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## Sustained Spending and Persistent Response : A New Look at Long-Term Marketing Profitability

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# SUSTAINED SPENDING AND PERSISTENT RESPONSE: A NEW LOOK AT LONG-TERM MARKETING PROFITABILITY


## Abstract

An intuitively appealing decision rule is to allocate a company's scarce marketing resources where they have the greatest long-term benefit. This principle, however, is easier to accept than it is to execute, because long-run effects of marketing spending are difficult to estimate. We address this problem by examining the over-time behavior of market response and marketing spending, and identify four commonly occurring strategic scenarios: business as usual, hysteresis in response, escalating expenditures and evolving-business practice. We explain and illustrate why each scenario can occur in practice, and describe its positive and negative consequences for long-term profitability.

When good time-series data on revenue and marketing spending are available, it is possible to apply multivariate persistence measures to identify which of the four strategic scenarios is taking place. We apply these ideas to data from two major companies in the packaged-foods and pharmaceuticals industries. We observe several long-term marketing effects, some with profitable and some with unprofitable consequences, and offer recommendations for each case.

We conclude that high-quality databases along with modern time-series methods can be instrumental in extracting vital long-term marketing-effectiveness information from readily available data. Therefore, managing marketing resources with long-run performance in mind need no longer be a pure act of faith on behalf of the executive. We hope that this and future work will contribute toward an improved allocation of scarce marketing resources in our companies.

# 1. INTRODUCTION

The question of optimal long-run marketing-resource deployment continues to receive wide interest among marketing academics and practitioners alike (Lodish et al. 1995; Mantrala et al. 1992; Slywotzky and Shapiro 1993). Academics are understandably surprised at reported empirical results that 85% of all promotions are losing money to the promoters, and that only half of the advertising expenditures generate economic benefits to the advertisers (Abraham and Lodish 1990). Practitioners are concerned to observe virtually entire industries go through prolonged money-losing periods, such as the U.S. airlines in the early nineties, and increasingly feel the pinch of demonstrating the long-run revenue generation of their marketing budgets (Cressman 1996; Gopalakrishna et al. 1995; Slywotzky and Shapiro 1993).

A key challenge, perhaps the most difficult, is that only short-term results of marketing actions are readily observable, yet at the same time, most will agree that short-term profit maximization is not the best paradigm for allocating resources. US businesses in general, and the marketing discipline in particular, have repeatedly been criticized for their short-run orientation (see e.g. Hansen and Hill 1991; Wind and Robertson 1983). Long-term profit maximization is considerably more difficult to operationalize, however, because there is little or no consensus of what constitutes the long run, and because market conditions continuously change, making it difficult to relate future outcomes to current actions (Dekimpe and Hanssens 1995a; Wind and Robertson 1983).

Do marketing investments themselves help shape the future by contributing to changing market conditions or by affecting the competitors' long-run position? Certain well-publicized marketing events have been said to change market conditions forever. For example, in the early nineties Compaq launched an aggressively-priced high-quality line of products, which is widely believed to have opened up the home market for personal computers. Johnson et al. (1992) observed an upward trend in the real price of several Canadian alcoholic beverages, and assessed its impact on the evolution of their consumption levels. Slywotzky and Shapiro (1993) describe how a sustained and consistent marketing campaign caused Zantac to gain a 50% market share in the anti-ulcer medication market, while Tagamet's share gradually eroded to 23% over the same 6-year time span. Similarly, Hanssens and Johansson (1991) discuss the

gradual share erosion of U.S. manufacturers in the domestic automobile market, which has been attributed in part to the differential effectiveness of the U.S. and Japanese manufacturers' marketing strategies. Much of this evidence is anecdotal, though, and there is no broad body of knowledge allowing us to *precisely* measure the degree to which marketing efforts affect the long-term evolution of the market place.

Indeed, currently-available managerial tools have been of little help in increasing our understanding of observable long-term marketing effects, or in offering guidelines for long-term resource allocation in evolving or changing markets. Marketing's focus has been on "short-run forecasting and optimization procedures, while assuming an essentially stable environment" (Wind and Robertson 1983, p. 13). However, in recent work (Dekimpe and Hanssens 1995a) we have argued that estimating the *persistent* or permanent effects of marketing actions helps resolve this problem. In a nutshell, marketing actions have persistent effects on sales if (1) the sales environment is evolving (as opposed to stable or stationary), and (2) this sales evolution is related to the marketing actions. In our empirical example, a home-improvement chain's price-oriented print advertising was shown to have a high short-run impact with limited sales persistence (mainly short-run benefits), while TV spending had a low short-run impact with substantial sales persistence (mainly long-run benefits). In this application, we illustrated that marketing can indeed have persistent performance (in casu, sales) effects which can be quantified empirically. However, when assessing the long-run *revenue* implications, we should not only consider the *output* (response) implications, but also the *input* (spending) side of the equation.

In this paper, we examine the long-run profitability implications of marketing decisions by comparing the ensuing spending strategies to their persistent results. First, we classify both marketing effort and market response as either short-lived (temporary) or persistent (evolving), and derive *four strategic scenarios*: *business as usual, escalation, hysteresis and evolving-business practice*. We examine why these scenarios exist, and what their consequences are for the long-run profitability of temporary as well as sustained marketing actions. We then turn our attention to two case studies that illustrate these strategic scenarios in the packaged-goods and pharmaceutical sector. In each case, we diagnose a

company's long-run marketing profitability based on historical market performance and marketing-mix data. The paper concludes with strategic recommendations based on long-run marketing profitability, and addresses some areas for future research.

## 2. TEMPORARY VERSUS SUSTAINED EFFORT AND RESPONSE

Companies continually adjust their marketing mix in response to perceived changes in the market environment and/or changes in their goals. Some of these adjustments are temporary in that the company abandons the change in favor of the previous level after a finite time period. For example, a brand that offers a two-week discount off an otherwise fixed price engages in such a temporary effort. Other changes are permanent (sustained) if there is no return to the previous level. If the same discount policy above leads to a regular practice of discount policies, that would be an example of a sustained effort. From a strategic perspective, the important question is whether or not temporary and sustained marketing efforts result in persistent market response that leads to long-run competitive advantage.

Figure 1 shows the four scenarios that can exist in terms of temporary vs. sustained effort and response. In each of the four graphs, we trace what happens to a brand's future performance and marketing budget after a one-unit budget increase in period $t$. The graphs depict the *incremental* impact compared to a situation where this initial increase had not happened. If it converges to zero, the initial increase had only a temporary impact, while if it converges to a nonzero level, it has initiated a permanent deviation from previous performance and/or spending levels. In the *business-as-usual* cell, we only see a temporary increase in sales and marketing support, i.e. the incremental impact disappears after a few periods. Sub-optimal decision making will therefore have no long-run impact on the firm's profitability. In the *evolving-business practice* case, on the other hand, the initial budget increase leads to persistent changes in both spending and performance. The relative magnitude of these changes, along with the brand's long-run profit margin, will determine the long-run revenue implications of the extra dollar(s) spent in period $t$. In contrast, only the long-run sales level is affected in the *hysteresis* case, and only the long-run spending level is updated in case of *escalation*, which clearly translates in, respectively, positive and negative changes to the

brand's long-run profitability.

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Figure 1 about here

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There are many real-world illustrations of the four scenarios described in Figure 1. For example:

1. Empirical evidence from scanner-panel data suggests that the performance and spending behavior of several frequently-purchased consumer brands and categories is stationary, i.e. these markets appear to be in a long-run equilibrium from which the brands can only deviate temporarily (Dekimpe, Hanssens and Silva-Risso 1996; Lal and Padmanabhan 1995). Yet companies resort repeatedly to promotional tactics in order to create temporary sales gains. This case can be classified as temporary marketing activity creating temporary incremental results, a scenario we have referred to as "***business as usual***". Companies that are profitable in such scenarios can sustain their positions for a long time by continuously playing this "business-as- usual" game; for example, the alternating price promotions by leading national brands (e.g. Pepsi and Coke) can be seen as a long-run strategy to defend their market share from possible encroachment by a third firm (Lal 1990).

2. Other markets are characterized by ***escalating marketing expenditures*** without long-run sales movements. Metwally (1978) examined six Australian markets (instant coffee, bottled beer, cigarettes, toothpaste, toilet soap and washing powder). In all instances, industry advertising outlays had increased by more than 300% over a 16-year period, while total sales increased by less than 70 percent. A detailed analysis of the relevant response and reaction elasticities confirmed the notion that advertising expenditures in all industries were self-canceling and escalating. Marketing escalation suggests that competitive action and reaction creates sustained marketing engagements without persistent sales or market-share gains for any of the players. While they may be profitable at the onset, escalation scenarios are typically not sustainable to the players.

3. ***Hysteresis*** is a phenomenon of temporary marketing action causing sustained sales

change. Little (1979) first used the term, and Simon (1994) presents conceptual evidence (e.g. loyalty after brand switching, organizational inertia, ...) in support of its existence. Marketing actions that exhibit hysteresis are particularly attractive to companies, because temporary investments generate permanent benefits. For example, Simon (1994) illustrates that the Gorbachev era in the former Soviet Union provided a fortuitous boost to brand equity and sales of the Gorbachev vodka label in Germany. During that political era, its sales rose by 500 percent and remained at that high level long after the demise of the political leader in 1988.

4. The 1970s and 80s have witnessed a gradual increase in the market performance of Japanese automobile makers worldwide (e.g. Hanssens and Johansson 1991). At the same time, Japanese firms invested sustained efforts in quality improvement, image building, distribution channels and aggressive pricing. This is an example of sustained marketing effort leading to persistent results, which we call the ***evolving-business practice*** scenario. So long as the ratio between results and spending is attractive, this scenario is sustainable to a competitor, though probably less attractive that the previous one. Indeed, in evolving markets the competitors must maintain marketing investments in line with market evolution, which is more costly than in the hysteresis case.

A recent empirical study on the incidence of stationarity vs. evolution in marketing gives a first indication on the relative occurrence of sustained spending and persistent response. While one would need the actual data to derive exact response-persistence and effort-sustenance levels, one can already infer whether or not such effects are *possible* from the level of integration of the variables' data-generating process: when a series is mean- or trend-stationary, all observed fluctuations are temporary deviations from a deterministic component. For integrated or evolving series, on the other hand, shocks to the series (partially) persist over time. Dekimpe and Hanssens (1995b) identified 419 empirically-derived time-series models on marketing data: 192 were stationary, while 227 were evolving. As illustrated in Table 1, both types occur frequently in both the performance and marketing-control series, suggesting that real-world marketing behavior will involve a mixture of the four strategic scenarios.

