ADVERTISING AND FIRM PROFITABILITY: A SIMULTANEOUS EQUATION MODEL

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Recently, several studies have used simultaneous equation models to investigate the relationship among profits, advertising and concentration. Strickland and Weiss [1976] criticized the single equation models of industrial structure and performance and estimated a three equation model of profits, advertising and concentration based on a sample of four-digit SIC industries. Martin [1979a] pointed out the identification problem in the Strickland-Weiss model and developed a three equation model of industrial profitability, concentration and advertising intensity based on the 1967 input-output tables for the United States. Pagoulatos and Sorensen [1981] highlighted the importance of price elasticity of demand in their simultaneous equation model which described the interrelationship between concentration, advertising and profitability of 47 U.S. food processing industries in 1967.

There are, however, two major drawbacks in these simultaneous-equation studies. First, they are all based on industry data although the underlying theories were developed mainly to explain firm behavior. (Most empirical studies of the relationship between firm advertising and profitability are based on single-equation models. For instance, Backman [1967], Federal Trade Commission [1969], Imel and Helmberger [1971], Shepherd [1972] and Vernon and Nourse [1973].) And second, as argued by Chappell, Marks and Park [1981], the unobservable entry barrier has not been approximated nor has the interaction between concentration and barrier to entry been rigorously studied.

Entry barrier is an unobservable variable and its impact on profitability is difficult to measure. Bain [1956] and Mann [1966] recognized that the effects of concentration upon profitability will differ depending upon whether entry barriers are high or low. However, they made subjective judgements as to whether entry barriers were "moderate to low," "substantial," or "very high" based on industry data collected. Martin [1979a, 1979b, 1979c] used empirical proxies for entry barrier. Some of his findings seem to imply an interaction between entry barrier and industry concentration although no explicit formulation of the interaction was specified.

In this study we follow the strategy of Chappell, Marks and Park [1981] to approximate the unobservable entry barrier by a switching regression equation suggested by Maddala [1977]. In addition, the interaction between concentration and advertising intensity is estimated through the use of a simultaneous equation model of firm profitability and advertising.

Methodology

The model consists of two equations: the first is nonlinear and models profitability; and the second, is linear and models the firms advertising intensity. Because the model is nonlinear, the full information maximum likelihood method (FIML) is used for efficient estimation of model parameters.

The profitability equation. The profitability equation is:

$$PM_i = a_0 + \frac{a_1}{1+e^{-B_0-B_1(A_i/S_i)}} MSH_i + a_2(MSH_i - MES/S)^2 + u_{1i}$$

where

PM_i = firm i's pretax profit margin

(A_i/S_i) = firm i's advertising sales ratio

MSH_i = firm i's market share in its 4-digit SIC industry

MES = the minimum efficient scale of firm i's 4-digit SIC industry

S = value of shipments of firm i's 4-digit SIC industry

Following the suggestion by Maddala [1977], observable advertising and the logistic function were used to approximate the unobservable entry barrier. From a theoretical point of view this approach is justified because advertising is a major competitive tool in establishing position in the marketplace.

Schmalensee [1974] argues that established firms achieve a significant market advantage. This occurs because their advertising effectiveness and product appeal have been enhanced by consumer experience with the product as well as the simple aggregate volume of competing advertising messages. Thus established firms can impose higher advertising costs on new entrants by increasing their own advertising expenditures. As a result, one would anticipate a higher barrier to entry, more market power and higher profits.

Continuous approximation of the entry barrier based on a cumulative density function is clearly an improvement over the subjective step function classification (a zero-one dummy variable). Using the estimates about the cumulative logistic curve one can calculate an index of the degree of the entry barrier for each firm. And, given the degree of the entry barrier, one can then assess the effects of concentration (market share) on profitability. Because higher concentration implies more market power and monopolistic behavior resulting in higher profits, B_1 and a_1 are expected to be positive.

Following Martin [1979a], the minimum efficiency scale variable (MES) was included in the profitability equation. The variable $(MSH_i - MES/S)^2$ is a measure of the deviation from the minimum efficiency scale. Thus the sign of the regression coefficient a_2 is expected to be negative.

The advertising equation. The advertising equation is specified as follows:

$$(A_i/S_i) = d_0+d_1PM_i+d_2FGR_i+d_3PCMI+u_{2i}$$

where

(A_i/S_i) = Firm i's advertising sales ratio.

PM_i = Firm i's pretax profit margin.

FGR_i = Firm i's sales growth rate from 1967 to 1972.

