**Making Sense of Common Dirichlet Deviations**

**1. Introduction**

Managers concerned with setting strategic objectives in consumer packaged goods (CPG) categories must first consider how consumer choice behaviour defines competitive market structure. Is a brand growing because it has reached more buyers, or because its customer base is becoming more loyal? Which competing brands pose more (or less) of a threat? Since market share is most frequently a zero sum measure it is important for managers to understand brand performance in its competitive context (Franses, Srinivasan & Boswijk, 2001) because the underlying metrics of buyer behaviour (purchase frequency, penetration, switching, distribution of heavy and light buyers by brand) can only be improved at the expense of competitors.

One model that has been extensively adopted in industry (Kennedy & McColl, 2012; Sharp 2010) is the NBD-Dirichlet (Goodhardt, Ehrenberg & Chatfield 1984), because (a) it closely describes how consumers buy and brands compete (Ehrenberg, Uncles & Goodhardt, 2004) and (b) because it is parsimonious, depending on just a handful of theoretical assumptions concerning the distribution of brand purchase probabilities (Ehrenberg & Sharp, 2000), and (c) because its output then incorporates many well-established empirical generalisations in repeat-buying across competing brands. These norms include the laws of Double Jeopardy, Natural Monopoly and Duplication of Purchase, and the invariant patterns of consumer heterogeneity (Ehrenberg, Barnard & Sharp, 2000).

Dirichlet modelling is descriptive, not prescriptive. It seeks to uncover the main effects in observed data, rather than to obtain a best fit. Its main use is to benchmark observed outcomes against what would be expected to happen in theory, in order to evaluate past performance, set realistic brand performance objectives, and develop insights in behavioural loyalty. Since most brand performance measures are about normal most of the time, when a deviation is observed it is not a call to reject the fitting, but rather to investigate *why* such a variance occurred. Indeed one of the main benefits of any Dirichlet fitting is the framework it provides from which to develop useful managerial insight.

Over time, and as a result of the model’s wide generalisation, a number of regular deviations have been repeatedly documented between expected and observed performance metrics. Some, such as an excess loyalty described for many high share brands (e.g. Fader and Schmittlein, 1993; Pare & Dawes, 2012) have attracted much attention; others such as the Erosion of Repeat Purchase Loyalty (East and Hammond, 1996) are rather less well known. This paper reviews the incidence, extent and nature of these consistently recurring deviations, using evidence from a single, extensive database, and so although the deviations reported here are not new findings in themselves, the value in summarising them in this way is threefold.

First, as Ehrenberg *et al.,* (2004) suggested, users of a Dirichlet model need to know about the range of deviations that they may routinely encounter, in order to correctly interpret unusual but not unknown aspects of market structure. We therefore provide a summary of the most common deviations, demonstrate how they can contribute to a better understanding of buyer choice behaviour in the context of the general model, and discuss the implications for strategic brand management. Second, many prior studies have tended to concentrate on one or two deviations in isolation, but because these may arise from the same breach of the theoretical assumptions, or produce complementary effects on two or more metrics, or share managerial significance, it is now valuable to discuss the main deviations together in order to understand any relationships between them. Third, the existence of a set of systematic deviations, some of which have taken on the characteristics of empirical generalisations in the literature, prompts a discussion of Dirichlet theory and the case for model adaptation.

The paper proceeds as follows. First, the NBD-Dirichlet is described and the deviations literature summarised to define the questions addressed. We next present the dataset and define the standard metrics used in the analysis along with an overview of the fitting procedure. The deviations are then empirically presented and discussed in detail, and the paper concludes with the summary and a discussion of the implications for managers, for marketing strategy and for theory development.

**2. Background**

*2.1 The NBD-Dirichlet model*

The NBD-Dirichlet model, usually just called the Dirichlet (Goodhardt, Ehrenberg & Chatfield 1984) describes the patterns of choice by buyers – how many buy at all, how often they buy and what else they buy in a fixed time period. The model broadly assumes that consumers choose from a small portfolio of the available options (split loyalty), with (1) on-going fixed propensities to choose any one item (e.g. brand X six times out of ten). Consumers differ in the rate at which they buy the category, and (2) propensities differ greatly from consumer to consumer and (3) are independent of incidence of brand choice. The NBD-Dirichlet is specified for (4) non-partitioned and (5) stationary markets, i.e. there are no subgroups in the population with different overall preferences and market size and brand shares are not changing. The model combines these five assumptions in two probability density functions, the Negative Binomial Distribution (NBD) for purchase incidence and the Dirichlet Multinomial Distribution (Dirichlet) for brand choice, to model simultaneously the number of purchases for each competing brand in a category in a fixed time.

The Dirichlet output reproduces many of the discipline’s most important empirical generalisations in consumer behaviour, such as the fundamental pattern of Double Jeopardy (Ehrenberg, Goodhardt & Barwise 1990), from a single model fitting. It has been consistently observed that in split loyal markets small brands suffer twice (hence Double Jeopardy); fewer people buy them than the more popular alternatives, and those that do, like them less and buy them a little less often. In these markets, the relationship between buyer numbers (penetration) and behavioural loyalty (e.g. purchase frequency) for all rival brands is mathematically predictable, but more surprising, the biggest difference between big and small brands is in the number of buyers they attract, and not the loyalty they earn, which varies little. The Law of Double Jeopardy thus defines “normal” buying in the category for a brand of any size. The pre-eminent effect of penetration on brand performance also underpins most other established behavioural regularities, including the Duplication of Purchase Law (Dawes, 2016; Ehrenberg & Goodhardt, 1970). This states that the customer base of any brand buys other brands in the category predictably, in line with each rival’s penetration, rather than with any perceived brand differentiation (Romaniuk, Sharp & Ehrenberg, 2007).

On the face of it, these behavioural norms and the Dirichlet assumptions could be quickly rejected by practitioners as unrealistic and restrictive; and yet the model and the laws continue to predict the aggregate patterns of observed choice behaviour closely for frequently bought categories in grocery and other “repertoire” markets (Scriven and Goodhardt, 2012), as well as for less frequently bought product in subscription markets (Sharp, Wright, and Goodhardt 2002). Dirichlet assumptions would be breached for example by any brand differentiation strategy that led to an effective segmentation of the market. Yet it has been repeatedly shown that not only do user profiles hardly differ between competing brands (Kennedy & Ehrenberg, 2001; Uncles *et al.,* 2012) but that those profiles also remain broadly stable even over consecutive years of continuous marketing spend (Anesbury, Winchester & Kennedy, 2017).

The Dirichlet is probably therefore one of the most highly generalised models in marketing; the validity of its outputs has been continuously and systematically tested through replications in many sets of data, by different researchers, under varied conditions, using multiple methods over almost thirty-five years. In that time although the range of marketing tactics available to practitioners on both client and agency side has changed almost beyond recognition, and market opportunities expanded in line, yet the fundamentals of consumer behaviour have remained the same, so that the model continues to find uses in benchmarking and describing choice behaviour in new, unfamiliar and uncertain situations.

*2.2 Building theory with Dirichlet deviations*

For marketing scientists, recurring deviations from Dirichlet norms in many sets of data lead to new empirical generalisations, to build underlying theory. Marketers are concerned with disrupting equilibrium, and although theDirichlet is not a dynamic model – it does not forecast change - in the steady state it can usefully predict period-to-period repeat purchase rates, how metrics differ from brand to brand as they evolve in longer (or shorter) time periods, and how those metrics would be expected to change in cases of growth or decline. Recently for example, Dawes (2016), McCabe *et al.* (2012) and Riebe *et al.* (2014) have successfully fitted model output to the observed buying metrics of dynamic brands, benchmarking those changes against the expected Double Jeopardy relationship, and confirming how increases in brand share (persistent and temporary) are explained by far greater movements in penetration than in purchase frequency.

The Dirichlet can provide answers to common managerial questions across the marketing mix, benchmarking what competitive structure might look like following an intervention. For example, Lomax and McWilliam (2001) applied Dirichlet benchmarks to evaluate the cannibalisation of a parent brand from line extensions, through deviations from expected Duplication of Purchase norms; Uncles & Kwok, (2008) described retail-type patronage across eight major cities in China and found existing choice distributions to barely deviate from Dirichlet predictions. Nelson-Field, Riebe & Sharp, (2012) used deviations from Dirichlet benchmarks to demonstrate how the quality of reach available through social media contained disproportionately few of the non-buyers needed to expand penetration.

Analysis of Dirichlet deviations has strengthened understanding of heterogeneous repeat-buying behaviour in a brand’s customer base. Romaniuk and Wight (2015) used repeat-purchase norms to demonstrate the surprising transience of a brand’s heavy buyers. They found that from one year to the next, although the sales contribution from this valuable heavy-buying *class* remained stable, around 50% of heavy buying households identified in year one could not be classed as heavy buyers in year two. Such apparently unstable behaviour, identified in the NBD literature as a regression to the mean effect (Goodhardt & Ehrenberg, 1967; Morrison, 1969), poses fundamental questions about managerial strategies that target buyer groups on the basis of their behaviour in a single period.

Understanding the sales importance of heavy buyers is critical, but since brand share growth depends on expanding the entire customer base it is useful to identify something of the current behaviour of a brand’s prospective customers. Trinh, Romaniuk & Tanusondjaja (2016) used the Dirichlet to explore the past and current behaviour of new brand buyers. Deviations from expected patterns revealed them typically to be heavy category buyers who bought the new brands rather more lightly than predicted.