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Table 1 about here

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## 3. REASONS FOR SUSTAINED MARKETING EFFORT AND PERSISTENCE IN PERFORMANCE

Since marketing consumes scarce financial and time resources, there are good reasons why companies would limit their efforts to periodic short-term or *temporary* spending. Among them, marketing budgets may be limited due to low commitment to marketing at the senior executive level, or management may believe that quick-fix solutions exist to improve the market position of their products. Why, then, would companies engage in *sustained change* in marketing spending, which is by definition more costly and implies a higher level of engagement? This question has been addressed in the strategy literature, most notably by Ghemawat (1990). In his view, commitment - which is defined as the tendency of strategies to persist over time - is a general explanation for sustained differences in organizational performance, and is generated by four driving factors:

*1.Lock-in*: investments in durable, specialized and/or untradeable "sticky" factors (Harrigan and Porter 1983). Production facilities are a good example of a sticky factor. In marketing, brand equity can also be considered a sticky factor, as it has been shown to be a major driver of sales performance (e.g. Aaker 1990), creating brand loyalty that erodes only slowly, if at all (e.g. Dekimpe et al. 1996). Other examples of lock-in include contractual agreements that prohibit the discontinuation of existing channel relationships, and the shift in power from manufacturers to distributors which has made it more difficult for the former to discontinue certain product varieties. A leading pet-food manufacturer, for example, is reluctant to stop the production of some of its unprofitable varieties for fear of losing shelf space for its other products.

*2.Lock-out*: Disinvestment creates foregone opportunities because of difficulties in reacquiring and redeploying the allocated factors. Also, the scarcity of certain marketing

resources may preempt potential contenders or put them at a competitive disadvantage. French auto maker Renault's decision to abandon the American market after several unsuccessful attempts is not likely to be reversed anytime soon, because of formidable barriers of entry and marketing resource requirements. In a distribution context, Rao and McLaughlin (1989) show that small firms have a harder time acquiring shelf space for their new products than larger, more established competitors. Similarly, first movers often occupy the most attractive locations in product-characteristics space, and extend their assortment to preempt entry into product-differentiation niches (Lieberman and Montgomery 1988).

*3.Lags* in adjusting the firm's stocks of sticky factors to desired levels. For many years, Coors was a successful regional brewing company in the US. When the company decided to become nationally distributed, it took about a decade to implement that strategy. Even when adjusting the most flexible marketing instrument, price, marketeers may be confronted with substantial lags. Leeflang and Wittink (1992), for example, indicate how manufacturer-induced price reactions to competitive activities require cooperation between retailers and manufacturers; in their Dutch example, it takes, on average, 5 to 10 weeks to actually implement the desired changes in a price or promotion plan.

*4.Inertia*: Firms have built-in biases to maintaining the status quo. They may be locked-in to a specific set of fixed assets (cf. supra), they may be reluctant to cannibalize existing product lines, or the organization may lack the flexibility to quickly adapt to changing conditions (e.g. Rumelt, Chapter 5 in Montgomery (1995)). As an illustration, Leeflang and Wittink (1996) report that firms' promotional calendars are set, in part, based on previous promotions that are believed to have been successful. Still, the speed of reaction to competitive moves or changing market conditions has been found to be a major determinant of a firm's performance (Bowman and Gatignon 1995). For example, in spite of clear market signals favoring fuel efficient automobiles in the 1970s, the market leader, General Motors, was slow in making the necessary adjustments to design and market large numbers of small cars.

Ghemawat (1990) argues that the commitment resulting from these four forces is a main factor associated with companies' performance across industries. His explanation, however, is restricted to the input or investment aspect of management. In order to test the commitment paradigm in a marketing framework, *we must also consider the output or performance aspect of management*, i.e. market responsiveness to sustained marketing effort. Indeed, what good is a sustained policy of quality improvement if customers' behavior is not responsive to quality changes ?

Previous research has shed some light on this important issue. In particular, Dekimpe and Hanssens (1995a,b) list six major reasons why there can be a long-run or persistent customer response to marketing effort. The first three of these reasons are due to customer behavior :

*1. **Immediate response,*** i.e. same-period sales action derived from the added value in the marketing effort. For example, instant market-share increases have been observed when any of twelve Australian detergent manufacturers lowered the price of their product (Carpenter et al. 1988).

*2. **Delayed response***, which measures subsequent-periods sales changes. Montgomery and Silk (1972), for example, find that pharmaceutical advertising influences market share up to six months after the expenditure. Similarly, the sales throughs after price promotions have been well documented (Blattberg et al. 1995).

*3. **Purchase reinforcement***, which reflects repeat purchases and/or word-of-mouth effects that can be traced to the original marketing effort. When launching a new way of banking for its customers, for example, a financial institution accelerated word-of-mouth effects by early advertising of its new technology (Horsky and Simon 1983).

The sequence of immediate and delayed customer response and purchase reinforcement may be sufficient in itself to create enduring changes to a company's sales. However, as these changes are not likely to go unnoticed within the company and the industry, subsequent managerial behavior may prolong or accelerate it. Still following Dekimpe and Hanssens (1995a), such behavior can take on three possible forms:

*4. Performance feedback*: good short-term sales response causes the firm to maintain or increase the effort. For example, a successful regional direct marketing campaign may be quickly extended to the national level in order to boost revenue even more. The performance feedback loop in market response has been amply documented in the scholarly marketing literature, starting with the simultaneous-equation modeling in Bass and Parsons (1969).

*5. Decision rules* may cause a given marketing effort to be accompanied by other company efforts. Many companies set their advertising budget as a percentage of sales (i.e. a direct implementation of performance feedback), or as a percentage of last year's budget (Hulbert 1981), and price promotions are regularly accompanied by increased advertising spending, e.g. to increase store traffic (Blattberg et al. 1995). Clearly, performance feedback and decision rules may both *result from* and *contribute to* a firm's commitment to certain marketing practices.

*6. Competitive reaction*: damage prevention and/or copy-cat action by competitors. Examples are abound in most industries, ranging from quick competitive price matching in gasoline retailing to imitating a competitor's technological product features in the personal computing industry. We refer to Hanssens (1980) or Leeflang and Wittink (1992) for an in-depth discussion on the variety of competitive reactions observed in many markets.

In conclusion, several behavioral phenomena may explain the existence of sustained or persistent change, both in marketing effort and in customer response. The resulting chain reaction of events may be complex, but it is important (a) to disentangle them analytically, and (b) to correctly interpret their long-run implications. Consider, for example, the following two hypothetical scenarios:

1. A company (A) engages in a marketing campaign that generates immediate positive market response, but no long-term purchase reinforcement. The short-term success of the campaign, however, causes the organization to lock itself into future campaigns. Competitors, fearful of damage to their market positions, react forcefully. Such a chain of events could lead to marketing escalation with no net benefits to the industry participants. The fare wars among American airlines in the early 1990s and their

disastrous effects on profitability are a good illustration of this scenario.

2. A second company (B) starts a campaign whose market response is slow in materializing. However, the gained customers engage in repeat purchase and positive word-of-mouth. As the company runs out of budget before campaign profitability is established, the effort is halted and the negative experience locks the company out of future campaigns of this kind. Such a chain of events leads to a missed opportunity due to short-sightedness in decision making.

What both strategic mistakes have in common is that the readily-observable short-term market-response effects were misinterpreted. Company A attributed persistence to only temporary results and spent too much, while company B failed to attribute such persistence and spent too little. In both cases, the decision makers would be characterized as myopic or "short-term" oriented. However, had they correctly read the persistence levels of their marketing efforts, they would have been able to implement a long-term productivity strategy, i.e. they could have compared the persistent benefits of their actions to their costs.

Our discussion so far has made the distinction between permanent and temporary effects of shocks in marketing spending and market performance. In empirical work, it may be important to recognize an intermediate step as well, the '*dust settling*' period between immediate and permanent effects. We will define and illustrate the dust settling phase as the number of time periods between the first occurrence of significant impact, and the first occurrence of stable long-run impact. For example, dust settling in the evolving-business practice scenario in Figure 1 takes about 8 periods.

Marketing effects during the dust-settling period can fluctuate widely and should therefore be accumulated (i.e. computing the total incremental expenditures and revenues that emerge because of the initial shock) for the purpose of assessing their impact. In contrast, the immediate effect can be derived from single-period observations; also, the quantification of the persistent or sustained impacts involves a single figure, as time subscripts are no longer needed once the impulse-response functions have stabilized. Our empirical illustration will reflect these distinctions and calculate separate profitability values for immediate, dust-settling and persistent effects of marketing investments.

## 4. MEASURING RESPONSE PERSISTENCE AND EFFORT SUSTENANCE

To derive the long-run (output and input) implications of one's marketing actions, one should be able to (a) capture the complex interplay of the aforementioned factors, and (b) translate the underlying short-run dynamics into their long-run consequences, as the long run emerges out of a sequence of short runs. We introduce Vector-AutoRegressive (VAR) models (Section 4.1) and their associated impulse-response functions (Section 4.2) as flexible tools to address these issues. Based on the response functions, one can easily derive the response-persistence, effort-sustenance and long-run profitability implications of an initial marketing-spending change (Section 4.3).

### *4.1. VAR models*

For ease of exposition, and without loss of generality, we consider a three-variable system describing the dynamic inter-relationships between a brand's sales performance (*S*), its marketing budget (*M*), and its competitors' marketing spending (*CM*). Assuming all variables to be stationary (we relax this assumption later), the VAR model can be written as:[1]

$$\begin{bmatrix} S_t \\ M_t \\ CM_t \end{bmatrix} = \begin{bmatrix} \pi_{11}^1 & \pi_{12}^1 & \pi_{13}^1 \\ \pi_{21}^1 & \pi_{22}^1 & \pi_{23}^1 \\ \pi_{31}^1 & \pi_{32}^1 & \pi_{33}^1 \end{bmatrix} \begin{bmatrix} S_{t-1} \\ M_{t-1} \\ CM_{t-1} \end{bmatrix} + \ldots + \begin{bmatrix} \pi_{11}^J & \pi_{12}^J & \pi_{13}^J \\ \pi_{21}^J & \pi_{22}^J & \pi_{23}^J \\ \pi_{31}^J & \pi_{32}^J & \pi_{33}^J \end{bmatrix} \begin{bmatrix} S_{t-J} \\ M_{t-J} \\ CM_{t-J} \end{bmatrix} + \begin{bmatrix} u_{S,t} \\ u_{M,t} \\ u_{CM,t} \end{bmatrix}, \quad (1)$$

where $J$ is the order of the model, determined on the basis of Akaike's information criterion (AIC). This specification captures all but one of the aforementioned factors: delayed response ($\pi^j_{12}$, $j=1, \ldots, J$), purchase reinforcement ($\pi^j_{11}$), performance feedback ($\pi^j_{21}$), inertia in decision making ($\pi^j_{22}$) and competitive reactions ($\pi^j_{32}$). Only instantaneous effects are not included directly, but these are reflected in the variance-covariance matrix of the residuals ($\Sigma$). This matrix, however, can only establish the presence of an effect, but not its direction, i.e. it cannot distinguish between $M_t \rightarrow S_t$ (marketing has an instantaneous effect on performance), $S_t$

$\rightarrow M_t$ (there is an immediate feedback relationship of sales on marketing spending), and $M_t \leftrightarrow S_t$ (both effects occurring simultaneously).

