MARKETING SCIENCE
Vol. 6 No. 2 Spring 1987
Printed in U.S.A.

MODELING COMPETITIVE MARKETING STRATEGIES: THE IMPACT OF MARKETING-MIX RELATIONSHIPS AND INDUSTRY STRUCTURE

GREGORY S. CARPENTER
Columbia University

This paper empirically analyzes the formulation of competitive marketing strategies consisting of product quality levels, promotional expenditures and prices. Using a simultaneous-equation model, we examine the use of prices and promotional spending as signals or indications of product quality, the impact of promotional spending on prices, and the impact of industry structure on the formulation of the complete marketing mix. The structural equations are developed using a theoretical model of optimal competitive marketing mix, and are estimated using business-level PIMS data, which consists largely of industrial, durable goods producers. For a cross-section of 1,100 of these businesses, three results of the estimation are especially interesting:

- Price-cost margins are high for high quality products, suggesting that high prices indicate or signal high quality.
- Promotional intensity is unrelated to product quality, suggesting that promotional effort provides no reliable signals of quality. Intensely promoted products earn low price-cost margins, however, indicating that promotional spending is associated with high price sensitivity.
- Quality levels, promotional intensity, and price-cost margins vary significantly with competitive and market conditions such as the concentration of competitors and the stability of market shares, although these relationships are generally weaker than relationships between quality, promotion, and price-cost margins. Quality levels are high and margins low in markets with unstable shares or unconcentrated competitors.

(Competition; Marketing Strategy; Econometrics; Industry Structure)

1. Introduction

Implicitly or explicitly all competing businesses employ a strategy to select a mix of marketing resources. Formulating such competitive strategies fundamentally involves recognizing relationships between elements of the marketing mix (e.g., price and product quality), as well as assessing competitive and market conditions (i.e., industry structure in the language of economics). For example, in the auto industry pricing and the setting of promotional budgets depend on the quality levels selected and the competitive conditions including the size of competitors and the height of industry entry barriers. Similar forces influence marketing strategy formulation in many other industries.

Modeling this process is the focus of an important research stream (e.g., Bailey 1975; Buzzell and Farris 1977; Doyle 1968; Farris and Buzzell 1979; Lilien 1979; Lilien and Weinstein 1984). These studies generate important insights into how marketing resources are allocated. For example, Lilien (1979) examines how promotional budgets

0732-2399/87/0602/0208$01.25

vary across industrial markets with the number of buyers, last year's sales, and a number of market-specific factors.

One limitation of these studies is that they typically focus on only one marketing mix element, usually advertising, which excludes important relationships between marketing mix variables. This is especially troublesome when examining the impact of product quality and competition on the marketing mix formulation. Quality can affect advertising, for instance, directly by increasing the effectiveness of advertising spending, or indirectly by raising profit margins and thus the incentive to advertise. Likewise, competitive and market conditions affect the entire mix of marketing resources, not just a single element.

In contrast, this paper models the competitive formulation of the broader marketing mix. We focus on product quality, promotional spending (including advertising and salesforce expenditures), and pricing. And we model the relationships between all three marketing mix elements as well as the impact of competitive and market conditions across all three.

This approach produces new insights into two important strategic marketing issues. First, we show how elements of the marketing mix are related. One of the most interesting of the relationships we examine is the impact of quality levels in promotional spending and pricing. Recent theoretical analyses show that higher quality brands optimally price above and spend more on promotion than do lower quality ones (e.g., Kihlstrom and Riordan 1984; Milgrom and Roberts 1986; Wolinsky 1983). If so, differences in price and promotional spending levels will reveal or *signal*[1] to buyers differences in quality levels between brands. We empirically analyze this quality-signalling role of prices and promotional spending. We also examine how promotional intensity and prices vary, a topic of much debate (e.g., Comanor and Wilson 1974; Ornstein 1977).

Second, we report empirical results on the impact of competitive and market conditions on the mix of marketing resources. We show, for instance, how the size of competitors' market shares and the height of industry entry barriers influence pricing, promotional spending, and quality levels. These results extend other studies that report similar relationships for a single marketing mix element (e.g., Farris and Buzzell 1979).

We investigate both issues using a simultaneous-equation model of product quality levels, promotional spending, and price-cost margins. We first formulate a theoretical model of optimal marketing mix that includes competitors' strategies, and solve it to derive optimal competitive marketing mix decision rules. Next, we analyze those rules to specify the structural model's equations and to formulate hypotheses about their coefficients' signs. The system of equations is estimated using business-level PIMS data, and the results validated using a second sample from the same data base.

Development and estimation of the model is divided into five sections. §2 formulates and solves the theoretical marketing mix model. The resulting decision rules are analyzed in §3 to specify the structural equations. §4 discusses the data and estimation method. The results are reported in §5, and §6 discusses limitations and summarizes the paper's insights.

2. Optimal Competitive Marketing Mix

Modeling Framework

Our unit of analysis is the individual business. We assume it competes with its rivals by selecting a strategy consisting of a price, promotional expenditure (including adver-

[1] Narrowly defined, a *signal* is an activity or attribute which conveys information from one individual to another in a market (Spence 1974, p. 1). For example, in the labor market, educational credentials convey important information to potential employers about applicants' abilities, training, and productivity. See Spence (1974) for a more thorough discussion of signalling, and for his pioneering analysis of its role in labor markets.

tising and sales force expenditures), and a product quality level. Competitors react to its strategy in formulating their own strategies. The strategies of the business and its competitors affect its sales through a market response function. Profits depend on the revenues generated through these sales less the cost of unit volume, which depends on both the quantity sold and the quality level selected, and the promotional expenditure. The business selects its strategy, subject to competitors' reaction, to maximize profits.

