Apparent Collusion, Price-Cost Margins and Advertising in Oligopoly

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ABSTRACT

This paper aims to crystallise the outcome of oligopolistic pricing behaviour in a single measure. This measure, related to the Lerner index of monopoly power, indicates the extent to which the industry in question succeeds in maintaining a price close to the monopolistic price. Since this would be the maximum price expected in a fully collusive situation the measure is termed an index of apparent collusion.

The equivalent parameter for advertising behaviour is then derived. The concept is then used in the discussion of the relationships between price-cost margins and advertising intensity and between advertising and concentration.

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APPARENT COLLUSION, PRICE-COST MARGINS AND ADVERTISING IN OLIGOPOLY *

The upper limit on equilibrium price in profit-maximising oligopoly is the joint monopoly or fully collusive price. If this is rarely achieved in practice it is because of either fear of inducing new entry into the industry or the costs and difficulties of enforcing a high price cost margin. These costs and difficulties are a function of industry structure in a way that Stigler (1964), for example, has analysed. Scherer (1970) has an extensive if less rigorous analysis of the many factors determining the extent to which different industries approach the joint monopoly extreme. These include such commonly used concepts as the number and size distribution of sellers, but also such less obvious factors as the standard of market information and the lumpiness and infrequency of orders. However, the threat of new entry may keep the price-cost margin down even where other structural conditions are highly conducive to a collusive solution. This suggests that the price equation for an oligopoly should be written

$$(1) \qquad P = \min \{ f(S), g(B) \}$$

where P is price, f is a function of structural characteristics, S, and g a function of the height of entry barriers. Further refinement might bring in the threat of government intervention as another possible constraint. If potential entry is ignored the lower limit on price is the Chamberlin "large numbers" solution, or, for homogeneous products, the Cournot equilibrium price as Nicholson (1972) shows. In what follows it will initially be assumed that barriers to entry are sufficiently high for potential entry to be ignored so that we can concentrate on the function f.

To a large extent the industry characteristics which are the arguments of f are conceptually distinct from the actual mechanism by which the pricing decision is taken (examples of which are price leadership and full cost pricing); if anything they determine that mechanism. This view of oligopoly, which examines the costs and difficulties of maintaining a price which recognises interdependence, does not depend on any one rigid mathematical model and is consistent with many of the different types of pricing behaviour. As it stands, however, it is somewhat too vague and general to lead to rigorous specification of econometric models. Implicit in the approach is a concept which might be termed "tightness", but which I call the degree of apparent collusion. The mathematics below, which owes much to Cowling's (1972) analysis, leads to a formal measure of this concept. It is not meant as an accurate description of the decision process of any firm.

The measure is indended to provide an explicit framework for thinking about oligopoly behaviour. To illustrate this the mathematics is followed by some discussion of empirical work involving concentration levels, advertising intensities, and price-cost margins.

Consider a typical firm in a differentiated oligopoly.

Let Q = total industry demand

q_i = demand facing firm i

p_i = price charged by firm i

The following demand elasticities can be defined:-

(1) $$\text{Let } \eta_i^f = \frac{\partial q_i}{\partial p_i} \cdot \frac{p_i}{q_i} = \frac{\partial \log q_i}{\partial \log p_i}$$

which measures the response of demand facing firm i when all other firms keep their prices constant.

(2) $$\text{Let } \eta^I = \frac{d\log Q}{d\log p_i} \quad \text{when } d\log p_i = d\log p_j \text{ for all } i,j.$$

This measures the response of industry demand to an equiproportionate increase in prices by all firms.

(3) $$\text{Let } \eta_i^* = \frac{d\log q_i}{d\log p_i} \quad \text{when } \frac{d\log p_j}{d\log p_i} = 1 \text{ for all } j.$$

This measures the response of the individual firm's demand when all firms increase prices in the same proportion. The analysis is simplified if we assume that when all firms change their prices in equal proportion market shares are unaffected.(1) This amounts to assuming a demand function of the form

(4) $$q_i = q_i\,(\lambda p_1, \lambda p_2, \;\ldots .\lambda p_n, X) / f(\lambda)$$

Where n is the number of firms in the industry, X is a vector of the other variables that affect demand, and λ is an arbitrary constant. I believe that this is a reasonable approximation to reality. If the unit prices of the different varieties differed greatly the income effects of the price changes might lead to an increase in market share of the cheaper varieties at the expense of the dearer ones. This consideration leads us to suppose that equation (4) will be a better approximation the more equal are the unit prices of the different varieties and the smaller the proportion of the budget which is spent on the good. This can only be a rough guide, however, since the demand functions involved represent the aggregate behaviour of many individuals who may have very different preferences.

