PROFIT TECHNOLOGY AND ADVERTISING: A NOTE ON THE SPECIFICATION OF ADVERTISING - PROFITABILITY MODELS

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I. Introduction

Since the publication of Comanor and Wilson's seminal paper {10} the advertising-profitability relation has received attention in a number of studies {18, 19, 22, 23, 24, 26, 30, 32, 34}. These mostly confirm the statistical association of advertising and profit which Comanor and Wilson found. However, those currently in print have done comparatively little to extend our insight into the relationship and, in the present writer's view, the Comanor and Wilson paper remains the foundation on which future investigations can most auspiciously be built. This is mainly because of its strength in considering the role of advertising as an entry barrier at the theoretical level[1] and its thoroughness, compared with most later studies, in considering alternative empirical specifications of the advertising variable. However it can be argued that Comanor and Wilson's measure of profitability is not the most relevant one and that the problem of simultaneous equation bias is more serious than was recognised by them. On the other hand the case for taking variability of profit into account, as argued by Sherman and Tollison {30} in a comment on Comanor and Wilson's paper does not seem very strong. Moreover, Sherman and Tollison's contention that the advertising-profit association is a spurious correlation, arising from mutual correlation with an aspect of production technology, is demonstrably false.[2]

II. The Choice of Dependent Variable : Profit Rate vs Price-Cost Margin

Along with most other investigators Comanor and Wilson chose to specify the profitability variable as profits after taxes as a percentage of stockholder's equity (Π/E). However, since their concern was with the impact of imperfect market structures on profit in product markets, there is

a powerful case for choosing the profit margin (Π/R) as used by Preston and Collins {7, 8, 9} and others. Basically this is because observed variations in Π/E will partly reflect the operation of the capital market which could obscure or distort the structure-performance relation under examination.

The detailed argument is as follows. The return on equity Π/E may be written as $\Pi/R \cdot R/E$ or $(p-c)/p \cdot R/E$ in the case of constant returns.(3) That is, the return on equity is the product of the price-cost margin (alias the Lerner index of monopoly under constant returns) and the inverse of the capital/output ratio, where the latter is measured in value terms in a particular way. Assuming constant returns and ignoring measurement problems for the time being, let cost c include normal returns to all inputs including the actual or implicit rental of capital services. Competition in the product market will reduce $(p-c)/p$ to zero in which case Π/E must also be zero, equity holders receiving a normal return. If product market competition is in abeyance we expect $(p-c)/p > 0$. However if the equity is traded in an efficient capital market we can easily observe both $(p-c)/p > 0$ and $\Pi/E = 0$ because equity values will rise where monopoly profit is earned. That is, assuming a capital market with full information and no artificial barriers to the amount of different stocks held by individual investors, zero variance in Π/E is perfectly consistent with high and varying amounts of monopoly profit (and resource misallocation) among firms and industries. In practice the capital market may very well not function so smoothly and zero variance in Π/E is certainly not what we observe. But the problem remains that, except by reference to Π/R, there is no way of telling how much of the variance in Π/E arises from product market imperfections and how much of it is a capital market phenomenon. If, as in the Comanor and Wilson analysis, we are concerned primarily with the former there is little point in allowing the latter to confuse us if this can be avoided.

The basic step in the foregoing argument is that however profitability is defined the price-cost margin is buried in the measure. It is therefore instructive to consider what is actual being explained in Comanor and Wilson's regressions. Using Sherman and Tollison's measure of the price cost margin[4] as the dependent variable in a typical Comanor and Wilson regression equation significantly improves the results (c.f. equations 1 and 3, table 1). Overall explanatory power and significance increase markedly and although the capital requirements variable loses significance the advertising/revenue coefficient is almost quadrupled and its t value rises dramatically. Moreover when the residual element in the return on equity is regressed on the same variables (equation 5, table 1) rather poor results are obtained which, however, apparently suggest that it is this element in Π/E which the capital market variable explains. However Sherman and Tollison do not deduct capital costs when measuring the price cost margin so that, capital inputs being asymmetrically treated, measured Π/R will vary with capital intensity. From an econometric viewpoint this can be compensated for by including an appropriate measure of capital intensity among the regressors, as Benishay {4} notes.[5] As is well known the specification bias resulting from the omission of a variable depends on two relations : that between the omitted and dependent variables and that between the omitted variable and any included regressors with which it is correlated. Contrary to Sherman and Tollison (as will be shown in the next section of this note) there is no presumption of a connection between capital and advertising intensity, at least in the orthodox theory on which Comanor and Wilson's model is built. Hence there is little <u>a priori</u> reason to expect specification bias in the advertising coefficient in equation 3.[6] In general, whatever may be thought of the theoretical argument in favour of Π/R and whatever other problems of interpretation there may be with the Comanor and Wilson model,[7] it appears to be Π/R rather than Π/E which the regression model and especially advertising "explains" in practice.