To circumvent this ambiguity, Evans (1989) and Dekimpe and Hanssens (1995a) propose to work with a transformed VAR model in which one imposes a certain ordering on the variables. For example, one could posit, based on managerial judgment, the following ordering: $M_t \rightarrow CM_t \rightarrow S_t$, which suggests that a brand's performance can be influenced instantaneously by both its own and its competitor's marketing spending, but that there are no immediate feedback relationships. Moreover, in this causal ordering, competitors can react immediately to a change in the brands' spending, but the brand can only react with some delay to a change in the competitor's spending. Technically, the "transformed" VAR model is obtained through a Cholesky decomposition of the $\Sigma$ matrix, and can be written as

$$\begin{bmatrix} S_t \\ M_t \\ CM_t \end{bmatrix} = \begin{bmatrix} 0 & \gamma^0_{12} & \gamma^0_{13} \\ 0 & 0 & 0 \\ 0 & \gamma^0_{32} & 0 \end{bmatrix} \begin{bmatrix} S_t \\ M_t \\ CM_t \end{bmatrix} + \begin{bmatrix} \gamma^1_{11} & \gamma^1_{12} & \gamma^1_{13} \\ \gamma^1_{21} & \gamma^1_{22} & \gamma^1_{23} \\ \gamma^1_{31} & \gamma^1_{32} & \gamma^1_{33} \end{bmatrix} \begin{bmatrix} S_{t-1} \\ M_{t-1} \\ CM_{t-1} \end{bmatrix} + \ldots + \begin{bmatrix} \gamma^J_{11} & \gamma^J_{12} & \gamma^J_{13} \\ \gamma^J_{21} & \gamma^J_{22} & \gamma^J_{23} \\ \gamma^J_{31} & \gamma^J_{32} & \gamma^J_{33} \end{bmatrix} \begin{bmatrix} S_{t-J} \\ M_{t-J} \\ CM_{t-J} \end{bmatrix} + \begin{bmatrix} e_{S,t} \\ e_{M,t} \\ e_{CM,t} \end{bmatrix},$$

in which the covariances between the error terms now equal zero (see Dekimpe and Hanssens 1995a for a more detailed discussion), and in which the instantaneous effects are given by the parameters $\gamma^0_{12}$, $\gamma^0_{13}$, and $\gamma^0_{32}$.

Thus far, we have specified the VAR model in the levels $S_t$, $M_t$, and $CM_t$. However, when some of the variables are evolving (integrated of nonzero order), regressions on the levels may result in spurious effects (see e.g. Diebold and Nerlove 1987). When dealing with evolving variables, the level of the variable (e.g. $S_t$) is replaced by its first difference ($\Delta S_t = S_t - S_{t-1}$) to ensure that the variables in the VAR model are stationary. When a variable is integrated of order $> 1$, the differencing order is adjusted accordingly. Numerous tests have been proposed to determine the order of integration of a series. The Augmented Dickey-Fuller (1979) test is used in our empirical illustrations (see Dekimpe and Hanssens 1995a for a discussion of this testing procedure).

*4.2. Impulse-response simulations.*

VAR models provide a comprehensive way of summarizing a system's short-term dynamics, but the multitude of parameter estimates may be hard to interpret, and do not provide insights into the resulting long-run implications of a given spending or price change. A more effective way is to derive the associated impulse-response functions, which trace the over-time impact of a change in one or more of the variables.

Consider, for example, the VAR specification in Appendix A, in which we assume that $S_t$ and $M_t$ are evolving (and therefore are expressed in their first differences), while $CM_t$ is assumed to be stationary (and therefore incorporated in the levels). To trace the over-time, *incremental* impact of an unexpected one-unit change (or shock) in the brand's marketing support in period $t$, we set all three variables equal to zero prior to $t$, set $(e_{S,t}, e_{M,t}, e_{CM,t}) = (0, 1, 0)$, and solve recursively for $S_{t+k}$, $M_{t+k}$ and $CM_{t+k}$ $(k = 0, 1, 2, ...)$ under the assumption that no further shocks occur to the system, i.e. assuming that $(e_{S,t+k}, e_{M,t+k}, e_{CM,t+k}) = (0, 0, 0)$ for $k = 1, 2, ....$ We illustrate the first steps of this recursive solution procedure in Appendix A. As shown in Dekimpe and Hanssens (1995a), the system eventually reaches an equilibrium, which corresponds to the long-run response persistence (for $S_t$) and long-run effort sustenance (for $M_t$ and $CM_t$) resulting from the initial one-unit change in $M_t$.

Before discussing the long-run *profit* implications, we want to draw the reader's attention to two potential caveats: (1) the danger of over-parameterizing the VAR model, and (2) the potential sensitivity of the results to the imposed causal ordering. First, the (transformed) VAR models are extremely flexible and capture a great variety of current and lagged effects, but the number of parameters to be estimated may become quite large. We therefore recommend to derive persistence and sustenance estimates from a *restricted* VAR model in which all coefficients with a $t$-statistic less than one in absolute value are set to zero (see e.g. Pesaran et al. 1993, or Van de Gucht et al. 1996 for a similar practice). Second, the impulse-response functions and their associated persistence/sustenance estimates may be sensitive to the imposed ordering. It is therefore important to incorporate a priori managerial insights when deciding on this issue, *and* to assess the robustness of the long-run findings to the specific ordering that was imposed.[2]

*4.3. Long-run profit implications*

Given a certain level of response persistence and effort sustenance, the question arises whether the extra sales dollars, combined with the brand's profit margins, are large enough to absorb the additional marketing expenditures. In three of our four strategic scenarios, the long-run profit implications are straightforward. In the *business-as-usual* cell, sales performance and spending are only temporarily affected, which precludes any long-run profit implications. In the *hysteresis* cell, additional sales dollars continue to flow in without sustained spending, which clearly creates a positive long-run surplus. This picture is reversed in case of *escalation*, and the brand's long-run profitability is eroded. When both long-run sales and spending are affected (*evolving-business practice* scenario), the net revenue implications are not immediately clear, and will depend on (a) the relative magnitude of the persistence and effort-sustenance estimates, and (b) the brand's long-run profit margin.

When the long-run profit margin is mean reverting, the net long-run surplus is easy to compute:

$$\textit{persistent surplus} = \textit{persistent sales} * \textit{long-run margin} - \textit{sustained cost} \qquad (3)$$

in which the historical mean of the margin series can be used as the best estimate of the brand's long-run profit margin. When this margin itself is evolving, however, e.g. because of cost reductions due to experience curve effects or because of gradually increasing/decreasing prices, no such simple formula exists. From a statistical point of view, an evolving series has no mean or variance, and hence one can no longer use the sample mean as a good proxy for its long-run value. However, break-even analyses may be used to determine what long-run margin management should be able to attain in order to break even, given the estimated response persistence and effort sustenance levels. Empirical illustrations of this procedure will be discussed in Section 5.

## 5. EMPIRICAL ILLUSTRATIONS

We present two case studies which illustrate different combinations of persistent response and sustained marketing spending. In a first example, we consider the sales history of a frequently-purchased branded good, derive the degree of effort sustenance for several marketing-mix variables, and quantify some long-run sales and profit implications. The second application considers the sales erosion of a pharmaceutical product, and illustrates how a failure to correctly read the long-run price and advertising dynamics may have led its management to harvest the brand prematurely.

### 5.1. Effort sustenance and response persistence for a frequently purchased consumer good.

One of the early published marketing-mix models focused on the relative effectiveness of pricing, advertising and promotion to stimulate the sales of a well-known packaged-food product in a competitive environment (Little 1975). The BRANDAID project provided management with econometric estimates of these instruments' relative effectiveness, and offered recommendations for improved resource allocation. As unit sales were gradually increasing over time, a deterministic trend was added to the model specification to account for the observed long-run movement (see Little 1975, p. 666). Deterministic trends, however, are independent of marketing spending, which makes the reported results relevant only for short-run marketing resource allocation.[3]

In our first illustration, we re-analyze the BRANDAID data using our long-term time-series models. Preliminary unit-root tests revealed that market performance as well as the three marketing variables (price, advertising and promotion) were evolving over time (see Appendix B for the relevant test statistics), and we therefore estimated a VAR model on the changes, as opposed to the levels. Both the brand's own price and the price of its main competitor were included, in order to capture competitive price pressure as well. As seasonal fluctuations were observed in the data (cf. Little 1975, p. 663), we added seasonal dummy variables to the VAR specification. Based on Akaike's order-selection criterion, a VAR model of order two was used, and to reduce the number of parameters in the model, we restricted all response parameters with a $t$-statistic less than one in absolute value to zero.

Our focus on long-run marketing behavior and spending is best served by examining the impulse-response graphs of promotional spending, advertising, price and sales response. Detailed estimation results are available from the authors. The persistence plots in Figure 2 show the over-time behavior of marketing and sales as a result of an unexpected change in one of the marketing-mix variables: Figure 2A shocks promotion, Figure 2B advertising, and Figure 2C price. In each instance, we let the sales variable be ordered last (i.e. it can be influenced instantaneously by all three marketing-mix variables), and the shocked variable first. For the intermediary variables, we assessed the robustness of our findings to their causal ordering, for example the sequence Own Price→ Competitive Price→ Advertising →Promotion → Sales versus Own Price→Competitive Price→ Promotion →Advertising → Sales in Fig. 2C and found the substantive results to be insensitive.

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Figure 2 about here

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*Long-run effects of advertising and promotion changes.* The behavior of advertising and promotion after an unexpected $1,000 shock shows substantial sustenance: about 38% of promotion shocks (or $380) and about 45 percent of advertising shocks (or $450) persist over time. In both cases, these levels stabilize after about five to six months. Since advertising and promotion are resource allocations, this finding suggests that managers have some inertia in their spending decisions, i.e. budget hikes as well as cuts tend to persist over time. In addition, shocks in advertising tend to create considerable cross-over effects in promotion, instantaneously ($600), during the dust-settling period ($1,707 cumulative from periods 0 to 5) and in the long run ($300). Therefore, the total long-run sustenance of a $1,000 change in advertising is $450 + $300 = $750. As for promotion, its cross-effect on advertising is much smaller, $230 instantaneously, $308 in the dust-settling period and $50 in the long run. Finally, there are no noticeable short- or long-run cross-effects of advertising or promotion on price, so these graphs are not reported in Figure 2.

As for the resulting sales response, both instruments have a positive immediate impact in the short run, with promotion being about 1.5 times as effective as advertising (14,800 vs. 9,000 extra lbs of product after a $1,000 shock), which confirms Little's (1975) finding on their relative effectiveness.

In terms of their long-term effectiveness, promotion response is also more persistent than advertising response in absolute terms ($5,900 vs. $3,700). It is interesting to note, however, that in relative terms (i.e. persistent response as a fraction of short-run response), a larger portion of the initial advertising effect carries over in the long run. Dekimpe and Hanssens (1995a) reported a similar finding when comparing the long-term effects of image-oriented TV advertising vs. price-oriented print advertising.

These empirical results offer a new perspective on the recommended long-run resource allocation between advertising and promotion. They favor the use of promotion expenditures which, compared to advertising, have a higher short-run and long-run sales effect, and result in lower long-run spending commitment. As for marketing's contribution to overall profitability, that critically depends on the magnitude and behavior of profit margins, on which we have no exact information. However, we can compute the long-run margin required to break even on advertising or promotion spending, as illustrated in Table 2.