If equation (4) holds the proportionate change in q_i is equal to the proportionate change in Q so that $\eta_i^* = \eta^I$. If

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(1) The need for this assumption was pointed out to me by D.G.Champernowne.

(4) does not hold it is necessary to substitute $\eta_i^* = \eta^I$ in all the formulae developed below.

The relationship between η_i^f and η^I can be found by the following

$$(5) \qquad \eta_I = \eta_i^*$$

$$(6) \qquad = \frac{d \log q_i}{d \log p_i} \text{ when } \frac{d \log p_j}{d \log p_i} = 1 \text{ for all } j$$

$$(7) \qquad = \frac{\partial \log q_i}{\partial \log p_i} + \sum_{j \neq i} \frac{\partial \log q_i}{\partial \log p_j} \cdot \frac{d \log p_j}{d \log p_i} \text{ when } \frac{d \log p_j}{d \log p_i} = 1 \text{ for all } j$$

$$(8) \qquad = \frac{\partial \log q_i}{\partial \log p_i} + \sum_{j \neq i} \frac{\partial \log q_i}{\partial \log p_j}$$

$$(9) \qquad = \eta_i^f + \sum_{j \neq i} \frac{\partial \log q_i}{\partial \log p_j}$$

$$(10) \qquad \therefore \sum_{j \neq i} \frac{d \log q_i}{d \log p_j} = \eta_I - \eta_i^f$$

Now consider the typical firm's profit maximising decision on price. By definition

$$(11) \qquad \Pi_i \equiv p_i q_i - C(q_i)$$

where Π_i is the firm's profits

and C is the firm's cost function.

To maximise profits $\frac{d\Pi_i}{dp_i}$ is set equal to zero :-

(12) $$\frac{d\Pi_i}{dp_i} = q_i + \frac{p_i dq_i}{dp_i} - \frac{dC_i}{dq_i} \cdot \frac{dq_i}{dp_i} = 0$$

(13) Now $$\frac{dq_i}{dp_i} = \frac{\partial q_i}{\partial p_i} + \sum_{j \neq i} \frac{\partial q_i}{\partial p_j} \cdot \frac{dp_j}{dp_i} + \sum \frac{\partial q_i}{\partial X_j} \cdot \frac{dX_j}{dp_i}$$

In this case $\frac{dp_j}{dp_i}$ and $\frac{dX_j}{dp_i}$ are i's conjectures about j's behaviour. Assume i's conjecture about X_j is either

$\frac{dX_j}{dp_i} = 0$ or more generally $\sum \frac{\partial q_i}{\partial X_j} \cdot \frac{dX_j}{dp_i} = 0$

(14) $$\therefore \quad \frac{dq_i}{dp_i} = \frac{\partial q_i}{\partial p_i} + \sum_{j \neq i} \frac{\partial q_i}{\partial p_j} \cdot \frac{dp_j}{dp_i}$$

Substituting (14) into (13) and multiplying by $\frac{p_i}{q_i}$ yields

(15) $$p_i + \left(p_i - \frac{dC_i}{dq_i}\right)\left(\frac{\partial \log q_i}{\partial \log p_i} + \sum_{j \neq i} \frac{\partial \log q_i}{\partial \log p_j} \cdot \frac{d\log p_j}{d\log p_i}\right) = 0$$

If $\frac{d\log p_j}{d\log p_i} = 1$ we have the Chamberlin small numbers case and the joint monopoly solution prevails. The other extreme is where $\frac{d\log p_j}{d\log p_i} = 0$ and the Chamberlin "large numbers" result prevails. The general case however is where

$$0 \leq \frac{d\log p_j}{d\log p_i} \leq 1$$

Let $\frac{d\log p_j}{d\log p_i} = \alpha_{ij}$. What does α represent?

It probably does not represent the exact true value of j's response to i's projected price change, except at that price level at which all firms are simultaneously in equilibrium. This is analogous to the Cournot and Chamberlin "large numbers" models in which the assumption of no reaction (on which each individual firm's behaviour is supposedly based) is only true when the industry is in equilibrium. α_{ij} is a parameter describing the behaviour of i rather than of j. In other words this model analyses what would happen if firm i acted as if firm j would respond to a price change at the rate α_{ij}.

