HETEROGENEITIES WITHIN INDUSTRIES AND STRUCTURE-PERFORMANCE MODELS

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Editorial

In this paper DENNIS C. MUELLER, Professor of Economics at the University of Vienna, and BURKHARD RAUNIG, economist at the Oesterreichische Nationalbank (Financial Markets Analysis and Oversight Division), examine the power of Structure Conduct Performance Models (SCP-Models) in explaining two long term profitability measures. They found that this explanatory power strongly depends on whether firms within an industry are homogeneous or heterogeneous. To find out whether firms within a certain industry are homogeneous or not, one simply has to look at firms 'profitability patterns. For antitrust policy, prohibition of horizontal mergers are justified well by SCP-Models but only if firms within the industry are homogeneous. If firms within an industry sector are heterogeneous the implications from SCP-Models may be misleading. In this case – the authors emphasize – more analysis is necessary to guide antitrust policy.

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Heterogeneities within Industries and Structure-Performance Models

Dennis C. Mueller*, Burkhard Raunig¶

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Abstract

This paper tests whether the results from standard structure-conduct-performance [SCP] models estimated at the industry level are sensitive to the degree of heterogeneity of the firms in the industries. Industries are separated into homogeneous and heterogeneous categories depending on whether the profit rates of firms within an industry converge on a common value or not. In "homogeneous" industries we find that both the long-run projected returns on assets for the industries and Bureau of Census price-cost-margins are well explained by variables usually included in SCP models, as in particular industry concentration. In contrast, few if any of the usual SCP-model variables are statistically significant in the regressions for heterogeneous industries.

Keywords: structure-conduct-performance models, heterogeneous industries

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I. Introduction

The basic framework of the structure-conduct-performance paradigm [SCP] was developed by EDWARD S. MASON (1939), and JOE S. BAIN (1954, 1956).[1] A causal relationship running from market structure to firm conduct, and from firm conduct to industry performance is assumed. The focal point of the analysis is the industry, and its performance is measured by some form of profit ratio, p. The ability of firms in an industry to collude is assumed to be related to industry concentration as measured by say the 4-firm concentration ratio, C_4. A typical SCP equation would look as follows:

$$p = a + bC_4 + gB + m \tag{1}$$

where B is a vector containing one or more measures of industry entry barriers. Equations like (1) would be estimated cross-sectionally with profits, concentration and entry barriers all measured at, say, the 4-digit SIC level.

Implicit in such exercises was the assumption that higher concentration allowed all firms in an industry to raise their prices, and that entry barriers protected the profit rates of all firms inside the industry. Despite the fact that product differentiation, as typically measured by advertising intensity, was inevitably found to be an important determinant of industry profitability, such variables were never assumed to differentiate the firms *within* an industry from one another. They were assumed merely to create a wall that differentiated the firms within an industry from those outside of it. Implicitly all firms within an industry were assumed to have the same profit rates, so that the profit rate of the industry could serve as a good measure of industry performance. Appropriately, attempts to measure the social costs of monopoly within the SCP tradition have done so using industry profit levels (e.g., MASSON and SHAANAN, 1984).

The suggestion that the assumption of intraindustry homogeneity across firms was false was made most forcibly by HAROLD DEMSETZ (1974) who attributed firm-level profitability differences to differences in efficiency. The importance of heterogeneities across companies has been confirmed in studies in the SCP-cross-sectional tradition that substitute firm profitability and market shares for industry profitability and concentration (SHEPHERD, 1972, 1975; RAVENSCRAFT, 1983), and by studies using time-series data that have found persistent

[1] For surveys of the literature see SCHMALENSEE (1989), SCHERER and ROSS (1990), HAY and MORRIS (1991), MARTIN (1993), and SHEPHERD (1997).

differences in profitability across firms even within industries (MUELLER, 1986, 1990a).

If company profits differ significantly across firms within industries, then industry profit measures are weighted averages of the company measures. The weak fits to industry level data often found in SCP studies may in part be due to this averaging out of important cross-sectional differences (CUBBIN and GEROSKI, 1987, p.427; SCHERER and ROSS, 1990, pp. 442-43). A further complication arises, when industries are out of long-run equilibrium. Short-run disequilibrium profits add measurement error to the dependent variable further weakening the robustness of cross-sectional comparisons.

On the other hand, in some industries there are no significant differences across companies, and the basic assumptions of the SCP model may be reasonably met. If profit data purged of short-run variability are used for these industries, one should obtain valid tests of the predictions of the SCP model. One goal of this paper is to provide such tests.