To formalize this framework, let $s = (p, m, r)$ denote the business' strategy consisting of its price, p, promotional outlay, m, and product quality level, r. Competitors' strategies are denoted by a similar triple, $\bar{s} = (\bar{p}, \bar{m}, \bar{r})$, where $\bar{p}$, $\bar{m}$, and $\bar{r}$ are aggregate measures of rivals' prices, promotional outlays, and quality levels, respectively. Competitor reactions are captured by a simple competitive reaction function denoted $\bar{s} = \bar{s}(s) = (\bar{p}(p), \bar{m}(m), \bar{r}(r))$. Unit sales are denoted q where $q(s, \bar{s}(s))$ is the business' market response function.[2] Cost of unit sales, denoted $c(q, r)$, increase in both volume, q, and quality, r. Finally, let Π be current profits for the business, where

$$\Pi = pq(s, \bar{s}(s)) - c(q, r) - m. \tag{1}$$

Optimal Competitive Marketing Strategy

To maximize (1), the business must account for (a) market response to its strategy, (b) competitors' reaction to it, and (c) market response to that competitive reaction. The optimal strategy, denoted $s^* = (p^*, m^*, r^*)$, balances the benefit of market response with the cost of competitive reaction, which requires that s^* satisfy

$$\partial\Pi/\partial p^* = \partial\Pi/\partial m^* = \partial\Pi/\partial r^* = 0 \tag{2}$$

given competitive reaction, $\bar{s} = \bar{s}(s)$.

To satisfy (2), we differentiate (1) with respect to each element of s to produce three optimal competitive marketing mix conditions:

$$L^* = -[e + \bar{e}]^{-1}, \tag{3}$$

$$M^* = L^*[u + \bar{u}], \tag{4}$$

$$R^* = L^*[v + \bar{v}], \tag{5}$$

where $L^* = [(p^* - c^*)/p^*]$ is the optimal price-cost margin, $c^* = c(q(s^*, \bar{s}(s^*)), r^*)$, $e = [(\partial q/\partial p)(p/q)]$ is the sales-price elasticity; $\bar{e} = [(\partial q/\partial \bar{p})(\partial \bar{p}/\partial p)(p/q)]$ is the competitor-price elasticity that captures competitor reaction, $(\partial \bar{p}/\partial p)$, and the impact of that reaction, $(\partial q/\partial \bar{p})$. $M^* = m^*/p^*q^*$ is the optimal marketing-sales ratio, where $q^* = q(s^*, \bar{s}(s^*))$; $u = [(\partial q/\partial m)(m/q)]$ is the promotion-sales elasticity, and $\bar{u} = [(\partial q/\partial \bar{m})(\partial \bar{m}/\partial m)(m/q)]$ is the competitor-promotion elasticity, much like $\bar{e}$. Finally, $R^* = r^*/p^*q^*$ is the optimal quality-sales ratio, $v = [(\partial q/\partial r)(r/q)]$ is the quality-sales elasticity, and $\bar{v} = [(\partial q/\partial \bar{r})(\partial \bar{r}/\partial r)(r/q)]$ is the competitor-quality elasticity.

Intuitively, equations (3) through (5) are simple marginal revenue-equal-marginal cost rules for optimal marketing mix for a single brand, adjusted for competitive reaction. For example, equation (3) can be rewritten as $p^* = c[e + \bar{e}]/[1 + e + \bar{e}]$ which

[2] This formulation describes a duopoly-like situation where one business faces one "aggregate" rival that reacts "simply" (so if the business changes its price, the rival responds only with price). These two simplifications enable us to incorporate essential elements of competition into an optimal marketing mix model without adding great complexity. Moreover, this level of competitive detail is sufficient for specifying the role of industry structure in our structural-equation model. See Cowling (1972) and Schmalensee (1972) for a variety of econometric models constructed with similar simplifications about competition. However, for computing actual optimal marketing mix levels, more complex assumptions may be needed to capture important features of competition. For three such models, see Carpenter, Cooper, Hanssens, and Midgley (1984), Hanssens (1980) and Lambin, Naert, and Bultez (1975).

reduces to the result for monopoly pricing if $\bar{e} = 0$. Similarly, equation (4) can be rewritten as $m^* = (u + \bar{u})(p^* - c^*)q^*$ which gives the optimal marketing budget, m^*, as equal to the effectiveness of promotional spending, $(u + \bar{u})$, multiplied by its net profit contribution, $(p^* - c^*)q^*$. This also reduces to the monopoly result if $\bar{u} = 0$. Equation (5) can be interpreted in the same way. Mathematically, all three are special cases of Lambin, Naert, and Bultez (1975).

Usefulness of Decision Rules

We use optimal marketing mix conditions (3) through (5) to specify our structural-equation model. These equations are useful conceptually for constructing our model because they provide a structure in which the optimal level of each marketing mix element is expressed as a function of the remaining marketing mix variables and competitive and market conditions. In equation (4) for example, M^* depends explicitly on the optimal margin, L^*, and through the promotion-sales elasticity, $u = [(\partial q/\partial m)(m/q)]$, on the optimal quality level that enters u through q. Furthermore, M^* depends on the intensity of competitive reactions, $\bar{u}$, which vary with the structure of the industry (e.g., the size of competitors' market shares and the height of entry barriers). This suggests the conceptual model shown in Figure 1, which is the basis for our empirical model.

