The Choice of Structure Measure in Industrial Economics

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Previous empirical studies of the structure-performance model in industrial economics generally have found individual firm market share to be superior to both the Hirschman-Herfindahl and four firm concentration ratio in explaining cross-sectional variation in profit. The approach in prior studies is to treat the choice between market share, the four firm concentration ratio, and the Hirschman-Herfindahl as a test of nested hypotheses. This paper employs empirical techniques appropriate for nonnested hypotheses. The finding suggests that although the Hirschman-Herfindahl and leading firm market share should be included in the model, the four firm concentration ratio can be deleted.

INTRODUCTION

Recent empirical research from the field of industrial economics fails to find the strong positive correlation between industry profits and market concentration that is hypothesized by the structure-performance model. Moreover, recent findings suggest that the correlation between firm market share and industry profit is stronger than the profits-concentration correlation and that when market share is included as a variable in regression models, concentration often is found to have a negative impact on profits (Ravenscraft, 1983; Branch, 1980; Gale and Branch, 1982). Kwoka (1979) offers an explanation for the observed negative coefficient for the four firm concentration ratio (CR4). His analysis uses nonpublic Federal Trade Commission data. His regressions of industry profit rates on the market share of the four largest firms reveal a negative coefficient for the share of the third firm and a statistically insignificant coefficient for the share of the fourth firm. Kwoka concludes, therefore, that the difficulty with CR4 arises from the inclusion of one irrelevant firm share (the fourth firm) and one firm share with an incorrect sign (the third firm). The recent literature discredits the tacit collusion or shared monopoly view that generally is associated with the structure-performance model and lends credibility to the revisionist or efficiency view which suggests that individual firm efficiency explains profit variation.

Proponents of the structure-performance model claim that the market concentration ratio is not the preferred structure measure for empirical models. Industrial economists generally regard the Hirschman-Herfindahl index as superior to the concentration ratio as a measure of market structure. A major advantage of the Hirschman-Herfindahl results from its sensitivity to both the number of firms and the relative firm size distribution.[1]

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[1] For an excellent review of the theoretical arguments related to the choice between the Hirschman-Herfindahl index and CR4, see John E. Kwoka, Jr., "The Herfindahl Index in Theory and Practice," *Antitrust Bulletin*, 30 (Winter 1985), pp. 915-947.

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Jacquemin (1987) analyzes a number of concentration indexes and defines desirable properties of concentration measures in terms of their ability to capture changes in numbers of firms as well as changes in the firm size distribution. He places particular value on the capacity of a concentration measure to capture the influence of large firms on the market. Although Jacquemin cites the properties listed above as desirable, he argues that the ultimate test for the usefulness of a measure is determined by the statistical properties associated with the measure.

Using various statistical criteria such as adjusted R^2 and comparisons of statistical significance levels for the coefficients on structure variables, prior studies conclude that the Hirschman-Herfindahl provides no more than modest improvement over CR4 in the structure-performance model. Several studies use foreign data (Hause, 1977; Cowling and Waterson, 1976; McFetridge, 1973; and Jones, Laudadio, and Percy, 1973) to compare the explanatory power of alternative structure measures. In general, these studies conclude that the Hirschman-Herfindahl index provides little or no additional explanatory power as compared to the concentration ratio in the structure-performance model. Conversely, the work of Cowling and Waterson, who conclude that the Hirschman-Herfindahl is consistently superior to CR4 in explaining cross-sectional variation in the price-cost margin, provides the one exception to this conclusion.

Although the foreign studies provide some insight, differences in the social and legal frameworks restrict their direct application to the U.S. Studies of the U.S. economy generally cover a particular sector such as banking (Fraser and Rose, 1976) or the savings and loan industry (Marlow and Wright, 1987). These studies provide insight regarding specific industries, but they are of little value in assessing the relative usefulness of the Hirschman-Herfindahl index and CR4 in explaining variations in profit across all industries.