To do so we employ the methodology developed by MUELLER (1986) to estimate long-run projected profits, and the speeds of adjustment to these long-run levels using time series data for the period 1977-95 for a sample of 912 companies, which we have been able to classify into reasonably defined 4-digit SIC industries. Based on these estimates the industries in which the firms reside are classified as either *heterogeneous* or *homogeneous* depending on whether the firms exhibit significant differences in their profitability patterns or not. A standard SCP model is then estimated using various sources of industry data on the two samples of industries. Significant differences in the estimates for the model are found across the two samples. In particular, industry concentration is found to be a much stronger predictor of industry profit margins in the homogeneous companies 'industries than in the heterogeneous industries.[2]

The paper is organized as follows: The next section describes the basic research design and the methodology to test for heterogeneity within industries. In Section 3 the results of the tests are presented and discussed. Section 4 introduces the industry level specifications, and reports our empirical findings for the industry level models. In Section 5 the same models are estimated using the profits of individual firms as the dependent variable. Conclusions are drawn in Section 6.

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[2] A somewhat comparable approach was employed by NEWMAN (1978), but using data for only chemical process industries. HARRY BLOCH (1994) has also demonstrated the importance of selecting industries composed of homogeneous companies, but his method of defining homogeneous industries was quite different from ours.

II. Methodology

One way to test for the presence of firm-level heterogeneities is to try and model their causes directly. Such a strategy is difficult, however, in that many of the causes of these heterogeneities, like first-mover advantages and managerial competence differences, are difficult to measure. Since our concern is the effect of these heterogeneities on profitability measures, a simpler alternative approach is to test for these directly. We do so using the autoregressive model of firm profit rates developed in MUELLER (1986) and GEROSKI (1990).

Assume that the annual profit rate p_{it} of a firm i in period t contains three components, the competitive rate of return c, a permanent firm specific rent r_i, and a short-run rent s_{it}.

$$p_{it} \equiv c + r_i + s_{it} \tag{2}$$

To remove the effects of the business cycle, p_i is expressed as the relative deviation of the profit rate (Γ_{it}) of firm i from the average profitability ($\overline{\Gamma}_t$) in the economy. Competition is assumed to erode short-run rents over time. The process of rent erosion is modeled with the following first-order autoregressive equation

$$s_{it} = l_i s_{it-1} + u_{it} \tag{3}$$

where, for stationarity, $| l_i | < 1$ must hold and u_{it} is an error term distributed with constant variance and mean zero. Since (2) holds in every period, it can be used to eliminate s_{it} and s_{it-1} from (3) to obtain

$$p_{it} = p_i(1 - l_i) + l_i p_{it-1} + u_{it} \tag{4}$$

where $p_i = c + r_i$ is the profit rate projected for firm i as t goes to infinity, and l_i is the degree of persistence of short-run rents. Equation (4) can be estimated with time series data on profitability for individual firms. The parameters of the model capture two basic features of the competitive process. In the long run the profit rates of all firms should converge on the same competitive return on capital, risk differences aside. Thus, in a perfectly competitive economy, $r_i = r_j = 0$, and $p_i = p_j = c$ for any two firms i and j. The speed of this convergence process measures the implicit speed at which the entry and exit of firms and flow of capital respond to and equilibrate profit rate differences. Equation (4) forms the basis of our homogeneity tests.

There are essentially two ways to think about homogeneity. First, one can view it in static terms: An industry is homogeneous if all firms within it have the same profit rates in the long run. In terms of equation (4) this interpretation would define an industry as homogeneous if $p_i = p_j$, for all n firms in the industry. We shall use this notion of homogeneity to categorize industries, and the long-run projected profit rates from eq. (4) as our measures of performance, since these seem most consistent with the static equilibrium underpinning of the SCP models.

Alternatively, one can think of homogeneity in terms of industry dynamics. In a homogeneous industry all firms move toward their long-run equilibrium profit rates at the same speed. This interpretation implies that $l_i = l_j$ for all n firms in the industry. Once again we might expect industry characteristics to be important in explaining the dynamics of industries containing firms with common adjustment processes (ls). We shall not explore this dimension of homogeneity.[3]

When one adds the possibility that an industry is always in equilibrium, i.e., $l_i = 0$ for all n firms, one obtains the six hypotheses listed in Table 1.

Table 1: Hypotheses

H1	$p_i = p_j$ and $l_i = l_j = 0$	
H2	$p_i = p_j$ and $l_i = l_j \neq 0$	HOMOGENEOUS INDUSTRIES
H3	$p_i = p_j$ and $l_i \neq l_j$	
H4	$p_i \neq p_j$ and $l_i = l_j = 0$	
H5	$p_i \neq p_j$ and $l_i = l_j \neq 0$	HETEROGENEOUS INDUSTRIES
H6	$p_i \neq p_j$ and $l_i \neq l_j$	

We separate the different categories of homogeneous industries from what we call heterogeneous industries on the basis of the long-run projected profit rates of the firms. To be classified as homogeneous, p_i must equal p_j, for the n firms in the industry. H1 is the strongest hypothesis one can make about homogeneity, the profit rates of all firms are equal, and are at their long-run equilibrium values all of the time, $p_i = p_j$, and $l_i = 0$ for all n firms. H2 is the second strongest hypothesis about homogeneity. Profit rates can deviate from their long-run levels, but these levels are the same across all firms, and they all follow the same adjustment process. In H3 the firms satisfy only the minimum condition for homogeneity,

[3] See, however, CUBBIN and GEROSKI (1987, 1990), MUELLER (1990b), WARING (1996) and MCGAHAND and PORTER (1997).