Assume that α_{ij} is the same for all firms j or, more generally, we can write

$$(16) \qquad \alpha_i = \bar{\alpha}_{ij} = \sum_{j\neq i} \alpha_{ij} \frac{\partial\log q_i}{\partial\log p_j} \Big/ \sum_{j\neq i} \frac{\partial\log q_i}{\partial\log p_j}$$

α_i is the weighted mean value of α_{ij}.

Equation (15) now becomes

$$(17) \qquad p_i + \left(p_i - \frac{dC_i}{dq_i}\right)\left(\frac{\partial \log q_i}{\partial \log p_i} + \sum_{j \neq i} \frac{\partial \log q_i}{\partial \log p_j}\right) = 0$$

Substitute the identity $\frac{\partial \log q_i}{\partial \log p_i} = \eta^f$ and equation (10) into (17).

$$(18) \qquad \therefore \quad p_i + \left(p_i - \frac{dC_i}{dq_i}\right)\left\{\eta^f + \alpha(\eta^I - \eta^f)\right\} = 0$$

$$(19) \qquad \therefore \quad \frac{p_i - \frac{dC_i}{dq_i}}{p_i} = - \frac{1}{\alpha\eta^I + (1-\alpha)\,\eta_i^f}$$

This is the required result. When $\alpha = 1$ the price-cost margin is $\frac{-1}{\eta^I}$, which is the familiar monopoly result.

When $\alpha = 0$, $\frac{p_i - \frac{dC_i}{dq_i}}{p_i} = \frac{-I}{\eta_i^f}$

which is the Chamberlin large numbers case result.

In the context of this model α is the extent to which the individual firm takes into account the effect of his pricing decision on that of other firms. When $\alpha = 1$ the result is the same as if the firms are colluding perfectly. When $\alpha = 0$ the result is the same as if firms are acting as though there were no mutual interdependence, and failing to create any effective collusion.

For any price-cost margin observed at either the firm or the industry level a value of α can be calculated if the firm and industry price elasticities are known. Rearranging (16) gives

$$(20) \qquad \alpha = \frac{\eta_i^f + p_i \;/\; (p_i - dC_i/dq_i)}{\eta_i^f - \eta^I}$$

Any particular price-cost margin may be generated by some mechanism other than the model outlined here; but by whatever mechanism a price-cost margin is generated a value of α can be calculated if the elasticities are known. The most general model of oligopoly is probably one based on Stigler's (1964) work. Stated briefly, in this view of oligopoly the aim of the firms in the industry would be to achieve the joint monopoly- or "perfectly collusive" - price. For a variety of reasons, including the difficulty of detecting and punishing price-cutting collusion is almost never perfect. The more perfect is collusion, the higher would be the calculated value of α, which would therefore be a suitable index of the degree of apparent collusion.

In general we might expect to observe values of α between 0 and 1. If barriers to entry were sufficiently low, however, the optimal price might be below the Chamberlain large numbers price. In such circumstances the interdependence between the oligopoly takes on a different character. For example the temptation to undercut one's rivals disappears.

α is said to be a measure of apparent collusion because the price-cost margin underlying it may not be generated by any explicit act of collusion on the part of the firms involved. For example, the price might be a historical accident kept constant by the existence of a kinked demand curve in the minds of the oligopolists. Indeed, the price might even be generated by the firms acting according to the model of conjectural variations in the context of which α was conveniently introduced. But because the way of looking at oligopoly in terms of the success of attempts at reaching the joint profit-maximising price is fe to be the most general α is considered to be an index of apparent collusion. This "collusion" might not involve any explicit act of communication by the firms involved, but may be the sort found in the literature on empirical games, e.g. Lave (1962).

Another way of looking at α might be as an index of the effective tightness of the oligopoly. It is clearly related to the Lerner (1943) index of monopoly power, but is a different concept since it separates out the effects of variations in the industry and firm elasticities of demand, which might be unrelated to the factors affecting an oligopoly's success at maintaining a high price.

A similar coefficient can be derived and calculated for advertising behaviour. Again assume a differentiated oligopoly.