John Kwoka's research utilizes U.S. data that cover all manufacturing industries. Kwoka (1979 and 1985) finds a slightly stronger statistical relationship between the Hirschman-Herfindahl and price-cost margin as compared to the relationship between the four firm concentration ratio and PCM. Kwoka, however, finds individual firm market share superior to both Hirschman-Herfindahl and CR4 as regressors in the structure-performance model. Kwoka's treatment of the model selection question as a test of nested hypotheses, when the choice between competing structure measures is nonnested, raises a serious question. Kwoka's research undoubtedly provides important insights, but his use of a nested model selection technique results in a failure to test properly for the possibility that multiple structure measures best specify the model. The nonnested techniques used in this paper allow for the possibility of including multiple measures within the model.

The empirical work of Harold Demsetz (1973) and the revisionists suggests that leading firm market share should be important in determining variations in profit rates. Demsetz argues that firm level efficiencies are rewarded through elevated profits and increased market shares. Although Demsetz acknowledges that there is a positive relationship between industry profit rate and the four firm concentration ratio, he argues that large firm efficiency is the causal factor rather than tacit collusion. His arguments imply that the market share of the leading firm should be related more closely to overall industry profitability than to the four firm concentration ratio or Hirschman-Herfindahl index.

Comparisons of CR4 with individual market shares suggest that market share is related more closely to variation in industry profit rates than is concentration (Ravenscraft, 1983; Branch, 1980; Gale and Branch, 1982). While the revisionists are willing to claim that this empirical research provides compelling evidence that efficiency rather than collusion explains variation in profit, debate of this issue continues. There are at least two arguments that cloud the revisionists' claim to victory. First, Shepherd (1986) argues that market share denotes a highly flawed measure of efficiency. Shepherd acknowledges the importance of market share, but he argues that share serves as a proxy for individual firm market power rather than for efficiency. Second, the Hirschman-Herfindahl rather than CR4 may represent the preferred measure of collusive opportunities.

This paper develops and texts empirical models that compare the four firm concentration ratio, leading firm share, and the Hirschman-Herfindahl index as explanatory variables in the structure-performance relationship. The research improves upon previous empirical studies in two important respects. First, it employs a database that covers all U.S. manufacturing for the sample year 1982. Previous studies have used data for single sectors of the economy or data that cover only a portion of manufacturing. The data include actual Hirschman-Herfindahl values that are computed using the market shares of all firms in each industry.

The second major contribution of the paper relates to the issue of nesting. By evaluating coefficients generated from restricted models, previous studies implicitly have treated hypotheses as nested. A popular techniques employs F-tests to compare restricted models in which the coefficient of one or more variables are set to zero coefficients. Treating the hypothesis as nonnested, however, provides a more appropriate evaluation of the alternative structure measures. It is apparent that nonnested hypotheses best test model specification because CR4, the Hirschman-Herfindahl index, and leading firm share represent proxies for different aspects of market structure. It is possible that the appropriate structure-performance model could contain all three measures or any combination of the three. Should the true model contain more than one measure, imposing restrictions upon the model introduces specification error that invalidates inferences regarding the relative explanatory power available from the alternative measures (Kmenta, 1986). This paper analyzes the three structure measures described above using a nonnested framework. The empirical analysis uses the J-test which was developed by Davidson and McKinnon (1981) for the purpose of model selection with nonnested hypotheses.

DATA

The *Census of Manufactures* for the sample year 1982 provides basic data for the paper. Changes in demand and capital intensity over time are measured using census data for the years 1977 through 1982. The data set contains 440 observations covering the entire manufacturing sector and Hirschman-Herfindahl measures computed by the Census Bureau covering the entire firm size distribution in each industry. Hirschman-Herfindahl values are missing for 14 industries as a result of government disclosure provisions. For these 14 industries, I generate proxies using the average of upper and lower bound estimates as set forth by Eckard (1989). For those industries with published Hirschman-

Herfindahl values, I find a .98 correlation between the true Hirschman-Herfindahl index and Eckhard's proxy.[2]

The level of aggregation for the study consists of the four digit SIC industry., *The Internal Revenue Service: Source Book of Corporate Statistics of Income*, which utilizes the enterprise standard industrial classification, serves as the source for supplemental advertising data. The empirical analysis treats the model selection choice between the concentration ratio, leading firm market share, and Hirschman-Herfindahl as nonnested and applies empirical techniques appropriate for testing nonnested hypotheses. The structure-performance model, which relates industry profit rates to structure measures, entry barriers, and other structural variables such as change in demand, provides the theoretical framework for the study.

