Cointegration analysis of brand and category sales: Stationarity and long-run equilibrium in market shares

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SUMMARY

The present study uses modern time series methodology to understand long-run equilibrium in markets and provides additional evidence of the frequent existence of stationary market shares for frequently purchased consumer products. Dekimpe and Hanssens, *Marketing Science* 1995; 14(2):G109–121 using a database of over 400 prior studies, found that 78 per cent of the market share series they studied were stationary, but that 68 per cent of the sales series were evolving. Our findings reconcile these results. A major contribution of this paper is its demonstration that the prior empirical evidence that a majority of sales series is in evolution is consistent with stationary market shares, if brand sales and category sales are cointegrated. To the extent that competitive activities have an effect on market share, an implication of our findings is that these activities may, in general, only have a temporary effect on market share. Finally, we distinguish, from a strategic perspective, between sales and share response at the primary-demand level (category sales), selective-demand level (brand sales) and relative-position level (market share) and identify strategic scenarios depending upon their stable/evolving nature. Copyright © 2000 John Wiley & Sons, Ltd.

KEY WORDS: econometric models; competition; stationarity; evolution; cointegration analysis

1. INTRODUCTION

1.1. Overview

Interest in the potential stationarity of market shares of brands arose initially because of the development and fitting of zero-order stochastic brand choice models of the type proposed by Ehrenberg [1] or of the equivalent model shown by Bass et al. [2]. These models assume that choice probabilities of heterogeneous consumers are constant over purchase occasions.
averages of the choice probabilities over consumers at a given time are the market shares (share of choices) for that time period. The assumed constancy of underlying choice probabilities would imply unchanging market shares over time. The stochastic choice models have been shown to provide reasonably good descriptions of aggregate purchase incidence data for brands as well as of aggregate brand switching data. Inasmuch as market shares are known to be changing over time because of promotions and other marketing activities, the question naturally arises as to how fits could be good when they are based on an assumption that implies the existence of unchanging market shares.

Ehrenberg [3] examines markets from a stochastic brand choice framework and has concluded that ‘...most markets are, however, more or less mature and approximately stationary—at least in the medium term (that is, when measured in periods of a week or more and up to a year or two). They may have some promotional ups and downs or the like superimposed’. This seems to suggest the existence of unchanging individual choice probabilities that are temporarily perturbed by marketing activity. In Figure 1(a)–1(c) we provide a graphical illustration of the phenomenon of stationarity in the market share of Heinz, over a 72-month period from 1960 to 1965, for the period from 1986 to 1988, and over the period from 1992 to 1994, respectively.* Casual inspection of these graphs suggests stationary share behaviour.

These market share patterns are important, particularly in light of findings in the literature. Research has found that for frequently purchased consumer goods, market shares are predominantly stationary and sales series are largely evolving (e.g., References [3–6]). Notably, Dekimpe and Hanssens [5], using a database of over 400 prior studies, found that 78 per cent of the market share series they studied were stationary, but that 68 per cent of the sales series were evolving. Our findings reconcile these results. A major contribution of this paper is its demonstration that the prior empirical evidence that a majority of sales series is in evolution is consistent with stationary market shares, if brand sales and category sales are cointegrated. We obtain this unique result as an outcome of the study. To the extent that competitive activities have an effect on market share [7], an implication of our findings is that these activities may, in general, only have a temporary effect on market share. We shall discuss and utilize formal tests of stationarity and we shall introduce and use cointegration analysis in an application of this methodology with respect to long-run equilibrium in markets.

2. BACKGROUND

2.1. Emerging empirical generalizations concerning stationarity and evolution of market share and sales

As pointed out in Section 1, some recent studies have examined the stationarity vs evolution in market share and sales. Research has found that for frequently purchased consumer goods, market shares are predominantly stationary (e.g., References [3–6]) and sales are mostly in evolution. Therefore, marketing mix variables only appear to have a temporary effect on share, while there is a potential for long-term effects on sales.

*We will return to a detailed description of the data shortly in Section 3.
Dekimpe et al. [8], used time-series analysis to examine the long-run effects on sales of price promotions for ketchup, liquid detergent, soup and yogurt. Using weekly scanner data for a period of 113 weeks, they estimated vector-autoregressive models (VAR) and vector-error correction models (VECM). They estimated a system of equations where brand sales, price and
competitor’s prices (all endogenous) are a function of lagged endogenous variables. Using impulse–response analysis, they traced the over time impact of a one-standard error shock in price. They concluded that price promotions have a significantly different impact on sales of national brands versus private labels, but these effects are only temporary. One exception is the soup market, where they observed a small long-term effect (a positive for private label and a negative effect for two national brands).

Using a similar model, Dekimpe and Hanssens [9] examined the persistence effects on sales of changes in marketing variables when sales series are evolving. The interested reader in referred to Campbell and Mankiw [10], Evans [11] and Lutkepohl and Reimers [12] for other applications of persistence analysis. Using persistence analysis. Dekimpe and Hanssens [13] measured the long-run effects of advertising on sales, and concluded that advertising does have a long-run impact on sales. They show that when sales are evolving it is possible for temporary variations in marketing variables to have a permanent effect on sales (hysteresis). Therefore, it is possible when competitive variables influence an evolving series, that temporary changes in a competitive variable will have long-run (permanent) effects. On the other hand, in stationary markets, Dekimpe et al. [8] have shown (when both market shares and competitive variables are stationary) it is very unlikely that one will observe permanent offsetting competitive effects due to temporary changes in marketing effort. This would suggest that these marketing expenditures only have a temporary effect.

