The Concentration-Profitability Relationship In American Industry: A Varying Parameters Model

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Abstract

The theoretical foundation upon which the structure-conduct-performance paradigm is built assumes that concentrated markets permit noncompetitive behavior on the part of the market participants permitting abnormal profits to accrue. Previous research examines this relationship in a variety of forms. In each case, no allowance is made for the relationship to change dependent upon the prevailing levels of economies of scale. This paper employs a varying-parameters model which relaxes the classic OLS assumption of constant coefficients for all sample observations. Instead, a factor-dependent, nonstocastic variable is incorporated which captures the manner in which concentration relates to profit margins based on measures of economies of scale. The results show that while market concentration is associated with profit, the nature of the relationship varies with the prevailing scale economies. Scale economies prove effective based on the sample data in restraining noncompetitive behavior and limiting the ability of participating units to extract profits in excess of those witnessed in more competitive environments. This conclusion supports the hypothesis that the use of scale measures as a varying parameter is suggested in any attempt to estimate the SCP relationship.

Introduction

In the past considerable effort has been made to model the relationship between industry performance and market structure. However, most of these studies have produced variant results leading to divergent conclusions and there still remains considerable disagreement as to the nature of this structural design. In the examination of this relationship, commonly identified as the structure-conduct-performance (SCP) paradigm, much of this empirical work often hypothesizes that concentrated markets permit collusive behavior leading to restricted output and higher prices (Domowitz, et al., 1988; Schumacher, 1991). This in turn results in market malfunction and abnormal returns. This argument, referred to as the structuralist position, concludes that monopolistic abuses are evidenced by the strong correlation found to exist between concentration and profits.

The structuralist position finds support among many of the studies recently conducted. Imel and Helmberger (1971) are instrumental in directing initial research efforts toward the study of this relationship. They find that markets exhibiting a pronounced level of concentration are characterized by profits levels above those prevailing in

more competitive markets. Schmalensee (1977) and Allen (1983) also find direct support for this position. By incorporating a measure of risk, Liang (1989) reports that the impact of concentration on bank profits is significantly more pronounced. Calem and Carlino (1991) also apply the SCP paradigm to banking data and conclude that strategic conduct is evident in certain financial markets.

Kurtz and Rhoades (1991) offer a slightly different interpretation. They posit that the prevalent findings of a significant and positive coefficient for market share and the insignificant coefficient for concentration when serving as regressors for profit evidence the potential for market abuse and support the relative-market-power hypothesis (RMP). The RMP hypothesis holds that not all firms are able to exercise that power and turn it to their advantage. Only firms with relatively large market shares and well-differentiated products are in a position to exercise market power with respect to pricing policies and thereby earn supernormal profits.

An opposing explanation of the SCP paradigm argues that concentration results from highly efficient operations, and is not a cause for concern which might prompt vigorous antitrust action (Chappell and Cottle, 1985; Hannan, 1991; Webster, 1989). This line of thought holds that the correlation between concentration and profits emanates from efficiency in the form of absolute cost advantages or economies of scale available to the market leaders. Shepherd (1972) identifies an influence of market share on profit measures separate from that exhibited by concentration. He concludes that profits are explained only in part by monopolistic behavior and that prevalent cost patterns are instrumental in forming profit functions. In his pioneering work, Demsetz (1973) states that concentration arises from efficient performance and the resulting supra-normal profits are a reward for that efficiency.

Berger (1995) offers still another alternative explanation of the relationship between performance and market structure. His results suggest that the relationship between profit and concentration is merely a spurious one created by correlations with other variable, especially market share. He concludes that efficiency and market power variables explain very little of the variance in profitability (R^2 below 10%) and the coefficients suggest that very large changes in efficiency and market share would be necessary to raise profit levels measurably.

To date the results of the investigation into the relationship between market structure and profit have been inconclusive. Past studies continue to disagree regarding the cause of the empirically observed correlation. Resolution of this conflict is instrumental in the formulation of public policy and our perception of industrial structure.

However, without exception, these past efforts at estimation have neglected to incorporate a universal measure of the prevailing economies of scale (cf. Stevens, 1990). Although some effort is made to capture the effect of efficiency by reflecting a necessary minimum efficient scale (MES), no complete measure of scale economies is attempted. Furthermore, little or no consideration is given to the manner in which the impact of concentration on performance varies with economies of scale.