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Table 2 about here

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The table shows the minimum required margins for advertising and promotion to be profitable over three different time horizons: instantaneous, dust-settling period and long run. At all three levels, promotion is significantly more profitable than advertising. Furthermore, the promotional spending the company engages in, does not jeopardize its long-run profitability, as the required long-run margins are *lower* than the short-term margins. In other words, *the economics of the long run are better than those of the short run.* Since only short-run margins are readily observable to managers, it suggests that profitable short-run promotion spending will also be beneficial in the long run, so long as the brand's short-run margins can be preserved.

*Long-run effects of price changes.* Three key findings emerge from Figure 2C. First, price shocks themselves are persistent: about 72 percent of a short-run change in the brand's price is preserved in the long run, and this fraction stabilizes in about six months. This suggests a substantial amount of inertia in the firm's price-setting behavior, which is not so surprising as price is a flow variable that is

naturally autocorrelated. Furthermore, unexpected price movements elicit strong and quick reactions from the brand's main competitor, as evidenced in a short-run competitive price response of 46%. Competitive price sustenance is comparable to the brand's own price persistence, as 72% of this short-run reaction is preserved in the competitor's long-run price level; therefore, the long-run competitive reaction to an initial price shock is 0.46*0.72 =0.33.

The cross-effects of price movements are not limited to competitive prices. Advertising and promotion react negatively to price changes. For example, a one-cent price cut results in a short-run advertising increase of $31,000 after one period, and a long-run increase of $12,000. Similarly, the immediate and long-term cross effects on promotions are -$62,000 and -$52,000. These results provide evidence that price cuts are not executed in isolation, but rather as a part of a total, sustained marketing effort.

These price dynamics produce a distinct sales persistence scenario. As expected, the immediate price effect is negative and strong (-18,300 lbs per penny). However, customers partially adjust to that price change, as the sales persistence stabilizes to approximately 33% of the initial sales drop (or 6,130 lbs/penny), and this in spite of a price persistence of 72 percent that is only partially matched by the competitor! A behavioral explanation for this finding is price-adaptations behavior on behalf of the customers (e.g. Kalyanaram and Winer 1995). In case of a sudden price increase, customers react negatively to the "sticker shock", but absent further shocks, they eventually restore part of their shopping behavior prior to the price hike. From a strategic perspective, such behavior may lead to a persistent profit opportunity if the brand is willing to incur short-run volume losses due to the sticker-shock effect.

### 5.2. Understanding sales erosion for a pharmaceutical product

The pharmaceutical industry is characterized by intense rivalry in the areas of new-product development and pricing. When a new drug is approved for commercialization, its maker receives a handsome reward for years of RandD and clinical testing in the form of patent protection which usually results in a price premium. However, competitors often try to improve upon the medical performance of the patented product and offer a 'new and improved' version at comparable price points. An example may be the advent of second-

generation anti-depressant medicines such as Zoloft that compete with the highly-successful pioneer, Prozac, on the premise of same effectiveness with fewer side effects.

We obtained a monthly sample of five years of market performance (number of prescriptions among a panel of physicians), marketing support (advertising in dollars, and detailing in number of sales force visits to doctors) and pricing data for the major competitors in a prescription drug market. We focus on the two major players in the market, brand A, the pioneer, and brand B, a successful challenger offering a product with similar performance and fewer side effects. Therefore, a major strategic question for brand A management was how to set its marketing strategy and its price path relative to the challenger in order to overcome its intrinsic quality disadvantage.

As Figure 3 illustrates, brand B was able to establish market leadership. The interesting research question therefore becomes to what extent brand A's actually chosen pricing and spending strategies delayed or accentuated this long-term erosion in its market position. Indeed, if our models reveal persistent sales response to pricing and/or marketing support, the increase in brand A's relative price coupled with a reduction in its marketing budget would be evidence of a premature harvesting of the brand which undermined the brand's long-run viability.

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Figure 3 about here

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Appendix B shows univariate test statistics that reveal evolutionary behavior in brand A's sales, advertising support, sales force contacts and relative price (price differential with brand B). Therefore, a VAR market-response model for prescriptions, detailing, advertising and relative price was estimated on differences, and the corresponding persistence graphs for shocks to brand A's relative price are shown in Figure 4.

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Figure 4 about here

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The results indicate, first of all, that changes in price differential persist over time: a $1 short-run increase in this differential results in a permanent increase of $1.08. Second, customer reaction to such price increases is strong and quick to materialize, estimated at -11 prescriptions per dollar after one period. Furthermore, about 13.5 percent of these short-run losses, or 1.5 prescriptions, are permanent, i.e. in every subsequent period the prescription level is lower than what it would have been without the initial price increase. These results again show that, while customers adjust over time to short-run price increases even when these price changes themselves are sustained, *they do not do so completely* . Therefore, there were negative long-run consequences of brand A's decision to gradually narrow the price differential with brand B.

These negative long-run effects were further amplified as they were accompanied by sustained reductions in brand A's marketing support, i.e. detailing and advertising. Indeed, the persistence plots in Figure 4 further reveal that price changes in the market had a negative long-term effect on brand A's advertising spending (immediate effect of -$90 with 82% sustenance) and detailing (-6 visits after one period with 29 percent sustenance). This cross-effect in A's marketing mix contributed further to the long-term decline of the brand, because there is evidence of these instruments' response effectiveness as well. Indeed, in separate simulations, we found short- and long-run effects of detailing and advertising: an unexpected $1,000 change in advertising is associated with 23 new prescriptions after two periods, with 32% persistence. An unexpected one-unit change in detailing (measured as physician contacts) results in 0.5 new prescriptions instantaneously, with 25 percent persistence.

The following strategic picture emerges from our long-term analysis: once the superior brand B entered the market, it gradually took over prescription sales of the pioneer, brand A. Brand A, however, decided to parallel and even exceed the upward price pattern of B and failed to establish a relative price advantage over B that could have offset its relative quality disadvantage and helped it defend its position. Consumers, on their side, reacted negatively to price hikes in the short run, and only partially adjusted to higher prices. Finally, the higher prices coupled with lower prescription levels may have prompted company A to start harvesting the brand prematurely, as they reduced both advertising and salesperson visits

to doctors. Since these efforts were effective in stimulating both short-run and long-run sales, brand A lost an opportunity to rebuild its brand franchise.

## 6.STRATEGIC RECOMMENDATIONS

Our paper has argued conceptually and empirically that marketing resources should be allocated for their ong-run impact on response, and that it is now possible to trace such impact when good-quality time-series (tracking) data are available. These new empirical methods have allowed us to estimate the short-run and long-run economic impact of pricing and marketing spending scenarios and to make cost-benefit comparisons. To the best of our knowledge, our approach is the first to have quantified the long-run profit implications of marketing allocations from readily observable data.

The results also lend themselves to the formulation of broad guidelines for marketing strategy and resource allocation. The first task, we argue, is to determine if the brand's sales follow a 'business as usual' or a continuously changing (evolving) pattern. If the answer is 'business as usual', managers can fit traditional market-response models on levels and use cost-benefit analysis to determine the profitability of their pricing and marketing spending strategies. Even though there may be some lagged response effects, the results do not have long-run profit implications as brand spending and performance return to their mean after a finite number of periods. A company that generates a short-run surplus under such conditions may be able to repeat its profitable marketing tactics and accumulate substantial wealth as time goes on.

If the sales pattern is evolving, the strategic picture changes dramatically. Short-run marketing decisions can - but need not - influence the long-run position and profitability of the company, so managers should pay particular attention to the long-run consequences of their actions. By calculating spending sustenance and response persistence, we can quantify these consequences and draw important inferences, such as:

. if response persistence is low, creating long-run marketing effects will require repeated efforts, which may or may not be profitable;

. if response persistence is high, it is possible to obtain long-run benefits from only one-time or infrequent short-term actions

and, in general,

marketing managers should ensure that response persistence is higher than spending sustenance. If the reverse is true, the company, and indeed the entire industry, may evolve into an unprofitable spending escalation.

## 7. CONCLUSIONS

Most marketing managers and academics alike will agree that scarce marketing resources should be allocated to create long-term as opposed to short-term impact and profitability. However, what constitutes the 'long run' and how it should be measured is an entirely different story, one that lacks definitions and analytical rigor.

This paper proposed that the analytical rigor should come from classifying marketing spending, market performance and their interrelation as either stationary (mean reverting, temporary) or evolving (sustained, persistent). Building on earlier work that described and illustrated empirical time-series measures of stationarity, evolution and persistence, we defined four possible strategic scenarios that managers and their products may find themselves in: business as usual, evolving-business practice, hysteresis and escalation. We reviewed reasons why marketing spending and market response is either short-lived or persistent. Finally, we proposed a measure of long-term marketing effectiveness, called persistent surplus, and related it to the four scenarios.

Our discussion revealed that real markets are indeed a mixture of the scenarios we described. Sometimes companies can reap long-term rewards from short-term marketing

investments (hysteresis). Other times it takes sustained spending to steer products or brands in a certain strategic direction (evolving-business practice). Yet other times market response is only temporary, yet managers spend their products into an unprofitable escalation scenario. Lastly, some markets are in a comfortable spending/response equilibrium where nothing changes in the long run.

By offering the tools for distinguishing between these scenarios and measuring their financial consequences, we hope to have contributed a rigorous, yet practical method for diagnosing product markets. This diagnosis leads, in turn, to specific strategic recommendations for marketing resource allocation. For example, our framework can be used to diagnose the difference between 'do or die' price wars and unnecessary price wars.

All the diagnosing we propose is based on routinely available time series of market performance (e.g. sales volumes) and marketing spending (e.g. sales force and promotion data). This focus makes our approach practical, but also imposes some restrictions. Most of all, we are dependent on relatively abundant, equally spaced data for all the important variables. From a managerial perspective, that means the company must have access to a good marketing data warehouse. Second, we have offered little guidance for the treatment of purely qualitative aspects of marketing strategy, such as positioning and communications message choice. Therefore the methods we advocate will be less useful in really new product categories with little or no historical data and/or established attribute structures.

This restriction leads us to recommend significant new research effort in the development of *empirical generalizations* on long-term marketing effectiveness and spending patterns. Given that time-series statistical software is becoming more accessible, we should be able to replicate the four strategic scenarios in the paper and learn about the determinants of spending sustenance and response persistence. In this process, various theories and frameworks from other disciplines, including psychology, economics and management strategy, can help us offer intuitively appealing explanations for the patterns we find. We hope that such research will advance our understanding and practice of long-term marketing resource allocation and its effectiveness.

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Footnotes

[1] For ease of exposition, we have omitted any deterministic components from the model. When needed, constant terms, seasonal dummy variables and/or deterministic trends can easily be added to the specification.

