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Abstract

The evaluation of the impact of product-market interventions on the firm's performance has traditionally been based on sales-based measures of the firm's performance ignoring, among other things, the impact on the price of the firm's stock. However, in today's dynamic environment many managers are interested in evaluating the impact of product-market interventions on the firm's performance in the stock market. This paper demonstrates the usefulness of the time-event methodology from financial economics to assess the impact of product-market interventions on the security prices of a firm's common stocks. The approach is used to examine the effects of Procter & Gamble's promotion of the American Dental Association endorsement of Crest on the security prices of Procter & Gamble and that of its major competitor, Colgate-Palmolive.

1. INTRODUCTION

The marketing manager has to make decisions in an environment which is constantly changing with a number of interventions being caused by competitors' actions (e.g., patent infringement), change in government regulations (e.g., price decontrol), acts by irresponsible elements of the society (e.g., Tylenol case), and so on. These interventions will have an effect on the performance of the firm. As recent examples consider the Tylenol case, Texas Instruments' exit from home computers, IBM's entry to the home computer market, Rely rampons and toxic shock syndrome, Eastman Kodak's entry into instant photography, the Russian boycott of the Olympics, and the imposition of substantial tariffs on large motorcycles. If these interventions affect the current as well as future cash flows of the firms involved, we expect that there will be impact on the firms' performance.

One approach to the measurement of the time series effects on sales, profits, and market share of such market interventions has been introduced by Box and Tiao (1974) under the title "Intervention Analysis." Box and Tiao build from the foundation of Box-Jenkins (1976) univariate and transfer function models, utilizing binary time series to represent the occurrence or non-occurrence of events which impact the real time series under consideration. An earlier application of this approach in the marketing literature was reported by Wichern and Jones (1977) to examine the effects of Procter & Gamble's promotion of the American Dental Association endorsement of Crest on the market shares of Crest and Colgate dentifrice during the years 1958-1963. Since then this approach has been used, for example, to study the impact of sudden increases in advertising (Leone 1980), special events such as back-to-school and Christmas (Kapoor, Madhok and Wu 1981), a strike (Hanssens

1980), and patent infringement (Mahajan, Sharma, and Wind 1984) on product sales.

In spite of its popularity, the intervention analysis approach is not without limitations. The approach is primarily data driven and ignores the process underlying the generation of the time series data. Furthermore, it ignores the impact of the intervention on the value of the firm, a conceptually more satisfactory measure of performance. This can be especially troublesome since market share and sales figures are not necessarily correlated with the value of the firm. For example, consider Texas Instruments' experience in the home computer business. When TI announced that they were exiting the home computer business the stock price actually rose in spite of the fact that TI was the market share leader.

It should also be noted that most of the applications of intervention analysis dealing with the impact of market interventions have primarily focused on sales or market share as a performance measure. Given the high correlation between market share and accounting returns of performance (e.g., ROI) reported by PIMS, the use of sales based performance measures may be defendable. However, the use of accounting returns as performance measures introduces further conceptual problems alluded to earlier. Normatively, according to financial and economic theory, the objective of the management of the firms should be to maximize the value of the firm as represented by the market prices of the security. This was articulated by Rothschild (1979) as "in today's environment, many chief executives are desirous of improving their P/E ratio and appreciating the value of their stock." Hence, from both the theoretical and practical viewpoints, the impact of market interventions should be examined on the market value of the firm and not solely its market share or profitability measured by accounting numbers. The two types of measures of

performance are related (see, for example, Beaver, Kettles and Scholes 1970), but the correlation is far from perfect. The basic difference is that market value reflects the expectation of investors relative to the future performance of the firm (an ex ante measure) while sales based measures or accounting returns are essentially retrospective measures (ex post) of achieved performance. As a simple example of the difference consider the fact that the stock of some high technology firms in recent years have traded in the security market at high multiples of book value while consistently losing money. Such results represent the expectation of investors that these firms would eventually be very profitable.