Documenting deviations from the expected behavioural response continues to uncover managerially significant findings, but a further stream of research investigates the correspondence between the mental structure of brand associations held by consumers and their past and future buying behaviour, suggesting further uses for the model. For example, Wright, Sharp and Sharp (2002) calibrated a Dirichlet from survey data using purchase intention probabilities collected from the Juster Scale and successfully validated the outcomes; Ludwichowska *et al.,* (2017) found that systematic over-estimates in self-reported survey measures of category purchase frequency could be successfully corrected across different buyer types using NBD norms.

Much marketing literature has proposed that attitude precedes behaviour, but Dirichlet analysis of the evidence suggests the reverse. Romaniuk & Nenycz-Thiel (2013) and Stocchi (2014) report a positive relationship between past behavioural loyalty and strength of brand association response, and Stocchi *et al.,* (2015) then found that the Dirichlet models brand memory structures well, but importantly, that deviations from the “mental” model rarely correspond with behavioural deviations. In other words, a behavioural “niching” performance, in which a brand shows a higher loyalty than Double Jeopardy predicts, is not generally matched by a “mental” niching response, implying that if there is little relationship at all in these deviations, one is highly unlikely to depend on the other. The pre-eminent driver of brand knowledge is prior experience.

All deviations (except random error) represent some sort of breakdown in the underlying assumptions of the model, and so it is an important feature of the Dirichlet that in cases where a deviation is observed, managerial insight can be derived using theory as a starting point. But with such a parsimonious zero-order model it must also be expected that there will be deviations between observed and theoretical values, even in near-steady state markets. A set of deviations has been commonly observed that affect some individual, or groups of individual, brands, and yet ***do not*** disrupt stability in brand performance. These occur in the predicted Double Jeopardy relationship between penetration and purchase frequency, are common, but not universal, and must therefore be taken into account by Dirichlet analysts when comparing observed and theoretical metrics.

*2.3 Known Double Jeopardy Deviations*

Since the publication of the model in 1984, five such Double Jeopardy deviations have been repeatedly recorded, in which the observed metrics for individual brands are at variance with Dirichlet predictions for brands of that size. Kahn, Kalwani and Morrison, (1988) inferred a brand to be positioned as either *niching* or *change of pace* if its purchase frequency deviated from its Double Jeopardy norm by more than 10%. They considered only 18 brands in four CPG categories but found deviations in ten, five niching and five change of pace. Later, Bhattacharya (1997) used the Share of Category Requirement metric in a much larger dataset (34 categories and 372 brands) to find that around a quarter of selected brands showed a niching deviation and around a third a change of pace characteristic. The motivation for both studies was in part to ascertain if marketing mix variables might be managed to deliver a far higher purchase frequency than penetration dictates under Double Jeopardy, but neither found a consistent explanation for either deviation.

Bhattacharya suggested that deviations from the Dirichlet should not therefore be considered as “good or bad”, but once identified, should warrant further managerial investigation as to their likely cause (p.433). For example, niching performance may be caused not by excess loyalty but by restricted penetration, as in the case of Private Labels (Dawes & Nenycz-Thiel, 2013; Uncles & Ellis, 1989) or of regional brands (Ehrenberg *et al.,* 2004). Conversely, a change of pace performance may result from seasonal demand i.e. for soups or Easter eggs, which are bought by many people but not consistently across a year (Uncles *et al.,* 1994).

*Excess Loyalty for High Share Brands:* Fader and Schmittlein (1993) examined the extent to which leading brands benefit from Double Jeopardy, and found that in 75% of cases (from a sample of 67 categories in the USA and Japan) there was a loyalty premium beyond the Dirichlet prediction. They suggested that this deviation resulted from a breach of the non-partitioning assumption (if a single Dirichlet distribution does not fully capture the household heterogeneity in the entire market), or perhaps segmentation caused by a wider availability for leading brands. Jung, Gruca & Rego (2010) replicated that study and found a rather lower incidence of excess loyalty for high share brands (49%) but in a far larger sample of categories (422 *vs* 28 US categories across three retail sectors). Pare & Dawes (2012) further extended the result in 20 UK product categories to find excess loyalty for 38% of high share brands (in this case both leaders and challengers) that was persistent over multiple years. Excess loyalty and niching deviations do not disrupt market structure by driving up market shares. The observed and predicted metrics describe the same brand sales outcome, but get there by different routes, and so “excess loyalty” may equally be a symptom of “too few” buyers (for some reason). In addition, because the deviation is far from universal, there is still little to suggest a causal relationship between excess loyalty and leading share, but neither is there a single explanation of why they so frequently go together.

*Deficit Loyalty for Low Share Brands:* In the context of a zero-order model the change of pace deviation might simply suggest variety-seeking behaviour towards a few brands in a category (Khan *et al.,* 1988) but Li *et al.,* (2009) proposed that there may be a systematic error in the Dirichlet loyalty estimation. By fitting polarisation statistics in 24 CPG categories they derived a rather steeper Double Jeopardy line than the Dirichlet predicted, therefore accounting for some excess and deficit loyalty. More recently however, Franke, Bennett & Graham, (2017) in a study excluding Private Labels, found that only six out of ten small brands showed deficit loyalty, while two in ten small brands were niching. On further investigation, the niching brands were identified as functionally partitioned (i.e. not direct substitutes in their categories, for example soya-based and premium ice creams or sugared and diet carbonates).

*Category partitioning:* Brands that share a functional difference commonly cluster to compete more or less intensely in partitions, and often show similar Double Jeopardy variances. For example, Cohen *et al.,* (2012) used a Duplication of Purchase analysis to show the Australian wine market is not segmented into red and white drinkers, but is a single category with functional price partitions, for example between cheaper cask wines and named varieties.

In summary, the Dirichlet is a parsimonious model describing a comprehensive set of observed buying metrics. Developed for stationary CPG categories, its use has now generalised to describe physical and mental market structures in B2B and B2C contexts. Dirichlet analysis involves evaluating deviations between theoretical norms and observed measures; it is therefore desirable to understand the five commonly recurring Double Jeopardy deviations rather better, because they form the context against which individual brand performance must be understood. Niching and excess loyalty have unsurprisingly attracted much discussion, but rather less attention has been paid to the change of pace deviations, and few investigations have considered all five Double Jeopardy deviations in one dataset to determine their relative prevalence and scale. The first objective of this study is therefore:

**To describe the scope, scale and incidence of the five Double Jeopardy loyalty deviations in many sets of NBD-Dirichlet applications.**

*2.4 Systematic Dirichlet Deviations*

Unlike the five Double Jeopardy deviations, a second type of deviation is known to occur systematically, affecting the performance metrics for all competing brands in every fitting. These systematic deviations are:

* The under prediction of sole-brand loyalty
* The under prediction of average purchase frequency of sole brand buyers
* The over prediction of period to period repeat purchase
* The erosion of repeat purchase loyalty

Ehrenberg *et al.,* (2004, p.1312) in discussing discrepancies in Dirichlet fittings, drew attention to the variance discrepancy (a shortage of very heavy category buyers against prediction) and a flatter than expected distribution of purchase heterogeneity, both well-known characteristics of the NBD. Earlier discussion of these NBD variances (e.g. Ehrenberg, 1988; Morrison & Schmittlein, 1988), concluded that while they most probably arose through non-stationarity they remained managerially insignificant in short run observations. Since the distribution of heterogeneous category purchase rates in the Dirichlet model is estimated using the NBD, similar types of deviation may result, but would then be distributed across every brand-buying metric reported.

*How stationary is stationary?* There is now copious evidence that established categories of CPG brands remain in near-equilibrium over time, with little persistent trend in market share (Bass & Pilon, 1980; Dekimpe & Hanssens, 2000). Trinh and Anesbury, (2015) found that most categories remain near-stationary even over five years, identifying changes in market share in excess of 3 points up or down for only 14% of brands. Dawes, Mayer-Waarden & Driesener (2015) examined loyalty measures (switching, SCR and average repertoire size) in 26 UK and US categories in periods ranging between six and thirteen years and found very little evidence for declining (or, for that matter, increasing) behavioural loyalty.

The Dirichlet is specified for no-trend conditions. Although Ehrenberg never claimed that the world was truly stationary in a strict econometric sense, he acknowledged it to be *near-stationary*, a situation where brand shares move *“a few points up or down”* (1988, p.12), but rarely persistently. Nevertheless, the Dirichlet is strictly zero-order, and assumes fixed propensities of incidence and choice in a context where individual propensities are unlikely to be fixed for long: if there is no further consumer learning what is the role of new product variants, or brand extensions? What can deeper distribution or a new advertising agency achieve? Any zero-order model must therefore be a compromise, and although the evidence says that the Dirichlet remains broadly a good one, the four systematic Dirichlet deviations might suggest a general violation of the fixed probabilities assumptions.

*Sole brand loyalty:* Marketers are interested in the proportion of their customer base that buys no other brand. In Dirichlet analyses, the penetration and purchase frequency of sole brand loyal consumers shows that they are never numerous and usually light category buyers (Ehrenberg et al., 2004; Scriven and Bound, 2004). The systematic under prediction of these two metrics by the model has therefore tended to attract little attention because the contribution to sales is small, especially as the penetration of sole loyals systematically declines with time.

*Period-to Period Repeat rates*: Similarly, although the model predicts period-to-period repeat rates that are usually over predicted, these have hardly been reported, although the possibility of improving predictions from one period to the next has led Trinh *et al* (2014) to adapt the Dirichlet using a Poisson-log-normal distribution to capture category purchasing and suggesting a steeper DJ line, consistent with Li *et al.,* (2009).

*The Erosion of Repeat Purchase Loyalty:* Underlying non-stationarity in repeat purchase is also reflected in the continuous erosion of repeat purchase loyalty (Ehrenberg,1988; East & Hammond,1996), observed over several non-consecutive Quarters when measured against NBD estimations and constantly stable penetration.

