UNIVERSITY OF STIRLING

DEPARTMENT OF MARKETING

ANDREW PETER SMITH

CONSUMERS' PRODUCT CHOICE BEHAVIOUR: AN APPLICATION OF CHAOS THEORY

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Abstract

The primary aim of this thesis is to apply chaos theory to consumer behaviour research. Chaos theory is essentially a theory of time series. The specific focus is product choice consumption behaviour. The conceptual basis for the work is taken from a theory thus far developed entirely outwith the topic focus of consumer research and marketing. The concepts and methods developed by chaos theorists in the natural sciences and some social and behavioural sciences are synthesised with concepts and methods from consumer research. The objective is to both shed light on the consumption process and explore the potential of chaos theory in this field. Ultimately the work attempts to address the question of whether consumer behaviour can be 'chaotic' as described by chaos theory.

In order to facilitate these objectives a diary study was conducted using sixty respondents. They were required to record their consumption of branded products for a period of three months. Five product categories were used with informants recording consumption of only one product type (twelve informants in each group). The product groups were as follows: soft drinks; savoury snacks; beer; chocolate snacks and packaged yoghurts and desserts. The data was coded and analysed by methods selected prior to data capture: weighted time series, spectral analysis and phase space analysis.

One of the principal findings of the research was that distinctive forms of behaviour were identifiable within the data set as a whole from which a five-fold typology is proposed. However the complexity and individuality of the forms was marked despite this apparent typology. The spectral analysis shows little evidence of regular or

periodic patterned behaviour; the series are essentially aperiodic. The phase space

analysis reinforces and enhances the analysis of the weighted time series and suggests

the series tend more towards chaos than ordered behaviour. The series obey certain

'rules' (i.e. they are 'randomised' but not random) consistent with the existence of

deterministic chaos. Moreover they appear globally stable and locally unstable. These

findings have a number of implications for various areas of consumer research (e.g.

variety seeking, loyalty and other aspects of consumption) and successfully extend the

application of chaos theory to another area of human behaviour research.

Acknowledgements

Chapter 1

Introduction

1.1 Why apply chaos theory to consumer behaviour?

'Chaos represents the first real scientific explorations of the non-linear inter-dependant world, ... retrospectively it becomes quite obvious that the earlier models allowed us to see only the smallest corner of the real world.' Goerner (1995) p6[1].

Chaos theory[2, 3] has been applied in a number of disparate natural and social science

disciplines in recent years. In particular chaos has revitalised and revolutionised time series

based research in the natural sciences and some social and behavioural sciences. It has also

enriched conceptual applications in a number of disciplines. However it would appear that

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[1]Goerner attempts to identify other more practical causes for this previous myopic thinking. Calculation and computation of complex non-linear phenomena was not possible or very difficult to execute until recently, essentially because of practical computing constraints. Whatever, this quotation sums up the feeling of chaos 'converts' and their 'belief' in the contribution of the new science of non-linearity to the body of scientific thought and investigation.

[2]From the outset the advocates of chaos theory have been involved in a semantic debate, they have challenged orthodox approaches often by questioning the meaning of a number of accepted terms such as chaos, randomness and order among others. Therefore when chaos theory refers to chaos it refers to its own definition of chaos rather than the classic definition, this definition is explored below and more fully in Chapter 2.

[3]The concept of chaos in its traditional guise is generally seen as negative, it features prominently in a number of creation myths and narratives, from Babylonian to Taoist, and from Greek to later Western traditions (Hayles, 1991). Perhaps the negative associations with chaos in the west are due in part to the ascendancy of binary logic; order is good, chaos is bad or the notion that something is either ordered or not.

marketing and consumer research have largely ignored this development. Thus far work in marketing has been confined to speculation on its significance (Diamond, 1993; Herbig, 1991; Herbig, 1990; Mix, 1993; Nilson, 1995) or speculative use of chaos influenced models on test data (Hibbert and Wilkinson 1994, Henderson and Latham, 1995, Winsor, 1995). This work, and work conducted in other disciplines, is explored in more depth in Chapter 2. The lack of empirical applications of chaos (or complexity theory[4]) in consumer research cannot be justified. Only once it has been attempted can its contribution and its potential contribution be assessed. There is no reason *a priori* why marketing or consumer research should remain aloof of developments that are impacting other disciplines. Therein lies the role of this thesis; an exploration of the value of chaos theory in empirical consumer research.