MODEL SPECIFICATION AND EMPIRICAL RESULTS

The structure-performance relationship, which has its formal origins in the work of Bain, Mann, Weiss, Shepherd, and others, provides the theoretical foundation for the basic regression model. Equation (1) presents the basic specification:

$$(1)\ PCM = \alpha_0 + \alpha_1 CR4 + \alpha_2 HERF + \alpha_3 SHARE + \alpha_4 ADIN + \alpha_5 SCALE + \alpha_6 CAPIN + \alpha_7 IMPTS + \alpha_8 GROW + \mu$$

Unless stated otherwise, all variables are measured at the SIC four digit level, are census based, and cover the 1982 sample year. Variable definitions are:

PCM = The price-cost margin measured as value of shipments minus payroll and material cost divided by value of shipments;
CR4 = The four firm concentration ratio;
HERF = The Hirschman-Herfindahl index;
ADIN = The ratio of advertising expenditures to total receipts enterprise standard industrial classification (IRS-based);
CAPIN = Capital intensity measured by the ratio of capital expenditures for the years covering the period 1977 to 1982 over value added for 1982;
SCALE = The ratio of capital intensity for the eight largest firms in each industry to the capital intensity of the firms not included among the largest eight;
IMPTS = The import ratio measured by the ratio of total imports to value of shipments;
SHARE = An empirical proxy for the leading firm's market share defined as the midrange estimate of the leading firm share as set forth by Eckard;[3] and

[2] These proxies could be replicated by obtaining CR4 and CR8 for each industry and following the procedure set forth by E. Woodrow Eckard, Jr., "The Extent of Single Firm Dominance in U.S. Manufacturing Industries," *Review of Industrial Organization* (Spring 1989), pp. 23-39.

[3] The author is grateful to Woodrow Eckard for making available estimates of the leading firms' share. Eckard's estimates do not include 14 industries included in the sample for this study. For these industries, the average of the naive upper and lower bound estimates are used. The naive lower bound is CR8 + 8. The naive upper bound assumes firms 2 through 8 have equal share with the remaining portion of CR4 assigned to the leading firm. For a detailed discussion of Eckard's approach to measuring leading firm share, see E.

GROW = Growth in demand measured by the change in industry value of shipments between 1977 and 1982.

Theoretical arguments and empirical evidence suggest that CR4 and HERF should be related positively to variation in the price-cost margin (Scherer, 1990). A positive and significant coefficient for either or both of these variables would provide evidence supporting the shared market power or collusion view from industrial economics. The model includes leading firm share to address the efficiency effects arguments presented by Demsetz and others, with a positive relationship expected between leading share and price-cost margin (Shepherd, 1990).

Advertising intensity (ADIN), scale, and capital intensity (CAPIN) are included to capture product differentiation, scale effects, and capital requirements as entry barriers and would be expected to be related positively to price-cost margin. The import ratio (IMPTS) captures the effects of import growth on the price-cost margin and would be expected to be related negatively to that measure of domestic profitability. Change in value of shipments (GROW) captures the impact of demand growth upon the price-cost margin and would be expected to be related positively to the price-cost margin due to the greater opportunity for profit that accompanies growth in demand (Scherer, 1990).

The work of Salinger (1990) suggests that imports may have a significant impact on the structure-performance relationship. Precedent exists in the work of Coughlin and Watkins (1985) for generating import-adjusted market structure measures. The works of Salinger and Coughlin and Watkins support the use of adjusted structure measures for CR4, SHARE, and HERF. I generate adjusted values by first computing total sales in the market including imports and then calculating the domestic share of the import-adjusted total market. Import-adjusted values for CR4 and SHARE result from multiplying the raw values of CR4 and SHARE by the domestic share of the market. To compute adjusted HERF, multiply the square root of the Herfindahl index by the domestic share of total sales and square the product.