Ehrenberg *et al.,* (2004) make the point that these regular discrepancies seldom curtail the application of the model if they are recognised by managers, but suggest that it remains important to record and categorise them so that analysts may understand them as a possible context for any marketing driven variation. Since it is likely that these further deviations may share some common cause in non-stationarity, the second objective of this study is to use a single extensive dataset:

**To evaluate the four systematic Dirichlet Deviations as aspects of the same breach of the stationarity assumption.**

Finally, and as an outcome of the response to these objectives, it will be important to identify links in explanatory theory between the two types of Dirichlet Deviations, particularly in regard to the assumptions breached, to contribute to that theory. This leads to a third objective, as called for in Ehrenberg et al., 2004:

**To categorise the nine Dirichlet Deviations in order to summarise their managerial implications.**

We now move on to describe the data set and the analysis employed before presenting the results.

**3. The Database and Analysis**

The main source of data used in the paper consisted of purchasing histories from 62 product categories (listed in the appendix) from the UK panels operated by Kantar, to whom we are greatly indebted for making the information available. The bulk of the analyses are based on the 52 weeks ending January 2005. Data for the previous five years was also available, and used to evaluate the erosion of repeat purchase loyalty.

In each category ten standard performance metrics were extracted for each of the top nineteen brands and Private Labels (by share) plus an aggregated ‘All Other’ entity, thus accounting for the total annual sales in each product field. In all, the performance of 1238 named brands and private labels (PL) was considered.

The metrics describe purchase occasion (rather than volume or value), and brand choices, aggregated to a household (rather than an individual) level. Ehrenberg (1988) argued that this simplification captured purchase incidence and brand choice across a heterogeneous consumer base in a fixed period with little loss of accuracy, but with very considerable benefits in reducing analytical complexity. The ten metrics are defined in the following section.

*3.1 The sales equation*

In a fixed period, the sales of any brand depend only on the number of buyers it attracts and how often on average they buy it. The two metrics needed are:

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| (1) Brand penetration = | Households buying X at least once in the periodTotal households in the population |
| (2) Average purchase frequency = | Total purchase occasions of X in the periodNumber of buyers of X in the period |

Brand sales volumes per hundred buyers in the period can then be estimated as (1) x (2), the sales equation (Ehrenberg, 1988 p.11.

*3.2 The distribution of light and heavy buyers*

In split loyal CPG categories that are bought relatively infrequently, managers are interested in building the loyalty in their customer base, maintaining the purchase frequency of heavier buyers, encouraging light buyers to buy more frequently and discouraging brand switching. In setting objectives, a range of behavioural loyalty metrics may be extracted from panel data and modelled by the Dirichlet. Comparative loyalty in the customer bases of rival brands can then be described by the distributions of their heavy and light buyers, summarised in this analysis as the proportion buying the brand once (light) and those buying five or more times (heavy) over a year.

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| --- | --- |
| (3) Proportion buying once = | Total number buying X once in the periodTotal buyers of X in the period |
| (4) Proportion buying 5+ times = | Total number buying X 5+ times in the periodTotal buyers of X in the period |

*3.3 Further behavioural loyalty metrics*

Five further metrics describe the relative extent to which brands attract heavier category buyers (heavy-half theory, first described by Twedt (1964)), the space they occupy in their buyers’ aggregate repertoires (Share of Category: SCR), the proportion of 100% loyal buyers they retain over a year and the average purchase rate of that buyer class, and last, the proportion of brand buyers from period 1 that repeat in the next. The main pattern consistently observed in behavioural loyalty metrics is however that they vary together (although not by much between brands), correlating closely with penetration (which varies greatly from brand to brand) and with market share (Uncles, Ehrenberg and Hammond, 1995). Metrics are calculated from panel data for each brand as follows:

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| --- | --- |
| (5) Average category purchases by brand buyers = | Total category purchases made by buyers of XTotal buyers of X in the period |
| (6) Share of category requirement (SCR) = | Total purchase occasions of X in the periodTotal category purchases by buyers of X  |
| (7) Incidence of 100%-loyal buyers = | Total number buying only X in the periodTotal buyers of X in the period |
| (8) Average purchase frequency of 100% loyals =  | Total purchases of X by buyers of X onlyTotal number buying only X in the period |
| (9) Repeat rate (six month to six month) = | Total number buying X in period 1& 2Total buyers of X in period 1 |

*3.4 Switching / Duplication of Purchase*

In markets characterised by split-loyal buying, the extent to which any brand shares its buyers with other rival brands, and which brands therefore compete more or less intensely can be ascertained from a switching matrix. This can be extracted from panel data and expected values are predicted from Dirichlet output. To establish switching and duplication of buyers, for each brand in the matrix the key metrics are:

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| --- | --- |
|  (10) Proportion of the buyers of X who also bought A, B, ….W, Y, Z in the same period is a constant (D) times the penetration of A,B,…W, Y, Z. for all brands X. |  |

*3.5 Analysis*

The ten performance metrics were extracted from the panel datasets for every brand in each category, and tabulated. A Dirichlet model was then fitted to each product field using the spreadsheet-based software written by Kearns (Bound, 2003), following the procedures outlined in Ehrenberg (1988, Appendix C). The software makes this process straightforward for practitioners and academics alike.

Each model was calibrated using the penetration and frequency for the category (B and W) and the penetration and frequency of brands (b and w). In this analysis we used all the brands as input, but calibration can be done using one or more. The software uses B and W to estimate an NBD distribution for category purchase heterogeneity, and the b and w of the brands to estimate the Dirichlet S parameter, broadly a measure of overall multi-brand buying in the category. The mixed distributions in the model then estimate the purchase distribution for the brands, and so the performance metrics. Model estimates can be produced for a brand of any share, and for any time period as well as the one used in fitting.

Finally, Dirichlet estimates (**T**) for all ten metrics were tabulated against the observations (O) and variances calculated for evaluation. The results are presented in the next section.

**4. Results**

*4.1 Overall Summary Statistics*

Table 1 shows the average, range (min and max), and MAD (mean absolute deviation from mean) across all 1238 brands for the first nine metrics analysed in observed (O) and modelled (**T** for Theoretical**)** data. It also shows the average percentage deviation and the rank correlation between observed and modelled. Brand switching is considered separately in Section 4.5.

From Table 1 we can see that the observations cover a very wide range, with the majority being for small brands (indicated by a mean penetration of only 7%). The model fits well overall, being mainly unbiased (observed and theoretical means are roughly equal), with high rank correlations and with mean spread in line with observations. However, at this aggregated level we can see that the model is biased for some measures (means of model and observed are not the same). The model over-predicts repeat-buying by an average of 26% and under-predicts the purchase frequency of 100%-loyal buyers by 1.4 purchases. We can also see a few more once only buyers (53% model v 60% observed), and fewer heavy buyers than predicted (15% model v 13% observed for 5+ buying). These findings confirm and quantify the extent at the brand level of the four systematic Dirichlet deviations discussed in section 2.

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Table 1 about here

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Some variability, especially for small brands, will be the result of sampling errors. The panel sample size in each case is around 10,000, which gives substantial subsamples for big brands to report depth of buying (a 10% penetration brand will have 1,000 buyers and around 150 5+ buyers: a 5% brand half that), but substantial sampling variability remains for the smaller brands. For example, 220 of the brands had penetrations of less than 1%, i.e. about 100 buyers in the panel, with an expectation of only fifteen 5+ buyers. In Dirichlet analysis, it is however the general patterns across a number of brands that we look at to establish main effects, rather than individual significance, such that we can establish the persistence of deviations if they are regularly revealed across many data sets (Kennedy *et al.,* 2014). We demonstrate the principle, describing the deviations seen in the buying of 100% brand loyal consumers of the Laundry Detergent category across large and small brands.

*4.2 Systematic Dirichlet deviations and 100% loyal buying metrics*

There is no evidence that large brands consistently outperform their competitors on the basis of having a much larger than expected base of very loyal consumers. Every brand will have few buyers who buy that brand and no other (100% loyals) given a time period with opportunity to make repurchases (Ehrenberg *et al.,* 2004). In a year these 100% loyals will typically make up between 10 and 20% of buyers, but buy it about as frequently as an average user. The 100% loyals are not heavy buyers of the brand, which therefore makes them light buyers of the category - they do not buy any other brand by definition. There is a Double Jeopardy pattern in the numbers too; bigger brands have more 100%-loyals, but for all brands over longer periods and more opportunities to switch, the incidence of 100%-loyals decreases markedly.

The summary statistics showed that the Dirichlet under-predicted sole loyalty measures of penetration by about 20% and purchase frequency by about one and a half occasions (almost half the observed rate). Table 2 illustrates how both patterns, in the empirical generalisation and in the deviations, in fact appear to be systematic across big and small brands in a typical product category, automatic washing products, despite the considerable potential sampling error seen in the metrics for one and two per cent share brands. It is also clear to see that there is more variability in the penetration of 100% loyals than in their purchase frequencies.

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Table 2 about here

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*4.3 Non-stationarity in repeat buying.*

The existence of slightly more once only buyers than predicted seen in Table 1 would be expected to be reflected also in lower than predicted period-to-period repeat, the percentage of buyers in one period who repurchase in a non-overlapping period of equal length, e.g. month-to-month, quarter-to-quarter, year-to-year. It does – a deficit of 26% between consecutive six-month periods.