[2] When the results are affected by the choice of temporal ordering, the approach advocated by Evans and Wells (1983) can be used . Rather than simulating the impact of a shock to one variable in a transformed VAR model, (Eq. 2) , they simulate the impact of a vector of shocks to the original, untransformed VAR model (cf. Eq. 1). For a shock of known magnitude $k$ to one of the variables (say, variable $i$) , they use the information in the variance-covariance matrix $\Sigma$ to compute the expected value of the other disturbance terms ( i.e. $k\ \sigma_{ij} / \sigma_{ii}$ when assuming multivariate normality), and trace their joint over-time impact on the variables in the system.

[3] In contrast, when a unit root is found in the data, the long-run trend is modeled stochastically rather than deterministically, and the impulse response functions along with their multivariate persistence calculations explicitly consider the linkages between evolution in performance and spending fluctuations (see Dekimpe and Hanssens 1995a for a detailed discussion).

## APPENDIX A

If we assume that (1) $S_t$ and $M_t$ are evolving, while $CM_t$ is stationary, (2) the causal ordering is $M_t \rightarrow CM_t \rightarrow S_t$, and (3) the order of the VAR model is one, we can write the "transformed" VAR model as:

$$\begin{bmatrix} \Delta S_t \\ \Delta M_t \\ CM_t \end{bmatrix} = \begin{bmatrix} 0 & \gamma_{12}^0 & \gamma_{13}^0 \\ 0 & 0 & 0 \\ 0 & \gamma_{32}^0 & 0 \end{bmatrix} \begin{bmatrix} \Delta S_t \\ \Delta M_t \\ CM_t \end{bmatrix} + \begin{bmatrix} \gamma_{11}^1 & \gamma_{12}^1 & \gamma_{13}^1 \\ \gamma_{21}^1 & \gamma_{22}^1 & \gamma_{23}^1 \\ \gamma_{31}^1 & \gamma_{32}^1 & \gamma_{33}^1 \end{bmatrix} \begin{bmatrix} \Delta S_{t-1} \\ \Delta M_{t-1} \\ CM_{t-1} \end{bmatrix} + \begin{bmatrix} e_{S,t} \\ e_{M,t} \\ e_{CM,t} \end{bmatrix},$$

or equivalently as:

$$\begin{bmatrix} S_t \\ M_t \\ CM_t \end{bmatrix} = \begin{bmatrix} S_{t-1} \\ M_{t-1} \\ 0 \end{bmatrix} + \begin{bmatrix} 0 & \gamma_{12}^0 & \gamma_{13}^0 \\ 0 & 0 & 0 \\ 0 & \gamma_{32}^0 & 0 \end{bmatrix} \begin{bmatrix} S_t - S_{t-1} \\ M_t - M_{t-1} \\ CM_t \end{bmatrix} + \begin{bmatrix} \gamma_{11}^1 & \gamma_{12}^1 & \gamma_{13}^1 \\ \gamma_{21}^1 & \gamma_{22}^1 & \gamma_{23}^1 \\ \gamma_{31}^1 & \gamma_{32}^1 & \gamma_{33}^1 \end{bmatrix} \begin{bmatrix} S_{t-1} - S_{t-2} \\ M_{t-1} - M_{t-2} \\ CM_{t-1} \end{bmatrix} + \begin{bmatrix} e_{S,t} \\ e_{M,t} \\ e_{CM,t} \end{bmatrix}.$$

To trace the over-time impact of an unexpected, one-unit shock to $M$, we set all variables equal to zero prior to $t$ (i.e. $S_{t-1}=0$, $M_{t-1}=0$, ...), set $(e_{S,t}, e_{M,t}, e_{CM,t}) = (0,1,0)$, and solve recursively for $M_{t+k}$, $CM_{t+k}$ and $S_{t+k}$, ($k$=0, 1, 2, ...) under the assumption of no further shocks to the system. For period $t$, we get:

$$\begin{aligned} M_t &= 1 \\ CM_t &= \gamma_{32}^0 (M_t - M_{t-1}) \\ &= \gamma_{32}^0 (1 - 0) = \gamma_{32}^0 \\ S_t &= 0 + \gamma_{12}^0 (M_t - M_{t-1}) + \gamma_{13}^0 CM_t \\ &= \gamma_{12}^0 (1 - 0) + \gamma_{13}^0 \gamma_{32}^0 \end{aligned},$$

and for period $t$+1:

$$
\begin{aligned}
M_{t+1} &= M_t + \gamma^1_{21}\,(S_t - S_{t-1}) + \gamma^1_{22}\,(M_t - M_{t-1}) + \gamma^1_{23}\,CM_t \\
&= 1 + \gamma^1_{21}\,(\gamma^0_{12} + \gamma^0_{13}\,\gamma^0_{32} - 0) + \gamma^1_{22}\,(1 - 0) + \gamma^1_{23}\,\gamma^0_{32} \\
CM_{t+1} &= 0 + \gamma^0_{32}\,(M_{t+1} - M_t) + \gamma^1_{31}\,(S_t - S_{t-1}) + \gamma^1_{32}\,(M_t - M_{t-1}) + \gamma^1_{33}\,CM_t \\
&= \gamma^0_{32}\,(\gamma^1_{21}\gamma^0_{12} + \gamma^1_{21}\gamma^0_{13}\gamma^0_{32} + \gamma^1_{22} + \gamma^1_{23}\gamma^0_{32}) + \gamma^1_{31}\,(\gamma^0_{12} + \gamma^0_{13}\gamma^0_{32}) + \gamma^1_{32} + \gamma^1_{33}\gamma^0_{32} \\
S_{t+1} &= S_t + \gamma^0_{12}\,(M_{t+1} - M_t) + \gamma^0_{13}\,CM_{t+1} + \gamma^1_{11}\,(S_t - S_{t-1}) + \gamma^1_{12}\,(M_t - M_{t-1}) + \gamma^1_{13}\,CM_t \\
&= \ldots
\end{aligned}
$$

These values are then substituted in a similar way in the equations for $M_{t+2}$, $CM_{t+2}$, and $S_{t+2}$. The different $S_{t+j}$ ($j$=0, 1, ...) together form the impulse-response function which gives the sales response to a shock in advertising. A *persistent response* is found when this impulse-response function converges to a non-zero level, and a *sustained effort* emerges when the $M_{t+j}$ stabilize at a non-zero level. Since *CM* is a mean-reverting series, the $CM_{t+j}$ will eventually return to zero irrespective of whether the initial shock happened to *S*, *M* or *CM*.

## Appendix B

### Unit Root Tests

A. Consumer product example

| | *m* | *b* | *t* | Unit root present? |
|---|---|---|---|---|
| Price | 6 | -0.44 | -2.48 | yes |
| Competitor Price | 0 | -0.17 | -1.59 | yes |
| Advertising | 4 | -1.39 | -2.62 | yes |
| Promotion | 4 | -1.34 | -2.28 | yes |
| Sales | 5 | -1.58 | -2.55 | yes |

B. Pharmaceutical example

| | *m* | *b* | *t* | Unit root present? |
|---|---|---|---|---|
| Price Difference | 3 | -0.03 | -0.57 | yes |
| Advertising | 5 | -0.05 | -0.42 | yes |
| Contacts | 1 | -0.19 | -1.80 | yes |
| Sales | 2 | -0.19 | -0.11 | yes |

Note: the results are based on augmented Dickey-Fuller (ADF) tests.

*m* = number of augmented terms, determined on the basis of the AIC criterion

*b* = parameter estimate of the lagged dependent variable

*t* = t statistic associated with the lagged dependent variable, to be compared against the 5% critical value of -2.89. The unit-root null hypothesis is rejected if the computed t-statistic is smaller than this value.

**Table 1**
**Frequency of Response Persistence and Effort Sustenance in Marketing**

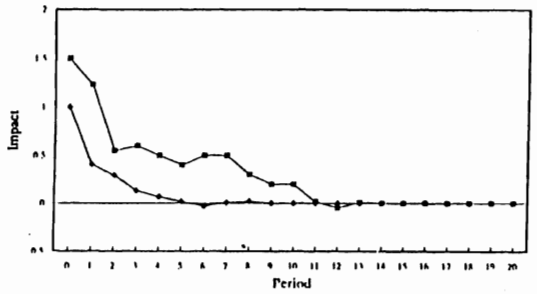
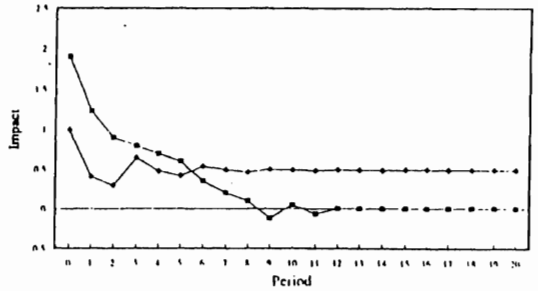
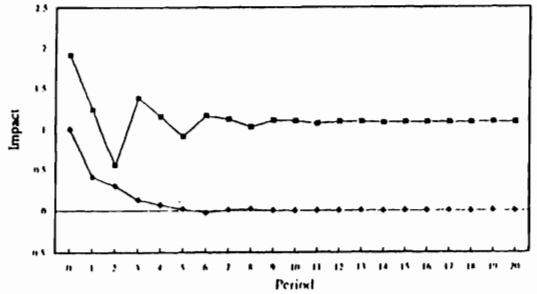
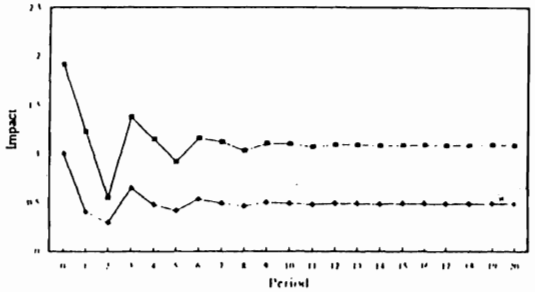
| | Stationary (zero persistence/sustenance) | Evolving (nonzero persistence/sustenance) |
|---|---|---|
| All variables | 192 | 227 |
| Market Performance | 89 | 131 |
| Marketing-Mix | 103 | 96 |

**Table 2**
**Short- and Long-Run Break Even Margins for Promotion and Advertising for a Frequently Purchased Consumer Product***

| Immediate | | | | Dust Settling | | | | Long Run | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Promotion | Advertising | Sales Response | Break-Even Margin | Promotion | Advertising | Sales Response | Break-Even Margin | Promotion | Advertising | Sales Response | Break-Even Margin |
| **$1,000** | $230 | 14,800 lbs | 8.3 c/lb | $2,270 | $308 | 34,300 lbs | 7.5 c/lb | $380 | $50 | 5,900 lbs | 7.3 c/lb |
| $600 | **$1,000** | 9,000 lbs | 17.8 c/lb | $1,707 | $2,613 | 24,800 lbs | 17.4 c/lb | $300 | $450 | 3,700 lbs | 20.3 c/lb |

*Read : a $1,000 shock in promotion is associated with a $230 immediate increase in advertising. The combined effect of these actions is to increase unit sales by 14,800 lbs. It therefore requires a margin of 8.3 c/lb to recover these marketing costs. During the dust-settling periods 0 through 5, promotion increases by $2,270 and advertising by $308, which augment unit sales by 34,300 lbs (cumulative). The break-even margin for the dust-settling period is 7.5 c/lb. In the long run, the same $1,000 promotion shock is associated with an increase in promotional spending of $380, and an increase in advertising of $50. With a long-run sales response of 5,900 lbs, this requires a break-even margin of 7.3 c/lb. The second line makes similar calculations for a $1,000 shock in advertising.