Data And Methodology:

It is the purpose of this paper to further investigate the nature of the relationship between concentration and performance. The methodology distinguishes itself from previous efforts by including a measure of scale economies in the form of a varying-parameters model designed to capture the manner in which scale influences the impact of concentration on performance. Further, an alternative definition of profit is utilized which, it is argued here, will lead to less equivocal results. A multi-product model is rejected in favor of a functional form specifying output as a single variable. It has been found that such a specification can reduced the problems associated with multicollinearity (Humphrey 1987). Previous research also shows that single-product models perform as well as the more complex functions without producing the problems of interpretation associated with the latter (Clark 1994; Hunter & Timme 1986; Schu-

macher 1991).

Based on the four-digit SIC classification, seventy-nine industries are selected from the 1987 Census of Manufactures by the Bureau of Census. Additional data defined below are taken from Standard and Poor's Industry Surveys for the concurrent year. These sources form the data base for this study.

Previous attempts to estimate the relationship inherent in the SCP paradigm neglected to consider the varying impact concentration has on profit as economies of scale change. They merely test the relationship with a linear model regressing performance measures on concentration with a vector of additional explanatory forces, Z_i, in the form

$$\pi = \alpha + B_1CON + \Sigma B_iZ_i + \varepsilon \quad (1)$$

where π is a selected measure of profit. Any consideration of scale economies is accomplished by including proxies for scale in the Z vector. The proxy of choice is traditionally a simple estimate of the capital requirement necessary to achieve the minimum efficient scale of operations. Generally, this proxy is constructed by calculating the median capital intensity of the firms in the relevant cohort. Thus, the effect of concentration on profit is captured by the partial derivative of (1) with respect to concentration:

$$\delta\pi / \delta CON = \beta_1 \quad (2)$$

It can be seen from (2) that the impact of concentration on profits is independent of the effects of all other independent variables. If $\beta_1 > 0$ and statistically significant, the hypothesis of no concentration-profit relationship is rejected.

Neglected in these early tests is the econometric relationship depicting the manner in which monopoly power, and its ability to generate abnormal profits, varies with scale economies. A varying-parameters model is well suited to a test of this nature (cf. Clark and Speaker, 1992). An important assumption of the OLS model is the constancy of the regression coefficients for all sample observations. The change in the response variable occurs because of changes in the values of the explanatory variables and the disturbance term. However, it is frequently argued that this assumption is not always a valid one. When using cross-sectional data at the firm or industry level, for example, it is unlikely that the response to a change in one or more explanatory variables is the same for all units. If the regression coefficients exhibit nonstocastic, factor-dependent variation a level of bias is introduced into the OLS model. A varying-parameters model can be used to identify any systematic variation in coefficients which would otherwise be captured (cf. Kmenta, 1986, p566). This principle was first applied by Lucas (1976) who advances the argument for which he later earned the Nobel prize that modeled coefficients are effected by the changing expectations of market participants.

Therefore, to capture the full effect of scale economies (SE), the relationship must be estimated within a framework of a varying-parameters model expressed as

$$\pi = \alpha + \beta_1CON + \Sigma\beta_iZ_i + \varepsilon \quad (3)$$

where

$$\beta_1 = \Omega_o + \Omega_1SE \quad (4)$$

As in (1), β_1 relates changes in profits to changes in concentration. However, β_1 is now itself a function of SE. By substituting (4) into (3) we have

$$\pi = \alpha + \Omega oCON + \Omega_1(SE)(CON) + \sum\beta_iZ_i + \varepsilon \quad (5)$$

Now the impact of concentration on profit is given by

$$\delta\pi/\delta CON = \Omega_o + \Omega_1SE \quad (6)$$

It may now be seen that the impact of concentration is not independent of all other factors, but instead depends on the respective values ascribed to the measures of scale economies. Then, assuming

β_1 is constant, is equivalent to assuming $\Omega_1 = 0$ in (5). Thereby, the hypothesis of a constant β_1 can be easily tested.