3. Structural-Equation Model

The three-equation model shown in Figure 1 can be written in simple linear form as

$$YB = X\Gamma + U \tag{6}$$

where Y and X are matrices of observations on price-cost margins, promotional intensity, and product quality levels, and of competitive and market conditions, respectively; B and Γ are matrices of parameters describing relationships between marketing mix elements and the impact of industry structure on each, respectively; and U is a matrix of errors.

Model Specification

We specify the structural equations that make up (6) and predict the signs of each coefficient using equations (3) through (5) in a two-step procedure. For each marketing mix variable, we first derive the relationship between it and the remaining two and, second, we derive how it varies with competitive reaction and consequently industry structure. For example, to specify the price-cost margin equation we show using (3) that margins are large when price sensitivity, e, is low; empirical evidence suggests that price sensitivities are low for high quality products, so we hypothesize a positive quality-margins coefficient. Furthermore, one can show using (3) that margins are large when competitive reaction, $\bar{e}$, is large; previous studies suggest that this occurs when competi-

FIGURE 1. Schematic Diagram of Structural-Equation Model

tors have large market shares, so we hypothesize a positive competitors' market share-margins relationship. This specification procedure is similar to that used to construct smaller but similar models (e.g., Cable 1972; Cowling 1972b; Martin 1979).

This procedure produces the three-equation model shown in Table 1. Its specification is consistent with models from a variety of fields, including marketing, management science, and economics (e.g., Bass 1974; Bass, Cattin, and Wittink 1974; Cable 1972; Comanor and Wilson 1974; Ornstein 1975; Cowling 1972b; Farris and Buzzell 1979; Lilien 1979; Martin 1979). The development of each equation follows.

Price-Cost Margins

Price-cost margins vary with product quality levels, promotional intensity, and industry structure, as shown in Figure 1.

Quality. First, consider the relationship between quality and price-cost margins. Quality levels are related to optimal margins, L^*, through the price elasticity, e in (3). Margins are high in (3) if e is small (in absolute value), which is often true for high quality products (e.g., Gerstner 1985; Phillips, Chang, and Buzzell 1983). Therefore, we hypothesize that margins are high for high-quality products.

A positive quality-margin relationship has one important implication for the value of prices as quality signals. If margins are high for high-quality products, then prices also will be high and will, thus, *signal* or indicate a high-quality product. If so, buyers can use prices to impute quality and guide choice, as studies suggest they do (e.g., Jacoby, Olson, and Haddock 1971; Peterson 1970; Rao 1971; Shapiro 1973).

The existence of a positive price-quality relationship raises one important issue when modeling it cross-sectionally as we will. If prices do signal quality, buyers use those signals *and firms know that*, then some firms may be tempted to set quality low and

TABLE 1

Structural Model Specification with Hypothesized Coefficient Signs

	Endogenous Variables		
	Price-Cost Margin	Promotion-Sales Ratio	Relative Product Quality
Endogenous Variables			
Price-Cost Margin		+	+
Promotion-Sales Ratio	?		
Relative Product Quality	+	+	
Exogenous Variables			
Constant	?	?	?
Market Share Instability	−	−	−
Competitors' Market Shares	+	−	−
Market Growth	−	+	+
R&D Intensity	+		
Investment-Sales Ratio	+		
Capacity-Market Ratio	+		
Buyer Concentration	−		+
Patent Protection			+
Number of End Users		+	
Purchase Frequency		−	
Purchase Amount		−	
Sales Direct to End Users		+	
New Product Intensity		+	
Capacity Utilization		−	

thus cost low but set price high, falsely signalling high quality, to earn an extraordinarily large short-term profit. If lucrative, such cheating will eventually destroy the positive price-quality relationship, so that examining it at one point may produce few lasting insights.

Klein and Leffler (1981) show, however, that in general cheating is suboptimal so long as higher quality brands earn higher *margins*, not just higher *prices*, compared to lower quality brands. By earning higher margins, the present value of honesty exceeds the large immediate profit of cheating. Therefore, if margins increase with quality, as we hypothesize, prices will signal quality, and examining them at one point in time produces meaningful and lasting insights.

Promotion. Second, price-cost margins are related to promotional intensity, like quality, through the price elasticity. How the price elasticity varies with promotional intensity has been the focus of much intense debate out of which two alternative hypotheses have emerged. On one hand, some argue that intense promotional spending is associated with brand loyalty, barriers to new competition, and thus low price sensitivity and large margins (e.g., Bain 1956; Comanor and Wilson 1974; Kaldor 1949). Lambin (1976) and Shultz and Vanhonacker (1978) report empirical support for this view. On the other hand, some argue that promotion provides buyers with information about availability of rival brands, and is thus associated with high price sensitivity and low margins (e.g., Nelson 1970, 1974; Ornstein 1977; Telser 1964). Eskin (1975), Eskin and Baron (1977) and Wittink (1977) report empirical findings supporting this argument. Based on this, the promotion-margins relationship is ambiguous.

Empirically estimating the margins-promotional intensity relationship will suggest whether promotions are associated with high or low price sensitivity and thus the extent of price competition. If promotional intensity is associated with limited price competition, then the price elasticity will be small and margins large when promotional spending is intense. On the other hand, if promotional intensity is associated with vigorous price competition, the price elasticity will be large and margins small when promotional spending is intense. See Comanor and Wilson (1974), and Ornstein (1977) for an extensive discussion and testing of these alternative arguments at the industry level; see Gatignon (1984) for one alternative view.