A deficit was found for most brands, and particularly small ones. Data for 12 weeks (not shown) also had a shortfall in repeat, but at only half the level. Conversely, for four-week periods the repeat level is slightly higher than predicted by 10%. In shorter periods, four-week data, brand marketing-mix effects such as price promotions can become more pronounced, while a few very heavy buyers can also skew observations slightly beyond estimates, but over longer periods this deviation results from a constant underlying market dynamic, the erosion of repeat purchase loyalty (Ehrenberg, 1988; East and Hammond, 1996), also known as the “leaky bucket”.

The stationarity assumption specifies that sales remain strictly constant over consecutive fixed periods, and that the same number of buyers purchase at the same average rate in each. In practice, most markets are like this, even over long periods (Dekimpe & Hanssens, 1995). In a stationary category there is a huge pool of consumers. Over consecutive periods, say quarters, many will become buyers of a particular brand. In every quarter if a bucket (defining the steady market share) were to be dunked in, it would come out full with a mixture of the brand’s buyers, some repeating from the previous period others from many periods before and some appearing for the first time. The Dirichlet predicts that in every quarter the mix of buyers in that bucket will always contain the same fixed proportion of repeating buyers from any prior quarter.

However, if a group of brand buyers from one quarter are identified and followed over subsequent quarters then the bucket appears to spring a leak: the proportion of buyers from that first quarter in every subsequent bucket should in theory hold steady but in practice it begins to erode away incrementally. At the same time the leak is topped up with other buyers to fill the bucket so penetration remains stable and superficially, brand performance is held broadly stationary. Share, penetration, purchase frequency, even period-to-period repeat (in short time periods) *seem* in equilibrium.

Under the surface every brand’s expected repeat buyers drip away because in reality purchase propensities are not truly fixed: consumers’ brand preferences occasionally change. East and Hammond (1996) reported a 15% loss of expected repeat buying in a year, reflecting declining propensities for some, countered by an increasing propensity for others that balance to maintain a steady brand share in each period.

Table 3 (Graham, 2011) summarises the average quarterly repeat purchase rates for 90 brands in 18 categories over six-years, reported from a sub-panel of continuous buyers in our dataset. This extension and replication found that erosion continues into the long term so that over five years an average brand lost 35% of its expected loyal customers, despite no loss of penetration.

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Table 3 about here

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The average quarterly repeat (top row), reflects the proportion of a brand’s buyers in one quarter that repeated the next; this remained near-stationary at around 37% over the entire period. The second row shows the rate at which the proportion of buyers repeating from the original period dripped away, and eventually declined by 35%. The difference between the two rows is therefore the proportion of “new” buyers acquired, which increased steadily over time. A leaky bucket was observed for all brands across this large dataset. It is a pervasive and constant marketing fact of life, caused by switching from and to brands at levels that exceed predicted rates, i.e. small but persistent changes in preferences. Despite being almost invisible in short term metrics, it implies the unattractive proposition for marketers of running hard just to stand still.

In modelling terms, the assumption of fixed propensities is universally breached. This is not surprising: it is unrealistic to think that buyers never change the brand preferences they hold, and although the Dirichlet allows for repertoire development as purchases of very low propensity items are made, it appears that the expansion happens a little faster than predicted for all brands across the category.

To return to Table 3, the balancing of “eroding” and “top-up” buyers in each quarter does not affect brand penetration – it is expected to remain steady, and the table shows it does. Higher customer churn may however bring about at least three of the deviations noted in Table 1; lower period to period repeat rates than expected, under-prediction of one-time buying for every brand (more new buyers than expected) and, because there is more switching and thus fewer repeats, the over prediction of heavier buying. Even over six years though, this cumulative loss of loyalty typically amounts to only 12% of a brand’s customer base (35% x 37%) and so what the data shows is that something like habitual regular choice with a small degree of churn in preferences overall, still describes the aggregate purchase patterns for all brands or categories well

*4.4 Double Jeopardy Deviations*

We next considered the incidence of the Double Jeopardy deviations. These differ in nature from the systematic deviations as they are not universal, but rather they affect individual brands in each category when the sales equation diverges from its Double Jeopardy relationship. We then considered the partitioning effect in brand switching defined by the Duplication of Purchase law.

*Niching and Excess Loyalty for leading brands* The phenomenon whereby some brands in a category have excess loyalty, above that predicted by Double Jeopardy, was first reported by Khan et al., (1988) and Bhattacharya (1997). Fader and Schmittlein (1993) estimated it to occur for the leading brand in between two-thirds and three-quarters of categories. We find similar results in our database. Table 4 shows % O-**T** for all 1238 brands divided into groups by share within their category. Higher share brands (5% or more) have higher purchase frequency, and higher share of category requirement than expected (even after accounting for Double Jeopardy, which predicts that larger brands will have slightly higher frequency than small brands). Conversely, very small brands (less than 1% share) have much lower frequency, fewer heavy buyers and lower share of category requirements than predicted.

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Table 4 about here

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If we consider just the brand leader in our 62 categories, we find that purchase frequency is under-predicted by 13% on average, i.e. very close to the level seen in Table 4 for big brands overall. For 18 of our 62 brand leaders there is a small over-prediction, so 44 are under-predicted, which at 71% is in line with Fader and Schmittlein’s estimated incidence. But there is a wide range in the deviations, from 10% over-prediction to over 70% under. Figure 1 plots the deviation for the brand leader in each category against the penetration of the brand.

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Figure 1 about here

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Not every brand leader follows the excess pattern, with some very high penetration brands showing little deviation (examples are Walkers Crisps, Hovis bread and Heinz soup), whereas other high penetration brands showing big under predictions (e.g. Wrigleys gum, Flora spread and Coca Cola). There are also some low penetration brand leaders, in either infrequent or very fragmented categories, that show big under predictions in frequency. But again, not always – e.g. Robertson’s marmalade, Evian and Lemsip. Table 5 shows that deviations do and don’t happen for big and small brands in all sorts of categories.

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Table 5 about here

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As yet, there is still no clear understanding of why many brand leaders have excess loyalty but some do not. One frequently advanced theory is that brand leaders are more likely to be available and therefore consistently find themselves in a position where no acceptable alternative is competing. This might explain the finding in Pare and Dawes (2012) that the deviation typically remains persistent, but with no trending effect on market share at least over three years. It does not explain why some leaders *do not* show excess loyalty, in particular dominant brands like Kellogg and Walkers crisps.

An alternative view is that the pattern is not due to extra purchasing by heavier buyers, but to a shortage of light buyers. This would happen if there was a larger than expected group who will not buy the brand leader at all for whatever reason, and is perhaps consistent with the fact that the pattern does not happen in all categories. It may also be that brand leaders are less prone to erosion of propensity. Both East and Hammond (1996) and Graham (2011) found erosion to have this Double Jeopardy characteristic.

The customer base of the leading brand tends to show a relatively lower category purchase frequency than that of its smaller rivals, the phenomenon known as Natural Monopoly (Ehrenberg, Uncles and Goodhardt, 2004; Sharp, 2010). If those buyers then show excess loyalty it follows that duplication of purchase with other brands must be lower than predicted. We do find lower purchasing of most other brands, and especially small brands, by the buyers of brand leaders, though this may be obscured if there is any partitioning at all.

*Restricted Distribution.* Another typical but less frequent example of a persistent deviation comes with restricted availability, in either space or time. Restricted availability means widely available in some circumstance, and hardly at all in others, rather than just patchily across circumstances. Examples of restriction in space are regional brands that exist (or have much larger share) in some area and not others, or private label brands that are only available in their chain and not in others (Dawes & Nenycz-Thiel 2013).

These cases lead consistently to purchase frequency that is higher than predicted and penetration that is lower. A brand shows loyalty metrics that look like a bigger brand, but with a reduced customer base because of its lack of availability. If the analysis is restricted just to the area where the brand is available, then the brand will have a bigger share in that area and the predicted metrics tend to fall in line with what would be expected for the bigger brand, and the excess loyalty would disappear. The soft drink Irn Bru is a good branded example, ubiquitous in Scotland where it can outsell Coca Cola, but less widely seen elsewhere. The private label deviation is especially noticeable in small but regionally strong chains (e.g. Aldi and Netto in the UK at the time of this data).

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Table 6 about here

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Conversely, restriction in time (seasonality, e.g. Easter Eggs are only distributed for six months of the year) leads to a higher penetration but lower purchase frequency than predicted if the analysis period covers the whole year. Seasonal brands show the customer base of a larger brand for the year, but are restricted in frequency outside the peak season. As with regionality, analysing for only the peak, or only the off-peak season makes the deviation disappear: the brand metrics tend to fall in line with the larger or smaller share respectively.

The Dirichlet deviation occurs because these types of brand buying are examples of partitioning – one part of the population has a different set of propensities from the rest, or in the case of seasonality, propensities differ at different times. It is not necessarily the case that such a brand would carry its higher loyalty into a new area if it were introduced there because the context and its history are different.

*Functional Differences.* Market partitions also occur when some functional brand characteristic exists designed to appeal to a restricted market sector. An extreme example is soya-based “ice creams” that serve the lactose-intolerant but do not compete directly with the majority of ice cream brands. These are smaller brands (because they have fewer buyers) but tend to be bought at higher rates than expected for a brand of its size (there are fewer acceptable alternatives).

Excluding brand leaders and cases of restricted distribution noted earlier, the few other examples of excess loyalty are characterized by having only a marginally higher loyalty than expected. Barely 30 of the 1238 brands show purchase frequency more than 0.5 above predicted. Table 7 shows some examples. Most have a clear functional difference from the mainstream offerings (e.g. Quaker crackers are rice based, Sensodyne is formulated for sensitive teeth. Space Raiders are clearly designed solely for children). The marketing literature regards niche brands as being small, with high levels of differentiation (in the minds of the consumer) and loyalty (Stocchi *et al* 2010). In practice, there is little evidence of this. Across categories, user profiles of competing brands hardly differ. (Anesbury et al, 2017), while there is no association found between ***differential*** rates of salience and behavioural loyalty (Romaniuk & Nenycz-Thiel, 2013; Stocchi, 2010; 2014; Stocchi *et al,* 2015). The evidence here shows that niching brands certainly have a limited user base but they have only a marginally higher loyalty, typically based on a functional difference.