PCMI = Profit margin of the 4-digit SIC industry to which firm i belongs.

The importance of profitability in the determination of advertising intensity has been recognized by Dorfman and Steiner [1954], Comanor and Wilson [1974] and Schmalensee [1972] among others. It has been shown that under certain circumstances the advertising sales ratio will be equal to the product of the price-cost margin and the advertising elasticity of demand. The industry profit variable should capture some industry specific effects. The firm sales growth rate from 1967 to 1972 reflects the dynamics of firm growth strategies. Thus, d_1 and d_3 are expected to be positive, while the sign of d_2 could go either way.

The Data

The sample consisted of 77 companies in the food and tobacco industries (SIC 2000, 2010, 2020, 2030, 2041, 2046, 2048, 2050, 2062, 2063, 2065, 2070,

2082, 2085, 2086, 2099, 2111 and 2121) drawn from the Compustat© tape for the year of 1972. The year 1972 was chosen because detailed industry-specific data from the Census of Manufacturing is also available for that year.[1] The names of these sample companies together with their SIC classifications are listed in Table 3.

The dependent variable of the first equation is the firm's pretax profit margin--computed using the following formula:

Profit Margin = (Income before Extraordinary
Items and Discontinued
Operations + Income Taxes +
Minority Interest) / Sales

All the measures in the above formula were obtained from the Compustat© annual industrial data file.

Advertising intensity was computed using advertising expense and sales data from Compustat©. A firm's market share was derived by dividing their sales as reported by Compustat© by the corresponding 4-digit SIC industry shipment data from the Census of Manufacturing. The minimum efficient scale was approximated using the following procedure: using the employment size distribution data of the Census of Manufactures, the employment bracket[2] of the median value of shipment of a 4-digit SIC industry was identified; the total value of shipments of the chosen bracket was then divided by the number of establishments in that bracket.

For the second equation, the advertising intensity and firm rates of return variables are the same as in the first equation. The five year growth rate of sales is computed based on firm data from Compustat©. The industry

profitability variable is computed using a crude price-cost margin formula: value of shipments minus cost of materials and wages divided by the value of shipments.

Empirical Results

The full information maximum likelihood method[3] was used to estimate the nonlinear simultaneous equation model. In order to see the extent of simultaneity in the model the results from the single equation estimates together with the FIML estimates are presented in Table 1 and Table 2. The estimated barrier of entry index is given in Table 3, and plotted in Figure 1.

The estimated regression coefficients B_1 and a_1 in the first equation and d_1 in the second equations are significant and positive establishing a clear simultaneous relationship. The single equation estimates of B_1 and d_1 have much smaller t-values than the FIML. The single equation OLS estimate of d_1 is only a little more than half of the FIML estimate. The significant estimates of a_1 and a_2 with correct signs indicate that the market share and minimum efficient scale are indeed important determinants of firm profitability. However, in the second equation estimates of both d_2 and d_3 are not significant enough to indicate that firm growth rate and industry profitability are important determinants of firm advertising intensity.

Conclusions

Individual firm data was used to study the interrelationship between profitability and advertising. A simultaneous equation model was estimated and indicates that a two-way relationship between profitability and advertising

was significant, thus casting doubt upon most of the empirical studies adopting a single-equation approach. The interaction between market share and the unobservable entry barrier variable has been identified and estimated. The use of the cumulative logistic curve to capture the interaction is an improvement over the subjective step-function entry barrier variable and separate treatment of entry barrier and market share. The interaction term was also found to be very important in the causal model of profitability and advertising.

However, the study also has limitations. The study used only data from the food and tobacco industries. Even though these are important, advertising intense industries, studies of other industries would certainly shed more light on the intricate relationships among profitability, advertising and entry barrier. As more data becomes available for other years and firms, additional models must be estimated.

FOOTNOTES

[1]When this paper was written, the detailed industry characteristics data in the 1977 Census of Manufactures had not been published. The Census year of 1967 was not used because very few firms in the Compustat© tape reported advertising expenses in 1967.

[2]When the median value of shipment falls in the very beginning of the employment bracket so chosen, the preceding employment bracket is also used in the computation of the minimum efficient scale.

[3]The FIML procedure of TSP 3.5 was used to estimate the model.