Schumacher notes that scale economies, despite their importance, are customarily neglected due to the difficulty in their measurement. Scale economies are often estimated using a translog multi-product cost function of the general form

$$\ln C = \alpha_o + \sum_i \alpha_i \ln Y_i + \sum_j \beta_j \ln P_j + \tfrac{1}{2}\sum_i \sum_k \sigma_{ik} \ln Yi \ln Yk + \tfrac{1}{2}\sum_j \sum_h \varepsilon_{jh} \ln P_j \ln P_h + \sum_i \sum_j \tau_{ij} \ln Y_i \ln P_j + \varepsilon \quad (7)$$

where Y_i represents n outputs and P_j are the prices of m inputs. Linear homogeneity in input prices is insured by the restrictions that $\Sigma_j \beta_j = 1$ and $\Sigma_j \varepsilon_j h = \Sigma_j \tau_{ij} = 0$.

Factor shares can then be derived using Shephard's lemma (Berndt 1991) by partially differentiating the cost function with respect to input prices as

$$S_j = \delta \ln C / \delta \ln P_j \quad (8)$$

$$S_j = \beta_j + \Sigma_j \varepsilon_{jh} \ln P_h \, \Sigma_j \tau_{ij} \ln Y_i$$

where S_j is the share of expenditures attributed to input j. Since $\Sigma S_j = 1$, the factor shares are not linearly independent. Therefore, to avoid singularity problems, one of the share equations is excluded in the estimation process. Overall scale economies (OSE), which can occur when all outputs are increased by a common factor, are estimated by differentiating the cost function with respect to all $\ln Y_i$:

$$OSE = \Sigma \, \delta \ln(C) / \delta \ln(Y_i) \quad (9)$$

If OSE = 1, OSE > 1, or OSE < 1, the firm is experiencing constant, decreasing or increasing returns to scale, respectively. However, Hunter and Timme argue that severe multicollinearity will result from the estimation of the interactive variables in (7). Furthermore, it is reasonable to presume that a high degree of correlation exists among the various forms of output which would exacerbate the problem of multicollinearity (Clark and Speaker, 1994).

In response to this drawback, Humphrey has proposed a quadratic model that measures scale economies based asset cost elasticities (ACE) and is designed to mitigate the problem of multicollinearity by decreasing the number of terms. The functional form is expressed as

$$\ln TC = \alpha + \beta(\ln TA) + \tau(\ln TA)^2 + \varepsilon \quad (10)$$

where lnTC is the logarithm of total costs and lnTA is the logarithm of total assets. Since the variables are expressed as logs, the estimated coefficients measure ACE as

$$ACE = \delta(\ln TC) / \delta(\ln TA) \quad (11)$$

$$ACE = \beta + 2\tau(\ln TA)$$

It can be seen from (6) that elasticity varies with the size of the economic unit measured in total assets. Then, if ACE < 1, cost economies exist with respect to size. As ACE approaches 1, the unit becomes more efficient moving down the average cost curve until it reached the point at which ACE exceeds 1 when diseconomies are experienced. Thus, an increase in the observed values of ACE up to 1 indicates an increase in efficiency.

This paper incorporates the Humphrey's model as a measure of economies of scale. The general model expressed by (10) is estimated for all observations. The data set is then separated by industry and, using (11), the ACE is computed at the mean level of total assets for each group.

The price-cost margin (PCM) commonly used as a measure of profit is adopted in this study. However, the methodology distinguishes itself from previous studies by redefining the PCM to produce less equivocal results. Earlier studies have failed to account for certain costs in the specification of the PCM function (Eckard, 1992). Specifically, the customary form does not account for advertising costs, rental payments, costs of capital, depreciation, or centralized management costs. The effect is to distort the true relationship

between the PCM and those explanatory variables selected for the model. While Weiss (1974) has shown that centralized management costs are not significant, it has been demonstrated that the remaining costs are useful in explaining profit differences across industries. The final expression for PCM becomes

$$PCM = VS - PAY - ADV - DEP - RENT - CAP / VS \quad (12)$$

where VS is the value of shipments, PAY is the in-plant payroll costs, ADV is advertising expenses and DEP is depreciation. RENT captures the imputed cost of the physical plant. Finally, CAP is the cost of capital computed as the total capital stock times the rate on AAA corporate bonds.