Competitive and Market Conditions. Third, we hypothesize that margins vary negatively with the instability of market shares and the rate of market growth, but positively with the size of competitors' market shares and with the height of entry barriers such as R&D intensity, investment-sales ratio, and the capacity-market ratio (i.e., minimum capacity needed to operate relative to the size of the served market). See Table 1.

We generate these hypotheses using (3). In (3), margins are large when the competitive-price elasticity, $\bar{e}$, is large and across markets, competitive-price elasticities are large when market shares are stable, competitors are concentrated, market growth low, and entry barriers high (e.g., Caves and Porter 1978; Scherer 1980; Stigler 1968). Consequently, we hypothesize that margins are large under these conditions, consistent with empirical industry-level studies (e.g., Bain 1956; Collins and Preston 1969; Martin 1979).

Additional Variable. In addition to these specified variables, we add buyer concentration as an exogenous variable to the price-cost margin equation as previous studies suggest (e.g., Lustgarten 1975; Martin 1979).

Promotional Intensity

Promotional intensity varies with price-cost margins, product quality, and industry structure as shown in Figure 1.

Price-Cost Margins. First, consider how promotional intensity varies with price-cost margins. The promotion-sales ratio, M^* in (4), is high if margins, L^*, are also high, all else equal. This implies a positive margins-promotion hypothesis, consistent with em-

pirical studies at the business and industry level (e.g., Comanor and Wilson 1974; Farris and Buzzell 1979; Martin 1979; Strickland and Weiss 1976).

Quality. Second, we hypothesize that high quality products are more intensely promoted than low quality ones. This hypothesis consists of two parts. On one hand, we expect high quality products to have more effective promotion, correspondingly lower promotional costs, and thus greater incentive to promote than low quality ones. In (4) this implies that u is high for high quality products, so that M^* is high too. Greater promotional intensity for high quality products is consistent with previous theoretical and empirical analyses (e.g., Farris and Buzzell 1977; Kihlstrom and Riordan 1984; Milgrom and Roberts 1986). On the other hand, promotional intensity varies indirectly with product quality levels through price-cost margins. If high quality products earn high margins and high margins are associated with intense promotion as we hypothesize, then high quality and promotion are positively related by this indirect link with price-cost margins. Together, both these positive direct and indirect effects produce an unambiguously positive *total* quality-promotional intensity hypothesis, which implies that high promotional intensity signals high quality.

Competitive and Market Conditions. Third, the optimal promotional intensity varies with the competitor-promotion elasticity, $\bar{u}$, which depends on market and competitive conditions. In markets where $\bar{u}$ is large (in absolute value), the promotion-sales elasticity ($u + \bar{u}$) is small, and the optimal promotion-sales ratio small. This competitor-promotion elasticity is greatest in markets where market shares are unstable, competitors are concentrated, and market growth is limited (Caves and Porter 1978; Martin 1979; Scherer 1980; Stigler 1968). Therefore, we hypothesize that promotional intensity is low under these conditions all else equal. See Table 1.

Additional Variables. In addition, we add six exogenous variables to the promotional intensity equation as other studies suggest: number of end users, portion of sales direct to end users, purchase frequency, purchase amount, capacity utilization, and new product intensity. See Bailey (1975), Comanor and Wilson (1974), Doyle (1968), Farris and Buzzell (1979), Lilien (1979), Lilien and Weinstein (1984), Martin (1979), Telser (1962).

Product Quality

Product quality varies with price-cost margins and competitive and market conditions as shown in Figure 1.

Price-Cost Margins. First, quality levels are high when price-cost margins, L^* in (5), are also high, all else equal. Intuitively, this suggests that the optimal quality level increases as does the revenue generated by it. Based on this, we hypothesize a positive margins-quality relationship.

Competitive and Market Conditions. Second, optimal quality levels vary with the size of competitor-quality elasticities. When $\bar{v}$ is large (in absolute value), the quality-sales elasticity ($v + \bar{v}$) is small and consequently the optimal quality level is low. We expect large competitor-quality elasticities in markets with unstable shares, concentrated competitors, and limited market growth, as in the case of promotion. Therefore, we hypothesize that quality levels will be low under these conditions. See Table 1.

Additional Variables. Additionally, buyer concentration and patent protection are included in the product-quality equation. See Porter (1980).

4. Data and Estimation

Measures, Data, and Sample

Measures of the variables are given in Table 2. All are four-year averages and follow conventional definitions (e.g., Bass, Cattin, and Wittink 1978; Comanor and Wilson 1974; Doyle 1968; Farris and Buzzell 1979; Lilien 1979).

TABLE 2
Variable Definitions

Endogenous Variables

Price-Cost Margin: Net sales plus lease revenues less purchases, manufacturing, marketing (advertising, sales forces, promotion, and administration), research and development and depreciation expenses as a percentage of total revenue (net sales plus lease revenues).

Promotion-Sales Ratio: Total promotion expense (including sales forces, advertising, promotion, and administration) as a percentage of total revenue.

Relative Product Quality: The percentage of sales from products superior to competitors, less the percentage of sales from products which are inferior to competitors.

Exogenous Variables

Market Share Instability: Average percentage differences from an exponential trend of market share over the four-year period.