Recent studies have investigated the evolution of market shares. Bronnenberg et al. [14] studied the ready-to-drink tea category and observed market shares are strongly influenced by retailer distribution decisions through the early growth stage, but this effect diminishes over time. The authors use a logically consistent model to quantify how a brand’s coupled market share and distribution evolve and to answer questions about the relative efficiency of influencing share (pull) vs seeking distribution (push). Franses et al. [15] utilize cointegration techniques to quantify the long-run effects of marketing effort. However, they are primarily concerned with aberrant observations that hamper the quality of data. In their illustrative example, they find different results for an outlier robust cointegration model as compared to non-robust methods.

Jedidi et al. [16] studied the long-run impact of advertising and promotions on brand choice and purchase quantity. They propose a utility framework, different from the models above, utilizing individual level scanner panel data rather than aggregate weekly data. Parameters in the utility function (intercept, price and promotion) are a function of long-term advertising, long-term promotions and loyalty where long-run advertising and promotions are specified as a geometric series of past advertising and promotional activities. They found a negative long-run effect on brand equity, measured by the intrinsic brand preferences of the utility function, and increasing price and price promotion sensitivity due to long-run promotions. Advertising only had a significant positive effect on brand equity. They also conducted a simulation analysis to determine the impact of changes in marketing strategies.

2.2. Modelling stationarity and long-run equilibrium using unit-root econometrics

Modern time-series methodology such as unit-root econometrics and cointegration analysis are well suited to study the issue of stationarity and long-run equilibrium in markets. First, unit root tests are used to test for the presence or absence of a unit root in the data. Once a long-run component is identified as being present in a series of interest, cointegration analysis is used to identify whether trends in variables are related to each other in the long run. The idea of using
cointegration analysis in the study of non-stationary time series comes from the work of Engle and Granger [17]. Cointegration analysis has been applied in a number of different fields, for example, to study the effects of public policy on the long-run relationship between narcotics usage and property crime [18], to measure the long-run relationship between advertising and sales [19, 20], to forecast new automobile sales [21], to forecast freight rates [22], to determine the long-run effect of marketing mix variables [9, 15]. For a detailed discussion of cointegration analysis we refer the reader to Banerjee et al. [23], Enders [24] and Harris [25].

A long-run equilibrium exists between brand sales, $S_t$, and category sales, $C_t$, if the amount $e_t$ by which the actual observations $S_t$ deviate from the equilibrium level $\beta C_t$, given the observed level $C_t$, is a stationary time series. The equilibrium error $e_t$ given by $\{S_t - \beta C_t\}$ contains useful information since the brand sales will move in a direction that satisfies the equilibrium.* In other words, if $\{S_{t-1} - \beta C_{t-1}\}$ is low, then brand sales are low relative to category sales and we might expect to see an increase in brand sales in future periods. On the other hand, if the term $\{S_{t-1} - \beta C_{t-1}\}$ is high, we might expect a decrease in brand sales in future periods. An advantage of cointegration analysis is that the extent of adjustment in a given period to deviations from the long-run equilibrium is given in the estimated equation. Several different testing procedures are available to determine the existence of long-run cointegrating relationships such as the Engle and Granger method and the multivariate extension, the Johansen method [26, 27]. Table I presents a summary of the above-mentioned literature on long-run effects of marketing mix variables on sales and share.

2.3. Objectives and contributions

The major objectives of this paper are: (1) to provide additional evidence of the frequent existence of stationary market shares for frequently purchased consumer products; (2) to demonstrate that the prior empirical evidence that a majority of sales series is in evolution is consistent with stationary market shares, if brand sales and category sales are cointegrated; and (3) to distinguish, from a strategic perspective, between market response at the primary-demand level (category sales), selective-demand level (brand sales) and relative-positive level (market share) and identify strategic scenarios depending upon their stable/evolving nature.

In dealing with the first objective, our analysis adds to the growing support for the empirical generalization that for many markets, market shares are stationary (see for example, References [5, 6]). Using data from 28 brands across eight product categories, we find that market shares either for all brands or for major brands are stationary.

As observed earlier, previous research has found that shares tend to be stationary while sales tend to be in evolution. What does this mean? This study contributes to an understanding and reconciliation of this empirical observation, analytically and empirically. Given that brand and category sales are evolving, we investigate whether these trends are related to each other. For example, is an upward (downward) trend in brand sales related to an upward (downward) trend in category sales? The trends would be related if there exists a long-run equilibrium or cointegrating relationship between brand and category sales. We demonstrate that the presence of a cointegrating relationship between brand and category sales also implies that market shares are mean stationary and hence is consistent with the above-mentioned empirical observation.

*See Reference [23] for a detailed discussion of the econometric analysis of non-stationary data.
We deal with the third objective, in a deviation from previous research by distinguishing, from a strategic perspective, between market response at the primary-demand level (category sales), selective-demand level (brand sales) and relative-position level (market share) and identifying potential scenarios depending upon their stable/evolving nature. In doing so, we extend the work of Dekimpe et al. [8], who focus only on brand and category sales. From a strategic perspective, it is useful to make a distinction between sales and market share. To illustrate, consider two scenarios, one where market shares are stationary in a category that has stationary sales and the other where market shares are stationary in a category that has evolving sales. Under the first scenario, firms are unable to improve the long-run relative and absolute positions, whereas under the second scenario the long-run absolute positions may improve even though firms are unable to...
improve their relative positions. From a managerial perspective, this distinction is important, for instance, because the long-term profitability implications of the two scenarios could be quite different. Further, category sales may be driven by exogenous factors but market shares are not and they would depend on the relative marketing activities of the firms. We illustrate the strategic scenarios using data from eight consumer product categories (ketchup, soup, toilet tissue, sugar, peanut butter, dry detergent and tuna) for which scanner data are available and provide the strategic implications of each of these scenarios. These implications underscore the importance of distinguishing between market response at the primary-demand level (category sales), selective-demand level (brand sales) and relative-position level (market share), which has not been done in prior research.