Again, for the sake of simplicity it is useful to assume that the demand function is of the form

(21) $$q_i = q_i(\lambda A_i, \lambda A_2 \; ..... \; \lambda A_n, Y) / g(\lambda)$$

where A_i is advertising by firm i

λ is an arbitrary constant

and Y is a vector of the other variables affecting demand (including the price vector.)

g is a function independent of i.

This ensures that when all firms increasing advertising by an equal proportional amount market shares are unchanged so that we can write the industry elasticity of demand with respect ot advertising as

(22) $$\eta^I = \frac{d\log Q}{d\log \Sigma A_i} = \frac{d\log q_i}{d\log A_i} \text{ when } d\log A_i = d\log A_j \text{ for all } j.$$

Let $\eta_i^f = \dfrac{\partial \log q_i}{\partial \log A_i}$, which measures the response of i's demand to a change in its advertising when other firms keep their advertising expenditures unchanged.

By the same argument as was used to deduce equation (10) from (5) we can show that

$$(23) \qquad \sum_{j \neq i} \frac{\partial \log q_i}{\partial \log q_j} = \mu^I - \mu^f$$

This will be used later on. Now consider the firm's optimal advertising budget. The firm's profits,

$$(24) \qquad \Pi_i = p_i q_i - C_i (q_i) - A_i$$

Advertising is here treated as an overhead and so is assumed not to affect marginal cost. Those items of promotional expenditure (such as attractive packaging) which do affect marginal costs should be treated separately (see p.20 below). To find the optimal advertising expenditure, set the derivation with respect to this variable to zero:-

$$(25) \qquad \frac{d\Pi_i}{dA_i} = p_i \frac{dq_i}{dA_i} - \frac{dC_i}{dq_i} \cdot \frac{dq_i}{dA_i} - 1 = 0$$

$$(26) \qquad \text{Now} \quad \frac{dq_i}{dA_i} = \frac{\partial q_i}{\partial A_i} + \sum_{j \neq i} \frac{\partial q_i}{\partial A_j} \cdot \frac{dA_j}{dA_i} + \sum \frac{\partial q_i}{\partial Y_j} \cdot \frac{dY_j}{dA_i}$$

Assume that firms behave as if they expect only advertising responses to changes in their advertising expenditures. (A similar assumption was made about price changes.) i.e. $\frac{dY_j}{dA_i} = 0$

or more generally $\quad \Sigma \frac{\partial q_i}{\partial Y_j} \cdot \frac{dY_j}{dA_i} = 0.$

Multiplying (25) by A_i/q_i and substituting equation (26) into it yields

$$(27) \qquad \left(p_i - \frac{dC_i}{dq_i} \right) \frac{\partial \log q_i}{\partial \log A_i} = \frac{A_i}{q_i}$$

Let $\quad \frac{d\log A_j}{d\log A_i} = \beta_{ij}$

We can either take the weighted mean value of β_{ij},

$$(28) \qquad \beta_i = \overline{\beta}_{ij} = \sum_{j \neq i} \beta_{ij} \frac{\partial \log q_i}{\partial \log A_j} \Bigg/ \sum_{j \neq i} \frac{\partial \log q_i}{\partial \log A_j}$$

as we did after equation (13) with α_{ij} or assume that β_{ij} is constant and equal to β. In either case this leads to

$$(29) \qquad \left(p_i - \frac{dC_i}{dq_i} \right) \left(\frac{\partial \log q_i}{\partial \log A_i} + \beta \, \Sigma \frac{\partial \log q_i}{\partial \log A_j} \right) = \frac{A_i}{q_i}$$

Substitute for $\Sigma \dfrac{\partial \log q_i}{\partial \log A_j}$ from (23) and substitute the identity $\dfrac{\partial \log q_i}{\partial \log A_i} = \mu_i^f$ into (29) :-

$$(30) \qquad \left(p_i - \frac{dC_i}{dq_i}\right)\left\{\beta\mu^I + (1-\beta)\,\mu_i^f\right\} = \frac{A_i}{q_i} \qquad (2)$$

rearranging gives

$$(31) \qquad \frac{A_i}{p_i q_i} = \left\{\beta\mu^I + (1-\beta)\,\mu_i^f\right\}\left(\frac{p_i - \dfrac{dC_i}{dq_i}}{p_i}\right)$$

$\dfrac{p_i - \dfrac{dC_i}{dq_i}}{p_i}$ can be found from (19).