**FIGURE 1**

| SALES RESPONSE | MARKETING EFFORT: TEMPORARY | MARKETING EFFORT: SUSTAINED |
|---|---|---|
| TEMPORARY | **BUSINESS AS USUAL**   | **ESCALATION**   |
| PERSISTENT | **HYSTERESIS**   | **EVOLVING - BUSINESS PRACTICE**   |

Sales  Marketing Mix

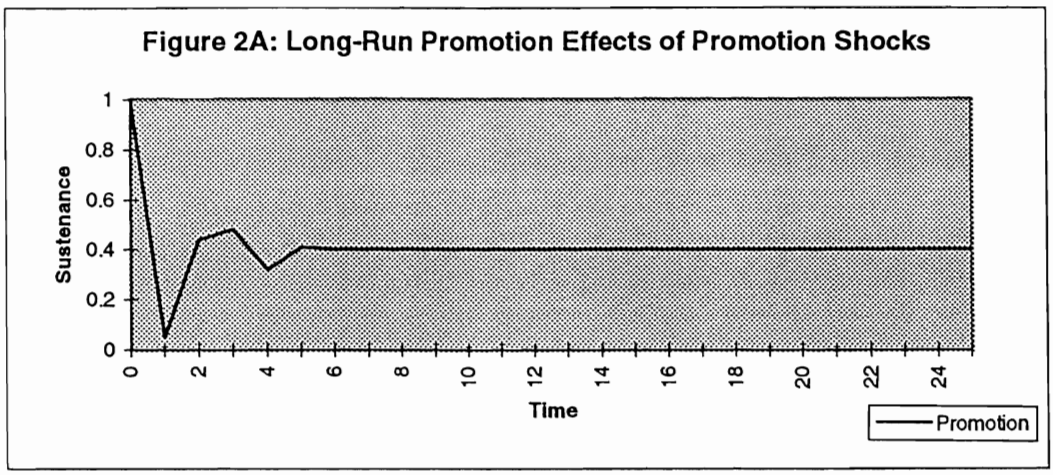


Figure 2A: Long-Run Promotion Effects of Promotion Shocks
Sustenance
1
0.8
0.6
0.4
0.2
0
0
2
4
6
8
10
12
14
16
18
20
22
24
Time
Promotion

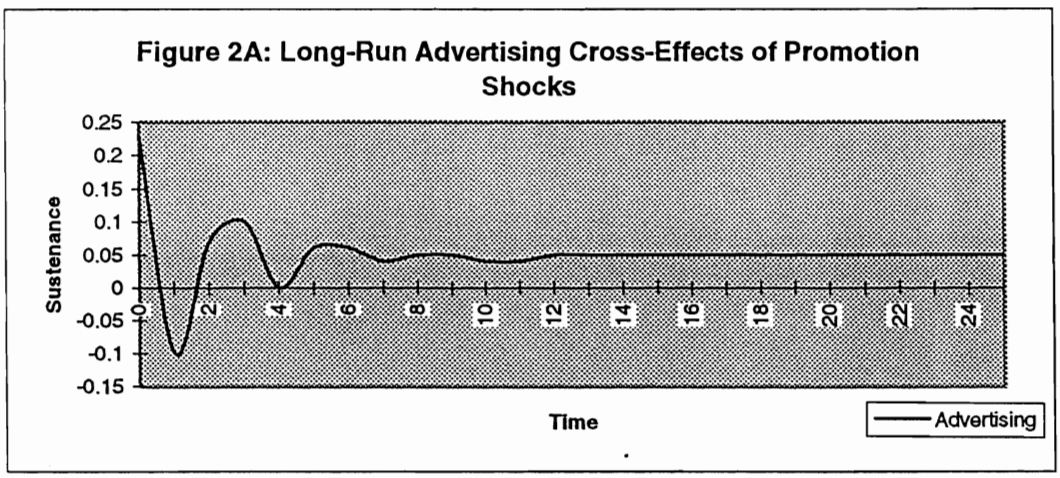


Figure 2A: Long-Run Advertising Cross-Effects of Promotion Shocks
Sustenance
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
0
2
4
6
8
10
12
14
16
18
20
22
24
Time
Advertising

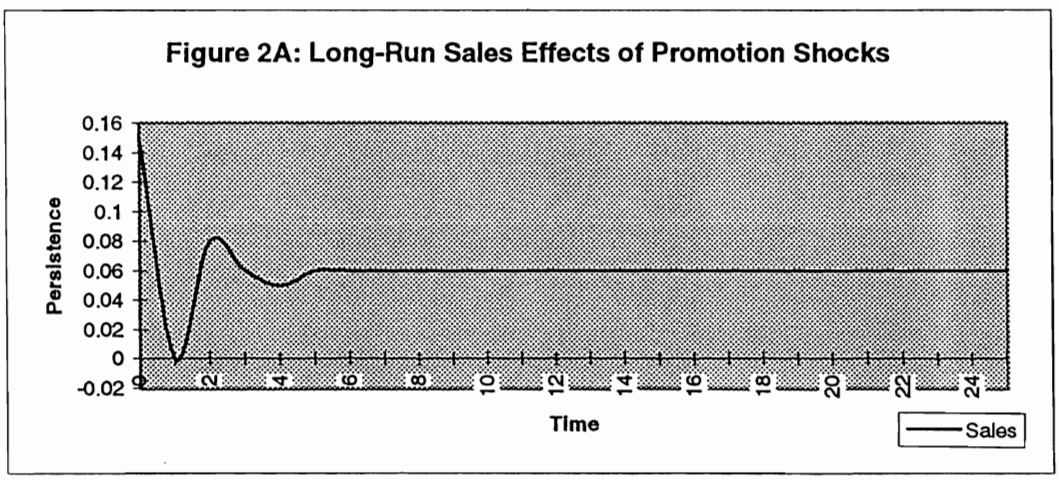


Figure 2A: Long-Run Sales Effects of Promotion Shocks
Persistence
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
-0.02
0
2
4
6
8
10
12
14
16
18
20
22
24
Time
Sales

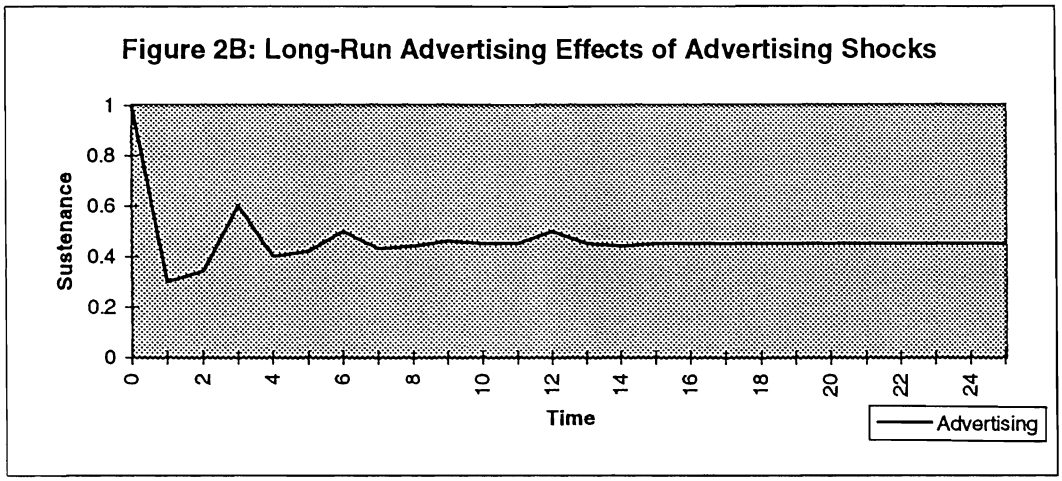


Figure 2B: Long-Run Advertising Effects of Advertising Shocks
Sustenance
1
0.8
0.6
0.4
0.2
0
0 2 4 6 8 10 12 14 16 18 20 22 24
Time
Advertising

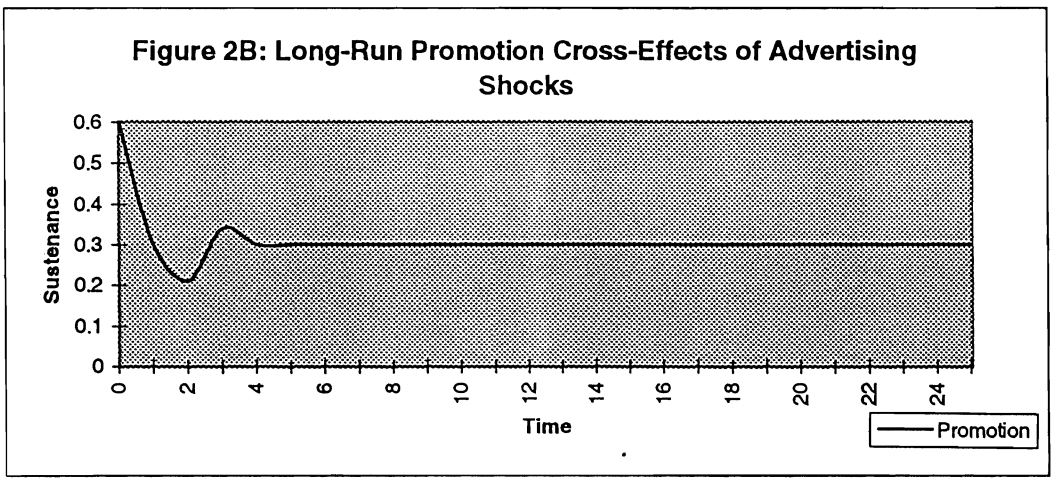


Figure 2B: Long-Run Promotion Cross-Effects of Advertising Shocks
Sustenance
0.6
0.5
0.4
0.3
0.2
0.1
0
0 2 4 6 8 10 12 14 16 18 20 22 24
Time
Promotion

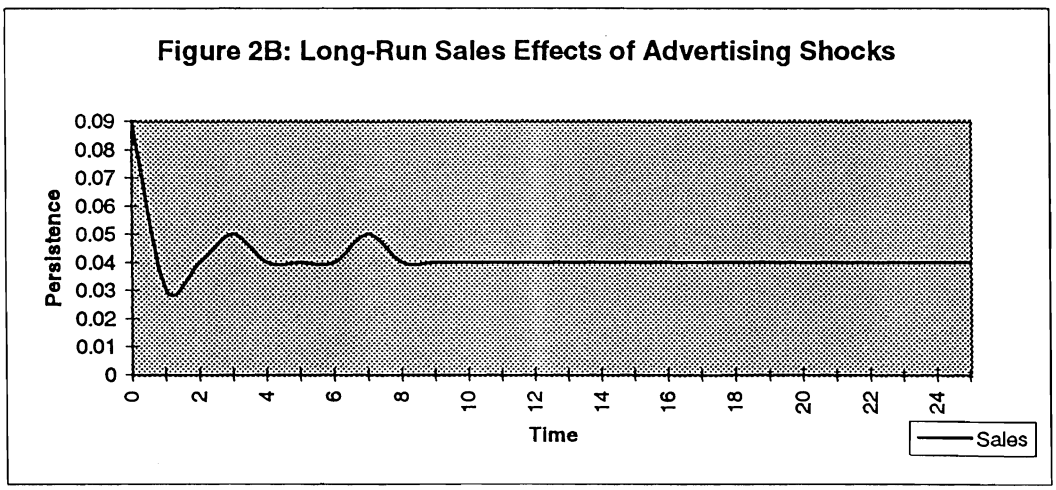


Figure 2B: Long-Run Sales Effects of Advertising Shocks
Persistence
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0 2 4 6 8 10 12 14 16 18 20 22 24
Time
Sales