The structure of the remainder of the paper is as follows. In Section 3, we provide an overview of the strategic scenarios with respect to market shares, brand and category sales and discuss the estimation approach. In Section 4, we describe the scanner data used and provide the empirical results. Section 5 presents conclusions and offers directions for future research.

3. LONG-TERM BEHAVIOUR OF MARKET SHARES, BRAND AND CATEGORY SALES

3.1. Testing univariate equilibrium share models

When a series may be appropriately modelled as depending on a constant plus a coefficient times a lag of the series plus a random term, testing whether a series is stationary or evolving may be accomplished by means of the well-known test proposed by Dickey and Fuller [28]. When more than one lag is involved the appropriate test is the augmented Dickey–Fuller test (ADF) [23]. We use these tests in examining the stationarity of market shares, sales and category sales.

3.2. Overview of scenarios

Stationary vs evolving conditions in market shares, brand and category sales give rise to eight possible scenarios.* We consider the following scenarios: stationary market shares and stationary brand sales for all brands in a stationary category (SSS), stationary market shares and stationary brand sales for a sub-set of major brands in a stationary category (SSS), stationary market shares and evolving sales for all brands in an evolving category (SEE), stationary market shares and evolving sales for a sub-set of major brands in an evolving category (SEE), and, evolving market shares and evolving brand sales in a stationary category (EES).† We discuss these in turn:

(i) **Stationary market shares and stationary brand sales for all brands in a stationary category (SSS).** This refers to the case where all market shares are stationary as are brand and category sales. What does this mean from a strategic perspective? Stationary market shares imply that all

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*Of these eight scenarios, the following three cannot occur for logical reasons: stationary market shares and evolving brand sales of all brands in a stationary category, stationary market shares and stationary brand sales of all brands in an evolving category, evolving market shares and stationary brand sales of all brands in a stationary category.

†Another scenario is evolving market shares and evolving brand sales in an evolving category. While this scenario is potentially interesting, we do not consider it in the paper since it is not present in the data used and leave further analysis to future research.
gains and losses are short-lived. To the extent that competitive activities have an effect on market share [7], an implication of our findings is that these activities may, in general, only have a temporary effect on market share.

(ii) *Stationary market shares and stationary brand sales for a sub-set of brands in a stationary category* (SSS). Under this scenario, while a sub-set of major brands has stationary market shares, to the extent that marketing activity has an effect on shares, this scenario also implies that at least two brands are engaged in a share war with one brand gaining at the expense of another. This suggests that while marketing activity may cause temporary perturbations in market shares for the sub-set of brands with stationary shares, this may not be case for the sub-set with evolving shares, consistent with Srinivasan *et al.* [29].

(iii) *Stationary market shares and evolving brand sales in an evolving category* (SEE). This refers to a scenario where all brands have stable market share in an expanding or declining market. From a strategic perspective, this kind of behaviour can arise due to two conditions. First, the category expansion may result from macro-economic or demographic factors. Second, marketing efforts of firms may drive the observed evolution in category sales. In the former case, it is conceivable that brands do not change their marketing mix but merely ride the long-run demand waves in an industry. But what is the meaning of stationary market shares and evolving sales? If brand sales and category sales are cointegrated this also implies that the market is in long-run equilibrium. Cointegration analysis is useful in finding stationary linear combinations of category and brand sales. If such regressions exist, then this is consistent with market shares being stationary or stable. From a strategic perspective, this implies that firms are unable to improve their relative position in spite of improving their absolute long-run performance with respect to sales.

(iv) *Stationary market shares and evolving brand sales for a sub-set of major brands in an evolving category* (SEE). This scenario has marketing strategy implications that are similar to those for scenario (iii) for the sub-set of brands that has stationary market shares. This scenario also implies that at least two brands have evolving market shares, and to the extent that market shares are influenced by marketing variables, the two firms may be engaged in a long-run market share battle.

(v) *Evolving market shares and evolving brand sales in a stationary category* (EES). Under this scenario, given that the category sales are stationary, to the extent that marketing activity has an effect on shares, at least two brands are engaged in a market share battle with one brand gaining at the expense of another in the long run. This is consistent with Ehrenberg [30], ‘... in near-stationary markets, everybody has to run hard to stand still.’ A strategic implication is that competitive marketing activity may have a long-term impact on market shares for the evolving sub-set.

3.3. Assessment of market equilibrium using cointegration analysis

If the sales series and category sales series are evolving, we investigate whether trends in variables are related to each other. The trends are related to each other if there exists a long-run equilibrium or cointegrating relationship between the variables. The concept of cointegration is a powerful one since it describes the existence of an equilibrium or stationary relationship among two or more time series, each of which is individually non-stationary [23]. In other words, an equilibrium relationship would imply that, even if they diverge from each other in the short run, such deviations are stochastically bounded or diminishing over time. Marketing variables may...
We are grateful to Clive W. Granger for pointing this out to us and motivating the following discussion. For the three- and four-brand case, one can show that a similar condition requiring the market shares across brands to sum to 1 is obtained.

Although $y_{i,t}$ will have $E(y_{i,t}) = 0$ and $E(y_{i,t}, y_{i,t-1}) = 0$ for all $k \neq 0$, $E(y_{i,t}^2)$ is not time constant. Thus $S_i/C_t$ does not have time-constant second moments but is 'mean-stationary'. We are thankful to Clive W. Granger and an anonymous referee for pointing this out to us.