As the estimate of performance, PCM is then regressed on the measure of concentration and these other explanatory regressors commonly used as control variables. Thus,

$$PCM = \alpha + \beta_1 CON + \beta_2 MES + \beta_3(VA/CM) + \beta_4(KO) + \beta_5(ADV/SA) + \varepsilon \quad (13)$$

where MES is the minimum efficient scale as described above, the concentration measure, CON, is the four-firm concentration ratio and VA/CM is the ratio of value added to the cost of materials. As standard practice (cf. Eckard) the two remaining control variables, capital to sales ratio, KO, and the advertising to sales ratio, (ADV/SA) are included. β_1 is designed to serve as the varying parameter as depicted by (4) by setting it equal to $\Omega_o + \Omega_1 ACE$ in which ACE is the magnitude of the prevailing scale economies as described above. The final model then appears as

$$PCM = \alpha + \beta_1 CON + \beta_2 MES + \beta_3(VA/CM) + \beta_4(KO) + \beta_5(ADV/SA)$$

$$PCM = \alpha + \Omega_o CON + \Omega_1(ACE)(CON) + \beta_2 MES + \beta_3(VA/CM) + \beta_4(KO) + \beta_5(ADV/SA) \quad (14)$$

Based on the results of prior studies and the underlying theoretical foundation, it is hypothesized in a priori fashion that

$(\delta PCM)/(\delta CON)$, $(\delta PCM)/(\delta MES)$, $(\delta PCM)/(\delta (VA/CM))$, $(\delta PCM)/(\delta (KO))$, $(\delta PCM)/(\delta (ADV/SA)) > 0$

It is further hypothesized that Ω_1 is positive and significant, indicating that the impact of market structure on profit-margins varies with the overall level of scale economies (ACE) prevailing in the market.

Empirical Results

To test the hypothesis that the relationship between profits and concentration is constant across different scale economies (ACEs), the parameters for (14) are estimated and reported in Table 1. In general, the estimates appear to conform to the expectations discussed above. All coefficients with the exception of (ADV/SA) are positive and significant. In accord with earlier studies, the results suggest that profits are significantly and positively related to the concentration ratios observed to exist. This correlation may be precipitated by market power or operational efficiency. In either event, firms in more concentrated industries are able to behave in a noncompetitive manner and thereby extract abnormal profits. Further, it is seen that the ratios of value added to cost of materials and that of capital to sales are also significantly related to profit levels. It is commonly presumed that each of the regressors act as barriers to entry, thereby allowing existing firms to manipulate market conditions to their advantage. The result, again, is higher profit margins.

Table 1
Results of the Varying Parameters Model

	Parameter	t-statistic	p-value
Intercept	0.25587	3.733	
CON	0.77451	8.919	0.000
MES	0.3247	4.557	0.010
(ACE)(CON)	0.92743	12.583	0.000
(VA/CM)	0.07391	5.169	0.001
KO	0.12852	7.594	0.057
(ADV/SA)	0.97087	1.757	0.172
SSE = 16.868			
$R^2 = 0.658$			

This same conclusion can be posed with reference to MES. The larger the minimum scale of plant, the more difficult it is for a new entrant to compete effectively. Established firms are thereby able to exploit their position by behaving noncompetitively thorough higher prices and lower output.

The test of the varying-parameter model is based on the hypothesis that β_1 in (13) is constant. The classical linear model assumes that the theoretical structure generating the sample observations is the same for each observation. Thus, there is a single parameter vector relating the observable dependent variable and the nonstocastic regressors. This implies that the same regression function holds for all observations.

However, given the formulation specified here, the impact of concentration on movements in the level of profits is allowed to vary across observations depending on the measure of scale economies. By constructing the model in this fashion the parameter variation allows the relationship to become tractable. If the impact of concentration upon profit does not change as scale economies are altered, then it may be assumed that β_1 in Equation (13) is constant. This, in turn, implies that Ω_1, the coefficient for (ACE)(CON), in (14) is zero.

However, the coefficient for (ACE)(CON) in Table 1 is indeed positive and highly significant. This suggests that the manner in which concentration impacts on profits varies with the level of economies of scale prevailing across industries. The null hypothesis that the level of concentration carries a constant coefficient is rejected.

Instead, it is concluded that as ACE increases, there follows an downward movement along the average cost curve as noted earlier. This improved level of efficiency alters the manner in which concentration relates to profit margins. Thus, the impact of concentration on profit depends on the respective values of measures of scale economies.