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Table 7 about here

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*Deficit Loyalty* As a counterpoint to the excess purchase frequency seen for many large brands, very small brands often show lower frequency than predicted (Table 4 above shows average deficit of 14% for brands with share less than 1%). This is perhaps not surprising given that very small brands will often have patchy availability and low levels of support, leading to low opportunity for regular choice. Sometimes the same characteristics of low loyalty coupled with a larger than expected penetration are found in bigger brands. Kahn et al (1988) use the term “Change of Pace”, meaning a brand that is only occasionally chosen by its users specifically because it is not part of their regular repertoire, i.e. change for change’s sake. Other authors use the term “Variety Seeking” in the same way, Van Trijp et al (1996) arguing that variation in behaviour should be attributed to true variety seeking only when variation is rewarding in itself.

Table 8 gives examples of lower than expected frequency found in our database. Unlike the rarity of our niche examples, there are several hundred showing this characteristic in our data, over 100 with penetration greater than 5%, share greater than 2% and frequency deficit of 10% or more.

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Table 8 about here

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As with brands with niche characteristics, some of these deficit loyalty brands also seem to exhibit functional differences: for example, Calpol is an analgesic formulated specifically for children, and the three yoghurt brands in Table 8 are all low-fat varieties aimed at adults. On the other hand, some of the examples seem fairly undifferentiated, certainly on a functional basis (e.g. the crisps, lemonade).

So, while being differentiated may restrict the potential user base there are clearly cases where it also seems ***to reduce*** rather than increase usage among brand buyers, and not all cases of deficit loyalty can be attributed to true variety seeking. The point is that many, possibly the majority of small brands suffer lower loyalty than expected even given Double Jeopardy. The question for marketers then becomes how to manage and possibly improve such intermittent purchasing.

*4.5 Partitions*

The Dirichlet makes predictions about the other brands that buyers of any brand will buy, modelling the Duplication of Purchase Law (Ehrenberg & Goodhardt, 1970). The independence assumptions of the model (and of the earlier empirical generalisation) dictate that the market remains unpartitioned (that is groups of brands do not cluster in user portfolios). The Duplication of Purchase Law then says that buyers of any brand buy other brands in line with the other brands’ size (penetration) (Scriven and Danenberg, 2010). Results are usually presented in the form of a Duplication Table as in Table 9 here.

In some cases, brands do group in partitions, which can be identified by the deviations from the expected, unpartitioned pattern. This usually reveals sub-categories in which groups of products are functionally different, and therefore we classify partitioning with other Double Jeopardy deviations. Brands within a sub-category compete more closely with each other and less with brands in other sub-categories.

We give two examples here, revealing two slightly different but typical competitive patterns. The first involves partitions where users in one partition tend to substitute brands from that partition for brands in the other partition. In the second example, users in one group supplement usage with additional brands, i.e. they buy the main brands just as much as other users, but tend ***to add*** other brands that are much less used by other buyers.

The spreads market has three very clear partitions: butter, healthy spreads (oil based) and non-dairy buttery taste substitutes (e.g. the classic “I Can’t Believe It’s Not Butter” ICBINB).

The butters and the butter substitute brands duplicate buyers much more with brands within their sub-group and rather less between brands in the other group (Table 9). However, the healthy spreads mostly show a normal level of duplication, between each other and with the brands in the other two groups. Similarly, buyers of the other two groups show neither more nor less of a tendency to buy a brand in the Healthy group. We conclude that butter substitutes tend to displace butters in portfolios of butter-substitute users and vice versa in the portfolios of butter users. Healthy spreads are bought at similar levels across users in all subgroups, so tend to complement or compete directly with brands in both other sub-groups.

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Table 9 about here

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In this example, the partitions are not clearly revealed in the penetration and purchase frequency metrics alone, although ICBINB, Utterly Butterly and St Ivel Gold all have higher penetration and lower frequency than the prediction showing a slight “variety seeking” pattern. At the same time Lurpak and Flora both reveal a large excess frequency from lower penetration bases over their Dirichlet estimates, the Excess Loyalty for Brand Leaders deviation. The full set of metrics together with their deviations reveals the nature of the structure of competition in this market.

In a second example, sugar confectionery, both the duplication table and the penetration/frequency metrics identify characteristics of partitions that clearly consist of products that are different and probably used in a different way. It could be argued that the sub-categories are different markets and so are not directly competitive even though all three product-types defined by the partitions are widely used across the buyers. Analysts using Dirichlet benchmarks can define a category of interest in many ways and the resulting patterns, including the deviations, will help to answer questions about competitive structure and market composition.

The large and fragmented sugar confectionery market contains several products that might appear to be “different”, such as mints, child oriented, hard, soft etc. The bottom half of Table 10 shows a number of small brands that might be classified as change of pace, whereas the first three brands in the table, the gum brands, all exhibit somewhat high frequency with a lower consumer base than predicted and certainly lower than other brands of similar size in the category. In other words, there is a potential limit to who is in the gum subcategory, but those who are in it buy rather more than expected relative to other confectionery.

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Table 10 about here

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The accompanying duplications in Table 11 confirm that there is much higher sharing of buyers between the brands of gum (top left of table) than the empirical generalisation suggests. Also, there is higher sharing between some of the change of pace brands and with the major non-gum brands. There is not the space in this paper to cover all the nuances of competition in this market, which are revealed by the Dirichlet Deviations, but it is clear that gum operates in a different way from other sugar brands.

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Table 11 about here

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Knowledge of Dirichlet theory and the Duplication of Purchase patterns give marketing managers a benchmark for “normal” buying, which together with deviations provide insight about market structure and competitive threats.

**5. Conclusion & Discussion**

Any competitive market structure fitted with a Dirichlet model will show deviations between observed and modelled values. Some occur when, as a result of a marketing intervention, individual brands disrupt market equilibrium. Dirichlet analysts can then derive useful insight by evaluating the brand performance metrics in a second period against stationary norms and the marketing objectives they set. Two further types of variance have also been consistently reported to occur, but in the continuing near-steady state. There are five Double Jeopardy deviations frequently observed for some brands in some categories, and also four further systematic deviations that occur for all brands in every category. There have been calls to record and categorise these latter types of deviation systematically so that analysts may better understand them as a possible context for the first, marketing driven, type of variance (Ehrenberg et al., 2004). This study has therefore reviewed the incidence, extent and nature of nine Dirichlet deviations, drawing together evidence for the first time from a single, extensive database.

Results are summarised in Table 12, and compared with those from prior replication studies, which have generally considered only one or two of the deviations in isolation. We now refer to the findings in discussing their implications for theory, marketing strategy and further model development.

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Table 12 about here

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First, the research has delivered a major replication of earlier work on Dirichlet deviations, examining behavioural norms and model fittings in over sixty categories and encompassing more than1300 brands. We found that the incidence and extent of the deviations continues to reflect prior research findings, some of which were first reported over thirty years ago but from far smaller data sets. The Table compares the present findings with earlier results.

Second, from the review of literature it was notable that the focus of early attention had been on the Double Jeopardy deviations (Khan et al., 1988) later establishing individual deviations as norms in their own right (e.g. Bhattacharya, 1997; Fader & Schmittlein, 1993; Pare & Dawes, 2012). When viewed together though, the nine deviations fall into *two* types: the Double Jeopardy deviations, which affect individual brands, and the systematic deviations that affect all brands in the fitting. When taken as a set the Double Jeopardy deviations describe a slightly steeper DJ curve in observed than modelled data (Li *et al.,* 2006; Trinh *et al.,* 2014), while the second set suggest that purchase propensities are not be quite fixed (East and Hammond, 1996; Ehrenberg, 1988). Both types of deviation have theoretical implications for Dirichlet analysts, and prompt continuing work on model adaptations.

Third, it was noted that *despite* the existence of the deviations, brand shares remained stable. Dirichlet deviations do not appear to lead to brand growth or decline, but are rather, “a marketing fact of life” as East & Hammond (1996) described the Erosion of Repeat Purchase Loyalty. It is however important for managers to understand the implications of any identified deviation for brand performance. In section 4 we demonstrated examples of this type of analysis, and in Table 12 the implications are highlighted, and then discussed in more detail in Section 5.2

*5.1 Implications for Dirichlet theory*

The theoretical assumptions of the Dirichlet are strict, but since the main effects observed in near habitual split loyal buying patterns are closely described, they are broadly supported. The deviations do however suggest some shift in consumer propensities away from a steady state. First, there is an almost universal erosion in brand purchase propensities, indicating that consumers occasionally change their brand preferences and therefore underlying propensities are not truly fixed. Erosion happens relatively more for small brands than big ones, but what is most surprising is that the effect tends to be balanced, giving the impression of stationarity despite the fact that 15% of the expected repeat buyers are lost in a year (East & Hammond, 1996). In the Dirichlet analysis this non-stationarity leads to systematic deviations in under and over predictions of light and heavy buying, giving a flatter distribution of purchase heterogeneity, and a lower observed repeat rate.

Second, there is evidence in some categories of partitioning (brand propensities not evenly distributed through the population, thus breaching the independence assumptions). The reason is often simply explained by differences in availability or usage on a seasonal or regional basis or sometimes a clear functional difference in product attributes that has a real effect on usage. With seasonality and regionality there is often nothing a marketer can do other than be aware of how it affects the metrics. It is simply the nature of competition in that market, and the Deviations quantify this.