To sum, the reported applications on the assessment of the impact of market disturbances using intervention analysis have primarily utilized sales based measures of the firm's performance ignoring the process underlying the generation of the time series data. The objective of this paper is to suggest an alternative approach to examine the impact of market interventions on the firm's performance. More specifically, the paper demonstrates the usefulness of the time-event methodology from financial economics to assess the impact of product market interventions on the firm's security market performance. Following Wichern and Jones (1977), the suggested approach is used to examine the effects of Procter & Gamble's promotion of the American Dental Association (ADA) endorsement of Crest on the security prices of Procter & Gamble and that of its major competitor, Colgate-Palmolive. Although any of the market interventions discussed earlier could have been used to illustrate the approach, the decision to use the Crest-Colgate situation was based on our desire to compare our results with those reported by Wichern and Jones (1977).

The next section describes the theoretical foundations of the time-event analysis. The empirical results and the implied intervention effects are

given in Section 3. The final section concludes with a summary of the results. For a historical background on the Crest-Colgate situation around the time of the ADA endorsement of Crest, the reader is referred to Wichern and Jones (1977).

2. THE METHODOLOGY

The efficient-markets hypothesis (see, for example, Fama (1976)) posits that secruity prices reflect all available information. Therefore, unanticipated changes, such as product-market interventions, result in a change in the security prices of the firm. Theoretically, this price change is an unbiased estimate of the present value of the change in future cash flows to the firm.

Given an efficient capital market, any product-market intervention that will affect future cash flows will cause a change in the firm's security prices as soon as the change is anticipated by investors in the capital market. This allows the possibility of, for example, security prices changing before the actual occurrence of the market intervention if its occurrence becomes obvious or information about the possible occurrence of the intervention is "leaked" to the security market.

In practice, the impact of an event on a firm's securities is measured by estimating the "normal" return to the stock in the absence of the event. The "abnormal" return to the stock then is the difference between the actual return and the normal return. This approach is what has generally been termed the time-event methodology commonly used by financial economists. This approach has been used in the fields of finance and accounting to study the effects on common stock prices of important economic events such as earnings and dividend announcements, capital structure changes, the merger announcements,

and the listing decision (see, e.g., Boness et al. (1974), Dodd (1977), Fama et al. (1969), Masulis (1983), Petit (1972), and Wansley et al. (1983)).

The time-event methodology, pioneered by Fama, Fisher, Jensen and Roll (1968), rests on an equilibrium model of an individual firm's expected rate of return on equity. Assuming that security returns have a multivariate normal distribution a single factor market model consistent with the well-known Sharpe-Lintner-Mossin capital asset pricing model (CAPM) can be formulated for time-event studies as:

$$\tilde{R}_{jt} = \alpha_j + \beta_j \tilde{R}_{mt} + \tilde{e}_{jt} \qquad (1)$$

where:

$\tilde{R}_{jt}$ = rate of return on security or portfolio j over period t;

$\tilde{R}_{mt}$ = rate of return on a value-weighted market portfolio over period t;

β_j = $\text{Cov}(\tilde{R}_{jt},\tilde{R}_{mt})/\text{Var}(\tilde{R}_{mt})$, the systematic risk of portfolio or security j;

$\tilde{e}_{jt}$ = the random disturbance term of the rate of return on security or portfolio j over period t, with $E(\tilde{e}_{jt})=0$.

Since the disturbance term, e_{jt}, represents the deviation of the rate of return in period t from the expected return, it is useful as a measure of the abnormal return. More specifically, in applying the above model to an event, the time surrounding the event is partitioned into two periods, an estimation period and an analysis period. The estimation period, which falls before the event, is used to estimate the parameters α_j and β_j as the intercept and slope, respectively, by a regression model of firm returns against market returns. Given these estimates of α_j and β_j, the prediction errors for each period t within the analysis period can be calculated as:

$$PE_{jt} = R_{jt} - (\hat{\alpha}_j + \hat{\beta}_j R_{mt}) \qquad (2)$$

where $\hat{\alpha}_j$ and $\hat{\beta}_j$ are the time series ordinary least squares estimates from the prediction period. R_{jt} is, of course, the total return, and the term in parenthesis is the estimate of the normal return. Therefore, PE_{jt} measures the abnormal performance at a given time during the analysis period due to the event. To measure the cumulative effect of an event upon the security's abnormal returns up to a specific time T within the analysis period, the cumulative prediction error (CPE) is computed:

$$CPE_T = \sum_{k=1}^{T} PE_{jk} \qquad (3)$$

The CPE is usually taken as a proxy for abnormal performance over an interval of the analysis period. The behavior of the CPE can be analyzed either visually or statistically to derive inferences regarding the impact of the event under study upon the security's returns. A significant upward (or downward) drift in the CPE can be taken as evidence of a positive (or negative) impact of the event in question on the excess risk-adjusted rate of return on a given security or portfolio. It should be noted, however, that CPE will provide useful inferences only if the security risk, $\hat{\beta}$, does not change significantly between the estimation and analysis periods. If there is a significant shift in the security or portfolio's systematic risk caused by the market intervention in question, a "moving-beta" CPE (see, for example, Bar-Yosef and Brown 1977) can be used to allow for the possibility that new significant information resulting from the market intervention might have caused a shift in the systematic risks.