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Figure 1 Estimated Entry Barrier Approximation

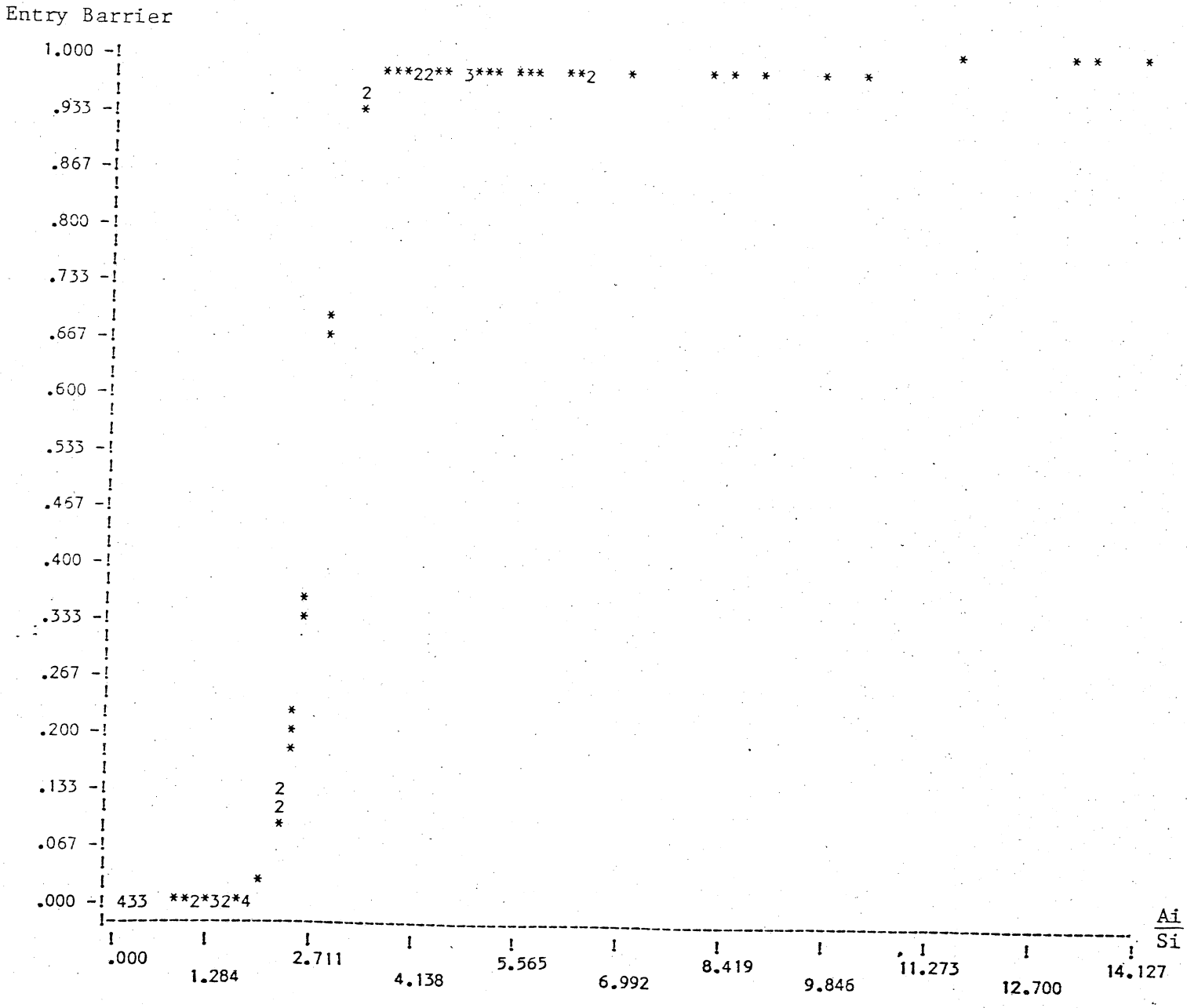

TABLE 1

Empirical Results of the Profitability Equation

	NLLS[1]		FIML[2]	
a_o	5.545	(8.556)[3]	5.518	(7.961)
a_1	1.578	(5.021)	1.784	(6.880)
a_2	-.007	(2.302)	-.942	(3.859)
B_0	-14.1871	(10.5629)	-14.1871	(10.5629)
B_1	4.857	(8.185)	4.942	(34.593)
SSR[4]	1740.9		1755.4	

[1]Nonlinear least square method.

[2]Full information maximum likelihood functions.

[3]The numbers in the parentheses are t-values.

[4]Sum of squared residuals.