Competitors' Market Shares: Sum of market shares of the SBU's top three competitors.

Market Growth: Four-year growth rate of the served market.

R&D Intensity: Total expenditures on research and development for products and processes as a percentage of sales.

Investment-Sales Ratio: Total investment (working capital, net plant and equipment and other assets) as a percentage of total revenue.

Capacity-Market Ratio: Standard operating capacity based on standard current work rules as a percentage of the total value of sales in the market served.

Buyer Concentration: The proportion of customers which account for 50% of sales, subtracted from 50.

Patent Protection: A two-valued (0, 1) variable indicating the absence or presence of patent-protected, unique, or proprietary products.

Number of End Users: A categorical measure of the number of end users for the product ranging from (1) 19 or fewer to (9) 25 million or more.

Purchase Frequency: Categorical measure of the frequency of purchase ranging from (1) once every five to 10 years, to (6) weekly or more frequently.

Purchase Amount: Categorical measure of the typical purchase amount of a single transaction ranging from (1) less than $1.00 to (9) over $10 million.

Sales Direct to End Users: Percentage of sales which are made directly to end users.

New Product Intensity: Sales originating from new products as a percentage of total sales revenues.

Capacity Utilization: Percentage of capacity utilized based on standard, current work rules.

Data are drawn from the Profit Impact of Marketing Strategy (or PIMS) data base maintained by the Strategic Planning Institute. The data base contains a large amount of information on a wide range of businesses in many markets. Member businesses tend to be large, sophisticated firms producing industrial durables, and may be unrepresentative of all businesses. For a more detailed discussion of the data's strengths and weaknesses, see Anderson and Paine (1978).

From this data base we have drawn a random sample of 1,100 observations from 1975 to 1984 on U.S. and Canadian businesses marketing both durable and nondurable industrial and consumer products. This sample, like the data base as a whole, consists largely of industrial businesses (72%), with over two-thirds (71%) of the businesses producing durable goods.

Estimation and Validation

The sample is randomly split into two subsamples of 550 observations each. For both subsamples equation (6) is estimated by both two- and three-stage least-squares (3SLS). For overidentified models like (6), 3SLS is the efficient procedure, but gains in efficiency may be offset by the propagation of any specification error throughout the system. Estimation by both procedures produced qualitatively similar results suggesting that misspecification is not a serious problem. The efficient 3SLS estimates for both data subsets appear in Table 3.[3]

[3] Prior to estimation, we also redefined certain variables to avoid problems in interpreting the resulting coefficients. The results presented in Table 3 appear with the effect of the transformation removed. See Appendix.

TABLE 3

*Three-Stage Least-Squares Parameter Estimates†**

	Price-Cost Margin Equation		Promotion-Sales Ratio Equation		Rel. Product Quality Equation	
	Sample I	Sample II	Sample I	Sample II	Sample I	Sample II
Endogenous Variables						
Price-Cost Margin			0.454[a]	0.408[a]	1.289[a]	1.496[a]
Promotion-Sales Ratio	−0.542[a]	−0.792[a]				
Rel. Product Quality	0.437[a]	0.500[a]	−0.215[a]	−0.201[a]		
Exogenous Variables						
Constant	2.997	2.071	21.420[a]	23.110[a]	10.810[b]	7.217
Market Share Instability	−0.562[a]	−0.298[a]	0.201[a]	−0.010	0.848[a]	0.437[c]
Competitors' Market Shares	0.106[a]	0.126[a]	−0.081[a]	−0.071[a]	−0.318[a]	−0.303[a]
Market Growth	−0.002	−0.047	0.035[b]	0.048	0.048	0.098
R&D Intensity	−0.397[a]	−0.458[a]				
Investment-Sales Ratio	−0.022[c]	−0.025				
Capacity-Market Ratio	−0.007	0.009				
Buyer Concentration	−0.594	−0.949[c]			0.350	1.100
Patent Protection					4.961[c]	1.953
Number of End Users			0.510[a]	0.568[a]		
Purchase Frequency			−1.151[a]	−0.894[a]		
Purchase Amount			−1.728[a]	−1.825[a]		
Sales Direct to End Users			−0.007	−0.007		
New Product Intensity			0.050[a]	0.091[a]		
Capacity Utilization			−0.001	−0.032[a]		

† Coefficient superscripts indicate significance at the (a) 0.01, (b) 0.05, and (c) 0.10 levels.

* Samples I and II both contain 550 observations.

5. Results

Overall the model fits well and supports our analysis. The median R^2 for the two-stage least-squares estimates across all three equations and both data subsets is 0.30, satisfactory for cross-sectional models like equation (6). Of all 58 coefficients, 39 (67%) are significant, all but three variables appear with the predicted sign, and all significant coefficients are the same sign and roughly the same size for both samples.

Marketing Mix Relationships

All coefficients between the three marketing mix elements are significant, indicating that systematic relationships used in marketing strategy formulation exist in both samples. Among these, three are especially interesting.

First, high quality is associated with a high price-cost margin. This positive quality-margin relationship implies that high prices signal high quality: For high quality products, prices and margins are correspondingly high, so that sellers may use prices to convey information about product quality to buyers, and buyers can correctly impute quality from price.