By comparing t-statistics for structural coefficients and performing F-tests for restricted models, previous research implicitly treats the choice between the Hirschman-Herfindahl and the concentration ratio as a nested hypothesis test. Jacquemin addresses the question of nesting by arguing that no structure measure is specified precisely. The fact that previous studies alternately find CR4, leading firm share, and the Hirschman-Herfindahl significant indicates that combinations of structure measures may be appropriate and thus provides evidence regarding the nonnested nature of the hypothesis test. An alternative approach to the question of model selection treats the choice between CR4, leading firm share, and the Hirschman-Herfindahl as a test of nonnested hypotheses and utilizes the J-test technique developed by Davidson and McKinnon (1981).

The nonnested hypothesis test can be expressed as:

(1a) $Y = X_1\beta_1$

Woodrow Eckard, Jr., "The Extent of Single Firm Dominance in U.S. Manufacturing Industries," *Review of Industrial Organization* (Spring 1989), pp. 23-39.

(1b) $Y = X_2\beta_2$,

where X_1 and X_2 may share some common variables, but neither hypothesis can be derived by merely placing restrictions on variables from the overall model. The simplest approach for testing nonnested hypotheses involves the technique that has come to be referred to as *artificial nesting* (Kmenta, 1986). Artificial nesting involves performing an F-test on the combined equation:

(2) $Y = X_1\beta_1 + X_2^*\beta_2^* + \varepsilon$,

where X_2^* contains all of the elements of X_2 except those that are common to X_1. The null hypothesis then is:

H_0: $X_1\beta_1$ is the true model; and
H_a: $X_1\beta_1$ is not the true model.

Because the hypotheses test X_1 against a hybrid of X_1 and X_2 rather than against X_2, artificial nesting fails to solve the model selection problem (Kmenta, 1986). A nonnested test requires that X_1 be tested against the true X_2, not against a hybrid of X_1 and X_2. Davidson and McKinnon (1981) suggest an alternative to the F-test that is represented by equation (3):

(3) $Y = (1 - \alpha)X_1\beta_1 + \alpha X_2\beta_2 + \varepsilon$.

A difficulty arises when we recognize that α (from equation (3)) is not identified. Davidson and McKinnon's solution, referred to as the J-test, substitutes the least squares estimator β_2 for α in order to achieve identification.[4] The null hypothesis tests that $\alpha = 0$. Failing to reject the null hypothesis suggests that the variables contained in X_1 represent the preferred model and that the additional variables from X_2 can be deleted. After testing X_1 against X_2, it is necessary to reverse the roles, testing X_2 against X_1. For example, this process would involve first testing the concentration ratio against the Herfindahl index and then testing the Herfindahl against the concentration ratio.

The test suggested by Davidson and McKinnon works by collapsing the explanatory power of the entire alternative model into the coefficient for α. Thus, the coefficient for a single variable—produced by first generating a column vector that equals the matrix product of each variable in the alternative model and its least squares coefficient—contains the total information of the alternative model. All the information from the alternative thus has been collapsed into a single variable. If $\alpha = 0$, the additional variable(s) from X_2 should be excluded.

The J-test allows us to perform hypothesis tests on model that otherwise might be affected by multicollinearity. Because the J-tests are based upon a single coefficient that

[4] Fisher and McAleer have developed an alternative modified JA-test which they claim has superior asymptotic properties as compared to the J-test. For large samples, the J-test and JA-test are equivalent. Due to the large sample of 440 observations in this study, the J-test and JA-test appear to be equivalent.

captures the explanatory power contributed by the entire alternative model, linear correlations between individual explanatory variables fail to influence the test. In other words, although the separate structure measures could be highly correlated, the J-tests would not be contaminated because they do not use raw values of competing structure measures in the same least squares equation (Davidson and McKinnon, 1981).