Substituting this in (31) and rearranging yeilds

$$(32) \qquad \frac{A_i}{p_i q_i} = -\frac{\beta\mu^I + (1-\beta)\;\mu_i^f}{\alpha\eta^I + (1-\alpha)\;\eta^f}$$

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(2) From this we can obtain an expression

$$\beta = \frac{\mu_i^f - (A_i/p_i q_i)\,(p_i \,/\, (p_i - dC_i/dq_i)\,)}{\mu_i^f - \mu^I}$$

This is a generalisation of Cowling's (1972) version of the Dorfman-Steiner (1954) condition for the optimal advertising outlay. With perfect collusion in both advertising and pricing behaviour it becomes the Dorfman-Steiner condition for monopoly. If no mutual interdependence is recognised $\alpha = \beta = 0$ and only the firm elasticities count. This is an intuitively obvious result since in these conditions the oligopolists are behaving as if they were monopolists facing a demand function of elasticities η_i^f and μ_i^f .

Further results can be obtained for the case where firms manage to "collude" over one variable but "compete" over the other, and with varying degrees of success at "conscious parallelism" over price and advertising strategies.

The α and β concepts provide a theoretical framework for the analysis of so-called structure-performance relationships deriving from the seminal work of Bain. These generally involve the regression of some measure of profits on an index of market concentration, the height of entry barriers and the miscellaneous other variables including sometimes the ratio of advertising expenditure to sales revenue for the industry. Although no clear rationale is usually given for this procedure it often "works" in the sense of yielding significant coefficients on at least some of the variables.

At least two effects can be sorted out. One is that η_f may decline as the market concentration increases. The other is that α will increase with increased concentration. Separation of these two types of effect should lead to specifications of this relationship more firmly grounded on theory. For example low barriers to entry should not affect η_f particularly but they may set an upper limit on α. If values for η_j^f and η^I can be obtained these could be used explicitly in the regression analysis - otherwise the factors which determine them would have to be used.

Of especial interest are the determinants of α. Scherer's book is very useful in listing the many factors involved but we have little idea of their relative importance. Quantitative work along these lines should be helpful in isolating the most important forces leading to high values of α. At the moment policy in Britain concentrates very largely on concentration and barriers to entry and overtly restrictive practices and tends to ignore practices such as information pooling which,Stigler shows theoretically, can improve the prospects for collusive behaviour.

Examination of equation 32 reveals that if elasticities are assumed constant the highest advertising-sales ratios will be in those firms which do not collude over advertising. This is not very surprising. Of more interesc is the result that for a given level of apparent collusion over advertising those firms with a higher degree of collusion over price (and the largest price-cost margins) will have the greatest advertising intensities. There are two implications of this.

There first is that advertising intensity is not dependent only on the demand elasticites with respect to advertising and price, but also on the degree of apparent collusion over price. Hence the common observation that non-price competition often occurs where price competition is slight.

The second implication is that those empirical studies which regress some measure of the price cost margin on, amongst other things, the advertising - sales ratio are, subject to simultaneous equation bias. (As Cowling (1975, ch.6) points out the only advertising variable which theory points to is the stock of advertising goodwill, and not the advertising-sales ratio so these studies are subject to specification bias also). These points have been made before (see, for example, Sherman and Tollison, 1971), but I feel that equation 31 is useful in clarifying them.

The analysis of apparent collusion also provides a simple explanation for the recently observed non-monotonic relationship between market concentration and advertising intensity (Cable, 1972 and Sutton, 1974). Cable's equation predicts the greatest intensity where the Herfindahl index of concentration is 0.4 (that is, where the equivalent number of equal sized firms (Stigler, 1968, p.31) is 2.5). Sutton finds the greatest intensity where the five-firm concentration ratio is 62 - 64% (depending on the sample chosen). Sutton's explanation is expressed in terms of a fairly large number of considerations, some of which appear very plausible. Cable's analysis is expressed in terms of the Dorfman-Steiner condition, but instead of the four elasticities of equation 32 he only uses one advertising elasticity and one price elasticity. It is hoped that my analysis generalises Cable's result and simplifies Sutton's theory.