Second, promotional intensity provides no such reliable quality signals. High quality is associated with a high margin, as discussed, which in turn is associated with more intense promotion. Indirectly, therefore, high quality products are more intensely promoted than low quality ones. But this positive effect is offset by a negative direct quality-promotional intensity relationship. High quality brands promote less intensely than do low quality ones, holding margins and other things equal. Together, these two effects cancel one another producing no overall relationship between quality and pro-

motional intensity.[4] Thus, our results provide no empirical support for theoretical models that predict a positive quality-promotional intensity relationship. Rather, our results show quality and promotional intensity, in total, are unrelated, and that buyers cannot impute quality from promotional intensity for this sample of businesses.

Third, high promotional intensity is associated with a low price-cost margin. This result provides no support for the contention that promotional spending is associated with brand loyalty, barriers to new competition, and high margins. Instead, for these PIMS businesses, promotion-intensive businesses earn low, not high margins, which suggests that intense promotion is associated with high price sensitivity, possibly due to high brand awareness and intense price competition.

The Marketing Mix and Competition

All three marketing mix elements vary significantly with competitive and market conditions, but in general these effects are smaller than relationships between marketing mix elements.

Price-cost margins are significantly larger when competitors' market shares are large, market shares are stable, and research and development spending is low. These results suggest that large competitors and stable market shares are associated with low price sensitivity, possibly due to large competitors-price elasticities. But R&D spending is associated with low margins, suggesting that it presents potential entrants with few barriers to entry.

Promotional intensity varies significantly with the size of competitors' market shares. Promotional intensity is low for businesses that compete in markets with concentrated rivals. This suggests that concentrated rivals are associated with a small benefit of promotional spending, possibly due to large competitive-promotional elasticities.

Product quality is also low in markets with large competitors' market shares. This suggests that concentrated competitors are associated with a small benefit of high quality, again possibly due to large competitive quality effects. Finally, unstable market shares are associated with low margins and consequently low quality levels, perhaps due to limited buyer loyalty.

6. Limitations and Conclusions

Limitations

These findings are limited by the framework used to construct the empirical model, the form of the structural model itself, and the data used to estimate it. We derived optimal marketing mix conditions in a static framework, ignoring the investment-like nature of promotional spending and other dynamics. This omission is mitigated by the tremendous stability of the data. Year-to-year fluctuations in the variables are minimal, suggesting that the static framework is a useful and reasonable approximation.

Second, we have considered only one case of competition. More general models of competitive marketing mix allocation could provide insights similar to ours but for a broader class of markets and situations. Developing such models remains important future work.

Third, the generalizability of the results is limited by the data used to fit the equations. PIMS data consist mostly of large, sophisticated, dominant industrial durable-producing businesses, and may be unrepresentative of all businesses operating in the North American economy. Questions have also been raised about the data's reliability

[4] For example, a one-unit increase in quality levels leads to an increase in margins by 50% as much, increasing promotion by roughly 40% again as much, for a total net effect of 20% on promotional intensity. At the same time, the same one-unit quality increase directly reduces promotional intensity by one fifth as much. The sum of these two effects produces no impact of quality on promotional intensity.

and validity. However, those who have examined the data tend to remain confident in their suitability for research (Anderson and Paine 1978). Moreover, statistical tests indicate a minimum of random error, a high quality data collection process, and small distortions even in self-reported measures (Phillips and Buzzell 1982).

Fourth, the use of one structural-equation model for all businesses limits the generalizability of the finding. The structural relationships estimated here may vary over different types of markets, as suggested by the median R^2 of 0.30. Indeed, the coefficients we report may be averages of a range of coefficients from a variety of market conditions, competitive conditions, or both. For example, Carpenter (1983) suggests that the promotion-quality relationship varies with the purchase frequency, and others report significant parameter differences across industry or business groups in studies of industry structure and profitability (e.g., Bass, Cattin, and Wittink 1978; Hatten and Schendel 1977; Porter 1974; Schendel and Patton 1978). Further research is required to analyze the stability of the structural relationships reported here.

In general, while limitations exist, none invalidates the essential findings of our study.

Summary

In formulating marketing strategies, systematic relationships between components of the marketing mix exist, as do relationships between the marketing mix and competitive and market conditions. We analyze these relationships in a three-equation model of product quality, promotional spending, and pricing for a cross-section of 1,100 PIMS businesses, consisting largely but not exclusively of industrial durable-goods producers. For this sample, our analysis produces three especially interesting insights:

- *Prices convey important information about product quality.* Higher quality brands, other things equal, price above lower quality ones and thus have larger margins, which implies that prices signal reliable information about quality to buyers. Therefore, at least for the businesses studied, you get what you pay for.

An important implication of this finding is that cheating or deceptive pricing is suboptimal. The profit from pricing honestly—so that price reflects quality—exceeds the profit from selling high quality brands at high prices for a while to build a favorable reputation and then cutting quality and costs, but not price. Apparently, honesty in pricing pays.

- *Promotional intensity conveys no quality information but nevertheless is associated with small margins and intense price competition.* Higher quality brands spend less on promotion than do lower quality brands, all else equal, but they also earn higher margins and devote a fraction of those to promotional spending. The net result for our sample is no systematic relationship between quality and promotional intensity. Thus, unlike prices, promotional intensity lacks information for buyers about product quality.

Interestingly, however, intense promotional spending is associated with small margins. An important feature of this finding is that it implies that intense promotion does not reduce the intensity of competition by building brand loyalty and barriers to the entry of new brands, which would lead to high margins. Instead, it suggests exactly the opposite. Intense promotion is associated with highly price sensitive buyers—even though it conveys no quality information—and thus intense competition.