Application of the J-test for this study would imply model selection tests focusing on the choice between the three competing market structure measures. The J-tests involve an iterative procedure that tests every combination of deleted variables. I apply the J-tests to the deletion of individual measures (i.e., the deletion of CR4, HERF, and SHARE individually) and also to the deletion of pairs of variables (CR4 and SHARE, HERF and SHARE, and CR4 and HERF). After completing all iterations of the J-test, a pattern should begin to emerge regarding the appropriate model in terms of the inclusion or exclusion of particular structure measures. The tests regarding the inclusion of an individual measure and the test concerning the inclusion of pairs of variables ideally should provide consistent results: if two individual measures should be included, then the pair comprised by those variables also should be included.

The arguments of Salinger (1990) and Coughlin and Watkins (1985) suggest that structure measures require import adjustment. All empirical results presented in the paper utilize import-adjusted structure measures.[5] Iterations of the J-test find application in the case of deletion of one variable or the case of pairs of variables. Tables 1, 2, and 3 report tests dealing with the deletion of single variables. Tests dealing with the deletion of pairs of variables follow in Table 4. In reading Tables 1, 2, and 3, the left column of each table contains the equation used to generate $X_2\beta_2$. The remaining columns deal with the J-tests with the row labeled test $\alpha = 0$ denoting the J-test result. If the t-statistic for the test of $\alpha = 0$ is statistically different from zero, I reject the null hypothesis that the variable(s) represented by the J-test (i.e., the variable(s) included in the alternative model) can be deleted from the model. Because each of the tests in Tables 1 through 3 concern the deletion of the same structure measure, there is no need to repeat the presentation of the equation that generates $X_2\beta_2$.

Table 1 contains tests regarding the inclusion of CR4 in the model. The table suggests that CR4 can be deleted when tested against SHARE and HERF either individually or as a pair. That CR4 can be deleted from the model suggests that the four firm concentration ratio contains less explanatory power than either the Hirschman-Herfindahl or leading firm share. Excluding CR4 from the model conforms with the arguments of Kwoka and others who suggest that the four firm concentration ratio proves flawed as a structure measure. Exclusion of CR4 when tested directly against the Hirschman-Herfindahl seems intuitive, because the Hirschman-Herfindahl more accurately measures the same collusive opportunities that the four firm concentration ratio also seeks to capture. The deletion of CR4 when tested against leading firm share appears more surprising. Thus, Kwoka's view that the four firm concentration ratio contains market shares of meaningless firms and/or shares of firms with the incorrect sign supports the finding to delete CR4.

[5] I perform J-tests to determine whether import-adjusted or unadjusted structure measures should be used. The J-tests are inconclusive which, according to Davidson and McKinnon, indicates that data are not rich enough to distinguish between alternative hypotheses. Theoretical arguments then provide the justification for using import-adjusted measures.

Table 1—J-Tests for Four Firm Concentration Ratio, 1982 Cross-Section of Manufacturing Industries, Price-Cost Margin Dependent Variable

	1st Iteration	J-Test HERF and SHARE	J-Test HERF	J-Test SHARE
INTERCEPT	.99	11.61	6.39	-.24
	(.16)	(1.55)	(.86)	(-1.04)
CR4[1]	-.004	--	--	--
	(-.53)			
SHARE[3]	--	-.17	--	-.05
		(-2.83)*		(-1.12)
HERF[1]	--	.003	-.001	--
		(2.99)*	(1.45)	
ADIN[2]	-.0003	.0004	.002	-.002
	(-.98)	(.98)	(.13)	(-.10)
SCALE[1]	.60	7.34	.48	1.79
	(.10)	(1.25)	(.09)	(.32)
CAPIN[1]	-.14	.38	1.01	-.71
	(-.66)	(.48)	(1.32)	(-.99)
IMPTS[1]	-.02	.05	.11	-.07
	(-4.02)*	(.60)	(1.39)	(-1.05)
GROW[1]	.27	-.89	-1.94	1.31
	(2.44)*	(-.54)	(-1.38)	(1.05)
Test $\alpha = 0$	--	4.16	8.08	-3.81
		(.79)	(1.58)	(-.83)
$\bar{R}^2$	.11	.12	.14	.12

t-ratios in parentheses

*Significant at the 5 percent level

Number of observations is 440 four digit SIC industries

[1]*Census of Manufactures*, 1982

[2]*Internal Revenue Service: Sourcebook, Corporate Statistics of Income*, 1982

[3]E. Woodrow Eckard, Jr., "The Extent of Single Firm Dominance in U.S. Manufacturing Industries," *Review of Industrial Organization* (Spring 1989), pp. 23-38