The existence of a long-term relationship implies that equilibrium error $e_t$ represents a stationary process. From an empirical perspective, under scenario (iii), brand sales are cointegrated with category sales and market shares are stationary. We demonstrate this scenario analytically using a two-brand case.* Let $S_1$ and $S_2$ be the sales of the two brands that are evolving or $I(1)$, and their sum, the category sales, is also $I(1)$. If $S_1$ is cointegrated with $C$, then there exists a constant $\beta_1$ such that

$$S_{1,t} = \beta_1 C_t + e_{1,t}$$

Similarly, if $S_2$ is cointegrated with $C$, then there exists a constant $\beta_2$ such that

$$S_{2,t} = \beta_2 C_t + e_{2,t}$$

As before, the existence of a long-term relationship implies that the equilibrium errors $e_{1,t}$ and $e_{2,t}$ represent stationary processes. Equations (2) and (3) can be written as

$$(1 - \beta_1)S_{1,t} - \beta_1 S_{2,t} = e_{1,t}$$

$$-\beta_2 S_{1,t} + (1 - \beta_2)S_{2,t} = e_{2,t}$$

For Equations (4) and (5) to hold, it follows that $e_{1,t} - e_{2,t}$ and $\beta_1 + \beta_2 = 1$. The latter condition is logical consistency constraint that the market shares across brands sum to 1. This is consistent with the interpretation of $\beta_1$ and $\beta_2$ as the long-run market shares of the brands.† Equations (2) and (3) can be written as

$$S_{1,t}/C_t = \beta_1 + e_{1,t}/C_t$$

$$S_{2,t}/C_t = \beta_2 + e_{2,t}/C_t$$

Hence if $e_{i,t}$ (where $i = 1, 2$) is iid, zero mean and independent of $C_t$, then $y_{i,t} = e_{i,t}/C_t$ will have $E(y_{i,t}, y_{i,t-k}) = 0$ for all $k \neq 0$ and so will look like white noise in terms of its mean properties.‡ This implies that the market shares defined by $S_{1,t}/C_t$ and $S_{2,t}/C_t$ are mean-stationary and have trending patterns in the typical two-year span of available scanner data. Cointegration models may therefore prove useful, as such models can allow for the presence of stochastic and deterministic trends in the data [15]. If a long-run equilibrium relationship holds between brand sales $S_t$ and category sales $C_t$, then they are related by an equilibrium relationship such as:

$$S_t = \beta C_t + e_t$$

$$\frac{S_{1,t}}{C_t} = \beta_1 + \frac{e_{1,t}}{C_t}$$

$$\frac{S_{2,t}}{C_t} = \beta_2 + \frac{e_{2,t}}{C_t}$$

*We are grateful to Clive W. Granger for pointing this out to us and motivating the following discussion.

†For the three- and four-brand case, one can show that a similar condition requiring the market shares across brands to sum to 1 is obtained.

‡Although $y_{i,t} = e_{i,t}/C_t$ will have $E(y_{i,t}) = 0$ and $E(y_{i,t}, y_{i,t-k}) = 0$ for all $k \neq 0$, $E(y_{i,t}^2)$ is not time constant. Thus $S_i/C_t$ does not have time-constant second moments but is 'mean-stationary'. We are thankful to Clive W. Granger and an anonymous referee for pointing this out to us.
long-run equilibrium values given by $\beta_1$ and $\beta_2$. Thus we demonstrate, analytically and empirically (in Section 4), that the prior empirical evidence that a majority of sales series is in evolution is consistent with stationary market shares, if brand sales and category sales are cointegrated.

Several different testing procedures are available to determine the existence of such long-run cointegrating relationships such as the Engle and Granger method [17] and the multivariate extension, the Johansen method [26, 27]. While the former uses an ordinary least-squares approach, the latter uses a maximum-likelihood method that tests for the number of cointegrating regressions. In this paper we will apply the Johansen maximum-likelihood estimator, which is the most widely used approach. The interested reader is referred to Maddala and Kim [31, pp. 155–197], who present an excellent review on estimation of cointegrated systems.

3.4. Vector error correction models (VECM)

Engle and Granger [17] show that the presence of a cointegrating relationship implies that the data are generated according to a partial adjustment or error-correction mechanism. The equilibrium error ensures that, after short-run deviations from the equilibrium, the system will return to its long-run equilibrium. In other words, the short-run dynamics are influenced by the deviation from the long-run relationship. These short-run dynamics are captured in the VECM. The error-correction model is obtained by adding the terms containing the lagged residuals as shown below:

$$
\begin{bmatrix}
\Delta S_{1,t} \\
\Delta S_{2,t} \\
\Delta C_t
\end{bmatrix} = 
\begin{bmatrix}
a_{10} \\
a_{20} \\
a_{30}
\end{bmatrix} + 
\begin{bmatrix}
x_{S1} & 0 & 0 \\
x_{S2} & 0 & 0 \\
x_{c} & 0 & 0
\end{bmatrix}
\begin{bmatrix}
e_{S1,t-1} \\
e_{S2,t-1} \\
e_{c,t-1}
\end{bmatrix} + 
\sum_{i=1}^{N} 
\begin{bmatrix}
b_{11} & b_{12} & b_{13} \\
b_{21} & b_{22} & b_{23} \\
b_{31} & b_{32} & b_{33}
\end{bmatrix}
\begin{bmatrix}
\Delta S_{1,t-1} \\
\Delta S_{2,t-1} \\
\Delta C_{t-1}
\end{bmatrix} + 
\begin{bmatrix}
u_{1,t} \\
u_{2,t} \\
u_{3,t}
\end{bmatrix}
$$

(8)

where $N$ is the order to the model determined using the log-likelihood criterion.* The error correction term is obtained from the cointegrating regression. The coefficients $x_{S1}$, $x_{S2}$, and $x_c$ measure the speed of adjustment of the dependent variables towards the long-run equilibrium.