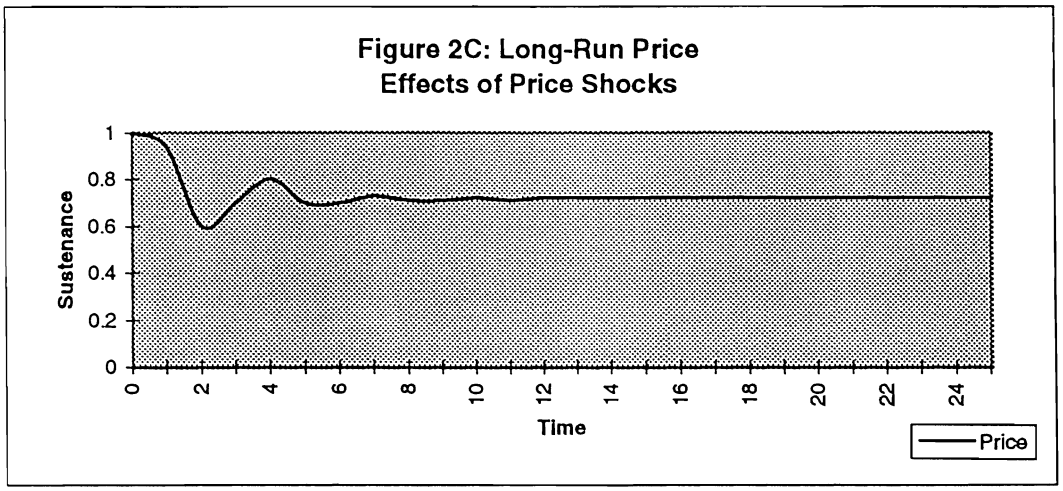


Figure 2C: Long-Run Price Effects of Price Shocks
Sustenance
1
0.8
0.6
0.4
0.2
0
0 2 4 6 8 10 12 14 16 18 20 22 24
Time
Price

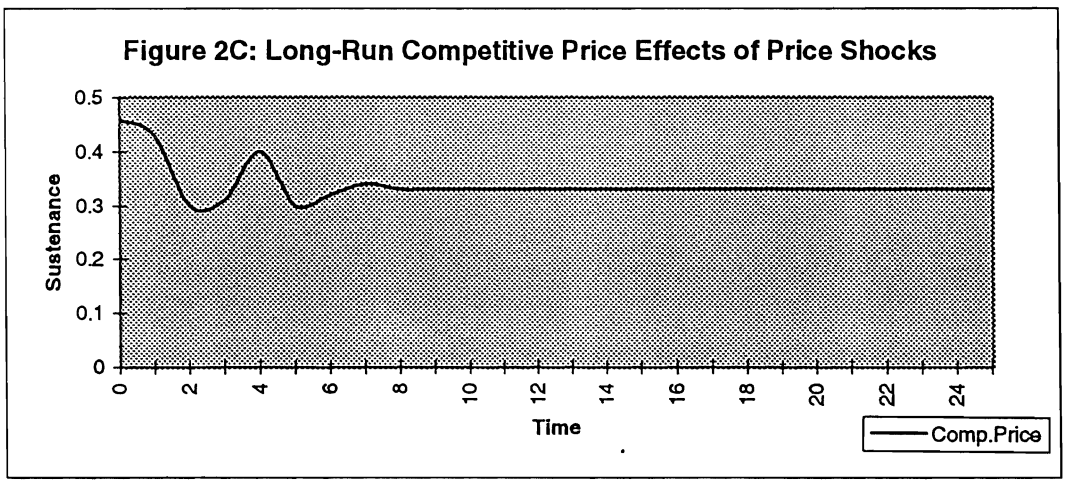


Figure 2C: Long-Run Competitive Price Effects of Price Shocks
Sustenance
0.5
0.4
0.3
0.2
0.1
0
0 2 4 6 8 10 12 14 16 18 20 22 24
Time
Comp.Price

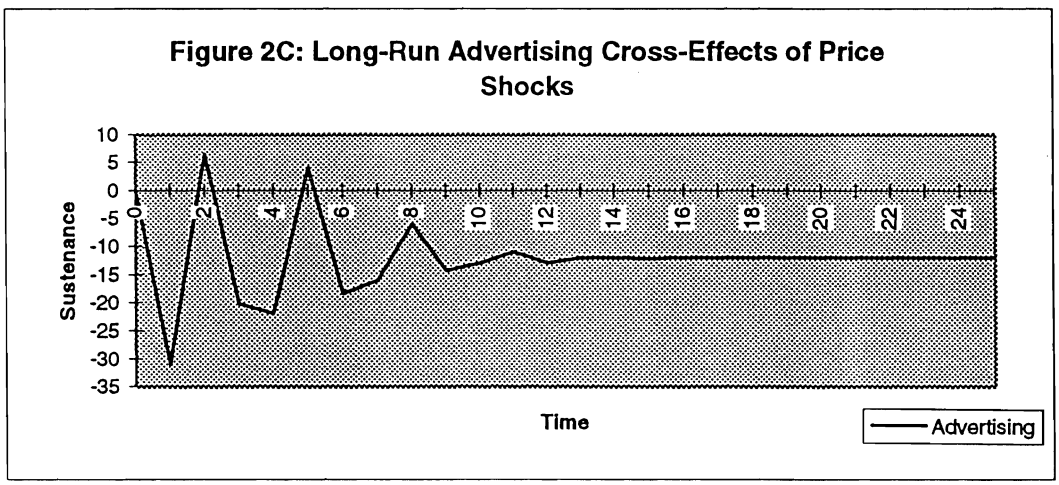


Figure 2C: Long-Run Advertising Cross-Effects of Price Shocks
Sustenance
10
5
0
-5
-10
-15
-20
-25
-30
-35
0 2 4 6 8 10 12 14 16 18 20 22 24
Time
Advertising

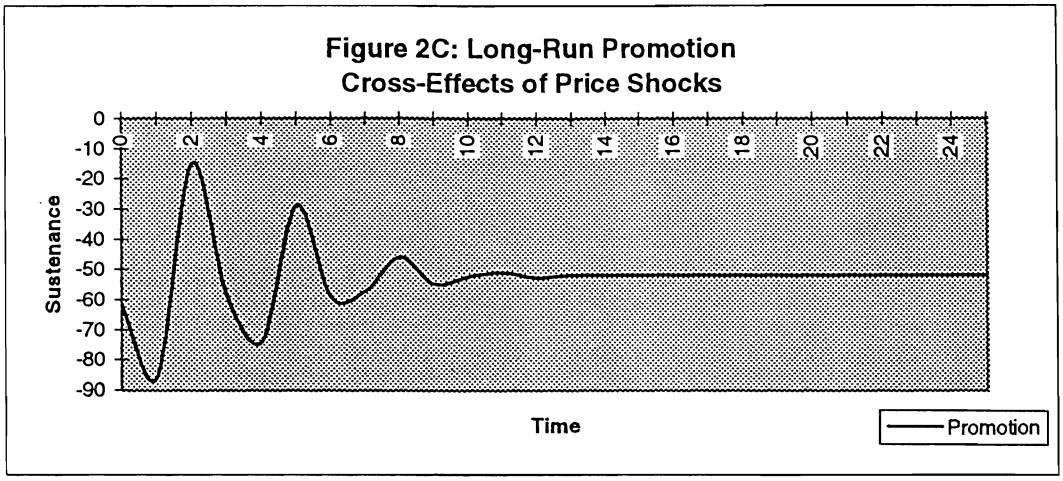


Figure 2C: Long-Run Promotion
Cross-Effects of Price Shocks
Sustenance
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
0
2
4
6
8
10
12
14
16
18
20
22
24
Time
Promotion

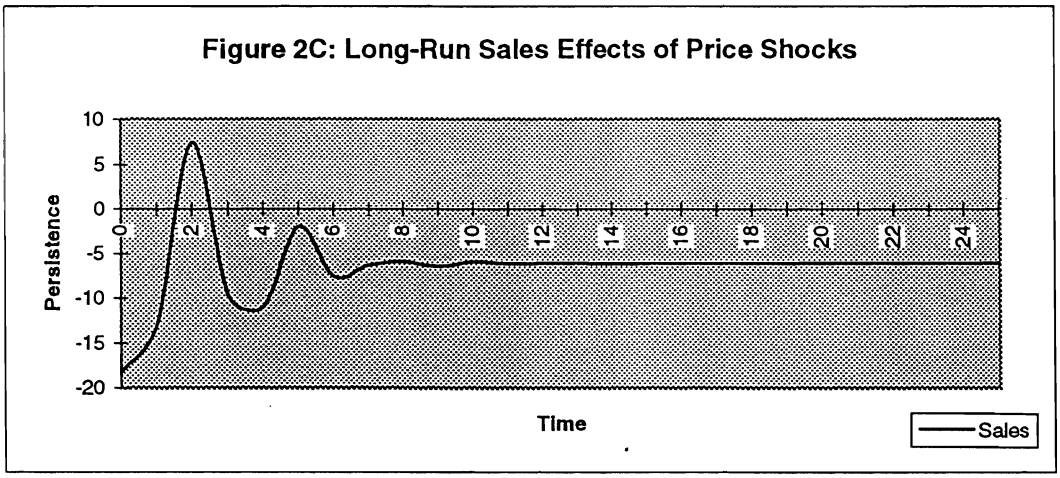


Figure 2C: Long-Run Sales Effects of Price Shocks
Persistence
10
5
0
-5
-10
-15
-20
0
2
4
6
8
10
12
14
16
18
20
22
24
Time
Sales