Table 2 contains the J-tests of the Hirschman-Herfindahl index against leading firm share and four firm concentration, once again, individually and as a pair. The J-tests suggest that HERF should be included in the model for every test except the direct test of the Hirschman-Herfindahl against CR4. The null hypothesis that HERF can be deleted from the model is rejected when the test is against CR4 and SHARE jointly, but the null hypothesis cannot be rejected when HERF is tested directly against CR4. The results presented in Table 2 provide evidence to suggest that a positive relationship exists between the Hirschman-Herfindahl and price-cost margin, whereas the results presented in Table 1 support the deletion of CR4. These results provide evidence to support the argument that the Hirschman-Herfindahl, not the four firm concentration ratio, provides a superior measure for collusive opportunities. Failure to reject the null hypothesis in the direct test of the Hirschman-Herfindahl against CR4 provides further evidence that these two structure measures contribute similar information to the model.

Table 3 contains the J-tests associated with the inclusion of leading firm share. The test results reported in the table indicate that leading firm share belongs in the model, whether the test is against CR4 and HERF individually or as a pair. This finding provides

Table 2—J-Test for Hirschman-Herfindahl Index, 1982 Cross-Section of Manufacturing Industries, Price-Cost Margin Dependent Variable

	1st Iteration	J-Test CR4 and SHARE	J-Test SHARE	J-Test CR4
INTERCEPT	-1.26	11.61	8.32	6.39
	(-.23)	(1.55)	(1.33)	(.87)
CR4[1]	--	-.02	--	-.04
		(-.79)		(-1.58)
SHARE[3]	--	-.17	-.18	-.22
		(-2.83)*		(-3.18)*
HERF[1]	-.00003	--	--	--
	(-1.15)			
ADIN[2]	-.0001	-.007	.007	.003
	(.01)	(.46)	(.41)	(.16)
SCALE[1]	-1.45	-116.35	-102.33	-40.86
	(.28)	(-2.96)*	(-2.92)*	(-1.40)
CAPIN[1]	-.15	-13.50	-11.73	-5.00
	(-.71)	(-3.02)*	(-3.03)*	(-1.49)
IMPTS[1]	-.01	-1.29	-1.12	-.48
	(-3.92)*	(-3.02)*	(-3.04)*	(-1.50)
GROW[1]	.27	23.89	20.71	8.93
	(2.41)*	(3.02)*	(3.04)*	(1.50)
Test $\alpha = 0$	--	86.95	-75.28	-31.83
		(2.98)*	(3.00)*	(-1.45)
$\bar{R}^2$	.14	.16	.15	.12

t-ratios in parentheses

*Significant at the 5 percent level

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rather strong evidence regarding the importance of leading firm share in explaining cross-sectional variations in profit. The findings of Demsetz, Ravenscraft, Shepherd, and others who argue that market share is a superior measure to other structure variables in explaining cross-sectional variations in profit, finds some support in these results. The negative sign for the coefficient on the leading firm market share measure is inconsistent with the hypotheses of either Demsetz or Shepherd.

The results reported here suggest that cross-sectional variations in industry profit rates are related to market share, but that the relationship appears more complicated than the arguments presented by Demsetz and Shepherd would suggest. An exhaustive analysis of the factors that account for the negative relationship between price-cost margin and market share goes beyond the scope of this study. The fact that previous studies omitted the Hirschman-Herfindahl index from the analysis may explain these differences.