3. EMPIRICAL RESULTS

As noted by Wichern and Jones (1977), the ADA endorsement of Crest was announced on August 1, 1960. During the ensuing period, Crest's market share climbed rapidly while Colgate's market share decreased markedly. The analyses by Wichern and Jones suggest that the nature of market share response was predominately caused by one ADA endorsement.

In order to examine the impact that the ADA endorsement of Crest had on the equity values of Procter & Gamble and Colgate-Palmolive the time-event methodology was applied to weekly return data. Weekly prices (corrected for stock splits) for the stocks of Procter & Gamble and Colgate-Palmolive and the Standard and Poor's 500 index were obtained from the Wall Street Journal. Closing prices on Friday of each week were used. When Friday fell on a holiday, the previous Thursday was used. In this manner 121 weekly returns were obtained with 65 observations before the announcement date and 57 observations after the announcement date. The time period covered was May 11, 1959 through August 28, 1962.

Given these data, regressions were run to estimate the parameters of the single-factor market model in Equation 1, for both Procter & Gamble and Colgate-Palmolive. Although the ADA announcement was made on August 1, 1960, under the hypothesis that the information of the ADA endorsement could have been "leaked" to the stock market prior to this date, pairs of regression runs were made on the entire data with different intervention dates (from 20 weeks prior to the announcement week until the week of actual announcement of the endorsement). Using explained variance as the measure of fit, the analyses indicated that the information about the ADA endorsement reached the stock market about two and a half months (9 weeks) prior to the actual announcement of the endorsement. Consequently, nine weeks prior to the actual announcement

was used as the cut-off date to divide the sample of observations into the estimation and analysis periods. The regression estimates of the market model for the estimation period are reported in Table 1. The signs, parameter values, and fit statistics are typical of those reported in the finance literature for the single parameter model (e.g., Masulis, 1983). These estimates were then used to calculate the cumulative prediction errors for the analysis period, as an estimate of the cumulative abnormal returns, as specified by Equations (2) and (3). The resulting estimates of the cumulative abnormal returns are shown plotted against time in Figure 1. In order to assure that the regression parameters did not change during the analysis period the "chow" test was applied (See Fisher, 1970, for a formal derivation). The results indicated that the regression parameters did not change significantly.

As Figure 1 shows there was substantial positive impact for Procter & Gamble and an even more substantial negative impact for Colgate-Palmolive until about 40 weeks after the ADA announcement. As this figure shows the maximum impact for Colgate-Palmolive occurs 26 weeks after the ADA announcement when the estimated cumulative abnormal return reaches -22.8 percent. By contrast the maximum impact for Procter & Gamble is +13.8 percent and occurs 17 weeks after the announcement. The assymetry of the magnitude of the impact occurs for two reasons: (1) there are several other companies involved in the toothpaste market so that the sum of the total impact is different from the sum of the impact of the two firms being studied; and (2) toothpaste constitutes a different percentage of revenue and profits for the two firms.

Table 2 shows estimates of the market shares of the major toothpaste brands before the announcement and one year later. With regard to the first point notice that there are four other major brands and three other marketing

companies involved. Furthermore, the impact of Crest's gains on the other companies' market shares is not uniform. In regard to the second point Colgate-Palmolive had 1961 sales of $1,541 million. Given a total toothpaste market of approximately $235 million in 1961, Colgate toothpaste was about 10.1 percent of Colgate-Palmolive's 1961 sales. By contrast, Crest was about 3.3 percent of Procter & Gamble's 1961 sales. For 1960 the difference in relative importance would, of course, be even greater. Even when Gleem sales are added in for Procter & Gamble, the percentage of 1961 sales of all toothpaste at 6.4 percent is still substantially below the 10 percent for Colgate-Palmolive. It should be noted that a significant and substantial impact is detected in firm value even though dentifrice sales are a small portion of total sales for each company.