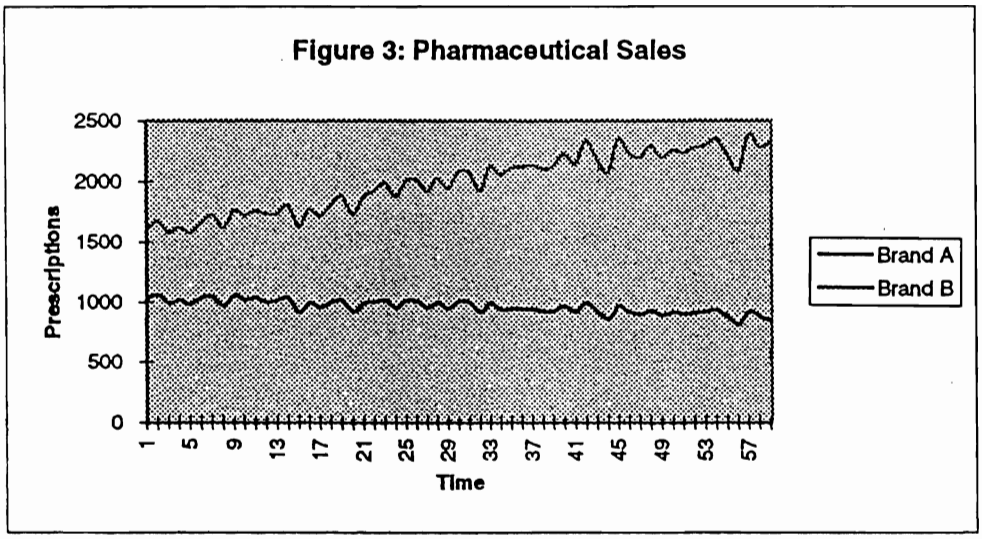


Figure 3: Pharmaceutical Sales
2500
2000
1500
1000
500
0
Prescriptions
1
5
9
13
17
21
25
29
33
37
41
45
49
53
57
Time
Brand A
Brand B

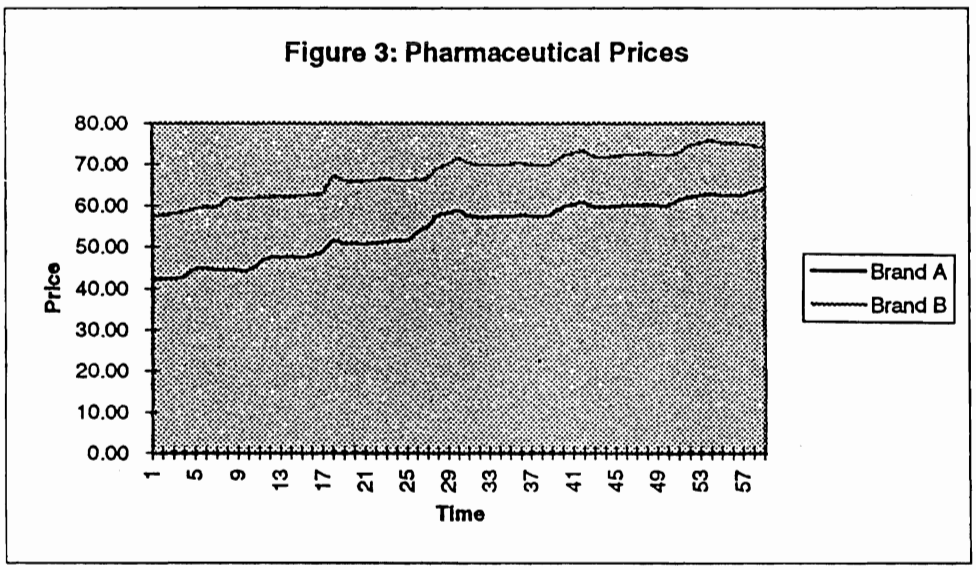


Figure 3: Pharmaceutical Prices
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Price
1
5
9
13
17
21
25
29
33
37
41
45
49
53
57
Time
Brand A
Brand B

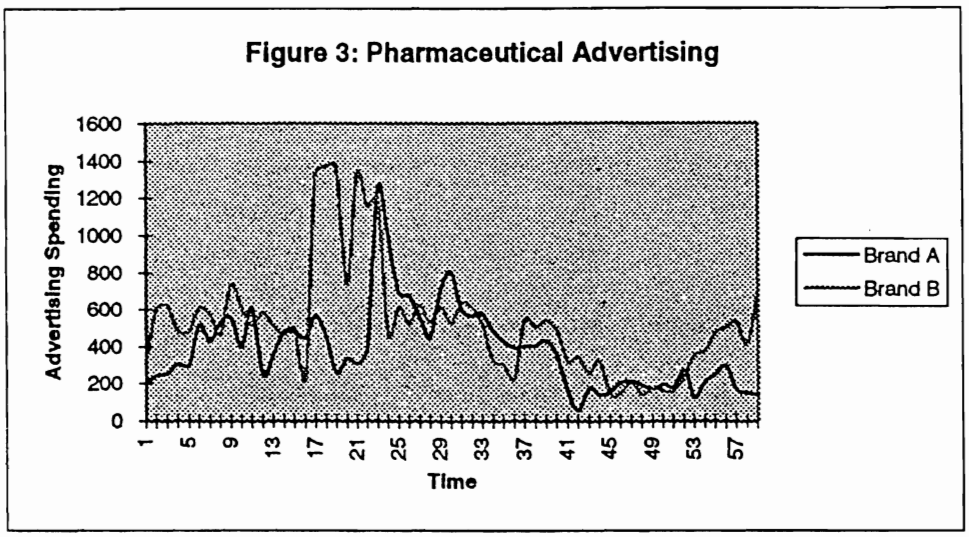


Figure 3: Pharmaceutical Advertising
Advertising Spending
1600
1400
1200
1000
800
600
400
200
0
1
5
9
13
17
21
25
29
33
37
41
45
49
53
57
Time
Brand A
Brand B

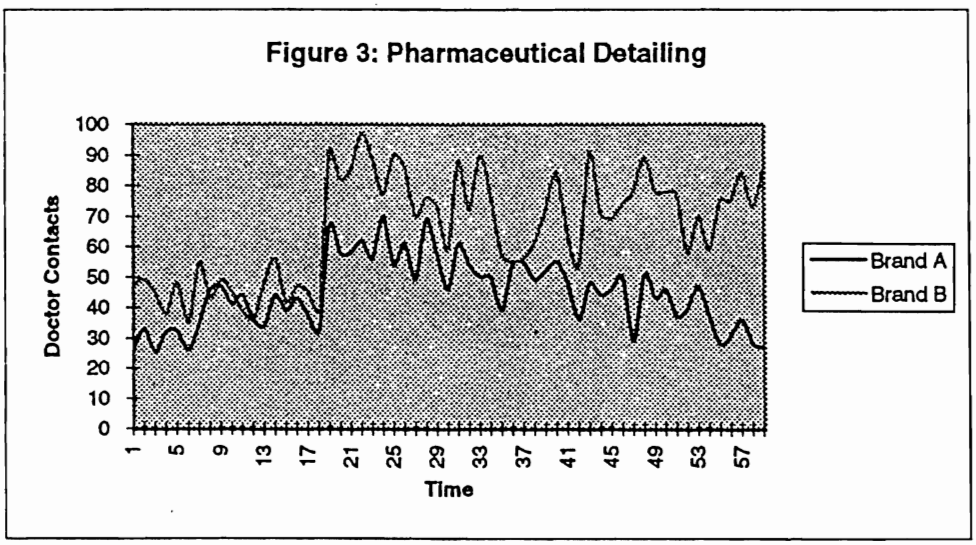


Figure 3: Pharmaceutical Detailing
Doctor Contacts
100
90
80
70
60
50
40
30
20
10
0
1
5
9
13
17
21
25
29
33
37
41
45
49
53
57
Time
Brand A
Brand B

**Figure 4: Long-Run Price Effects of Price Shocks**

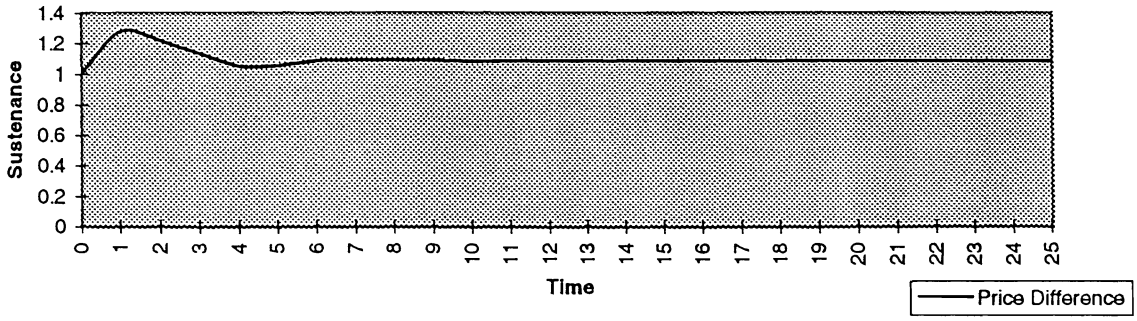



**Figure 4: Long-Run Advertising Cross-Effects of Price Shocks**

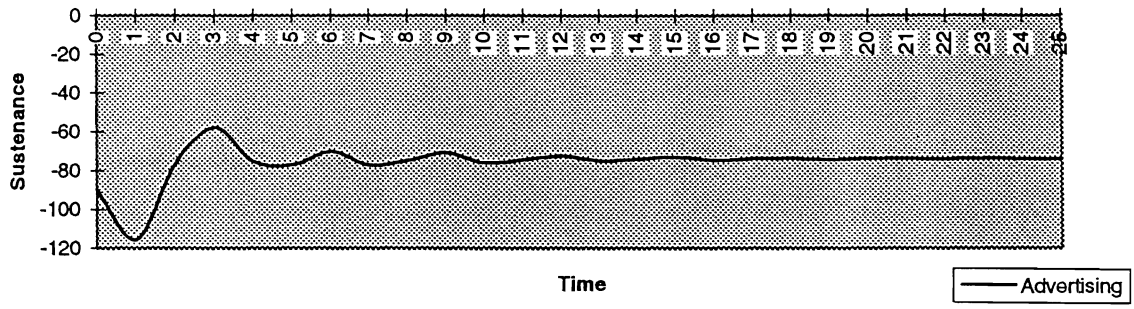



**Figure 4: Long-Run Detailing Cross-Effects of Price Shocks**

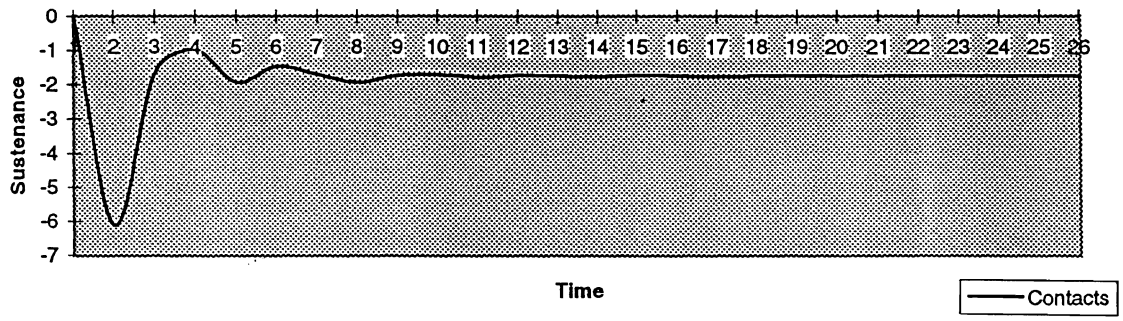



**Figure 4: Long-Run Sales Effects of Price Shocks**