TABLE 2

Empirical Results of the
Advertising Equation

	OLS[1]		FIML[2]	
d_0	.647	(.778)[3]	.007	(.006)
d_1	.263	(4.792)	.461	(9.463)
d_2	-.002	(1.350)	-.002	(.545)
d_3	.044	(1.522)	.012	(.372)
SSR[4]	541.3		639.8	
			LLF[5]	-.4514

[1]Nonlinear least square method.

[2]Full information maximum likelihood functions.

[3]The numbers in the parentheses are t-values.

[4]Sum of squared residuals.

[5]Log likelihood function of the simultaneous equation model.

TABLE 3

The Estimated Index of Entry Barrier

SIC CODE	COMPANY NAME	INDEX OF ENTRY BARRIER
2000	Beatrice Foods Co.	.0113744
2000	CPC International Inc.	.999628
2000	Campbell Soup Co.	.999091
2000	Capitol Food Ins. Inc.	.00203467
2000	General Foods Corp.	1.00000
2000	General Mills Inc.	.999955
2000	Kellogg Co.	1.00000
2000	Nabisco Inc.	.999994
2000	Pillsbury Co.	.710813
2000	Standard Brands Inc.	.360639
2000	Universal Foods Corp.	.00000225027
2000	Ward Foods Inc.	.000424073
2010	Cagle's Inc.	.00000564583
2010	Federal Co.	.0000139837
2010	Glover Inc.	.00000213077
2010	Hormel (GEO. A.) & Co.	.000324765
2010	Mayer (Oscar) & Co.	.000250556
2010	United Brands	.0000846426
2010	Valmac Industries Inc.	.00000271129
2020	Borden Inc.	.687641
2020	Carnation Co.	.200338
2020	Dellwood Foods	.00000225927
2020	Kraft Inc.	.346295
2030	Gerber Products Co.	.149935
2030	Heinz (H.J.) Co.	1.00000
2030	Orange-Co., Inc.	.113608
2030	Smucker (J.M.) Co.	.00285641
2030	Sonesta Intl. Hotels Corp.	.140788
2030	United Foods Inc.	.00000698971
2041	Conagra Inc.	.0000187276
2041	Intl. Multifoods Corp.	.00166863
2046	American Maize-Products-Cl.	.00134625
2046	Staley (A.E.) Mfg. Co.	.132283
2048	Ralston Purina Co.	.997850
2050	American Bakeries Co.	.0000161627
2050	Campbell Taggart Inc.	.0127388
2050	Flowers Industries Inc.	.181493
2050	Tasty Baking Co.	.104581
2062	Ingredient Technology Corp.	.00000225927
2063	Holly Sugar Corp.	.00000309991

TABLE 3

The Estimated Index of Entry Barrier
(continued

SIC CODE	COMPANY NAME	INDEX OF ENTRY BARRIER
2065	Hershey Foods Corp.	.984931
2065	Tootsie Roll Industries Inc.	.998475
2065	Wrigley (WM.) Jr. Co.	1.00000
2070	Central Soya Co.	.00000516778
2082	Anheuser-Busch Cos. Inc.	.999302
2082	Carling O'Keefe Ltd.	1.00000
2082	Heileman (G.) Brewing Inc.	.999998
2082	Olympia Brewing	1.00000
2082	Pabst Brewing Co.	.999832
2082	Pittsburgh Brewing	1.00000
2082	Schaefer (F. & M.) Corp.	.999999
2082	Schlitz (Joseph) Brewing	.999964
2085	American Distilling Co.	.00935757
2085	Brown-Forman Distillers-Cl.	1.00000
2085	Glenmore Distilleries Co.	.999939
2085	Heublein Inc.	1.00000
2085	Publicker Industries Inc.	.0322398
2085	Seagram Co. Ltd.	1.00000
2086	Coca-Cola Bottling Co. of N.Y.	.992561
2086	Coca-Cola Co.	1.00000
2086	Cott Corp.	.00272574
2086	Dr. Pepper Co.	1.00000
2086	General Cinema Corp.	.955875
2086	Mei Corp.	.236647
2086	Pepcom Industries	.0206140
2086	Pepsico Inc.	1.00000
2086	Royal Crown Cos. Inc.	.996581
2099	Acton Corp.	.0145523
2099	Stange Co.	.00000225927
2099	Sun City Industries	.00000245609
2111	American Brands Inc.	.999988
2111	Conwood Corp.	.959652
2111	Liggett Group	1.00000
2111	Philip Morris Inc.	1.00000
2111	Reynolds (R.J.) Inds.	.999967
2121	U.S. Tobacco Co.	.944532
2121	Universal Cigar Corp.	.00102867