Chaos theorists employ particular analytical techniques, and have developed new techniques of analysis to explore the obscured order and complex forms that they have identified. These have provided unique insights into many processes, systems or behaviours as they evolve over time particularly those that are inherently complex[5]. This has had implications for fundamental notions such as prediction, order, control, complexity and randomness. Chaos has also provoked fundamental questioning of the premises on which some subjects and paradigms are based (for example meteorology (e.g. Lorenz, 1993), psychology (e.g. Goerner, 1995), mathematics and physics (e.g. Stewart, 1989)). Anything which evolves through time and which is amenable to measurement or quantification can be subjected to the concepts and styles of analysis associated with

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[4] Complexity theory is not synonymous with chaos theory although there is considerable cross-over. Waldrop (1992) and Kaufman (1993) provide lucid explanations of complexity theory.

[5] Even a cursory look at the consumer research literature indicates the inherent complexity of the consumer and the act of consumption. Myriad determinants are suggested including symbolic meaning, situation, attitude, social factors among many others.

chaos. Anything that can give insights into the nature of unpredictability and uncertainty is likely to be valuable in informing conceptual, empirical and managerial perspectives on consumer behaviour.

Since chaos theory is principally a theory of time series evolution it is most likely to contribute to the understanding of their application within consumer behaviour research. The interpretation of longitudinal data in consumer research is often problematic, particularly at the level of the individual consumer. Arguably time series research is an under-valued area of consumer research and marketing. Moreover the literature review of previous research work into product choice behaviour over time (described in Chapter 3) revealed a number of 'knowledge gaps'. The gaps identified reinforced the rationale for employing chaos theory and are briefly reviewed below[6].

There appears to be a dearth of investigations examining the *form* of time series. The vast majority of such research using time series use modelling techniques (e.g. regression analysis) rather than more descriptive techniques (e.g. plots, spectral analysis, phase space). Chaos research has a history of model usage and of more descriptive analytical methods, but the latter are often more adaptive and transparent. Certainly descriptive techniques are often overlooked outside of chaos research, possibly because they are perceived as less rigorous or more ambivalent. Chaos theorists often argue that ambivalence is an indicator of complexity and rather than being seen as a problem it is seen as an indicator of complex processes. As for the question of perceived lack of rigour descriptive techniques are often very rigorous and

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[6] Clearly many of the points made below will be elaborated upon and developed throughout the thesis.

often make less imposition on the data than modelling techniques. However they often require a greater degree of interpretation.

There is also an absence of work relating to the temporal aspects of the consumption of very frequently purchased goods e.g. soft drinks, snacks, chocolate etc. Whilst the Dirichlet modellers have looked at goods consumed on a frequent basis the very frequently consumed category (more than once every one or two weeks) is an acknowledged problem area for them (Ehrenberg, 1988).

There also appeared to be an opportunity for more time series investigations of *consumption* as opposed to *purchase*. Purchase is often easier to monitor than consumption, but purchase is only a part of the process and it is difficult to record *all* purchases made by an individual from all outlets. Certainly consumption and purchase are not synonymous although this is often implied by some researchers looking at product choice behaviour. Moreover the emphasis on purchase has often alienated time series research from the main body of consumer research.

Generally there is a lack of work relating to *individual* as opposed to *household* behaviour time series. Inferences about individual consumption are problematic from household level data. Again this has served to alienate some time series research from the main body of consumer research where individual choice and behaviour is more often then not the principal focus of research.

The focus suggested by these knowledge gaps was reinforced by some methodological considerations. For example the requirement for a large number of observations

(consumption events) in a given period of time reinforced the rationale for looking at very frequently consumed goods.

Due to the expeditionary and exploratory nature of the research described in this thesis no hypothesis is tested as such. Rather the research described aimed to address the following questions generated as a result of the literature reviews reported in Chapters 2 and 3. The knowledge gaps identified above helped orient the work and provide focus but the primary aim was to address the following questions. Clearly these are based on the fact that no comparable study had apparently been undertaken:

i] Are chaos theory's analytical techniques an appropriate mechanism for investigating consumption?

By implication therefore it also addresses the following question:

ii] Is individual consumption or consumer behaviour ever chaotic (as described by chaos theory)?

It is possible for the answer to i] to be affirmative and the answer to ii] in the negative (but not *vice versa*), or for both to be negative. None of these three possible outcomes will represent failure or success as such, clearly the implications will be different but all these outcomes represent valid findings.

1.2 Overview of the thesis' structure

The thesis chapter structure is represented in the table 1.2 below, whilst the function and content of each of these chapters is discussed below.

Table 1.2 Thesis chapter structure.