- *Competitive and market conditions have a significant but small effect on the marketing mix formulation compared to relationships between marketing mix elements.* Certain elements of industry structure significantly influence marketing mix formulation, notably the size of competitors' market shares and the stability of market shares. However, these effects tend to be small, especially when compared to the impact of quality on margins and of margins across the marketing mix. This finding has important public policy implications in that it suggests that fears of rising prices due to increasing consolidation in industries such as airlines may be overstated. Prices reflect

quality differences to a much greater degree than differences in the size of rivals among the businesses studied.

Taken together, these three findings suggest that prices convey important information about quality in many markets, promotional spending does not but, nevertheless, affects the intensity of competition, and industry structure plays a small role compared to quality and prices in influencing marketing strategies.[5]

[5] This paper was received May 1983 and has been with the author for 4 revisions.

Appendix

The system of equations given by (6) cannot be estimated straightforwardly because of the definition of the price-cost margin variable. The variable, denoted L^*, is defined as

$$L^* = [(pq - PUR - c - m - \text{R\&D} - D)/pq]$$

where now pq is total sales revenues; PUR, total purchases; c, costs; m, marketing expense; R&D, research and development expense; and D, depreciation expenses (see Table 2). L^* can be rewritten as

$$L^* = [1 - (PUR/pq) - (c/pq) - (m/pq) - (\text{R\&D}/pq) - (D/pq)].$$

Clearly, m/pq and R&D/pq appear both as a component of the dependent variable and as an explanatory variable in the equation for L^*; see Table 1. This makes interpreting the coefficients of m/pq and R&D/pq difficult. To avoid this problem, L^* is recalculated as

$$L^{*\prime} = [1 - (PUR/pq) - (c/pq) - (D/pq)]$$

by adding m/pq and R&D/pq to both sides of the price-cost margin equation.

Doing so changes the interpretation of the coefficients of m/pq and R&D/pq in the equation for $L^{*\prime}$. The null hypothesis of no effect of m/pq and R&D/pq on price-cost margins changes from *zero* to *one*: A coefficient greater than one indicates a positive effect, whereas a coefficient less than one indicates a negative effect. For example, consider the simple regression model $y = x\beta + u$ where $y = (1 - z - x)$. We can rewrite the model as $y' = x\beta^* + u$ where $y' = (1 - z)$ and $\beta^* = (\beta + 1)$. In this transformed model if $\beta^* = 1$, $\beta = 0$; if $\beta^* > 1$, $\beta > 0$, and $\beta^* < 1$ implies $\beta < 0$.

Coefficients of the variables affected by the transformation of the price-cost margin variable appear with the effect of that transformation removed to simplify presentation and discussion.

Acknowledgements. My sincere thanks to Nicholas Economidies, John Howard, Donald Lehmann, Charles Lillis, Stanley Ornstein, Lydia Price, L. G. Thomas, three reviewers, the Area Editor, Subrata K. Sen, the UCLA Marketing faculty, and especially John U. Farley for helpful discussions and comments. I am also grateful to the Strategic Planning Institute for providing data and computing resources and to Frank Alpert for research assistance. Of course, any remaining errors are mine.

References

Anderson, C. R. and F. T. Paine (1978), "PIMS: A Re-Examination," *Academy of Management Journal*, 3, 602–612.

Bailey, Earl L. (1975), *Marketing Cost Ratios of U.S. Manufacturers*. New York: The Conference Board.

Bain, Joe S. (1956), *Barriers to New Competition*. Cambridge, MA: Harvard University Press.

Bass, Frank M. (1974), "Profit and the A/S Ratio," *Journal of Advertising Research*, 14, 9–19.

———, Phillipe Cattin and Dick R. Wittink (1978), "Firm Effects and Industry Effects of Market Structure and Profitability," *Journal of Marketing Research*, 15, 3–10.

Cable, John (1972), "Market Structure, Advertising Policy and Intermarket Differences in Advertising Intensity," in *Market Structure and Corporate Behavior*. Keith Cowling (Ed.), London: Gray-Mills.

Carpenter, Gregory S. (1983), "Modeling Competitive Marketing Strategy: Theory and Estimation," unpublished Ph.D. dissertation, Columbia University.

———, Lee G. Cooper, Dominique M. Hanssens and David Midgley (1984), "Asymmetric Market Share Models," working paper, Graduate School of Management, UCLA.

Caves, Richard E. and Michael E. Porter (1978), "Market Structure, Oligopoly, and Stability of Market Shares," *Journal of Industrial Economics*, 24, 289–313.

Collins, N. R. and Lee E. Preston (1969), "Price-Cost Margin and Industry Structure," *Review of Economics and Statistics*, 51, 271–286.