These results imply that a model testing the impact of concentration on profit should attempt to estimate this relationship only by permitting the relevant parameter to vary across industries in response to the existing economies of scale. Failure to do so could generate bias and misleading results. By allowing for this factor-dependent variation a more complete understanding of the relationship between concentration and profits is possible.

Importance Of The SCP Paradigm:

The relevance to decision-makers of the relationship between profits and market conditions cannot be over-stated. Business managers must fully understand the powerful forces affecting their firms' performances if they are to function in an effective manner. In the effort to achieve the theoretical and practical objective of maximizing the value of the firm, such insight is quite useful in the establishment of company policies that concern all aspects of the business operations. Policies regarding pricing practices, cost considerations and efficiency can be formulated only after closely scrutinizing the interaction of forces which comprise the SCP paradigm. This practice will permit the determination of policy that will serve them well far into the future.

Further, decisions which focus on capital budgeting procedures, innovations and the commitment to research and development can best be made within the framework presented by the SCP relationship. Without an account of this intricate association, actions taken to promote the firm's overall objectives and insure survival of the institution are unlikely to prove successful in the long run.

Certainly, the ultimate impact of proposed merger activity, consolidations and divestitures cannot be projected without a thorough understanding of the model examined here. Nor, for that matter, can such actions be competently designed.

In general, consideration must be given to the relationship between performance as judged by some identified profit-measure and market structure if these important decisions are to produce optimality. If business managers fail to consign

sufficient importance to the market context in which they function, their actions are destined to fail.

The importance of the SCP paradigm is also of importance to regulatory bodies and public agencies charged with governing business behavior. The creation and enforcement of laws designed to promote vigorous and healthy competition can effected only after a careful examination of the resulting effect. If public welfare is to be enhanced, it is essential that regulations are constructed with a clear vision as to their impact on both businesses and the general consuming public. The effect of public policy and the eventual impact on market concentration and universal consumer welfare can be discerned only within the SCP framework.

Summary And Conclusion:

The theoretical foundation upon which the structure-conduct-performance paradigm is built assumes that concentrated markets permit non-competitive behavior on the part of the market participants permitting abnormal profits to accrue. Previous research examines this relationship in a variety of forms. In each case, no allowance is made for the relationship to change dependent upon the prevailing levels of economies of scale.

This paper employs a varying-parameters model which relaxes the classic OLS assumption of constant coefficients for all sample observations. Instead, a factor-dependent, nonstocastic variable is incorporated which captures the manner in which concentration relates to profit margins based on measures of economies of scale. The results show that while market concentration is associated with profit, the nature of the relationship varies with the prevailing scale economies. Scale economies prove effective based on the sample data in restraining noncompetitive behavior and limiting the ability of participating units to extract profits in excess of those witnessed in more competitive environments. This conclusion supports the hypothesis that the use of scale measures as a varying parameter is suggested in any attempt to estimate the SCP relationship.

Suggestions For Future Research:

The evidence presented here suggests that an examination of the structure-conduct-performance paradigm benefits from a consideration of the manner in which scale economies impact the profit-concentration relationship. A more complete perception is gained by considering the manner in which this relationship varies with prevailing scale economies.

However, while this study recognizes that firms experiencing different scales exhibit variant performance-structure relationships, there is a need to more fully define the nature of this relationship within scales. Future effort is needed to elaborate on this issue by classifying firms on the basis of scale and more closely examining its influence for different scale measures. A more complete perception of the full impact of scale on firm profits and how they relate to market concentration could thereby be obtained. This approach would permit a more precise measure of how firms' performances are impacted within specific scale ranges not identified in this paper. The ensuring accretion in detail into this relationship could prove quite useful in furthering the examination of the SCP paradigm begun here.

While several of the studies cited herein examine scale economies, considerably less attention has been devoted to economies of scope and the manner in which they relate to product mix. There is a pronounced need to expand the range of empirical research to encompass a more thorough investigation of scope and its relation to the SCP paradigm.

Further, insufficient study has been devoted to the examination of the use of superior management and production technologies across industries. While some research focusing on specific industries has been forthcoming (Berger, 1991; Mester and Crone, 1994), a more general approach is needed which permits the comparison of several industries simultaneously. These concerns pose a challenging agenda for future research.

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