The results reported in this paper indicate that including the Hirschman-Herfindahl in the model causes the sign for share to change from the positive coefficient reported in previous studies to the negative coefficient reported here. The higher capital intensity and

Table 3—J-Test for Leading Firm Market Share, 1982 Cross-Section of Manufacturing Industries, Price-Cost Margin Dependent Variable

	1st Iteration	J-Test HERF and CR4	J-Test HERF	J-Test CR4
INTERCEPT	1.84	-3.49	-1.48	-3.82
	(.31)	(-1.07)	(-.63)	(-1.23)
CR4[1]	--	.003	--	.003
		(.90)		(2.22)*
SHARE[3]	-.02	--	--	--
	(.98)			
HERF[1]	--	.00002	-.0001	--
		(-.55)	(2.05)*	
ADIN[2]	-.001	2.86	3.21	2.79
	(-.04)	(3.05)*	(3.79)*	(3.09)*
SCALE[1]	1.39	-3.44	-1.53	-3.76
	(.25)	(-1.10)	(-.67)	(-1.26)
CAPIN[1]	-.14	-.07	-.07	-.072
	(-.67)	(-2.21)*	(-2.14)*	(-2.30)*
IMPTS[1]	-.02	-.001	-.001	-.001
	(-4.15)*	(.55)	(-..82)	(-1.05)
GROW[1]	.27	.03	.03	.03
	(2.44)*	(.46)	(.55)	(.46)
Test $\alpha = 0$	--	-.01	-.01	-.01
		(-2.46)*	(-2.44)*	(-2.48)*
$\bar{R}^2$	.13	.15	.14	.16

t-ratios in parentheses

*Significant at the 5 percent level

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high fixed costs of leading firms could make them especially vulnerable during recessions, as in 1982. While the data used in this study are too aggregated to test this explanation, support for this view can be found in the work of Domowitz, Hubbard, and Petersen (1986). By including the Hirschman-Herfindahl index, the model includes the generally regarded best measure of market power. Previous studies omit the Hirschman-Herfindahl index and thus could incorrectly attribute the effects of market power to share. The fact that previous studies limit analysis to CR4 and market share suggests that models used to evaluate the importance of market share in explaining profit variations most likely suffer from specification bias in the form of the omitted variable, the Hirschman-Herfindahl index. The results presented here suggest that a complicated relationship exists between the price-cost margin, leading firm share, and the Hirschman-Herfindahl index and supports the need for further study. Unfortunately, the firm level data needed to embark upon an exhaustive study regarding the complicated linkages between the various structure measures and profitability remain generally unavailable.

Table 4—J-Tests for Deletion of Two Variables, 1982 Cross-Section of Manufacturing Industries, Price-Cost Margin Dependent Variable

	Deletion of CR4 and HERF		Deletion of HERF and SHARE		Deletion of CR4 and SHARE	
	1st Iteration	2nd Iteration	1st Iteration	2nd Iteration	1st Iteration	2nd Iteration
INTERCEPT	-6.39	8.46	8.33	9.24	-.24	--
		(1.13)	(1.33)	(1.36)	(-.04)	
CR4[1]	-.04	--		-.002	.02	--
	(-1.58)			(-.24)	(.83)	
SHARE[3]	--	-.01	-.18	--	-.05	
		(-.74)	(-3.15)*		(-1.12)	
HERF[1]	.001	--	.002	--	--	.0002
	(1.45)		(3.00)*			(.37)
ADIN[2]	-.001	-.001	-.001	-.0002	-.004	.001
	(-.03)	(-.04)	(-.05)	(-.013)	(-.02)	(.05)
SCALE[1]	5.35	2.33	6.92	.91	-.50	-2.06
	(.79)	(.41)	(1.18)	(.15)	(-.08)	(-.39)
CAPIN[1]	-.13	-.002	-.22	.004	-.17	.07
	(-.63)	(-.009)	(-1.04)	(.017)	(-.77)	(.27)
IMPTS[1]	-.02	-.001	-.01	-.0004	-.014	.001
	(-4.16)	(-.18)	(-3.95)*	(-.069)	(-3.86)*	(.60)
GROW[1]	.28	.02	.25	.004	.27	-.17
	(2.48)*	(.11)	(2.24)*	(.029)	(2.35)*	(-.55)
Test $\alpha = 0$	--	.92	--	.99	--	1.59
		(1.45)		(3.10)*		(1.56)
$\bar{R}^2$	.12	.16	.16	.14	.12	.13

t-ratios in parentheses

*Significant at the 5 percent level

Number of observations is 440 four digit SIC industries

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[2]*Internal Revenue Service: Sourcebook, Corporate Statistics of Income*, 1982