Comanor, William S. and Thomas A. Wilson (1974), *Advertising and Market Power*. Cambridge, MA: Harvard University Press.
Cowling, Keith (1972a), *Market Structure and Corporate Behavior*. London: Gray-Mills.
——— (1972b), "Optimality in Firms' Advertising Policies: An Empirical Analysis," in *Market Structure and Corporate Behavior*. Keith Cowling (Ed.), London: Gray-Mills.
Doyle, P. (1968), "Advertising Expenditure and Consumer Demand," *Oxford Economic Papers*, 20, 394–416.
Eskin, Gerald J. (1975), "A Case For Test Market Experiments," *Journal of Advertising Research*, 15, 27–33.
——— and Penny H. Baron (1977), "Effect of Price and Advertising in Test-Market Experiments," *Journal of Marketing Research*, 14, 499–508.
Farris, Paul W. and Robert D. Buzzell (1979), "Why Advertising and Promotional Costs Vary: Some Cross-Sectional Analyses," *Journal of Marketing*, 43, 112–122.
Gatignon, Hubert (1984), "Competition as a Moderator of the Effect of Advertising on Sales," *Journal of Marketing Research*, 21, 387–398.
Gerstner, Eitan (1985), "Do Higher Prices Signal Higher Quality," *Journal of Marketing Research*, 22 (May), 207–215.
Hanssens, Dominique M. (1980), "Market Response, Competitive Behavior, and Time Series Analysis," *Journal of Marketing Research*, 17, 470–485.
Jacoby, J., J. C. Olson and R. A. Haddock (197!), "Price, Brand Name and Product Composition Characteristics as Determinants of Perceived Quality," *Journal of Applied Psychology*, 55, 470–479.
Kaldor, Nicholas (1949). "The Economic Aspects of Advertising," *Review of Economic Studies*, 18, 1–27.
Kihlstrom, Richard E. and Michael H. Riordan (1984), "Advertising as a Signal," *Journal of Political Economy*, 92, 427–450.
Klein, Benjamin and Keith B. Leffler (1981), "The Role of Market Forces in Assuring Contractual Performance," *Journal of Political Economy*, 89, 615–641.
Lambin, Jean-Jacques (1976), *Advertising Competition and Market Conduct in Oligopoly*. Amsterdam: North-Holland.
———, Philip Naert and Alain Bultez (1975), "Optimal Marketing Behavior in Oligopoly," *European Economic Review*, 6, 68–128.
Lilien, Gary L. (1979), "ADVISOR 2: Modeling the Marketing Mix for Industrial Products," *Management Science*, 25, 191–204.
——— and David Weinstein (1984), "An International Comparison of Determinants of Industrial Marketing Expenditures," *Journal of Marketing*, 48, 46–53.
Lustgarten, Stephen R. (1975), "The Impact of Buyer Concentration in Manufacturing Industry," *Review of Economics and Statistics*, 17, 125–132.
Martin, Stephen (1979), "Advertising, Concentration, and Profitability: The Simultaneity Problem," *Bell Journal of Economics*, 10, 639–647.
Milgrom, Paul and John Roberts (1986), "Price and Advertising Signals of Product Quality," *Journal of Political Economy*, 94, 796–821.
Nelson, Phillip (1970), "Information and Consumer Behavior," *Journal of Political Economy*, 78, 311–329.
——— (1974), "Advertising as Information," *Journal of Political Economy*, 82, 729–754.
Ornstein, Stanley I. (1975), "Empirical Uses of the Price-Cost Margin," *Journal of Industrial Economics*, 24, 105–117.
——— (1977), *Industrial Concentration and Advertising Intensity*. Washington, D.C.: American Enterprise Institute.
Peterson, Robert A. (1970), "The Price-Perceived Quality Relationship: Experimental Evidence," *Journal of Marketing Research*, 7, 525–538.
Porter, Michael E. (1974), "Consumer Behavior, Retailer Power, and Market Performance in Consumer Goods Industries," *Review of Economics and Statistics*, 56, 419–436.
——— (1980), *Competitive Strategy: Techniques for Analyzing Industries and Competitors*. New York: Free Press.
Phillips, Lynn W. and Robert D. Buzzell (1982), "Product Quality and Business Performance: An Examination of Rival Hypotheses in the PIMS Data," working paper, Harvard University.
———, Dae R. Chang and Robert D. Buzzell (1983), "Product Quality, Cost Position, and Business Performance: A Test of Some Key Hypotheses," *Journal of Marketing*, 47, 26–43.
Rao, Vithala R. (1971), "Salience of Price in the Perceptions of Product-Quality: A Multidimensional Measurement Approach," *Proceedings*, American Marketing Association, 571–577.
Schendel, Dan E. and G. R. Patton (1978), "A Simultaneous-Equation Model of Corporate Strategy," *Management Science*, 24, 1611–1621.
Scherer, Frederick M. (1980), *Industrial Market Structure and Economic Performance*. Chicago: Rand-McNally.
Schmalensee, Richard (1972), *The Economics of Advertising*. New York: North-Holland.

Schultz, Randall L. and Wilfried R. Vanhonacker (1978), "A Study of Promotion and Price Elasticity," Paper No. 657, Krannert Graduate School of Management, Purdue University.

Shapiro, Benson P. (1973), "Price Reliance: Existence and Sources," *Journal of Marketing Research*, 10, 286–294.

Spence, A. Michael (1974), *Marketing Signalling: Informational Transfer in Hiring and Related Screening Processes*. Cambridge: Harvard University Press.

Stigler, George J. (1968), "Price and Non-Price Competition," in *The Organization of Industry*. Homewood, IL: Richard D. Irwin, Inc.

Strickland, Allan D. and Leonard W. Weiss (1976), "Advertising, Concentration, and Price-Cost Margins," *Journal of Political Economy*, 84, 1109–1121.

Telser, Lester (1962), "Advertising and Cigarettes," *Journal of Political Economy*, 70, 471–499.

——— (1964), "Advertising and Competition," *Journal of Political Economy*, 72, 537–562.

Wittink, Dick R. (1977), "Advertising Increases Sensitivity to Price," *Journal of Advertising Research*, 17, 39–42.

Wolinsky, Asher (1983), "Prices as Signals of Product Quality," *Review of Economic Studies*, 50, 647–658.