The foregoing analysis negates one argument put forward by previous writers in favour of Π/E[8] and qualifies another. The first is that the rate of return on investment is what competition equalises and, indeed, what must be equalized to avoid "catastrophic inefficiency" in resource allocation {31, p.54}. But as we have seen a competitive capital market could equalize Π/E whatever is happending in product markets. This equalisation does not guarantee allocative efficiency since it is compatible with high and varying degress of monopolistic distortion throughout the economy. Moreover the Lerner index goes straight to the heart of the traditional approach to efficiency of resource allocation; Π/E is relevant in this context only to the extent that it is a more readily available proxy for the price-marginal costs discrepancy {2 p.375}. The second argument for preferring Π/E to Π/R is the latter's alleged insensitivity to differences in capital intensity among the sample and its over-sensitivity to short run demand fluctuations. The first has been shown to be a matter either of careful measurement, all inputs being treated symmetrically, or of including a capital intensity regressor. As for the second, recognition that Π/R is incorporated in any profitability measure suggests that the relative over-sensitivity of Π/R to short run influences has itself been overstated. Π/R may well be the most volatile element in measured rates of return, but any lower degree of variability which is observed in rate of return series is desirable only insofar as it arises from systematic compensation for aberrations from long run positions rather than from the presence of other less volatile but essentially irrelevant ingredients in what is being measured.

Another argument for preferring Π/E - that it is what firms maximise if they act in the interests of shareholders - is simply irrelevant. There is no reason why the firm's maximand must be the dependent variable in empirical models. All that matters is that the empirical model is specified to include regressors which are consistent with the objection function orig-

TABLE 1. Comonor and Wilson Msdel : Linear Unweighted Regression (O.L.S.)[1]

	Dependent	Constant	Advertising/ Revenue Ratio	4-Firm Concen- tration Ratio	Capital Require- ments	Scale Economies	Demand Growth	Π/R	D1	$\bar{R}^2$	F
	Comonor & Wilson :										
1)	Π/E	4.73	0.51	0.002	0.028	0.09	0.23			.315	4.97
		(4.00)++	(3.17)++	(0.005)	(2.79)++	(0.62)	(0.01)				
	Sherman & Tollison :										
2)	Π/E	2,06	0.17	(0.02)	0.030	0.18	0.23	0.175		.395	5.62
		(1.31)	(0.83)	(-0.46)	(3.180)++	(1.29)	(1.09)	(2.37)+			
3)	Π/R	15.19	1.93	0.084	-0.01	-0.53	-0.22			.395	6.56
		(5.99)++	(5.56)**	(1.18)	(-0.06)	(-1.69)	(-0.05)				
4)	Π/R	15.24	1.92	0.084	-0.01	-0.52	-0.003		-0.31	.378	5.31
		(5.87)++	(5.23)++	(1.16)	(-0.51)	(-1.59(	(-0.006)		(-0.12)		
5)	R/E	0.39	-0.01	-0.001	0.003	0.006	0.007			.288	4.51
		(4.77)**	(-1.23)	(-0.50)	(3.92)**	(0.58)	(0.46)				

Note 1. t values in parenthesis. Variables defined as in Sherman and Collison [30] except for D1 which is a dummy of value one for durable markets and zero otherwise.

inally postulated. Whether the maximand is some complex managerial utility function, a rate of return, simple profit maximisation, or whether we assume cost plus pricing, mathematical ingenuity should enable us to choose among a number of possible dependent variables each paired with an appropriate set of regressors. Certainly it is not difficult to begin with profit maximisation and end with (p-c)/p on the left hand side. For instance, we know that under unconditional profit-maximising monopoly we have simply:

$$(1) \qquad (p-c)/p \; - \; 1/\eta^{p}$$

where η^{p} is own price elasticity of demand. Evidently the regressors in this case are simply the determinants of η^{p}.