Chapter 1	Introduction
Chapter 2	Chaos Theory
Chapter 3	Product Choice Behaviour
Chapter 4	Methodology
Chapter 5	Data Analysis & Findings
Chapter 6	Discussion & Conclusion

Chapter 2 provides an exposition of the principal concepts that together make up chaos theory. This chapter also reviews the application of chaos in the natural sciences, social and behavioural sciences. Chapter 3 aims to identify the conceptual and empirical potential of chaos theory in respect of existing consumer research. Research perceived to be of most relevance to temporal processes is reviewed and critiqued. At this point existing criticisms of various approaches are augmented with criticisms that arise from the adoption of a chaos theory perspective. In Chapter 4 the first sections constitute reviews of recent debates concerning the methodological location of chaos theory and recent debates concerning methodology in consumer research. The methodology and methods employed in this thesis are then espoused and explained. Chapter 5 presents the findings and analysis of the empirical research. Explanatory examples of the techniques employed are included to assist understanding of the analysis on the primary data (branded food and drink consumption diary data from 53 respondents). Chapter 5 concludes with a discussion of the efficacy with which the principal research questions were addressed and a review of the core findings. Finally the concluding chapter explores some of the wider implications of this work in terms of its contribution to a number of areas of consumer research e.g. loyalty, variety seeking and brand choice. A review of the methodological and managerial implications and suggested areas for future related research is also provided. A number of appendices relating to data capture methods, informant information and analysis and data are also included.

Chapter 2

Chaos Theory

2.1.Introduction

The primary function of this chapter is to provide an overview of the basic concepts, sub-theories and ideas that together constitute chaos theory. The aim is to explore their significance in terms of the continued development of the natural sciences and behavioural and social sciences in order that the specific aims of this piece of research can be placed in perspective. Chaos theory is a collective term for a discrete area of complexity science, it contains within it a number of related ideas and theories; it is essentially an umbrella term. However, all of these theories and ideas share the common aim; to enrich understanding of complex and dynamic processes and systems. Moreover they are interrelated and contribute and enrich each other's meaning and significance. The section below (2.2) defines and explores the most fundamental chaotic terms and concepts. It also begins to illustrate their interrelationships and demonstrates that they are greater than the sum of their parts.

The introductory sections of this chapter are weighted towards an understanding of the application described in subsequent chapters. The aim is not to replicate the expositions in the seminal references cited, however it is problematic to define or explain chaos theory in any summarised form; any attempt to do so is open to the charge of trivialisation or reductionism. The method employed here uses direct reference to other texts and presentation of illustrative examples of recent conceptual and empirical application. It should be emphasised that these initial explanations will be followed by a continual development and enrichment throughout the subsequent chapters as the methodology, findings and implications of the work are explored. For example the concept of phase space is introduced in this chapter, its definition is then substantially enriched in chapters 4 and 5. Abstracted consumption examples are also used to illustrate the potential and rationale for wider conceptual and empirical investigation than the application described in this thesis.

2.2 The language of chaos

2.2.1 A note on interrelation and structure

This section poses a problem; without some imposition of structure then the exposition of chaos is likely to be both confused and confusing. However dedicating discrete sections to each concept means that any descriptions of their interrelationship is problematic. Nonetheless a structured approach is adopted here. It cannot be over-emphasised that each concept is only one part of a whole that is chaos theory. Firstly the basic notion of non-linearity is explored thereafter the essence of the chaos concept is discussed. The antecedents of chaos; sensitivity to initial conditions and feed-back (interdependence) are

then explored. After these key areas have been discussed other areas of chaos research are explored including the crucial concept of the attractor and phase space.

2.2.2 'Non-linearity'

Chaos is about non-linearity, or more accurately, it is about particular forms of non-linearity. Quite simply non-linearity refers to any relationship which cannot be expressed as a simple linear equation e.g. $x=by$, where b = constant parameter. A linear process is one in which a change in any variable will provoke a change of the same proportion in the 'output' of the process. For example, if eggs cost £1 for six, and one buys twelve then the cost will be £2, 24 will cost £4 and so on. It is not necessary to plot this relationship in a two dimensional graph to illustrate its strictly linear nature. On reflection it should also become apparent how few relationships in life can be regarded as linear. For example taking one dose of medication may reduce a symptom effect by x amount, but taking two doses will not necessarily be twice as effective (even if the egg example can become non-linear if a discounted price is paid for greater quantities, indeed this is often the case): 'Linear and independent are idealised cases of non-linear and interdependent. Thus as Ulam quipped, "calling chaos the study of non-linear systems is like calling zoology the study of non-elephant animals"'. (Goerner, 1995. p6.).