Niche and Change of Pace brands have a bit more or a bit less loyal usage than the norm identifies. This points to the shape of propensity distributions being slightly different for some brands. But niche brands tend to be small because they have a restricted audience who still also buy the main brands. A different propensity distribution could also be the cause of the brand leader excess loyalty pattern, but that remains an important topic for further research.

*5.2 Implications for strategic marketing planning*

The Dirichlet is easy to use for managers concerned with deriving competitive advantage for their brands because it consistently quantifies the structure of split-loyal competition between every brand in a category, identifying the behavioural metrics that can realistically be changed and how much change is needed on each in order to achieve a sales or share objective.

In this “Dirichlet world”, Sharp (2010; 2012) and Romaniuk & Sharp (2015) have emphasised the importance of managing the mental and physical availability of the brand, the relative prominence of the space it holds in the minds of all category consumers, and across all available shelves. They argue that the probability of its next purchase in the face of all alternative offers depends on that prominence – brand salience - and not on what Batra *et al.,* (2012) describe as brand love. Romaniuk (2013) argued that brand love is not only statistically rare, but more importantly, that there is no evidence to show that building it (even if that were possible) leads to higher market share, sales or profitability. Results presented in this study, covering nearly 1300 household-name brands, in supporting the theoretical assumptions of the Dirichlet, also found no evidence for the operation of successful loyalty-based differentiation and segmentation strategies.

Instead, in Dirichlet markets brands must run hard to stand still – the most expensive battle they face is to maintain penetration by constantly attracting new brand buyers and nudging existing buyers back from other brands, even if their buying is light. The Dirichlet shows that light buying is critical to sales. All brands have more light buyers than heavy, and the distributions do not change, so in a market that in aggregate views all brands as largely substitutable, all category buyers are legitimate targets because they already buy and use that product.

Where deviations occur for individual brands, they can highlight opportunities, and these are identified in Table 12. For example, where partitions are identified in a market, a brand should be competing in every one, or it will not be competing across the whole market, therefore losing potential sales. For any niching brand there is a clear opportunity to identify why penetration is low, and increase sales not through loyalty (which is already at the rate of a bigger brand) but by building the customer base.

*5.3 Implications for analysts and researchers*

Our findings have some implications for model development. From the consistent analysis of all nine deviations it is now clear to see that the biases in the model output reflect known NBD discrepancies, in over-predicting repeat purchase and under predicting light buying (Ehrenberg, 1988; Morrison and Schmittlein,1981;1988). This is very noticeable in Table 1 from the mean brand period-to-period repeat metrics, and in the distributions of once and 5+ buyers, which suggests that these biases are distributed from the Gamma/Poisson distribution in the Dirichlet across all brands in the fittings.

Trinh *et al* (2014) successfully addressed this problem in the context of predicting what one buyer class will do in a subsequent period, by replacing the NBD with the Poisson log-normal distribution, but found that there was little benefit to the overall fit in a single period. The steeper PLN distribution would however appear to be a better fit to the observed Double Jeopardy curve, and might therefore reduce the incidence of Double Jeopardy deviations as Li et al (2006) suggested. Adaptations of the NBD-Dirichlet might now be benchmarked against the deviations we categorise here as a further test of fit, although any new model has a high bar to jump in terms of usability; understanding the Dirichlet deviations allows a compromise to be made between managerial ease of use, and model fit.

*5.4 Limitations and future research*

This study considered repeat-buying of consumer packaged goods in the UK and mainly over the course of a single year. Results on this basis replicated prior findings from different markets and using different datasets, but there is now a need to extend the work into further categories, and especially to pursue the systematic non-stationary deviations in further and extended time periods, but also over subscription markets and into industrial buying contexts.

Knowledge of Dirichlet buying patterns and deviations will continue to contribute useful insight as long as underlying theory remains robust in the face of the rapidly developing marketing context. Eventually the deviations may come to describe a boundary condition to that theory, and work is continuing to extend the use of the Dirichlet into new buying situations, but also particularly into the domain of brand memory structure and brand knowledge, linking cognitive and behavioural dimensions in consumer choice outcomes with more certainty.

Finally, the limitations of the NBD in describing consumer purchasing heterogeneity are well documented, particularly in analysing period-to-period repurchasing (conditional trend), but promising results using alternative models have already been reported (Trinh *et al.,* 2014) that suggest advances on the NBD-Dirichlet analysis. Further research might now ascertain the extent to which these newer models account for the Double Jeopardy and systematic Dirichlet Deviations reported here.

**Acknowledgments**

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**Appendix –The 62 Product Categories in the main data set.**

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| --- | --- | --- |
| Analgesics | Everyday Biscuits | Packet Tea |
| Automatic Washing | Everyday Treat Biscuits | Porridge Oats |
| Batteries  | Fabric Conditioner Liquid | Premium Ice Cream |
| Bodysprays | First Aid Dressings | Ready to Eat Cereal |
| Bowl Blocks | Flavoured Water | Savoury Snacks |
| Butter | Fresh Soup | Shampoo |
| Carbonated Water | Fruit Drinks | Standard Pot Ice Cream |
| Carbonates no Lemonade | Ground Coffee | Still Water |
| Cat Food | Hair Conditioner | Sugar Confectionery |
| Child Lollies Ice Cream | Healthier Biscuits | Tea Bags |
| Chocolate Biscuit Bars | Ice Cream Filled Cones | Thick Brown Sauce |
| Chocolate Confectionery | Indigestion Medicines | Toilet Soap |
| Chocolate Snack Bars Ice Cream | Instant Decaff Coffee | Tomato Sauce & Ketchup |
| Cistern Block | Instant Porridge | Toothpaste |
| Cold Treatment Medicines | Instant Standard Coffee | Vitamins |
| Cough Liquid Medicines | Jam | Vodka |
| Cough Lozenges | Lemonade | Wet Ambient Soup |
| Crackers & Crispbreads | Liquid and Ground Coffee | Whisky |
| Crisps | Liquid Bleach | Wrapped Bread |
| Deodorants | Margarine | Yoghurt |
| Dog Food | Marmalade |  |

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**Table 1. Observed (**O) **and Theoretical (T) summary for nine brand metrics** Kantar Worldpanel: 52 weeks to Jan 2005. Brand level data.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 1238 Brandsin 62 categories | Average | Min | Max | MAD | Correlation: O and T |
| **Penetration** O | 6.6 | 0 | 78 | 6 | 0.98 |
| **T** | **6.8** | **0** | **79** | **6** |  |
| **(**O-**T**)/**T %** | 5.2 |  |  |  |  |
| **Ave Purchase** O | 3.3 | 1 | 37 | 2 | 0.87 |
| **T** | **3.2** | **1** | **28** | **1** |  |
| **(**O-**T**)/**T %** | 3.2 |  |  |  |  |
| **% Buyers: Once** O | 60 | 0 | 100 | 13 | 0.77 |
| **T** | **53** | **14** | **83** | **9** |  |
| **(**O-**T**)/**T %** | 14 |  |  |  |  |
| **% Buyers: 5+** O | 13 | 0 | 62 | 9 | 0.79 |
| **T** | **15** | **0** | **62** | **7** |  |
| **(**O-**T**)/**T %** | -15 |  |  |  |  |
| **Category Freq** **(by brand buyers)** O | 15 | 1 | 199 | 12 | 0.98 |
| **T** | **15** | **2** | **140** | **12** |  |
| **(**O-**T**)/**T %** | 6 |  |  |  |  |
| **SCR** O | 32 | 2 | 90 | 12 | 0.82 |
| **T** | **33** | **8** | **76** | **11** |  |
| **(**O-**T**)/**T %** | -1 |  |  |  |  |
| **26 wk Repeat %** O | 39 | 0 | 92 | 14 | 0.70 |
| **T** | **52** | **18** | **93** | **11** |  |
| **(**O-**T**)/**T %** | -26 |  |  |  |  |
| **100%-Loyal Pen**O | 24 | 0 | 100 | 14 | 0.83 |
| **T** | **21** | **0** | **69** | **12** |  |
| **(**O-**T**)/**T %** | 19 |  |  |  |  |
| **100%-Loyal Freq** O | 3.3 | 0 | 42 | 2 | 0.20 |
| **T** | **1.9** | **1** | **9** | **0** |  |
| **(**O-**T**)/**T %** | 83 |  |  |  |  |
|  |  |  |  |  |  |
| * 26 week repeat shown for O and T as we do not have year 2 actual data to calculate 52 week repeat.
 |

**Table 2. Incidence and Buying by 100% Brand-Loyals**

|  |  |  |  |
| --- | --- | --- | --- |
| Brand | Market | 100% Loyal | % Deviation |
|  | Share | Incidence | Purchase per | Incidence | Purchase |
|   | % |  | buyer |  |  per buyer |
|   |  | O | **T** | O | **T** |  |
|   |   |   |  |  |  |  |   |
|  Persil | 22 | 25 | **17** | 5.6 | **4.2** | 49 | 32 |
|  Ariel | 14 | 20 | **14** | 6.1 | **3.9** | 42 | 55 |
|  Bold | 10 | 20 | **13** | 6.2 | **3.8** | 58 | 65 |
|  Surf | 8 | 9 | **12** | 6.0 | **3.7** | -26 | 63 |
|  Tesco | 8 | 18 | **12** | 5.2 | **3.7** | 46 | 42 |
|  Asda | 5 | 15 | **11** | 6.4 | **3.6** | 29 | 80 |
|  Sainsbury | 2 | 11 | **11** | 4.9 | **3.5** | 6 | 41 |
|  Lidl | 2 | 28 | **10** | 3.7 | **3.4** | 162 | 7 |
|  Asda Smartprice | 1 | 23 | **10** | 5.7 | **3.4** | 120 | 66 |
|  Aldi | 1 | 17 | **10** | 3.8 | **3.4** | 60 | 10 |
|  Co-op | 1 | 9 | **10** | 6.0 | **3.4** | -16 | 75 |
|  Sains Perform+Protect | 1 | 5 | **10** | 5.0 | **3.4** | -54 | 47 |
|  Ecover | 1 | 33 | **10** | 5.2 | **3.4** | 223 | 51 |
|   |   |   |   |   |   |   |   |
| **Average** | **5** | **16** | **11** | **5.2** | **3.6** | **40** | **45** |