[3]E. Woodrow Eckard, Jr., "The Extent of Single Firm Dominance in U.S. Manufacturing Industries," *Review of Industrial Organization* (Spring 1989), pp. 23-38

Table 4 contains J-tests regarding the deletion of pairs of variables. Beginning from left to right, the tests deal with the joint deletion of CR4 and HERF, SHARE and HERF, and CR4 and SHARE. Each pair of tests implies a different equation to generate $X_2\beta_2$, so that two columns are reported for each test. The J-tests reveal that only one pair of variables, HERF and SHARE, significantly contribute to the model. Tests involving any pair that includes CR4 result in a failure to reject the null hypothesis, so that the pair of explanatory variables is deleted from the model. From Table 4, one concludes that the four firm concentration ratio should be deleted from the model, regardless of whether the test is applied to CR4 individually or with another structure measure. This result provides strong evidence that the four firm concentration ratio is a flawed measure. The finding that the pair of variables, Hirschman-Herfindahl and leading firm share, contain explanatory power reinforces the previous results from individual tests on these variables. It is evident from the results of this study that the appropriate model includes both the Hirschman-Herfindahl and leading firm share as regressors in the structure-performance relationship

and that the widely used four firm concentration ratio fails to meet the criteria for inclusion in the model.

Tables 1 through 4 reveal that the coefficient for advertising intensity, which was included to proxy product differentiation, proves generally insignificant. The growth in demand variable yields generally positive coefficients, as hypothesized, and coefficients appear statistically significant in many equations. Similarly, the import variable yields generally negative coefficients, as hypothesized, and many appear statistically significant. The capital intensity and minimum scale variables exhibit negative coefficients in every case in which either variable proves significant. Given that 1982 was a recession year, the negative and frequently significant coefficients for scale effects and capital intensity appear logical. Economic downturns could be expected to have a greater impact upon the profitability of highly capital-intensive firms due to their relatively high fixed costs.

CONCLUSIONS

This study suggests a number of important results. First, there is evidence to support the claim that the Hirschman-Herfindahl index provides a superior proxy to the four firm concentration ratio as a measure of market structure. Support for this finding lies in the results of J-tests that treat the choice between the Hirschman-Herfindahl and CR4 as a test of nonnested hypotheses. The J-tests conclude that the Hirschman-Herfindahl index should be included in the model, while CR4 can be deleted. Moreover, the leading firm share data employed in this study verify the strength of market share revealed in previous studies. The leading firm share variable exhibits a negative coefficient, however, a result that contradicts the hypothesized sign for the leading firm variable. One possible explanation for the negative sign focuses on the impact of recession on leading firms as opposed to other firms in the market due to greater capital intensity and higher fixed costs of leading firms. The negative and significant coefficient for the capital intensity variable supports the notion that the 1982 recession likely contributed to the negative coefficient for leading firm share.

This study focuses on evaluating the revisionist and traditional approaches to the structure-performance model using data that include the Hirschman-Herfindahl index and using empirical techniques that apply to nonnested models. The fundamental question addressed by the study concerns whether the use of nonnested empirical techniques alters the conclusions of previous research regarding the superiority of market share in structure-performance models. The overall finding suggests that an appropriate specification of the structure-performance model contains both the Hirschman-Herfindahl index and leading firm share. The findings support the view of Jacquemin who argues that no single best measure of market structure exists, but that numerous measures exist that possess desirable characteristics. From a public policy perspective, the results suggest that neither the pure traditional nor pure revisionist view of the structure-performance relationship is correct.

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