There is one other characteristic of the estimated abnormal returns shown in Figure 1 that is noteworthy. In the vicinity of 40 weeks after the announcement the differences in cumulative abnormal returns narrows significantly with the negative returns for Colgate-Palmolive disappearing and the positive returns for Procter & Gamble declining. This change which occurs in May and June of 1961 appears to be in conformance with continuing developments in the marketplace. In mid-June 1961 a one-time president of the ADA told a press conference in Boston that Crest's ads were "unethical, misleading, and unfair." Previous to this news conference "canned" editorials paid for by Colgate-Palmolive (but not identified as such) were distributed to papers throughout the nation. Many of the papers ran the editorial.

During Spring 1961 several new toothpastes, obviously intended to compete with Crest on the basis of also containing flouride, were test marketed. Prominent in the effort was Colgate-Palmolive with two new entrants. Bristol

Myers also test marketed a flouride toothpaste. The ADA offered to evaluate these products for possible endorsement. Along with these new products there were increased advertising expenditures for the established competitors.

During the summer of 1961 a petition was circulated among members of the ADA for presentation at the annual ADA meeting in October challenging the advisability of the Crest recognition. The trade press took this effort seriously as evidenced by the title of one article: "Will P&G's Crest Lose its ADA Recognition?"

In sum, by mid-1961 it appeared that any of three things might occur: (1) ADA might rescind their endorsement of Crest; (2) flouride toothpastes from other manufacturers might gain the ADA endorsement; and/or (3) even without the endorsement heavy advertising and new flouride brands might capture significant market shares. This new information apparently reached the market about 40 weeks after the ADA endorsement of Crest. (For discussions of the various events occurring in the year after the announcement mentioned above, see Printers Ink, June 23, 1961, October 13, 1961, October 20, 1961; and the references listed in the Wichern and Jones (1977) article.)

4. CONCLUSIONS

If we accept the fundamental premise that the primary purpose of a firm should be to increase the wealth of the shareholders, then the impact of any product market intervention should be based on the resultant changes in the shareholders' wealth represented by the financial market prices of the security. As shown by the ADA endorsement of Crest dentifrice the security market does respond to product market interventions and sometimes the impact of such interventions can be highly significant.

This paper proposed the utilization of the time-event methodology from financial economics to analyze the dynamics of market interventions. As compared to the data driven approaches, such as Box and Tio's Intervention Analysis, this approach is theoretically sound and empirically easy to implement since the stock returns for the companies involved are readily available. The approach assists in isolating the impact of market interventions and estimating its effect on the present value of future cash flows to shareholders. Clearly, assessment of the impact of market interventions on the firm's market position, estimated by sales based measures, is meaningless unless it can be translated into shareholder values.

The reported analyses of the Crest-Colgate situation around the time of the ADA endorsement of Crest indicate that in addition to impacting the market shares of the products involved, the endorsement also had an impact on the market values of Procter & Gamble and Colgate-Palmolive. Although brand managers are interested in assessing the impact of such a market intervention on aggregate market share, top management and shareholders are more interested in assessing the impact on the security prices. However, as illustrated, by combining the sales based measures and the security prices, it is useful to assess the impact of additional market share gains (or losses) on the market value of the firm.

Methodologically, the approach has much to recommend it. As we have extensively discussed, firm value is a conceptually stronger measure. The data requirements for the model are modest with almost no cost involved because stock prices are freely and readily available. Contrast this to the development of market share data. Furthermore, data are readily available on one's competitors, a most appealing circumstance given the value of competitive information.

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Figure 1
Estimated Cumulative Abnormal Returns