$p_i = p_j$, for $i, j = 1, n.$

The most extreme hypothesis that one can make about heterogeneity is H6, firms have different long-run projected profit rates, and they approach them at different speeds. Both H4 and H5 require that the long-run projected profit rates of the firms differ. Our main hypothesis is that for industries for which H1, H2 or H3 hold, the long-run profit rates of the firms in an industry, and thus the long-run profit rates of the industries themselves, can be explained by the characteristics of the industries. Industry characteristics will not be good predictors of industry profit rates, on the other hand, in industries composed of heterogeneous firms.

The six hypotheses listed in Table 1 can be tested using Zellner's (1962) seemingly unrelated regression procedure. A set of equations for each industry is jointly estimated under the assumption that the residuals are uncorrelated across time, but allowing for the possibility that the residuals of the individual equations are correlated at a given point in time. Since equation (4) is nonlinear in its parameters, the systems must be estimated with nonlinear estimation techniques, before the relevant Wald test statistics implied by the hypotheses are computed.

III. Data and Results of Heterogeneity Tests

The data are from the Compustat data base. Profit rate time series could be computed for 912 U.S. manufacturing firms over the period 1977 to 1995. The profit rate is defined as after tax income plus interest expenses divided by total assets. Interest expenses are added back to make the profit rates independent of the sources of finance. The average profit rate in manufacturing was proxied by the unweighted average of the profit rates of the 912 firms, and the deviations of the firms' profit rates (p_{it}) were computed relative to this mean.

All 912 firms were not used in the heterogeneity tests. Firms that Compustat assigned to only a two or three digit SIC industry were excluded for two reasons. First, industries at this level of aggregation are usually too broad to be considered meaningful economic markets. Second, the fact that Compustat assigned a firm to one of these broad industry categories suggests that the firm may be quite diversified and thus also not a good candidate for inclusion in our tests. Firms lacking the industry level data needed later in the structure-performance regressions were also dropped.

As indicated above, the tests were conducted by estimating a system of nonlinear seemingly unrelated time series regressions for the individual firms in each four digit industry. Before these systems were estimated, a time series equation was estimated for each firm. Firms for which the profit path did not appear to converge, i.e. the estimated $l > |1|$, were dropped.[4] After these various deletions we were left with 492 firms, assigned to 92 four digit industries, for which we could conduct the homogeneity tests. The results in Table 2 were implied by the tests of the cross-equation restrictions and the hypotheses presented in Table 1.[5]

Table 2:
Results of Homogeneity Tests

Degree of homogeneity	Hypothesis	# of Industries
1	$p_i = p_j$ and $l_i = l_j = 0$	12
2	$p_i = p_j$ and $l_i = l_j \neq 0$	22
3	$p_i = p_j$ and $l_i \neq l_j$	11
Industry Effects more important		45
4	$p_i \neq p_j$ and $l_i = l_j = 0$	10
5	$p_i \neq p_j$ and $l_i = l_j \neq 0$	8
6	$p_i \neq p_j$ and $l_i \neq l_j$	29
Firm Effects more important		47

For 45 out of the 92 industries convergence of individual firm profit rates on a common level for the industry could not be rejected. For the other 47 industries the restriction of equal long-run profitability among individual firms was rejected at the 5% level of significance. In 32 of the 45 industries classified as homogeneous, both parts of the test for homogeneity were met, i.e. we could not reject the hypotheses that the long-run projected profit rates were equal, and that the speeds of convergence on these rates were equal.

The assumption that all of the firms in an industry were in long-run equilibrium each period (i.e. $l = 0$ for all the firms within an industry) could not be rejected in 22 cases. For firms in the other 70 industries, however, the results imply that short-run rents do not disappear within one period. These results are consistent with the findings in MUELLER (1986) for the US over the 1950-72 period, and in MUELLER (1990a) for six other countries. Also consistent with these earlier findings is the rejection of the homogeneity assumption for 47 industries. Taken together

[4] The residuals of the first-stage regressions were examined for serial correlation using the F-tests version of the Breusch-Godfrey LM tests for serial correlation. No significant departures from white noise where found in virtually all cases.

[5] A separate table listing the industries placed in each category and the number of firms in each industry in our sample is available from the authors.

the results imply (1) that competitive forces often require more than one year to eliminate short-run rents, and (2) that persistent differences in performance across firms exist within many industries. Thus, one cannot assume that the profits observed in an industry at a given point in time are near their long-run equilibrium values, nor necessarily that these long-run values equal one another. Both inter- and intraindustry variations in profit rates are important in many cases.