When we start to consider phenomena with many determinant variables, the emerging importance of chaos and other non-linear science becomes all the more apparent. However, a very important caveat is that non-linearity is not synonymous with terms like chaos or complex dynamics. It is a necessary but not sufficient condition for chaos.

It would be misleading to give the impression that the acknowledgement of non-linearity represents innovation on its own. Non-linear models and the idea of underlying order in time series have been around for quite a while. Traditionally though this order has often been sought by aggregating data, modelling and forecasting techniques. Indeed the social sciences and marketing still rely on a number of linear models and linear forms of expression and analysis which seek to identify and assume linear relationships. However, many researchers accept that few behaviours and relationships are strictly linear in reality. Moreover, concepts such as rationality and other mental processes are more often than not associated with linearity. Human activity and interaction intuitively appear inherently non-linear in nature. Why should consumption, as a particular human activity, be an exception?

Chaos theory represents the most significant advance in the investigation on non-linear phenomena since Newton. Why eschew its application in a consumer behaviour context? The only linearities in consumption will occur as utterly stable attitudes or as 100% repeat buying of a brand. Not many consumer researchers would contend that these are anything but rare exceptions. To paraphrase the quotation above: calling consumer behaviour the study of stable linear activity is like calling zoology the study of non-elephant animals.

2.2.3 'Chaos' :

Essentially the term 'chaos' as applied in chaos theory re-defines systems which exhibit apparent unpredictability. Systems or phenomena are seen as *unpredictable* yet *deterministic* (this should not be confused with the metaphysical notion of determinism). Chaos theory also demonstrates that unpredictable, apparently random systems can in fact

obscure submerged structures of order; notably Gleick (1987) who describes a chaotic system as one where order 'masquerades' as chaos. Therefore chaos and order are not necessarily seen as opposites, they are shown to be capable of co-existence or synthesis within one system, the latter masquerading as the former (or even *vice versa*). The crucial point is that such a system is determined and is not random i.e. the concept of randomness is re-defined or even clarified. A truly random pattern in the terminology of chaos is therefore defined as one in which no systematic pattern exists even when extended into infinity and within which there is no determined order whatsoever. Williams (1997) revisits the definition of randomness and emphasises how extreme and unusual true randomness actually is:

-every possible value has an equal chance of selection

-a given observation is not likely to recur

-any subsequent observation is unpredictable

'Traditional' statistics sees processes which are unpredictable as stochastic processes e.g. the so-called random walk (Granander & Rosenblatt, 1957). Chaos theory allows this category of processes to de described as deterministic, hence the term deterministic chaos (Williams, 1997). Chaos is 'qualitative' in that it often seeks to investigate the general character of a system's long-term behaviour, rather than seeking numerical predictions about a future state. It asks the following type of questions: what characteristics will all outcomes of a system exhibit? how does this system change from exhibiting one behaviour to another? Chaotic systems are unstable since they tend not to resist any disturbances but instead react to them (see section 2.2.4 – Sensitivity to initial conditions). In other words, they do not shrug off 'external' influences but are partly

navigated by them (although chaos challenges the division between exogenous an endogenous and dependent and independent variables – see section 2.2.5 - Interdependence). The variables describing the state of a system do not demonstrate a regular repetition of values and are therefore aperiodic. This unstable aperiodic behaviour is often highly complex.

Cilliers (1998) highlights the important point that chaos can come from simple causes; simplicity is not necessarily synonymous with an absence of complexity in chaos e.g. some simple equations can rise to complex behaviour. The consensus among mathematicians (according to Williams 1997) is that most discrete non-linear equations can give rise to chaos *given an appropriate choice of parameters*. An illustrative example is the general quadratic equation $y = ax^2 + bx + c$, where a,b, and c are parameters. If b and c are set at zero then $y=ax^2$ from which chaos does not develop. However if c=0 and a= -b then the logistic equation derived itself gives rise to chaos: '...chaos is able to generate complex behaviour which appears random'. (Serletis, 1996 p210).

Chaos challenges the meaning of randomness and forces a clarification of the term; if something is *determined* how can it be *random*? An individual consumer or group of consumers may well behave in a manner which could be traditionally described as random, however it should be more accurately described as unpredictable, since randomness implies that there is no systematic determinants. Chaos tells us that when we say random we often mean complex. Crucially and perversely chaos also suggests that apparently random systems and behaviours can in fact submerge obscured and complex

forms of order (Gleick, 1987)[1]. This order may occur as a fractal form or may be revealed in the analysis of a system's attractors (these concepts are described below in section 2.2.8 - Attractors and 2.2.7 - Fractals). Chaos does not dismiss erratic behaviour or apparently random data movements as 'noisy' or suggest aggregating data; in fact the contrary is the case. 'Noise' in a series represent real data values that are perceived to be obscuring the 'true' form. However so called noise is created by the same system as the supposed 'real form'. Chaos theory does not contend that some data values are more valid that others i.e. all data values are equally valid (this point is developed later in section 2.2.9.).

