration to the more generally used model relating seller concentration and barriers to entry to rate of return.

The second model employed adds measures of input market structure to the equation:

\[ R = a + b_1 (\text{SCO}) + b_2 (\text{BCO}) + b_3 (\text{BEO}) + b_4 (\text{SCI}) + b_5 (\text{BCI}) + b_6 (\text{BEI}). \]

The models were estimated first for 1963 and then for 1967. This allowed evaluation of the contribution of the input structure variables to
the explanation of variance in rate of return. It also allowed a comparison of both models in two time periods.

Results, 1963

The conventional model relating rate of return to seller concentration for 1963 resulted in a positive and significant relationship. Equation one in Table 1 shows a significant value both for the t test of the regression coefficient and the F test. The $R^2$ statistic indicates that variation in seller concentration explains about 57 percent of the variation in rate of return.

When measures of barriers to entry and buyer concentration facing an industry are added (equation 5, Table 1) the $R^2$ statistic rises to .76. Further, the signs of the b values are as hypothesized with seller concentration and barriers to entry positively related to rate of return and buyer concentration negatively related to rate of return. The t values for the regression coefficients are also significant.

Adding the input market structure measures to the regression equation, results in further improvement of $R^2$. In equation 9 BCI is positively related to rate of return (as hypothesized) and has a significant t value. Further $R^2$ increases from .76 in equation 5 to .86 and F continues to be significant. While SCI does not produce a significant t value, it does have the hypothesized sign. The sign of the coefficient for BEI is negative as was hypothesized. BEI does not however have a significant t value.

Using F tests to compare the addition of the output and input variable indicated a significant improvement. When BEO and BCO are added to the equation: $F = 6.33$, $F_{.05} = 3.63$. When SCI, BCI, and BEI are added the improvement is not significant at .5 percent but is significant at the 10 percent probability level ($F = 3.10$, $F_{.10} = 2.56$).
The general results for 1963 supported our hypotheses that the structure of input and output markets were helpful in explaining industry rate of return.

Results, 1967

The results using 1967 input-output data are substantially different than those for 1963. Equation 3 (Table 1), with seller concentration of output as the only variable, had an $R^2$ of .07. The t-value for the SCO regression coefficient was not statistically significant, although the sign was positive as hypothesized.

Adding BCO and BEO in equation 7 increases the $R^2$ to .33. All variables still have the hypothesized signs. The regression coefficients for SCO and BCO are not statistically significant, but that for BEO is. A strong association between rate of return and barriers to entry in output markets as measured exists despite lack of statistical significance for SCO.

Results adding the input market structure measures for 1967 are shown in equation 11 (Table 1). Addition of these variables resulted in an increase in $R^2$ to .65 from .33. The regression coefficient for BCI is statistically significant, but the sign is negative rather than positive as hypothesized. The regression coefficient for SCI is not significant. Further, the sign is positive rather than negative. The derived nature of SCI from SCO might lead to the expectation that SCI may not be significant since SCO is not significant. Barriers to entry in input industries (BEI), is significant. BEI also has the hypothesized negative sign. Barriers to entry in output industries (BEO) is not significant, while SCO is significant.
| Numbers in parentheses below the F statistics are the significance levels for each F. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Numbers in parentheses below the regression coefficients are t values. |

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Regression results 1963-1967

Table 1

-12-
Using F tests to compare the addition of output and input variables indicated a significant improvement in the model. The addition of BEO and BCO was significant at the 10 percent (F = 3.27, F.10 = 2.67) while the addition of SCI, BCI, and BEI was significant at the 5 percent level (F = 3.96, F.05 = 3.41).

Results, Comparison 1963 and 1967

Comparison of the 1963 and 1967 results for output market structure measures indicates a radical difference for 1967 over 1963. Neither seller or buyer concentration are significant in 1967 when input measures are not included. Industry rate of return (R) is significantly higher for 1967 although seller concentration (SCO) remains unchanged.4/ Decline in significance of seller and buyer concentration may be due to rising demand during 1967 compared to 1963. Increased rate of return with relatively little change in seller concentration for 1967 is consistent with this hypothesis.

Percentage change in the index (1967 = 100) of industrial production (GRTH) from 1960 to 1966 for 1963 (Appendix Table 1) and 1964 to 1970 for 1967 (Appendix Table 2) was initially employed as a growth measure (GRTH) to evaluate the hypothesis of rising demand in 1967. A positive regression coefficient would be anticipated. Data for this growth measure were computed from 1971 Business Statistics, Department of Commerce. The regression coefficient for the variable was not significant in either 1963 or 1967, although the relationship was positive.5/

The Effect of Excess Demand

To further explore the hypothesis of rising demand during 1967 another variable was defined to measure excess demand (ED). This variable was
defined as the percentage change in end of year inventories divided by the percentage change in shipments. Data for this measure were taken from the Annual Survey of Manufacturers.