IV. Empirical Findings for the SCP Model

Equation (1) is an example of the garden variety SCP equation estimated in the literature, and forms the basis for our exploration of the effects of firm heterogeneities on industry level regressions of profitability on market structure variables. Equations resembling (1) can be derived from the dominant firm pricing model (SAVING, 1970), and Cournot-type oligopoly models (COWLING and WATERSON, 1976). A state-of-the-art SCP model probably should endogenize most of the right-hand side variables, include entry and exit equations, nonlinearities of all sorts, and perhaps more.[6] Since the purpose of this article is to highlight the impact of firm heterogeneities on SCP modeling, and not to present the definitive SCP model, we shall confine ourselves to estimating rather simple versions of (1).

There are theoretical reasons to expect that the relationship between profitability and concentration may be nonlinear, however. Given the central role this variable plays in all SCP models, we shall modify (1) to allow for such nonlinearities. Thus, following GEROSKI (1981), we might write

$$b = b_0 + \sum b_j (C_4)^j \qquad j = 1, \ldots, n. \tag{5}$$

Although assuming that (5) holds would in principle allow us to estimate virtually any possible relationship between profits and concentration, problems of multicollinearity quickly arise as one adds higher order terms in concentration.

Thus, we confine ourselves to estimating a third-order polynomial in concentration. In our entry barrier vector we include four of the usual suspects (advertising intensity (AD), R&D intensity (RD), import penetration (IM), and the growth rate of industry sales (GR).[7] Calling

[6] Our time series estimates "net out" the effects of past entry and exit on company profitability, and thus should remove possible biases from omitting these equations.

[7] We did not include two additional variables that often appear in SCP models -- measures of minimum efficient size and capital

ACR the four-firm concentration ratio adjusted for imports, gives us the following equation.[8]

$$(6) \qquad p = a + b_1 ACR + b_2 ACR^2 + b_3 ACR^3 + g_1 AD + g_2 RD + g_3 IM + g_4 GR + m$$

To test whether the presence of firm heterogeneities has an impact on the results one obtains from such a model, we have estimated (6) using industry level data for our samples of homogeneous and heterogeneous industries as determined by the heterogeneity tests. If firm-level heterogeneities are important, we should observe significant differences in the estimated coefficients between the two subsamples. In particular, we expect that the SCP model of eq.(6) provides a better fit to the data in the homogeneous industry sample.

We estimate (6) with two differ dependent variables. The first is the *long-run projected industry profit rate* (P). It is the direct analogue to the long-run projected profit rates estimated for each firm to determine industry homogeneity. The variable was generated using annual industry time series data over the period 1976-95. Profitability was measured as the return on assets, and computed by aggregating the annual profits and assets data over the firms in each industry that are in our sample.[9,10] To remove the impact of the business cycle, the data were again transformed into a time series of *relative profitability*, Π_{It}, by subtracting from each industry's profit rate in a given year the average over all industries for that year, and then dividing by the average.[11] Estimates of P_I were then obtained by estimating equation (7) for each of the 92 industries in our sample.

$$\Pi_{It} = P_I(1 - l_I) + l_I \Pi_{It-1} + m_{It} \qquad (7)$$

The interpretation of the parameters in the equation is identical to that for (4), but applies now to our aggregated industry level data.

Because P_I is itself an estimate that varies in precision for each industry, heteroskedasticity

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requirements. Each of these should go into the concentration equation in a multi-equation SCP model, although they might also be included in the profitability equation as measures of entry barriers. Thus, a positive correlation between concentration and profitability might be partly due to the omission of these variables.

[8] The precise definitions of the variables and the data sources can be found in the appendix. Arguments concerning the expected signs and interpretation of the explanatory variables can be found in the studies cited in n. 1.

[9] Of course, only firms that were examined in the heterogeneity tests were used in this procedure.

[10] The average industry profit rate for industry I in year t is defined as $\Gamma_{It} = (\Sigma_i INC_{it} + \Sigma_i INT_{it}) / \Sigma_i AT_{it}$, $i = 1, \ldots, n$, $t = 1976, \ldots, 1995$, where INC denotes income after taxes, INT is interest paid, AT stands for total assets, I denotes industry I and n is the number of firms in industry I that were used in the heterogeneity tests.

[11] Π_{It} is defined as $\Pi_{It} = (\Gamma_{It} - \overline{\Gamma}_I) / \overline{\Gamma}_I$, where $\overline{\Gamma}_t$ is the unweighted average over the 912 firm profit rates that are available in year t.

may arise when estimating the SCP models. To avoid this, a form of GLS is employed, in which all observations are weighted by the inverse of the standard deviations of the estimated P_I's (SAXONHOUSE, 1976). Our measure of profitability is a return on capital. Most standard oligopoly models, however, imply that the dependent variable should be the price-cost margin or profit to sales ratio. Accordingly, all right-hand-side variables were weighted by the sales to capital ratio to make the deflators on both sides of the equation consistent.