To summarize, our framework consists of three major steps. First, we assess the presence of evolution versus stability in sales (or market share) by observing the behaviour of the series over time. The absence of a unit root indicates mean-reverting behaviour or stationarity. The presence of a unit root indicates that there is an evolutionary component in sales or market share. Next, if the data indicate the presence of unit roots, we investigate whether these non-stationary components are related to each other. Finally, if cointegration has been established, we test for the existence of a partial adjustment equilibrium or error-correcting behaviour. Further, we illustrate the strategic scenarios described in Section 3.2 using data from the eight consumer product categories.

*Though the likelihood-ratio test and AIC/SIC information criterion approach are equivalent, the real difference is in the significance levels, which are usually fixed at 5 per cent in hypothesis testing, and are selected automatically (typically starting at more than 10 per cent in small samples but converging to 0 for larger ones) in the information criterion approach. Loose significance levels are not necessarily the best choice in cointegration analysis and the discussion on this issue cannot be regarded as closed with a clear guideline. Model choice by residual correlation statistics (such as Ljung–Box $Q$) has often been reported to yield the poorest results.
4. DATA DESCRIPTION AND EMPIRICAL RESULTS

A.C. Nielsen household scanner panel data from two test markets in the U.S. on the purchases of ketchup, peanut butter, tuna, toilet tissue, dry detergent, soup and sugar were used to construct the time series of weekly shares, brand and category sales. In addition, we used another database for the ketchup category, that of store movement data supplied by A.C. Nielsen for the period from 1992 to 1994. The latter has a sample of 690 stores across ten regions in the US.* Of these categories, two databases, the ketchup scanner panel data and the soup scanner panel data, have also been examined by Dekimpe et al. [8]. We compare our findings with theirs later in this section.

Our database aggregates across varieties to the brand level, consistent with our focus on the maintenance of market share equilibrium at the brand level rather than at the Stock Keeping Unit (SKU) level.† However, this causes some loss of information due to possible underlying heterogeneity among varieties. Thus, the competitive interaction effects may be subjected to aggregation bias [32, 33]. To control for this bias, we performed pooling tests to determine whether we can pool the different varieties for a brand. Over 90 per cent of the varieties could be pooled consistent with Link [34], who recommends using data within homogeneous sub-sets to overcome the bias issue. Market share of a brand is calculated as the share of the pooled unit sales of the brand. In all categories, we consider the major brands and aggregated all brands other than the major brands into one figure referred to as Rest in all the categories. This resulted in a total of 28 brands in the eight databases that we analyse. Each time series consists of 104 weekly observations. We provide a brief description of the brands considered in each category in Table II. We discuss the results for each one of the five scenarios in turn.

(i) Stationary market shares and stationary brand sales in a stationary category (SSS). We find this case holds for two categories—ketchup and soup. We describe the results for each of these categories in turn. We conducted the unit root test; the results in Table II show that market shares of all brands are stationary while the brand sales of all brands as well as category sales are stationary.‡ Therefore, the ketchup market is consistent with stationarity or with the existence of a long-run equilibrium.

Next, we examine the soup category. We control for seasonal effects in sales by using the seasonal equivalent of Equation (5) for the ADF test (see Reference [5]).§ Our results summarized in Table II show that market shares of Campbell brand and Rest are stationary as are brand sales and category sales. Thus the soup category is consistent with stationarity. Therefore, we find that in the long run the relative position of the players is unaffected by the marketing mix activity and all gains and losses are temporary, consistent with Lal and Padmanabhan [6].

We should point out that these ketchup category results are consistent with those obtained by Dekimpe et al. [8] using the same data source. We extend their analysis by examining market

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*The use of different samples for the two databases on ketchup causes us to classify the two into different scenarios and we shall return to this issue shortly.

†Retailers typically assign each product a SKU (similar to the universal product code (UPC)) and use it as a unique identifier for their products to help track sales, etc.

‡We start by including 12 lags, determine the greatest lag with a significant t-value and re-test using this number of lags.

§A constant is included and we test for trends and seasonality in the data.

A. constant is included and we test for trends and seasonality in the data.

§Seasonality can cause non-stationarity and persistent effects (see for example, Reference [35]). Controlling for seasonality, we find that the series is stationary.
Table II. Classification of Scenarios*

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Market share</th>
<th>Brand sales</th>
<th>Category sales</th>
<th>Market share ADF range and significance level</th>
<th>Empirical observation: category, (year), brands</th>
<th>Strategic implications</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(all)</td>
<td>(all)</td>
<td>(all)</td>
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</tr>
<tr>
<td>II: SSS</td>
<td>Stationary</td>
<td>Stationary</td>
<td>Stationary</td>
<td>−4.19 to −6.67&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3. <em>Toilet tissue</em> (1985–1987) Northern and Rest</td>
<td>All gains and losses are temporary for the major brand sub-set</td>
</tr>
<tr>
<td></td>
<td>(major brand sub-set)</td>
<td>(major brand sub-set)</td>
<td>(all)</td>
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<tr>
<td>IV: SEE</td>
<td>Stationary</td>
<td>Evolving</td>
<td>Evolving</td>
<td>−3.32 to −5.67&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7. <em>Dry detergent</em> (1986–1988) Cheer and Oxydol</td>
<td>Same as case (iii) for the stationary sub-set</td>
</tr>
<tr>
<td></td>
<td>(major brand sub-set)</td>
<td>(major brand sub-set)</td>
<td>(all)</td>
<td></td>
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</tr>
<tr>
<td>V: EES</td>
<td>Evolving</td>
<td>Evolving</td>
<td>Stationary</td>
<td>None are significant</td>
<td>8. <em>Tuna</em> (1985–1987) Chicken of Sea, Star Kist, Rest</td>
<td>Marketing activity may improve relative as well as absolute position of some of the brands</td>
</tr>
<tr>
<td></td>
<td>(all)</td>
<td>(all)</td>
<td>(all)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


<sup>b</sup>Denotes significance at the 1 per cent level.