The addition of the excess demand measure was hypothesized to have a positive effect on profits when demand was rising. When ED was added to the regression analysis (Table 1 equations 2, 4, 6, 8, 10, 12) it had a substantial effect on the 1967 results. In all of the models for 1967 (equations 4, 8, and 12) ED has a significant t value. Further the addition of ED increases $R^2$ substantially. When F tests are applied to the addition of ED it is significant at the 5 percent level ($F = 6.95$, $F_{0.05} = 4.45$) for the first comparison (equation 3 vs. 8) and significant at the 10 percent level for the second and third comparison (equation 7 vs. 8 and 11 vs. 12 with $F = 4.33$, $F_{10} = 3.07$ and $F = 3.55$, $F_{10} = 3.18$ respectively).

The addition of ED increases the t value for SCO in all equations for 1967. Further the addition of ED reduces the significance of BCO, SCI, BCI, and BEI all which might be expected to be less important with rising demand. The addition of ED does not remove the problem of conflicting signs for SCI and BCI in 1967.

Concentration-Profits Over Time

The results of the excess demand analysis indicated that the impact of concentration on profits is very much related to the economic climate at the time the relationship is tested. In order to get further insight into this relationship the market structure measures in the study (SCO, BCO, BEO, BEI, BCI, and SCI) were regressed against profit data over a range of years surrounding 1963 and 1967. The results of this analysis
generally supported the results when adding ED. Where the 1963 structure variables were run against annual profit data from 1958 through 1966 the relationship between structure and concentration was relatively stable and significant for all years except 1966. When the 1967 structure variables were run against annual profit data from 1964 to 1969 the significance of the relationship declined steadily. In general in periods of rapid economic growth the concentration-profits relationship deteriorates.7/

Implications

Research on the relation of rate of return and market structure has always paid lip service to vertical market relationships. Few empirical studies have included specific measures of market structure in the input or output industries. This study and that of Brooks have shown the importance of taking vertical market structures into account. While the regression results reported here are not overwhelming, they add supporting evidence to theoretical propositions regarding rate of return and vertical structural variables.
1. This is not to imply that vertical market structure has been ignored but to indicate that the major emphasis has been on seller concentration and other horizontal market measures.

2. Use of the term significant indicates, unless otherwise specified, the 5 percent probability level.


4. Using the paired t-test at 5 percent, $t_{19} = 3.37$ for $R$ and $t_{19} = .78$ for SCO with the table $t_{19} = 1.73$. Paired t-test from *Statistical Inference* by Li, Ann Arbor, Michigan: Edwards Brothers, Inc., 1964.

5. The regression results were:

   1963:  $R = 5.08 + .13 SCO + .27 BEO - .11 BCO + .02 GRT$  
          (4.77)  (2.94)  (-3.06)  (.88)

   1967:  $R = 10.52 + .03 SCO + .30 BEC - .09 BCO + .02 GRT$  
          (.73)  (1.93)  (-1.70)  (.52)

   with numbers in parenthesis indicating t-values for regression coefficients.

6. Ideally one would compare the relationships measuring each variable over a number of years. Data is not available for some of the measures except at specific points. The stability of the structural variables does indicate that these variables do not vary greatly over time.

7. A similar analysis was run for return on sales with substantially the same results. Return on sales was derived from IRS data. The data are from Table 3, 1963 and 1967, *Statistics of Income: Corporation Income Tax Returns*, Internal Revenue Service.
REFERENCES


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Appendix Table 3 & 4

Distribution of Output for the Industries Used in the Analysis

Appendix Tables 3 and 4 show the value of shipments from each of the twenty 2-digit manufacturing industries to each of those same industries plus, for each industry,

1. the subtotal of value of shipments to manufacturing industries
2. total value of shipments to all industries (total inter-industry transfers)
3. value of shipments to final demand markets
4. adjustments for
   (a) shipments to governments
   (b) capital formation
   (c) changes in inventory
   (d) net exports
5. the total value of shipments for each industry.

NOTES:

1. The supplying industries are read from the left column, and the distribution is read across the top of the table.
2. 0 means no shipments.
3. * means that there were shipments, but their value was too small to be of any significance.
4. Figures are in millions of dollars at producer's prices.
5. The figures in parentheses in each of the right-hand columns represent the fraction that that entry represents of the total industry shipments, except that the subtotal of shipments to 2-digit industries is shown as a fraction of total inter-industry transfers.
6. Textile mills was defined to include all SIC industry classifications of 22 while apparel was defined to include all SIC industry classifications of 23 and 39996.

|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|

**Notes:**

- This table presents the input-output distribution in millions of dollars for 20 two-digit industries of the United States economy, 1969.

**Appendix Table 3**
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Appendix Table 4


Note: 1965.