Two remaining arguments have been put forward in favour of Π/E: that it avoids problems arising from the vagaries of accounting practice and in particular the haphazard revaluation of assets especially in periods of rapidly increasing prices; and that in the U.S. Π/E is reported by Fortune and easy to collect. It must be admitted that using Π/R will generally not avoid problems with the valuation of capital or capital services (in order to estimate capital costs or define a capital intensity variable). However, the ready availability of Π/E should not be given much weight and, in any case, is not true of the U.K. where no equally convenient source exists.

Two postscripts are in order. First, it is not argued that the functioning of the capital market is irrelevant for industrial economic analysis, only that there may be occasions when product and capital market behaviour must be kept analytically distinct. The second postscript concerns the significance of observed price-marginal cost discrepancies for resource allocation. It is becoming commonplace to point out that structure-profit relations may understate resource misallocations due to market power because

observed cost levels are inflated by discretionary expenditures and/or "X-inefficiency". Two further reservations exist. One is that where the threat or actuality of anti-trust sanctions on firms are likely to place emphasis on profitability, firms may behave as if under overt "fair rate of return" rules and choose unduly capital intensive methods, as anlysed by Averch and Johnson {1}. In this case too structure-profit relations will fail to capture the full allocative distortion. The second reservation has to do with the reliability of the price-private marginal cost divergence as a welfare guide when we know that optimality may require systematic price-private cost divergences if there are externalities, or additional constraints giving rise to second best problems (Baumol and Bradford {3}). More fundamentally, what is the relevance of the marginal cost pricing prescription in situations where consumer preferences are endogenous to the model, as they strictly must be in the Comanor and Wilson model or any other which incorporates advertising? Perhaps we all make mental adjustments when we come upon such difficulties in the literature. Certainly the empirical literature itself contains few reminders of the need to do so, let alone indications of what these adjustments should be.

III. The Relevance of Technology (Cost Fixity and the Variability of Profit)

Sherman and Tollison {30} interpreted the price-cost margin $(p-c)/p$ as a measure of short-run fixity of costs. They then alleged that the Comanor and Wilson advertising-profit relation is a spurious correlation, arising from the fact that cost-fixity is an important determinant of both profitability (Π/E) and advertising intensity. Cost fixity affects profitability, they argued, because it raises the variability of profit, other things being equal, which leads investors to demand higher average returns in compensation for variance. The impact of cost fixity on advertising can be seen, according to Sherman and Tollison, from the monopolist's profit

maximising condition (equation (1) above) together with the Dorfman-Steiner {14} condition for optimal advertising:

$$(2) \qquad \mu = \eta^P$$

where μ is the marginal revenue product of advertising. On the assumption that μ is falling at equilibrium optimal advertising will be a decreasing function of η^P and hence, from equation (1), an increasing function of cost fixity. Having made this discovery Sherman and Tollison proceeded to treat cost fixity as an omitted variable. When cost fixity is added to the Comanor and Wilson model the advertising/revenue variable loses significance and explanatory power is improved (equation 2, table 1); when advertising is then dropped almost no explanatory power is lost. Naturally Sherman and Tollison considered that these results confirmed their arguments.

But their argument is false.(9) It is false because it requires a causal flow running from technology (cost fixity) to consumer preferences (which determine elasticity of demand) and thence, eventually, to the optimal level of advertising for the firm. This is quite contrary to orthodox micro theory, in which technology and preferences are taken as exogenous, and is explicitly ruled out in some axiomatic theoretical presentations.(10) Specifically, Sherman and Tollison's error concerns the causal flows associated with the optimality condition:

$$(p-c)/p = 1/\eta^P$$

To the monopolist c and η^P are exogenous, determined by technology (given input prices) and consumer preferences respectively. Given the objective to maximise profit, these jointly determine a particular price-quanity combination. It so happens that the price-cost margin which results is