*Kantar Worldpanel: 52 weeks to Jan 2005.* Percentage deviations:(O-**T**)/**T**

**Table 3. Six Year Erosion of Repeat-Purchase Loyalty**

**for 90 Brands in 18 Frequently Purchased UK Categories**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Year 2% | Year 3% | Year 4% | Year 5% | Year 6% | Erosion %(Y2-Y6)/Y2 |
|  |  |  |  |  |  |  |
| Mean Quarterly Repeat % | 36 | 37 | 35 | 37 | 37 |  |
| Mean Quarterly Repeat % from Y1 | 36 | 32 | 28 | 26 | 23 | 35 |
|  |  |  |  |  |  |  |
| **Annual Acquisition** | **0** | **6** | **8** | **11** | **13** |  |

*Kantar Worldpanel, 1998-2005. Subset of c. 4,000 continuous buyers*

**Table 4. Distributions of deviations on various metrics by brand size**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number of | Brand  | Penetration |  Purchase | % Buying | % Buying | SCR |
| Brands | Share % | % |  per Buyer | Once | 5+ | (%) |
| 48 | 20 or more | -8 | 11 | 6 | -5 | 11 |
| 128 | 10 to 19 | -5 | 10 | 8 | -7 | 8 |
| 240 | 5 to 9 | -6 | 12 | 9 | 1 | 7 |
| 233 | 3 to 4 | -1 | 8 | 10 | -1 | 1 |
| 427 | 1 to 2 | 12 | -2 | 17 | -21 | -6 |
| 162 | less than 1 | 29 | -14 | 28 | -57 | -16 |
| **1238** | **All Brands** | **5** | **3** | **14** | **-14** | **-1** |

*Kantar Worldpanel: 52 weeks to Jan 2005.* Percentage deviations: (O-**T**)/**T**

**Table 5. Leading brands: deviations from predicted purchase frequency**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Category | Brand | Market | Pen. | Purchase per buyer | % Deviation |
|  |  | Share% | % |  |  | (O – **T)/T** |
|  |  |  | O | O | **T** |  |
|  |  |  |  |  |  |  |
| Crisps | Walkers | 68 | 67 | 13.3 | **13.1** | 2.0 |
| Wrapped Bread | Hovis | 15 | 66 | 9.7 | **9.6** | 2.0 |
| Ambient Soup | Heinz | 41 | 56 | 7.4 | **7.0** | 5.1 |
| Yoghurt | Muller | 24 | 52 | 11.8 | **10.0** | 18.8 |
| Crackers | Jacobs | 18 | 46 | 3.1 | **3.5** | -9.3 |
| Carbonated drink | Coca Cola | 21 | 45 | 11.1 | **9.7** | 14.4 |
| Everyday Biscuits | McVitie | 14 | 40 | 4.4 | **4.7** | -6.4 |
| Margarine | Flora | 24 | 39 | 7.6 | **5.7** | 32.3 |
| Sugar Confection | Wrigleys | 32 | 35 | 10.7 | **7.1** | 50.1 |
| Marmalade | Robertsons | 21 | 15 | 2.5 | **2.5** | -1.6 |
| Cold Treatment | Lemsip | 36 | 10 | 1.4 | **1.4** | -5.1 |
| Lemonade | Tesco | 13 | 9 | 5.4 | **4.2** | 28.7 |
| Fresh Soup | Covent Garden | 32 | 9 | 4.0 | **3.4** | 18.7 |
| Indigestion Meds | Rennie | 33 | 7 | 2.3 | **2.0** | 11.5 |
| Cough Liquid Meds | Benylin | 19 | 5 | 1.3 | **1.4** | -9.8 |
| Whisky | Asda | 9 | 3 | 4.3 | **2.5** | 74.4 |
| Carbonated Water | Tesco Value | 15 | 3 | 5.6 | **3.9** | 42.0 |
| Packet Tea | P.G.Tips | 20 | 2 | 5.4 | **4.4** | 23.5 |
|  |  |  |  |  |  |  |
| **Average** |  | **24** | **27** | **5.9** | **5.1** | **15** |

*Kantar Worldpanel: 52 weeks to Jan 2005.*

**Table 6. Deviations due to restricted availability**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Category | Brand  | Market Share  | Penetration % |  Purchase per buyer  |
|   |   |
|   |   | **%** | O | **T** | O | **T** |
| ***Regional Brands*** |  |  |  |  |  |  |
|  Carbonated Drink |  IrnBru | 5 | 12 | **21** | 11.5 | **6.2** |
|  Tea |  Yorkshire Tea | 6 | 8 | **11** | 5.0 | **3.4** |
|  Bread |  Braces Bakery | 1 | 3 | **7** | 11.7 | **5.7** |
|  Whisky |  Bruce+Co | 5 | 1 | **3** | 5.8 | **2.4** |
|  Ice Cream Cone |  Ysco | 3 | 1 | **1** | 3.2 | **1.9** |
|  Cough lozenge |  Jakemans | 5 | 1 | **2** | 2.6 | **1.5** |
|  | **Average** | **4** | **4** | **8** | **6.6** | **3.5** |
|  |  |  |  |  |  |  |
| ***Private label*** |  |  |  |  |  |  |
|  Analgesics |  Asda | 16 | 13 | **17** | 3.7 | **2.7** |
|  Ice Cream |  Morrisons | 5 | 13 | **18** | 3.7 | **2.8** |
|  Soup |  Tesco | 7 | 12 | **15** | 5.6 | **4.4** |
|  Everyday biscuits |  Netto | 2 | 4 | **7** | 7.1 | **3.5** |
|  Choc bisc. bars |  Aldi | 2 | 4 | **8** | 4.9 | **2.6** |
|  Carbonated water |  Sainsbury | 13 | 3 | **3** | 4.8 | **3.9** |
|  | **Average** | **8** | **8** | **11** | **5.0** | **3.3** |
| ***Seasonality*** |  |  |  |  |  |  |
|  Chocolate Confect. |  Creme Egg | 2 | 19 | **12** | 2.2 | **3.5** |
|  |  |  |  |  |  |  |

*Kantar Worldpanel: 52 weeks to Jan 2005.*

**Table 7. Deviations due to positioning/functionality**

|  |  |  |  |
| --- | --- | --- | --- |
| Brand  | Market Share | Penetration % | Purchase per buyer |
|   |
|  | **%** | O | **T** | O | **T** |
|  |  |  |  |  |  |
|  Quaker Crackers | 16 | 25 | **38** | 5.1 | **3.3** |
|  Warburtons Bread | 15 | 49 | **66** | 12.6 | **9.4** |
|  Muller Light Yoghurt | 14 | 34 | **47** | 11.0 | **7.9** |
|  Sensodyne T’paste | 9 | 12 | **16** | 3.2 | **2.4** |
|  K.P. Space Raiders | 2 | 3 | **5** | 4.8 | **3.2** |
|  Ecover laundry | 1 | 2 | **2** | 3.9 | **3.2** |
|  |  |  |  |  |  |
| **Average** | **9** | **21** | **29** | **6.8** | **4.9** |

*Kantar Worldpanel: 52 weeks to Jan 2005.*

**Table 8. Change of Pace Brands**

|  |  |  |  |
| --- | --- | --- | --- |
| Brand  | Market Share  | Penetration % |  Purchase per buyer  |
|   |
|  | ***%*** | O | **T** | O | **T** |
|  |  |  |  |  |  |
|  Schweppes Lemonade | 12 | 14 | **11** | 3.2 | **4.2** |
|  K.P. Crisps | 7 | 22 | **18** | 4.3 | **5.5** |
|  SkiYoghurt | 4 | 22 | **17** | 4.6 | **5.9** |
|  Calpol | 4 | 7 | **5** | 1.6 | **2.4** |
|  Kerrygold Butter | 3 | 9 | **6** | 3.0 | **4.3** |
|  Danone Shape Yoghurt | 3 | 21 | **13** | 3.6 | **5.7** |
|  Yoplait Weight Watchers | 3 | 18 | **13** | 4.1 | **5.7** |
|  Sprite | 2 | 17 | **9** | 3.1 | **5.5** |
|  Golden Wonder Crisps | 2 | 8 | **5** | 3.2 | **4.9** |
|  Lilt | 2 | 13 | **7** | 3.0 | **5.4** |
| **Average** | **4** | **15** | **10** | **3.4** | **5.0** |