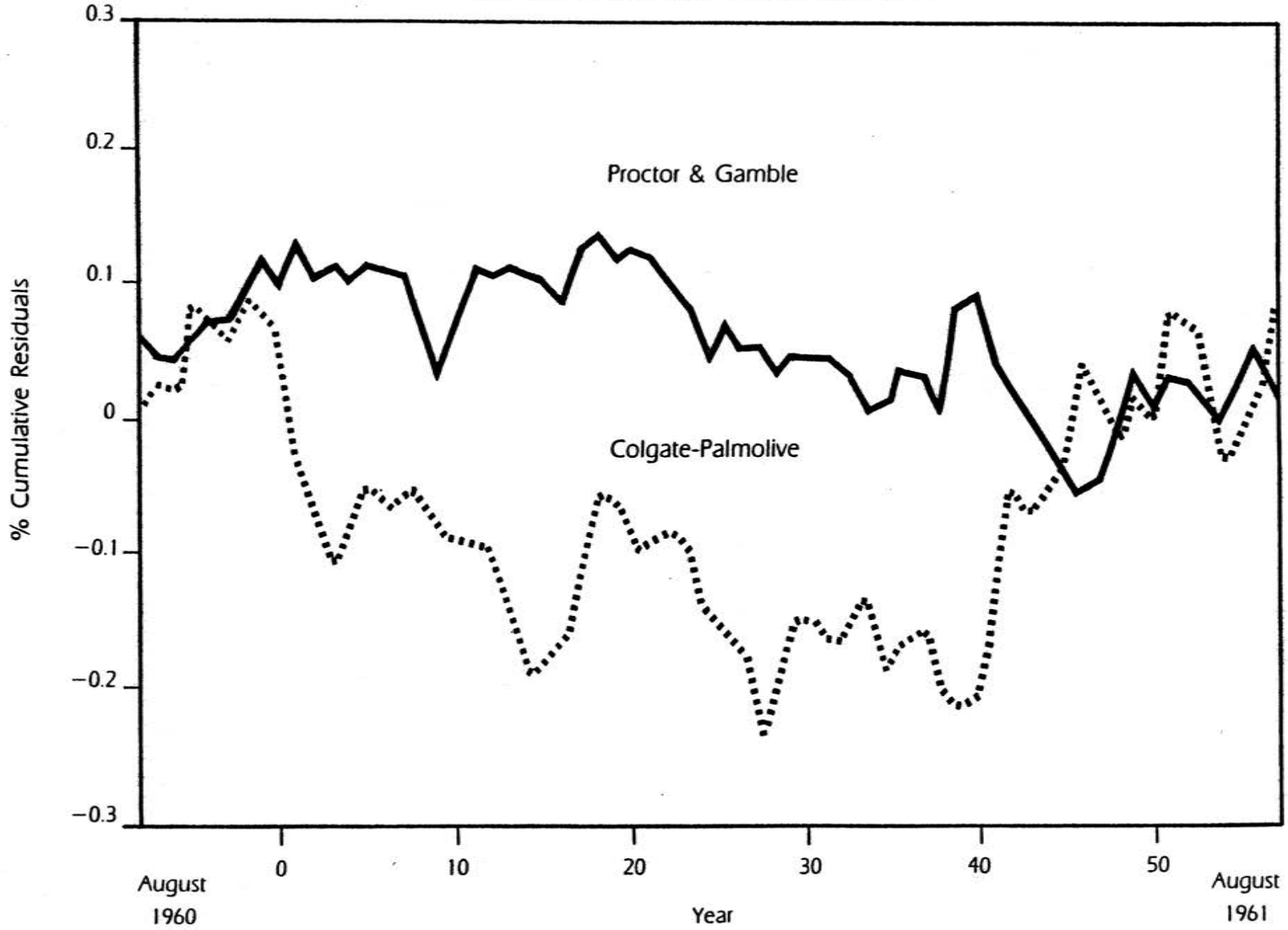

Table 1

Market Model Regression Coefficients

Firm	$\hat{\alpha}_j$	$\hat{\beta}_j$	Adj. R^2	Durbin-Watson
Colgate-Palmolive	.000	1.464	.2801	2.752
	(.001)	(21.400)		
Procter & Gamble	.007	.895	.1926	2.346
	(4.044)	(13.123)		

Table 2

Market Share Estimates[1]

Company	Brand	July 1960	July 1961
Colgate-Palmolive	Colgate	33%	26%[2]
Procter & Gamble	Crest	12%	22%[2]
Procter & Gamble	Gleem	20%	20%
Lever Brothers	Pepsodent	11%	9%
Lever Brothers	Stripe	8%	7%
Bristol Myers	Ipana	7%	6%
Various	Various	9%	10%
		100%	100%

[1]From "Will Crest gain or lose from rival's stealthy tactics," Printer's Ink, June 23, 1961, pp. 10-12.

[2]By January 1962 Crest had surpassed Colgate.

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