Table 3:
SCP model with long-run projected industry profit rate P as dependent variable

Variable	Pooled	Sample: Homogeneous	Sample: heterogeneous
ACR	1.447	2.162	0.398
	(0.854)*	(0.974)**	(1.469)
*ACR*2	-0.057	-0.070	-0.024
	(0.026)**	(0.030)**	(0.045)
*ACR*3	0.0005	0.0006	0.0002
	(0.0002)**	(0.0002)**	(0.0003)
AD	2.909	4.587	2.164
	(0.876)***	(1.265)***	(1.312)
RD	1.755	0.206	1.782
	(0.841)**	(1.537)	(1.276)
IM	-0.488	-0.512	-0.230
	(0.182)***	(0.225)**	(0.364)
GR	-0.331	-0.787	-0.221
	(0.378)	(0.443)*	(0.752)
a (intercept)	-5.672	-19.674	3.997
	(9.028)	(10.453)*	(15.134)
R^2 bar	0.176	0.396	-0.067
F-statsitic	3.768***	5.128***	0.587
ACR	1.513	2.924	0.098
	(0.855)*	(1.052)***	(1.303)
ACR2	-0.059	-0.101	-0.010
	(0.027)**	(0.033)***	(0.042)
ACR3	0.0006	0.0009	0.0001
	(0.0002)**	(0.0003)***	(0.0003)
a (intercept)	-3.776	-23.419	10.741
	(8.815)	(11.0.5)**	(13.330)
R^2 bar	0.050	0.217	-0.088
F-statsitic	2.595*	5.076***	ne
No. Obs.	92	45	47

Standard errors in parentheses beside coefficients
*, **, *** significantly different from zero at the 0.1, 0.05, 0.01 probability levels

Legend:

ACR	Four-firm concentration ratio (adj. for imports)	AD	Advertising intensity
ACR2	Concentration raised to the second	RD	R&D intensity
ACR3	Concentration raised to the third power	IM	Import intensity
		GR	Growth rate of sales

The upper portion of Table 3 presents the estimates for eq.(6). In the first column are the estimates for the pooled sample of 92 industries. All coefficients are significant at the 10 percent level or better except for the growth variable. The pattern of signs on the concentration variables implies an S-shaped relationship between concentration and profitability. Profitability increases with concentration over the full range of concentration values, but at varying speeds. The coefficients on all of the other variables are of the predicted sign except for the insignificant coefficient on growth.

Columns 2 and 3 present the estimates for the subsamples of homogeneous and heterogeneous industries. They are dramatically different from one another. The adjusted R^2 for the homogeneous industries sample is about .4, the adjusted R^2 for the heterogeneous industries sample is less than zero. The three concentration terms in the homogeneous sample are all significant at the 5 percent level, and exhibit the same S-shaped pattern as in the full sample. Advertising and import intensity are both highly significant and of the predicted sign in the homogeneous industries regression. R&D is of the predicted sign, but is not significant. Growth exhibits a negative coefficient, as in the pooled sample, and is significant at the 10 percent level in the homogeneous industries sample. No variable is significant at even the 10 percent level in the heterogeneous industries regression. These results rather strikingly confirm the important consequences of estimating an industries-level SCP model with data on industries that contain heterogeneous firms. Had one by chance selected a sample that *only* contained the heterogeneous industries, one would erroneously have concluded that there was no relationship between profitability and the set of SCP variables. The relationship between these variables and profitability is strong enough in the homogeneous industry sample that it still appears in the pooled sample. But clearly the fit that one gets to this sort of SCP model using industry data is likely to be quite sensitive to the mix of homogeneous and heterogeneous industries that one happens to have in one's sample.[12]

In the bottom half of Table 3 we present estimates having dropped all variables other than the three concentration terms from the equation. The same S-pattern appears in both the pooled data and the homogeneous industries subsamples, with the latter again having a much higher adjusted R^2. Indeed, concentration alone explains 22 percent of the variation in profitability in the homogeneous industries subsample. Again no coefficient on concentration is significant in the heterogeneous industries subsample.

There are at least two objections that one might make to our construction of an industry profit rate by aggregating the profits and assets of the firms that Compustat assigns to an industry. First, the firms undoubtedly have some sales outside of the industry. The likely bias from firm diversification is difficult to gauge, however. It could be that all firms in an industry had similar profit rates on their assets in this industry, but different rates on their assets outside of the industry, and thus what in fact is a homogeneous industry appears heterogeneous. Alternatively, diversification could drive all profit rates toward the sample mean, and thus make

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[12] Owing to the large standard errors on the coefficients in the heterogeneous industries sample, a Chow-test on the restriction of equal parameters for both subsamples failed to reject their equality at conventional levels of statistical significance. But the dramatically better fit to the data obtained for the homogeneous industries subsample warrants, we believe, the conclusion in the text.

heterogeneous firms appear to be homogeneous. We tried to reduce these sorts of biases by dropping firms that Compustat did not assign to 4-digit industries, but we certainly did not eliminate it entirely.