a measure of the reciprocal of the price elasticity of demand but no causal connection is implied, essentially because p is endogenous. Once this link of the causal chain is broken the connection between technology and optimal advertising is also lost although, incidentally, the subsequent relationship between price elasticity and advertising can be shown more succintly than with the aid of (2) via a simple transformation of the Dorfman Steiner rule which produces:(11)

$$(3) \qquad A/R = \eta^A/\eta^p$$

where η^A is the advertising elasticity of demand. Of course it is possible that we could have a different theory in which production technology did help determine optimal advertising levels.(12) But there is no guarantee that the optimality condition (1) would survive such a reformulation and, in any case, it is clearly to orthodox theory that Sherman and Tollison themselves appealed.

There remains the question of whether variability of profit needs to be included in a profitability equation to take account of the mean-variance compensation mechanism described by Sherman and Tollison. Comanor and Wilson {11} pointed out that this is necessary only insofar as investors cannot avoid the risk associated with high variability through portfolio diversification. Alternatively one might argue that there is no problem if we are successful in measuring long run profits, since if capital markets work efficiently the long run risk premium is zero with short run losses and gains averaging out over a period of years. Thirdly, the need for a variability-of-profit regressor also depends on the choice of dependent variable. This is because the compensation mechanism described is a capital market phenomenon. By assumption final producers pursue profit-maximising policies with whatever results are dictated by market structural conditions.

Compensation for variability of profit will presumably be effected not by product market pricing adjustments but by the capital market attaching a lower equity value to a firm earning a given profit level when this is subject to fluctuation. On this argument variability of profit would not affect price cost margins under any circumstances.

If for any reason a variability of profit variable is required it would seem logical to take a more direct approach than either Sherman and Tollison or Comanor and Wilson. What the investor sees and allegdly compensates for is variation in profit levels from one reporting period to another. Hence the most obvious choice would be the time variability of industry profits or the variance among firms within the industry or some combination of the two. One previous empirical analysis is less than encouraging about the likely result; Stigler {31} failed to find a reliable correlation between mean profit and two such measures of riskiness.

IV. Causality

It has been shown that in Comanor and Wilson's advertising-profit relationship it is the price-cost margin which should be and really is explained, and use has been made of two profit maximising conditions under monopoly:

$$(p-c)/p = 1/\eta^P \quad \text{and} \quad A/R = \eta^A/\eta^P$$

Of course, the latter pertain to the firm so that in relating them to inter-industry empirical models an aggregation problem has somehow to be dealt with. One approach, adopted by the author in a previous paper {6}, is to think of the "typical" or "average" firm in each market for whom, by definition, the firm and industry level ratios are the same.(13)

On this basis the optimality conditions together with the re-estimated Comanor and Wilson result suggest a much more serious problem of simultaneous equation bias than was recognised by Comanor and Wilson, who saw the possibility of feedback as arising only from a discretionary expenditure mechanism. In half of the regressions reported in their original paper the advertising/sales ratio is used (and most subsequent researchers have made the same choice). If profit maximisation is applied consistently to the model, Comanor and Wilson (and others) have in these cases estimated:

$$1/\eta^{p}_{ij} = f\ (A/R_{ij}\ ,\ Z_{ij})$$

where Z_{ij} is a vector of other included variables for the typical firm i in the j^{th} market (and hence for the market as a whole). This is obviously subject to simultaneous equation bias since the advertising-determinants relation can be written {6}:

$$(A/R)_{ij} = g\ (\eta^{p}_{ij}\ ,\ X_{ij})$$

where X_{ij} is a vector of determinants of the advertising elasticity η^{A}_{ij}. Moreover the simultaneity problem does not vanish when absolute advertising expenditure is used in place of A/R, since the advertising determinants relation can also be written:

$$A_{ij} = h\ (V_{ij}\ ,\ \eta^{p}_{ij}\ ,\ N_{j})$$

where V_{ij} is a vector of determinants of μ_{ij} and N_j is the number of firms in the industry which, if not directly observable, might be captured by the reciprocal of the Herfindahl concentration index or some other, correlated, measure of concentration.