<sup>c</sup>Denotes significance at the 5 per cent level.
shares, in addition to brand and category sales. In a divergence from their results, we find that the soup market is stationary, whereas they found evidence of evolution in sales. One possible explanation is that we control for seasonality. As they point out, more work is needed to enhance the power of unit root tests as it is sometimes difficult to classify a series as being stationary or evolving with a low persistence level.

(ii) **Stationary market shares and stationary brand sales for a sub-set of major brands in a stationary category (SSS).** We find this to be valid in one category—toilet tissue. The unit root test results summarized in Table II show that the market shares of Northern and Rest are stationary, while the market shares of Charmin and Cottonelle are evolving. Further, the sales of Northern and Rest brands are stationary, while those of Charmin and Cottonelle are evolving. Category sales are stationary. Therefore, a sub-market consisting of two major brands has stationary market shares. From a strategic perspective, to the extent that marketing activity has an effect on shares, this scenario implies that at least two brands may be engaged in a share war with one brand gaining at the expense of another. These brands are Charmin and Cottonelle in the toilet tissue category. Thus, while marketing activity causes temporary perturbations in market shares for the sub-set of brands with stationary shares, this may not be the case for the sub-set with evolving shares [29].

(iii) **Stationary market shares and evolving brand sales in an evolving category (SEE).** This case refers to a situation where market shares are stationary, or in long-run equilibrium, even though brand and category sales are evolving. We find this condition to hold in three categories—ketchup, sugar and peanut butter. Unit root test results, which are summarized in Table II, show that market shares of all brands are stationary. The sales of the brands—Heinz, Hunts, Del Monte and Rest—are evolving. Next, we examine the category sales. Our test results show that category sales are also evolving. In this case, we proceed to examine whether there is a cointegrating relationship between each of the brand and category sales.

Cointegration analysis is performed on four variables: sales of Heinz, Hunts, Del Monte and category sales. First, we need to determine the number of lags to include in the cointegration relation. We use the Johansen and Juselius estimation method [27]. The PCFiml software is used for estimation purposes [36]. This method determines the cointegration rank, the number of significant cointegrating vectors and the associated vectors with the long-run parameters. Several different test procedures exist to determine the cointegration rank, with the most widely used being the trace test and the eigenvalue test (see References [26, 27]).

The Johansen FIML test indicated the presence of three cointegrating relationships among the variables. The results of this analysis are provided in Table III.

<table>
<thead>
<tr>
<th>Likelihood ratio</th>
<th>5 Per cent critical value</th>
<th>( \lambda_{\text{crit,0.95}} )</th>
<th>Hypothesized No. of CE(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \lambda_{\text{trace}} )</td>
<td>( \lambda_{\text{crit,0.95}} )</td>
<td>( \lambda_{\text{trace}} ) &gt; ( \lambda_{\text{crit,0.95}} )</td>
<td></td>
</tr>
<tr>
<td>87.34</td>
<td>39.89</td>
<td>Yes</td>
<td>None*</td>
</tr>
<tr>
<td>47.51</td>
<td>24.31</td>
<td>Yes</td>
<td>At most 1*</td>
</tr>
<tr>
<td>21.67</td>
<td>12.53</td>
<td>Yes</td>
<td>At most 2*</td>
</tr>
<tr>
<td>0.91</td>
<td>3.84</td>
<td>No</td>
<td>At most 3</td>
</tr>
</tbody>
</table>

*denotes rejection of the hypothesis at 5 per cent significance level.
Table IV. Long-run equilibrium relationship between brand sales and category sales.

<table>
<thead>
<tr>
<th>Variable</th>
<th>( S_{\text{Heinz}} )</th>
<th>( S_{\text{Hunts}} )</th>
<th>( S_{\text{Del Monte}} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.607(^b)</td>
<td>0.126(^b)</td>
<td>0.056(^b)</td>
</tr>
<tr>
<td>(0.005)</td>
<td>(0.0028)</td>
<td>(0.0014)</td>
<td></td>
</tr>
<tr>
<td>ADF statistic</td>
<td>-7.15</td>
<td>-4.88</td>
<td>-6.59</td>
</tr>
<tr>
<td>Critical value</td>
<td>-2.76</td>
<td>-2.76</td>
<td>-2.76</td>
</tr>
<tr>
<td>Cointegration</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

\(^a\)The standard error of the estimate is included in parenthesis. The critical value (at 5 per cent level) for unit root tests obtained from Philips and Oularis [38].
\(^b\)Significant at \( p < 0.01 \).

We find that there are three significant cointegrating vectors. The first cointegrating vector shows the long-run relationship between Heinz sales and category sales, the second one the long-run relationship between Hunts sales and category sales and the third the relationship between Del Monte sales and category sales. The results reported are the so-called restricted long-run relationships. Following Doornik and Hendry [37], we first estimated the unrestricted relationship and next tested for restriction using log-likelihood ratio tests. Based on this analysis, we concluded that sales of Heinz is only significant in the first long-run relationship and was constrained to zero in the other long-run relationships. Similarly, we concluded that sales of Hunts (Del Monte) is only significant in the second (third) long-run relationship and was constrained to zero in the other long-run relationships. The cointegrating vectors are reported in Table IV.