The second objection to our industry profit rates is that they are based only on the firms that were used in the heterogeneity tests and these, even if undiversified, might not be representative of their entire industries. This objection loses some of its force when one recognizes that the firms in the Compustat data base tend to be rather large firms and thus account for large fractions of their industries' activities. Nevertheless, these objections suggest that additional tests of the hypothesis are warranted. We provide these by reestimating eq. (6) with Bureau of Census price-cost margins.

Census price-cost margins are based on plant level data. The Census survey covers virtually all plants in an industry, and problems of diversification arise only in the few cases where plants produce more than one product, and its secondary product falls outside of the industry. Although Census price-cost margins have these advantages, they differ from the theoretically implied price-cost margin in that no allowance is made for capital costs, advertising or R&D. The usual way to adjust for the cost of capital is to include the industry capital to sales ratio as a separate right-hand-side variable.[13] We correct the price-cost margins for the omission of advertising and R&D using estimates of these outlays.[14] These adjusted margins (APCM) as well as the standard measure (PCM) were constructed for our 92 industries for the year 1992 and used to estimate (6) supplemented by the capital to sales ratio. The results are presented in Table 4.

Comparison of the results for PCM at the top of Table 4, and P in Table 3 for the *pooled sample* reveals no important qualitative differences. The three concentration terms exhibit the same S-shape relationship to profits, advertising and R&D have positive and significant coefficients, import intensity has a negative sign, but in Table 4 is insignificant.

The fit to the data is again improved when one moves to the homogeneous industries sample (R^2 = .57), worsened in the heterogeneous industry sample (R^2 = .38). A Chow test now rejects the null hypothesis of identical parameter vectors for both the homogeneous and heterogeneous industries samples (10% level). The concentration terms exhibit the now

[13] Since the price-cost margin has sales in the denominator, the other right-hand-side variables are not weighted by the sales to capital ratio in these regressions.

[14] Industry advertising and R&D to sales ratios were multiplied times industry shipments to obtain an estimate of industry advertising and research and development expenditures. These were then subtracted from the numerator of the standard Census price-cost margin to obtain a better profit measure.

familiar S-pattern with all three being significant at the 1 percent level in the homogeneous industries subsample, while none is significant in the heterogeneous industries subsample. Only advertising and the capital to sales ratio are statistically significant in the heterogeneous industries regression.

If advertising and R&D do not create entry barriers or lead to above normal profits in any other way, their coefficients in the PCM equations should equal 1.0 to reflect the accounting adjustment required to measure true economic profits. The coefficients on advertising are all substantially above 1.0, however, in each of the three equations.[15] Thus, we find that advertising continues to exhibit a positive and significant impact on industry price-cost margins in both the pooled and the heterogeneous samples when the adjusted price-cost margin (APCM) is used as the dependent variable (bottom of Table 4). The fit of the equation falls dramatically from an R^2 of 0.38 to one of 0.14 for the heterogeneous industries regression indicating that the higher R^2 is mostly due to this one variable.

[15] JOHN CARTER (1978) obtained similar coefficients in his study using Census price-cost margins.

Table 4:
SCM model estimated with Census price-cost margin (PCM) and adjusted Census price-cost margin (APCM)

Dependent variable: *PCM*		Sample	
Variable	Pooled	homogeneous	Heterogeneous
ACR	1.436 (0.477)****	2.038 (0.726)***	0.045 (0.879)
*ACR*2	-0.043 (0.013)***	-0.055 (0.018)***	-0.007 (0.025)
*ACR*3	0.0004 (9.4E-5)***	0.0005 (0.0001)***	8.2E-5 (0.0002)
AD	1.708 (0.308)***	1.781 (0.671)**	1.678 (0.345)***
RD	0.825 (0.207)***	1.112 (0.656)*	0.110 (0.345)
IM	-0.139 (0.064)**	-0.107 (0.105)	-0.149 (0.109)
GR	0.003 (0.231)	-0.421 (0.337)	0.374 (0.302)
KS	0.025 (0.029)	0.008 (0.024)	0.120 (0.067)*
a (intercept)	12.148 (5.032)**	3.457 (8.541)	21.287 (7.291)***
R^2 bar	0.462	0.57	0.382
F - statsitic	10.783***	8.295***	4.555***
Dependent variable: *APCM*			
ACR	unchanged	unchanged	unchanged
ACR2	0.708 (0.308)**	0.781 (0.671)	0.678 (0.302)*
ACR3	-0.175 (0.207)	0.112 (0.656)	-0.889 (0.302)***
a (intercept)	unchanged	unchanged	unchanged
R^2 bar	0.335	0.532	0.136
F - statsitic	6.725***	7.256***	1.908*
No. Obs.	92	45	47