The argument depends principally on what happens to the parameters α and β as concentration rises. (Variations in the elasticities of demand are regarded as being of secondary interest). α and β are determined by many factors of which the level of concentration is one. Assume that these other factors are constant. At very low levels of concentration, near the atomistic extreme both α and β can be expected to approach zero. At monopolistic levels of concentration the parameters should reach their upper bound, which will be unity in the case of an unconstrained monopolist, possibly less if barriers to entry are not sufficiently high or intervention by government is threatened.

The crucial assumption is that between these bounds α starts to increase before β does so. In other words that as the level of concentration increases the recognition of mutual dependence arises first in pricing considerations and only secondly in advertising decisions. The reasons for this are possibly twofold. First is the matter of gestation lags, Brems (1958), Nicholson (1972) and Scherer (1970) point out that greater levels of apparent collusion will occur where retaliation for any lapse from the status quo is swift. Advertising policy generally takes longer to change than pricing decisions. The second reason is that the gains and losses involved in setting the appropriate price are likely to be much greater than those involved in setting the appropriate level of advertising. Price competition is potentially more ruinous for an industry than is advertising competition.

These considerations lead to the graphs for α and β shown in Fig. 1.

Since $|\eta^I| < |\eta^f|$ the absolute value of the denominator in (32) will fall as α starts rising before β there will be an initial rise in A/pq which will be modified and eventually reversed as β starts to rise. This is shown in the lower half of Fig. 1.

One complicating factor is that whilst the upper bound on β is clearly unity,[1] the lack of sufficiently high barriers to new entry (or the threat of government intervention) may lead to the upper bound for α being less than one. If this is the case the α and β curves will cross over and for highly concentrated industries with low barriers to entry we are likely to observe that $\beta < \alpha$ (see broken line in Fig. 2).

There is another reason why β may exceed α. Strictly speaking α represents the degree of recognised interdependence over the price-cost margin. If the nature of the product is fixed and costs are the same across firms this amounts to recognising mutual dependence over price. But where product quality is a variable the firms in the industry may choose to increase sales by improving quality rather than increasing price. Since improving quality will often increase variable costs the effect of such competition will be to reduce the price-cost margin just as surely as price reductions. Furthermore, the gestation lag for quality change may well be greater than for advertising. This may lead to the degree of apparent collusion being greater over advertising than over the price-cost margin. The obvious example where this may occur is in the motor industry.

Equation 32 can also be used in interpreting Cowling's results (1972). He compares the advertising-sales ratio with μ^f / η^f for a number of industries and uses this as a test of optimality of the firms' behaviour. The implication is that if $A/R = -\mu^f / \eta^f$

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(1) Keith Cowling claims that even very concentrated industries may have a value of $\beta < 1$ or even < 0 if they are attempting to create barriers to entry through advertising. This hypothesis can, of course, be tested and estimation of β for a number of industries might (or might not) provide evidence that firms behaved in this way.

the behaviour is optimal. However, equation 32 tells us that this is only true in the context of a situation where $\alpha = \beta = 0$. $A/R \neq \mu^f / \eta^f$ may imply, rather than non-optimality, that at least one of α and β is non-zero. Non-optimality can only be deduced where one of α and β is outside the zero-one range.

The extreme departures from optimality occured for cars and toothpaste where $-\frac{\mu^f}{\eta^f} \Big/ \frac{A}{R}$ were 23.0 and 0.78 respectively. Sufficient information is available to work out α and β for cars over the period 1956 - 68. Prescott (1972) estimates that η^I is -0.63 for that period. Cubbin (1975) estimates the industry's average price-cost margin for the period as 23.6% and the long run value of η^f as 7.07 (Strictly speaking if the firm maximises profits over several periods the relevant elasticity should be somewhat less than this depending on the rate of discount employed. Our estimate of α should therefore be regarded as an upper bound). Using equation 17 the estimate of α is