As described in the previous section, the concept of cointegration allows us to describe the existence of an equilibrium relationship between two series, each of which is non-stationary. The intuition is that non-stationary movements in category sales remove non-stationary movements in brand sales, so that only transitory components are left in the residuals.

We test for the condition that \( e_{i,t} \), the residuals from each of the cointegrating regressions, as in Equations (2) and (3), are iid, zero mean and independent of \( C_t \). As pointed out in Section 3.2, this will then imply that \( y_{i,t} = e_{i,t}/C_t \) will have \( E(y_{i,t}y_{i,-k}) = 0 \) for all \( k \neq 0 \) and so will look like white noise in terms of its mean properties. Johansen’s FIML test has provided the cointegrating vectors and has established the stationarity of the residuals of the cointegrating regressions. Nevertheless, we run one more test proposed by Philips and Oularis [37] to confirm that the residuals from the cointegrating regression are white noise (in Table IV). Further, we test for independence between \( e_{i,t} \) and \( C_t \). In all three cases, we find that the residuals are white-noise processes and independent of \( C_t \). Therefore, the interpretation of the coefficients is that the long-run market share of Heinz is 60.7 percent, the long-run market share of Hunts is 12.6 percent and the long-run market share of Del Monte is 5.5 percent; all are significant at the 1 percent level, and the long-run market shares are mean-stationary. While each of the brand and category sales may move up or down, a long-run equilibrium exists, towards which the market adjusts.

In Johansen’s method, the cointegrating regression is estimated jointly with the error correction model. As pointed out earlier, the idea is that a portion of the disequilibrium from one period to the next is corrected in the next period. The output from the estimation of the error-correction model is shown in Table V.
Table V. Results of the VECM for the ketchup category.

<table>
<thead>
<tr>
<th>Variable</th>
<th>$\Delta S_{\text{Heinz}}$</th>
<th>$\Delta S_{\text{Hunts}}$</th>
<th>$\Delta S_{\text{Del Monte}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta C (-1)$</td>
<td>-0.646$^b$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.208)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta S_{\text{Heinz}} (-1)$</td>
<td>0.584$^c$</td>
<td>-0.013$^d$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.264)</td>
<td>(0.007)</td>
<td></td>
</tr>
<tr>
<td>$\Delta S_{\text{Hunts}} (-1)$</td>
<td></td>
<td>0.138</td>
<td>-0.199$^b$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.124)</td>
<td>(0.085)</td>
</tr>
<tr>
<td>$\Delta S_{\text{Del Monte}} (-1)$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ES$_{\text{Heinz}} (-1)$</td>
<td>-1.257$^b$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.283)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ES$_{\text{Hunts}} (-1)$</td>
<td></td>
<td>-0.188$^b$</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.070)</td>
<td></td>
</tr>
<tr>
<td>ES$_{\text{Del Monte}} (-1)$</td>
<td></td>
<td></td>
<td>-0.395$^b$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.097)</td>
</tr>
</tbody>
</table>

$^a$The standard error of the estimate is included in parenthesis.

$^b$Significant at $p < 0.01$, $^c$Significant at $p < 0.05$ and $^d$Significant at $p < 0.10$.

The sign — indicates the row variables is assumed to have no effect on the dependent variable in the corresponding column. (-1) denotes the one-period lag. The number of lags is determined using the log-likelihood criterion.

We estimated the system of equations specified in (8) using full information maximum likelihood. Following Dekimpe and Hanssens [9], we only include parameter estimates, which have a $t$-value greater than one. Insignificant parameters are deleted step-wise, first deleting the parameter with the lowest $t$-value and next re-estimating the equation, deleting the parameter with the next lowest $t$-value and so on.

In the case of three major brands, Heinz, Hunts and Del Monte, the coefficients of the error-correction terms are negative as expected and significant at the 1 percent level with magnitudes of $-1.25$, $-0.18$ and $-0.395$, respectively. As mentioned earlier, an interpretation of these coefficients is that they reflect the speed of adjustment of the corresponding dependent variable towards the equilibrium. Thus, it is worth noting that Heinz, the market leader in terms of market share, has the fastest speed of adjustment towards equilibrium while Hunts, the market follower, is the slowest in terms of speed of adjustment. Del Monte, the market challenger, adjusts faster than Hunts to equilibrium, suggesting that Del Monte is aggressively defending its share. The results are consistent with the two goals of marketing as stated by Bass et al. [39], ‘One purpose of marketing activity is to make behaviour non-stationary in a direction that is favourable to a brand. Another purpose is to prevent behaviour from becoming non-stationary in a direction which is not favourable to a brand’.

One difference we observe in the ketchup category results across the two different data sets is that, for the period from 1986 to 1988, market shares are stationary, and sales of all major brands and category sales are stationary, while in the data set for the period from 1992 to 1994, market shares are stationary but sales of all major brands and category sales are evolving. One possible explanation for this is the difference between the two samples. The sample from 1986 to 1988 uses weekly household scanner data on two test markets in the U.S., whereas the sample from 1992 to 1994 uses store movement data from 690 stores across 10 regions in the U.S.
consistency in the results with respect to the variables that are the focus of this paper: market shares of major brands are stationary in both samples. This is an important point since category sales may be driven by exogenous factors, hence regional differences matter, but market shares are not and may depend only on the relative marketing activities of the firms.