Hence, the original Comanor and Wilson result needs to be confirmed in a larger model which includes at least an advertising-determinants equation of the type indicated above, as well as the original profit equation. How close Comanor and Wilson have come to this in the two equation models to which they have referred {11, p.410} has yet to be seen. The present writer has some doubts whether such an extension of the model is possible with the existing sample, which spans a wide range of consumer goods markets, including durables. This is because the variables comprising the vectors V,X seem to be noth numerous and, in several cases, extremely hard to quantify or proxy. The solution to this problem adopted in the author's own study, previously referred to, was to restrict the sample in such a way as the minimize the likely variation among the sample observations in these trouble-some variables. This resulted in a sample confined to non-durable goods, mainly food, passing through the same retail outlets. Arguably, the models can only be expected to work when the sample is constrained in this way. Certainly the present writer's attempts to extend the Comanor and Wilson model met with little success (table 2). The advertising variable did retain significance in the profit equation but none of the variables in the advertising equation was significantly different from zero, so that the profit equation is identified in only the weakest, most formal of senses. Admittedly the variables being relied upon to identify the profit equation (revenue and two dummy variables) leave a great deal to be desired,[14] so the test must be regarded as wholly inconclusive, and the question left open for future attempts to resolve it.

In a recent addition to the list of advertising-profitability studies Vernon and Nourse {32} claim to have avoided simultaneous equation bias. This is because profit rates at the level of the individual firm are explained in their model by the A/R ratio for the relevant market, among other things,[15] and:

Table 2 — Comanor and Wilson Model : T.S.L.S. Estimates[1]

$$\frac{\hat{\Pi}}{R} = \underset{(4.3)}{9.17} + \underset{(0.46)}{2.07}\,\frac{A}{R} + \underset{(0.07)}{0.10}\,CR - \underset{(0.023)}{0.028}\,K - \underset{(0.30)^{++}}{0.67}\,SE + \underset{(2.69)}{4.26}\,\dot{D}$$

$$\frac{\hat{A}}{R} = \underset{(41.95)}{12.05} - \underset{(3.14)}{0.78}\,\frac{\Pi}{R} + \underset{(0.14)}{0.05}\,CR + \underset{(22.5)}{6.56}\,\dot{D} - \underset{(0.000005)}{0.000001}\,R - \underset{(17.42)}{5.52}\,D1 + \underset{(36.30)}{16.46}\,D2$$

Note 1. Asymptotic standard errors in parentheses. Variables are:

C.R.	:	Concentration Ratio
K	:	Capital Requirements
S.E.	:	Scale Economies
$\dot{D}$	:	Demand Growth
R	:	Sales Revenue
D1	:	Durable/non-durable dummy variable
D2	:	"Sensitive products" dummy variable (See Cable {6}).

> "... this argument [an extension of the Dorfman Steiner condition] does not predict a positive relation between firm profit rates and industry advertising/sales ratios (rather, firm profit rates and firm advertising)."

Of course this argument is unavailable if the "typical" or "average" firm approach to the problem of aggregation, presented earlier, is thought to be at all sound. More generally, it is hard to see how the industry A/R ratio can be a function of anything other than the same variables which determine the A/R ratios of firms within that industry, in which case the simultaneity problem is not disposed of. These objections to Vernon and Nourse's argument might recede if, in practice, there was little correlation between the firm and industry level ratios. In fact Vernon and Nourse report a simple correlation coefficient of 0.62 which must be reckoned rather high, especially as firm and industry advertising data were taken from different sources and the data for the firms apparently may include some advertising outside the firm's principal market. Thus it seems unlikely that the causality problem can be solved simply by switching to the firm level for observations. On the other hand, there may be other good reasons for doing this, among them the fact that this will make it easier to generate the larger samples needed to estimate more complicated, simultaneous equation models while still restricting the sample to a relevant subset of markets.

V. Conclusions

A rather powerful argument can be advanced in favour of using the profit margin instead of the return on equity as the dependent variable in advertising-profitability models. This would also apply to other models in which the concern is with the impact of imperfect market structures on profit in product markets. Markedly better empirical results can be obtained with the Comanor and Wilson model when this substitution is made. The a priori

case for including variability of profit as an additional explanatory variable is rather weak, especially when the profit margin is being explained. The argument that both high profits and high advertising intensity are due to technological factors is not well founded in orthodox theory. While the evidence of an association between advertising and profit is now well established in single equation models, the simultaneity problem is sufficiently severe as to make the development of multi-equation models highly desirable. These might usefully incorporate an advertising-determinants equation of a type which has previously been experimented with in a single equation model, and there are grounds for making observations at the firm rather than the industry level. Discussion of the normative significance of structure-profit relations is hampered at present by theoretical limitations arising from second best problems and, where advertising is concerned, the lack of welfare guidelines when preferences are endogenous.