*Kantar Worldpanel: 52 weeks to Jan 2005.*

**Table 9. Partitions in the UK butters and spreads market**

|  |  |  |  |
| --- | --- | --- | --- |
|  | ***Butters*** | ***Buttery Taste Spreads*** | ***Healthy Spreads*** |
|  **Who also buy:** | Lur pak | Anchor | C’ty Life | ICB INB | Ut’yB’ly | Cl/er | Gold | Vitalite | Flora | St/rk | Bert-olli | Will-ow |  |  |
| **Buyers of:** |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| Lurpak  | - | 30 | 27 | 21 | 22 | 14 | 13 | 6 | 40 | 30 | 17 | 7 |
| Anchor | 33 | - | 35 | 25 | 23 | 18 | 15 | 6 | 40 | 30 | 19 | 9 |
| Country Life | 36 | 42 | - | 22 | 20 | 16 | 13 | 6 | 40 | 36 | 19 | 14 |
| I C B I N B | 23 | 25 | 18 | - | 56 | 32 | 27 | 11 | 35 | 29 | 11 | 11 |
| Utterly Butterly | 24 | 24 | 17 | 57 | - | 35 | 26 | 11 | 36 | 29 | 12 | 10 |
| Clover | 22 | 26 | 19 | 46 | 50 | - | 23 | 9 | 38 | 27 | 12 | 10 |
| St Ivel Gold | 24 | 25 | 18 | 46 | 43 | 28 | - | 15 | 43 | 31 | 13 | 9 |
| Vitalite | 24 | 23 | 17 | 41 | 40 | 22 | 32 | - | 47 | 30 | 13 | 9 |
| Flora  | 27 | 25 | 21 | 22 | 22 | 17 | 16 | 8 | - | 30 | 14 | 8 |
| Stork  | 30 | 28 | 28 | 27 | 26 | 17 | 17 | 8 | 44 | - | 17 | 10 |
| Bertolli | 31 | 31 | 25 | 19 | 20 | 14 | 13 | 6 | 37 | 29 | - | 7 |
| Willow | 24 | 30 | 36 | 35 | 33 | 23 | 18 | 8 | 39 | 36 | 13 | - |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Average Duplication** | **27** | **28** | **25** | **32** | **31** | **20** | **19** | **8** | **39** | **30** | **15** | **10** |

*Kantar Worldpanel: 52 weeks to Jan 2005.*

**Table 10. Loyalty Deviations in Sugar Confectionery**

|  |  |  |  |
| --- | --- | --- | --- |
| Brand  | Market Share  | Penetration % |  Purchase per buyer  |
|   |
|  | **%** | O | **T** | O | **T** |
|  |  |  |  |  |  |
|  Wrigleys | 32 | 35 | **53** | 10.7 | **7.1** |
|  Orbit | 5 | 12 | **15** | 4.8 | **3.9** |
|  Hubba Bubba | 2 | 5 | **5** | 3.9 | **3.5** |
|  Rowntrees | 9 | 22 | **24** | 4.7 | **4.3** |
|  Bassetts | 10 | 29 | **27** | 4.2 | **4.5** |
|  Haribo | 4 | 14 | **12** | 3.2 | **3.8** |
|  Skittles | 2 | 9 | **7** | 2.5 | **3.6** |
|  Starburst Fruits | 2 | 10 | **5** | 1.8 | **3.5** |
|  Tic Tac | 1 | 6 | **5** | 2.5 | **3.5** |
|  Werthers | 1 | 5 | **3** | 2.4 | **3.4** |
|  Hall Soothers | 1 | 4 | **3** | 2.3 | **3.4** |
|  Swizzels | 1 | 8 | **5** | 2.1 | **3.5** |
|  Chewits | 1 | 9 | **5** | 1.9 | **3.5** |
|  **Average**  | **5** | **12** | **12** | **4.0** | **3.9** |

*Kantar Worldpanel: 52 weeks to Jan 2005.*

**Table 11**  **Partitions in the UK sugar confectionery market**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | ***Gums*** | ***Main Brands*** | ***Mints*** | ***Fruit Confectionery*** |
| **Who also buy:** | Ws | Orb | HB | Rw | Ba | Har | TT | Wert | Hall | Skit | Swiz | Chw | Star |
| **Buyers of:** |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Wrigleys | - | 25 | 9 | 29 | 36 | 18 | 11 | 6 | 6 | 12 | 11 | 10 | 13 |
| Orbit | 73 | - | 15 | 31 | 38 | 21 | 10 | 4 | 8 | 13 | 9 | 9 | 14 |
| Hubba Bubba | 70 | 41 | - | 43 | 53 | 20 | 18 | 7 | 6 | 27 | 21 | 28 | 29 |
| Rowntrees | 46 | 17 | 9 | - | 56 | 30 | 16 | 9 | 10 | 23 | 19 | 20 | 26 |
| Bassetts | 44 | 16 | 8 | 44 | - | 31 | 15 | 10 | 9 | 17 | 19 | 17 | 21 |
| Haribo | 44 | 18 | 6 | 46 | 61 | - | 14 | 9 | 8 | 24 | 28 | 23 | 27 |
| Tic Tac | 60 | 18 | 13 | 57 | 69 | 33 | - | 9 | 15 | 26 | 23 | 24 | 28 |
| Werthers | 44 | 10 | 7 | 45 | 65 | 30 | 13 | - | 8 | 27 | 21 | 24 | 20 |
| Hall Soothers | 56 | 25 | 7 | 55 | 69 | 30 | 25 | 10 | - | 20 | 20 | 15 | 29 |
| Skittles | 47 | 17 | 13 | 54 | 51 | 37 | 18 | 13 | 8 | - | 26 | 32 | 37 |
| Swizzels | 45 | 14 | 11 | 51 | 67 | 49 | 18 | 11 | 9 | 29 | - | 38 | 29 |
| Chewits | 42 | 12 | 15 | 51 | 56 | 38 | 18 | 12 | 7 | 35 | 36 | - | 36 |
| Starbust Fruits | 45 | 16 | 13 | 56 | 58 | 39 | 18 | 9 | 11 | 34 | 24 | 31 | - |
| **Average Duplication** | **47** | **17** | **8** | **44** | **56** | **32** | **16** | **9** | **8** | **21** | **20** | **20** | **24** |

*Kantar Worldpanel: 52 weeks to Jan 2005.*

**Table 12**  **Nine Dirichlet Deviations. Type, incidence, derivation and managerial implications**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Deviation** | **Identified in:** | **Assum-****ptions breached** | **Incidence**  | **Suggested** **cause** | **Managerial** **Implications** |
| **Double Jeopardy Dirichlet Deviations** |
| Excess loyalty for high share brands(Table 4 and 5) | Fader & Schmittlein, (1993)Jung, Gruca, & Rego, (2010)Li, Habel & Rungie (2006)Pare & Dawes, (2012) | 3 and 4 | Prior Incidence: 50-75%This replication: 70%Mean deviation = 10% | Not linked to “mental” share- Limitations of the NBD- Distribution anomalies- “Lack” of light buyers. | Target the market - even leading brands continue to build penetration of very light buyers over time.  |
| Niching performance(Table 6 and 7) | Bhattacharya, (1997)Dawes, Nenycz-Thiel, (2013). Kahn, Kalwani & Morrison (1988) Uncles & Ellis, (1989) | 3 and 4 | Prior Incidence: 25-33%This replication: <5%(excl. PLs, leaders, regional)Mean deviation = 50% | Restricted penetration:  - Private Labels  - Regional brands - Functional difference | Expand penetration to build sales and share. Niching performance may fade as sales increase.  |
| Change of Pace performance(Table 8) | Bhattacharya, C.B. (1997)Kahn, Kalwani & Morrison (1988)  | 3 and 4 | Prior Incidence: 25-33%This replication: c.10%Mean deficit = 20% | Restricted opportunity: - seasonal buying- loss of distribution- new line extension | Extend the season, maintain (build) ***all*** distribution, extend support for penetration growth.  |
| Deficit loyalty for small share brands(Table 2, 4, 10) | Franke, Bennett & Graham, (2017)Pare, Dawes & Driesener, (2006)Scriven and Bound (2004)Tanusondjaja, Trinh, & Romaniuk, (2016)  | 3 and 4 | Prior Incidence: 25-60%This replication: 36% Mean deficit =24% | Higher than expected penetration of 1x buyers. A Natural Monopoly effect. (see also Erosion) | Market share depends on penetration: invest in penetration-building first & maximise distribution.  |
| Category Partitioning(Table 6, 7, 9 11) | Ehrenberg & Goodhardt (1970)Lomax et al., (1996)Dawes (2016) | 3 and 4 | Not available, not a simple calculation | Functional partitions and price-tiering. | Identify market partitions and make sure to compete in them all.  |
| **Systematic Dirichlet Deviations** |
| Erosion of Repeat Purchase Loyalty (Table 1) | Ehrenberg (1988)East & Hammond (1996)Graham (2011) | 1 and 5 | Prior deviation: 15% paThis replication: 35% over five years | Under-predicted rates of HH repertoire growth leading to excess switching  | Market hard to attract a fair share of switchers in order to maintain penetration. |
| Period to Period Repeat deficit(Table 3) | Ehrenberg, Uncles & Goodhardt, (2004)Trinh et al (2014) | 1 and 5 | Prior Studies: n/aThis incidence: c90% Mean deficit: 25% | Limitations in the NBD predictions from P to P. | Invest in penetration to maintain (top up) share |
| Excess sole brand buyers (Table 2) | Ehrenberg, Uncles & Goodhardt, (2004)Scriven & Bound, (2004) | 3, 4 and 5 | Prior Studies: SometimesThis incidence: 60%Mean deviation: 20% | As above  | Maintain but don’t expect to build the brand solely in this way |
| Excess sole-brand loyalty (Table 2) | Ehrenberg, Uncles & Goodhardt, (2004)Scriven & Bound, (2004) | 3, 4 and 5 | Prior Studies: FrequentThis incidence: 70% Mean deviation: 83% | As above | Maintain but don’t expect to build the brand solely in this way |

**Figure 1. % Deviation from Predicted Frequency *vs* Penetration**

**Brand Leaders in 62 Categories**