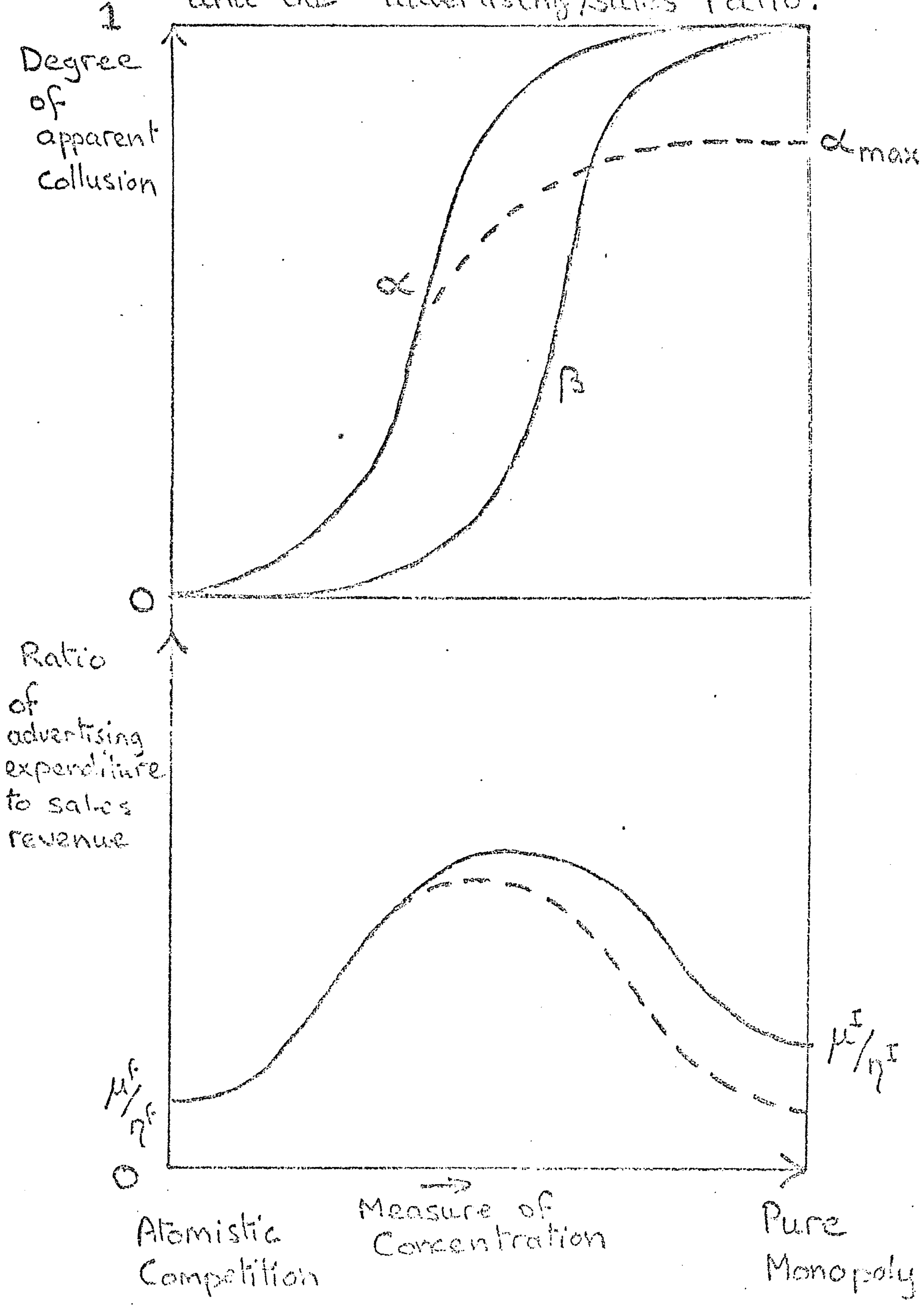
$$\frac{-7.07 + 100/23.6}{-7.07 + 0.63} = 0.44$$

Cowling and Cubbin (1971) estimate μ^f as 0.914. If we assume $\mu^I = 0$ we can obtain an estimate for β which will be a lower bound using the formulas derived from equation (30). The figure for the advertising-sales ratio is taken from Table 1 in Cowling (1972). The resultant estimate of β is 0.968, implying a very high level of apparent collusion over advertising.

Unfortunately there is not sufficient information at hand to calculate α and β for toothpaste. It is apparent that the empirical application of the concept of apparent collusion requires a lot of painstaking work on individual industries. Four elasticities and a price-cost margin need estimating for each industry.

But even if the initial empirical applications are limited I believe that the equations presented in this paper provide a framework for thinking about oligopoly which combines the exactness of a mathematical formula with the degree of generality required for such a complicated subject. The underlying concept is implicit in the modern approach to oligopoly theory as exemplified by Scherer and one of the purposes of this paper was to provide an explicit formulation of it.

Fig. 2. The relationship between market concentration, degree of apparent collusion, and the advertising/sales ratio.



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