Standard errors in parentheses beside coefficients
*, **, *** significantly different from zero at the 0.1, 0.05, 0.01 probability levels

Legend:

PCM	Industgry price-cost-margin	AD	Advertising intensity
APCM	Industry price-costg-margin adjusted for advertising- and R&D outlays	RD	R&D intensity
		IM	Import intensity
ACR	Four-firm concentration ratio (adj. for imports)	GR	Growth rate of sales
ACR2	Concentration raised to the second	KS	Capital to sales ratio
ACR3	Concentration raised to the third power		

V. Firm-level Findings

The results reported in Tables 3 and 4 give clear evidence of the sensitivity of SCP-model tests using industry data to the heterogeneity of the firms in each industry. As a further test of the importance of firm-level heterogeneities, we have reestimated equation (6) using the projected profits for each *firm* as the dependent variable, and the same set of industry-level explanatory variables. Thus, the data for the dependent variables are identical to those used to make the estimates reported in Table 3, except that they have not been aggregated to obtain industry measures of profitability.

The results are reported in Table 5. The first column presents the results for the pooled sample of homogeneous and heterogeneous industries. All coefficients are of the same sign as for the pooled sample in Table 3. All are significant at the five percent or better level.

The second and third columns of Table 5 report the results for the homogeneous and heterogeneous industries. The coefficients on the three concentration variables have the same signs as in Table 3, and are highly significant. The coefficients on the other explanatory variables have the same signs as in Table 3, with the exception of R&D, which is nevertheless insignificant in both equations. The set of industry-level explanatory variables explains 20 percent of the variation in long-run projected profits for this subset of firms. Thus, knowing the characteristics of the *industry* a firm is in— in particular the concentration of the industry— allows us to explain the firm's long-run projected profits, *if* the firm belongs to one of the industries that we have characterized as homogeneous.

In contrast, the same set of industry-level variables explains only 11 percent of the variation in long-run projected profits for the subset of heterogeneous firms, and all three coefficients on the concentration terms are statistically insignificant. The only coefficient for the heterogeneous industries in Table 5 that is significant at conventional levels is for advertising. To explain differences in *firm-level* profits in heterogeneous industries, we would need to have firm-level explanatory variables, like market share.

Table 5:
SCP model with long run projected profit rates of firms as dependent variable

Variable	Pooled	Sample: Homogeneous	Sample: heterogeneous
ACR	1.603 (0.573)***	4.602 (0.868)***	-0.492 (0.834)
*ACR*2	-0.047 (0.017)***	-0.128 (0.027)***	0.015 (0.026)
*ACR*3	0.0003 (0.000)**	0.001 (0.0002)***	-0.0002 (0.0002)
AD	2.381 (0.610)***	2.028 (1.114)**	2.574 (0.754)***
RD	1.064 (0.516)**	-0.506 (1.278)	0.887 (0.637)
IM	-0.465 (0.132)***	-0.222 (0.203)	-0.347 (0.0210)*
GR	-0.876 (0.286)***	-1.595 (0.395)	-0.803 (0.463)
a (intercept)	-5.713 (5.767)	-37.363 (7.547)***	15.296 (8.398)
R^2 bar	0.098	0.195	0.110
F-statsitic	8.580***	7.627***	6.241***
No. Obs.	492	300	192

Standard errors in parentheses beside coefficients
*, **, *** significantly different from zero at the 0.1, 0.05, 0.01 probability levels

Legend:

ACR	Four-firm concentration ratio (adj. for imports)	AD	Advertising intensity
ACR2	Concentration raised to the second power	RD	R&D intensity
ACR3	Concentration raised to the third power	IM	Import intensity
		GR	Growth rate of sales

VI. Conclusions

This paper has tested whether the results obtained from standard SCP models estimated at the industry level are sensitive to the degree of heterogeneity of the firms in the industries. Our criterion for separating industries into homogeneous and heterogeneous categories was whether the profit rates of firms within an industry converged on a common value or not. When they did, we found that both the long-run projected returns on assets for the industries and Bureau of Census price-cost-margins were well explained by the variables included in the usual SCP model. In particular, a polynomial in concentration by itself explains the data for the homogeneous industries quite well. The same set of *industry-level* variables explains long-run differences in the profits of individual firms for the firms in the homogeneous industries.