Footnotes

(1) Their analysis may, however, need to be considered alongside the argument of Brozen {5} and Schmalensee {29}, which are discussed by Cowling {12}.

(2) Other issues, including the omission of lagged advertising effects and the appropriateness of the advertising/sales ratio as a measure of the advertising entry barrier are discussed elsewhere by Kelly and Cowling {22}.

(3) $\frac{\Pi}{R} = \frac{pX - cX}{pX} = \frac{p-c}{p}$ where p is product price, X is output and c is average and marginal cost. These equalities may also hold approximately where there are initially increasing returns but constant unit costs over all outputs not less than minimum efficient scale. There is, of course, some evidence to suggest the latter is a frequently encountered case (Bain {2} Johnston {20}).

(4) The variable used is their "advertising adjusted cost-fixity" defined as:

$$1 - \frac{vX}{pX - s}$$

where v is variable cost and s is advertising expenditure.

(5) Comanor and Wilson's capital requirements variable is not an appropriate measure because of inter-industry differences in the minimum-efficient-scale output level.

(6) Bias is much more to be expected in the capital requirements coefficient. Hence the previous interpretation of equation 5 was in tentative terms.

(7) See below, especially section IV.

(8) These and other arguments to be discussed will be found in {2, p.402; 4; 7; 17; 21; 28 p.80; 31 pp 84-58}.

(9) Replying to Sherman and Tollison, Comanor and Wilson {11} looked at the elements contained in the profitability and cost fixity variables and proclaimed them almost identical. Morevoer experiments with a "more direct" measure of cost-fixity, based on capital costs, did not generate the outcomes which Sherman and Tollison found. The arguments in the previous section of this note would, on a different approach, confirm Comanor and Wilson's assessment: since Π/R is what the Comanor and Wilson model explains best Sherman and Tollison have effectively included the same variable on both sides of their regression equation. Even if this were not so, one could question Sherman and Tollison's reliance on the t test to choose between variables when, by their own arguments, the estimates are prone to multicollinearity.

(10) Walsh {33 p.227} writes an Axiom of Neutrality of Transformations: Any two transformations are indifferent <=> their inputs are indifferent and their outputs are indifferent. This implies that processes or activities as such do not give rise to preferences.

(11) $\eta^A = \frac{A}{X} \cdot \frac{\partial X}{\partial A} = \frac{A}{pX}\mu = \frac{A}{R}\mu$. In equilibrium $\mu = \eta^A \frac{S}{A} |\eta^P|$. Therefore $\frac{\eta^A}{\eta^P} = \frac{A}{R}$. The earliest derivation of the optimality condition in this ratio form of which the writer is aware is in Franke {15} p.

(12) The only direct theoretical connection between technology and advertising known to the present author is in Galbraith {16, pp. 202-207}. In his description of the new industrial state the imperatives of technology (specifically, highly capital intensive methods and long lead times) and the objectives of the technostructure intensify the degree to which firms plan to reduce uncertainty by means which include advertising. But, of course, this theory has never been formally systematized and it would be inappropriate to graft small pieces of it onto the orthodox model.

(13) To allow for varying market structures among the sample of observations, the monopolist's optimality conditions must be extended to oligopoly e.g. by incorporating interaction terms into the relevant elasticities (Lambin {25}) or by taking explicit account of the degree of apparent collusion (Cubbin {13}). The argument in this note is essentially unaffected by this modification. Likewise, the simultaneity problem is essentially unaltered if lagged advertising effects are introduced and the Dorfman-Steiner condition is replaced by its dynamic analogue derived by Nerlove and Arrow {27}.

(14) The full list of variables which should be present is discussed at some length in {6}.

(15) The firm's A/R ratio is also included and the problem of simultaneity recognised in a footnote.

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