For the sugar category, unit root tests indicate that the market shares of C&H brand and Rest are stationary while the sales of C&H as well as the brand sales of Rest are evolving as are category sales. For the peanut butter category, these tests indicate that market shares of Jiff, Skippy, Peter Pan and Rest are stationary, while brand and category sales are evolving. Cointegration analysis and error-correction modelling for the sugar and peanut butter categories reveal that these markets are also consistent with the existence of long-run equilibrium.* Dekimpe and Hanssens [5] found that 78 per cent of the market share series they studied were stationary, but that 68 per cent of the sales series were evolving. Our findings reconcile these results.

(iv) Stationary market shares and evolving brand sales for a sub-set of major brands in an evolving category (SEE). The dry detergent category is an exemplar for this scenario. We consider five major brands—Surf, Tide, Cheer, Oxydol and Rest. Unit root tests summarized in Table II show that market shares of Cheer and Oxydol are stationary, while those of Surf, Tide and Rest are evolving. The sales of the brands Surf, Cheer, Oxydol and Rest are evolving while Tide sales are stationary. The test indicates that category sales are also evolving. Next, we examine the presence of a cointegrating relationship between the brand sales of Cheer and Oxydol and category sales by performing the regressions of brand sales with category sales. We find that a sub-set of the market consisting of the major brands Cheer and Oxydol is in long-run equilibrium, while the sub-set consisting of Tide, Surf and Rest is evolving. In contrast, the Tide brand has stationary sales and a non-stationary market share in a category that is evolving downward and this suggests that Tide is gaining ground relative to competitors. These cases are of interest. The question of the long-run relationship between the shares and marketing activity of the brands is beyond the scope of this paper and we postpone this analysis to further research (see for example, Reference [29]).

(v) Evolving market shares and evolving brand sales in a stationary category (EES). The brands considered in the tuna category are Chicken-of-Sea, Starkist and Rest. The test results summarized in Table II indicate that brand market shares and brand sales are evolving, while category sales are stationary. Since all the market shares are evolving and sum to 1, this implies that the cointegrating rank using the Johansen method is 1 with the long-run equilibrium relationship between the brands having the coefficients (1, 1, 1). Therefore, from a strategic perspective, marketing activity may improve the relative position (share) as well as the absolute position of some brands under this scenario.

5. CONCLUSIONS AND FUTURE RESEARCH

The major focus and contribution of this paper has been to study the long-run equilibrium in market shares. We accomplish three objectives in this paper. First, our analysis adds to the growing support for the empirical generalization that for many markets, market shares are

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*The empirical estimates from cointegration analysis and error correction models for the categories, sugar, peanut butter and detergent are available with the authors and are not reported here in the interest of space.
stationary and in long-run equilibrium. Using data from 28 brands across eight product categories, we find that market shares either for all brands or for major brands are stationary. Dekimpe and Hanssens [5], using a database of over 400 prior studies, found that 78 per cent of the market share series they studied were stationary, but that 68 per cent of the sales series were evolving. Our findings reconcile these results. While each of the brand and category sales may move up or down, there exists a long-run equilibrium towards which the market adjusts. A major contribution of this paper is its demonstration, empirically and analytically, that the prior empirical evidence that a majority of sales is in evolution is consistent with stationary market shares, if brand and category sales are cointegrated. To the extent that competitive activities have an effect on market share [7], an implication of our findings is that these activities may, in general, only have a temporary effect on market share.

From a strategic perspective, we distinguish between market response at the primary demand level (category sales), selective demand level (brand sales) and relative position level (market share) and identify strategic scenarios depending upon their stable/evolving nature. In doing so, we extend the work of Dekimpe et al. [8], who focus only on brand and category sales. The study of market shares is important for several reasons. Among them, category and brand sales may be driven by exogenous factors, while market shares depend mostly on the relative marketing activity of firms. Further, the managerial implications are different; for example, consider the implications of scenarios (i) and (iii) outlined in Section 3.2. Under the former, firms are unable to improve the long-run relative and absolute positions whereas under the latter scenario the long-run absolute positions may improve even though firms are unable to improve their relative positions. From a managerial perspective, this distinction is important; for instance, the long-term profitability implications of the two scenarios could be quite different.

Our results indicate that promotions and other marketing activities are unlikely to increase share in the long run. Recently, Mela et al. [40] examined the long-term effects of promotion and advertising on consumer sensitivities to price and promotion and found that although these variables do influence consumer sensitivities, they do not influence long-term market share, a result that is entirely consistent with the existence of long-run equilibrium.

There exists the potential to disturb equilibrium through new products and product improvements and, from a managerial perspective, the most fruitful approach for obtaining share gains would appear to be an emphasis on such activities. A recent study reported by James Findlay of Information Resources Inc. [44] indicates that of 240 product categories with thousands of brands scanned in 1992 and 1993, only 164 brands increased share by more than three share points; of those 164 brands, 80 per cent were associated with new product initiatives of one sort or another.

An additional area of managerial exploration associated with stationary markets is that of possible reduced promotional spending. Ehrenberg et al. [4] have studied the after-effects of price-related consumer promotions across many different brands and product categories. They assessed four aspects of possible after-effects of promotional sales peaks, including before-to-after sales and before-to-after repeat buying. They concluded that consumer promotions for established brands have no noticeable effect on subsequent sales or brand loyalty. Further, they suggest that management implications point towards reduced rather than increased spending on price-related promotions. However, not very much is known about equilibrium spending levels that are required to maintain equilibrium shares. Unilateral reductions would seem to be risky but worth exploring. Procter and Gamble recently experimented with reductions in consumer and trade promotions [42, 43] with mixed results. A fruitful area of future research is to examine the role of competitive marketing variables in maintaining market share equilibrium.
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