In contrast, *none* of usual SCP-model variables was statistically significant in the regressions for heterogeneous industries when the long-run projected returns on assets was the dependent variable. Only advertising, and the capital to sales ratio were statistically significant for the heterogeneous industries subsample, when Bureau of Census price-cost-margins were the dependent variable. Only industry advertising was significant in explaining firm-level differences in profits for the heterogeneous industries subsample.[16]

These empirical findings are interesting in several respects. First, they suggest that the claim that firm-level estimates of SCP models are superior to industry-level estimates, which many authors have made in the last 25 years, may have been exaggerated. When a SCP model is estimated over a sample that contains the kind of homogeneous firms that justify estimating the model at the industry level of aggregation, the results are close to what one expects. The rather poor fit to this sort of model, which many authors have observed in the past, seems likely to have arisen because the authors' samples inadvertently pooled observations from homogeneous and heterogeneous industries. In this respect, our results support and strengthen the findings of BLOCH (1994), since we have employed a quite different methodology for selecting our homogeneous firm industries.

Second, our results reconfirm the findings of several early studies that many firms tend to converge on significantly different profitability levels, often even when located in the same 4-digit industry. To explain differences in the profit levels of these firms some firm-level characteristics would seem to be needed. Lacking data on market share and the like for our

[16] At the firm level, the measure of profitability is a return on assets and thus the capital/sales ratio is not included as an independent variable.

sample of firms, we have not run these tests, but the results extant in the literature suffice to substantiate this claim.[17]

In this regard it is perhaps worth emphasizing that our results do *not* imply that market structure is irrelevant when evaluating performance and policies for heterogeneous industries. What we have shown is that *industry concentration* is not systematically associated with profitability in these industries. We suspect that market share would be positively correlated with company profit rates in these industries, and there is no reason to expect that entry barriers are not relevant in these industries. Indeed, the one variable that is significantly correlated with profitability in the heterogeneous industries is advertising intensity, which is often interpreted as a component of entry barriers.

The implications of our findings for antitrust polices that are grounded on the logic of the SCP model are two fold. First, increases in concentration can be expected to increase profitability in homogeneous industries. Under the assumption that this concentration/profitability link is a result of attenuated competition in more concentrated industries, a rather simple, structuralist approach to mergers can be defended— in homogeneous industries. In these industries, horizontal mergers should be prohibited where industry concentration levels are already high and/or the mergers will significantly increase these levels. On the other hand from our results, a merger's impact on competition in a heterogeneous industry is much less clear, and a more thorough economic analysis of the likely impact of a horizontal merger in one of these industries seems warranted. Thus, another implication of our findings is that an industry's profit patterns over time should be examined to determine whether the industry meets the homogeneity assumption of the SCP model before applying the logic of this model to antitrust policy.

A similar conclusion holds with respect to future research within the SCP tradition. Before estimating an SCP model using industry-level data, one should examine the patterns of profitability of the firms in each industry to determine whether they are sufficiently homogeneous to allow them to be aggregated and employed as a meaningful measure of industry performance. Follow-up studies might also go inside of the heterogeneous industries and test whether subsets of companies converge on common profit rates, and if they do whether "mobility barriers" exist between these groups.

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[17] See, SHEPHERD (1972, 1975), RAVENSCRAFT (1983), and MUELLER (1986).

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Appendix

Data Sources of Variables used in Structure / Performance Regressions

variable abbreviation	variable	abbreviation of source
dependent variables		
P	long run projected industry profit rate	Compustat*
PCM	industry price cost margin in 1992	CM
APCM	industry price cost margin in 1992 adjusted for advertising and R&D outlays	CM
independent variables		
ACR	four firm concentration ratio (adjusted for imports)	CM, OEI
AD	industry advertising to sales ratio	Compustat, R+T**, (W)**
RD	industry R&D to sales ratio	Compustat, To**. (GV)**
IM	industry import to sales ratio	OEI
GR	industry growth of sales	CM
KS	industry capital to sales ratio	Compustat

* Data are aggregated over the firms that are assigned to a particular four-digit industry by Standard & Poors. Only data of firms for which homogeneity tests were carried out were used to construct the aggregate numbers.

** Abbreviations of data sources in parenthesis indicate secondary data sources. These data were imputed in the few cases where data were not available from primary data sources.

Sources:

CM Census of Manufacturers for 1987 and 1992, Subject Series: Concentration Ratios In Manufacturing, U:S Department of Commerce, Economics and Statistics Administration, BUREAU OF THE CENSUS

OEI U.S. Commodity Exports And Imports As Related To Output for 1992, U.S CENSUS BUREAU

R+T Rogers, R. T. and Tokle, R. J. (1993) 'Advertising Expenditures in U.S. Manufacturing Industries, 1967 and 1982', *Private Strategies, Public Policies & Food System Performance*, Working Paper Series, Regional Research Project Ne-165, University of Connecticut. The data were kindly provided by Richard T. Rogers in computer readable form.

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W Data set kindly provided by Christoph Weiss (University of Linz, Austria).The data are based on various issues of the U.S. CENSUS BUREAU and a joint project by the University of Pennsylvania, the Bureau of the Census and SRI. Inc.