The following examples of time series provide some indication of the variety of forms that a time series can take from ordered to 'disordered'. In this context the data values might represent brands, frequency of patronage or purchase over time for example, or coded representation of brand names. Here it is taken to represent the number of clothes shops visited per week.

Figure 2.2.3.1: Steady state behaviour series

Time/week
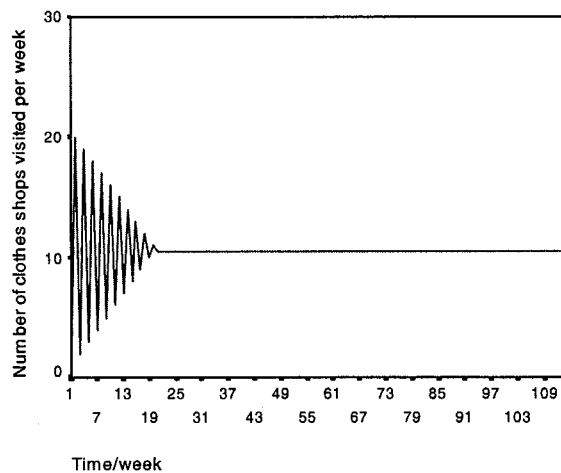
[1] Herein lies the contradiction in the assertion that chaos theory challenges the Newtonian premise of a knowable mechanistic universe, the fact that some see chaos as an example of 'post-modern science' should not obscure the fact that it is not a relativist approach (this is discussed in more depth in Chapter 4). Chaos suggests that the universe or systems and phenomena within do adhere to some underlying structure, as a Newtonian would assert. However it is the nature of this order which is called into question by chaos, it is complex and non-linear.

Figure 2.2.3.2: Two period behaviour series (one cycle)

Time/week
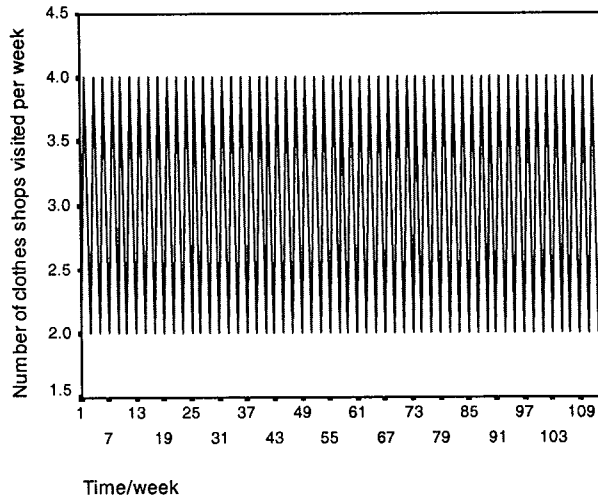
Figure 2.2.3.3: Four period behaviour series (two cycles)

Time/week
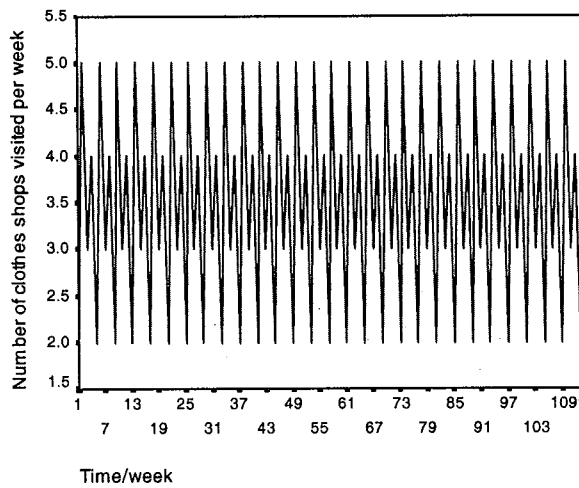
In figure 2.2.3.1 the series reaches and equilibrium state after a diminishing oscillation whilst in figures 2.2.3.2 and 2.2.3.3 a regular non-linear movement is occurring in the form of periodic behaviour which might be expected if seasonal or other regular determinants override the series.

Figure 2.2.3.4: Complex or potentially chaotic series (commodity prices – 1995/1996)

Time/week

14
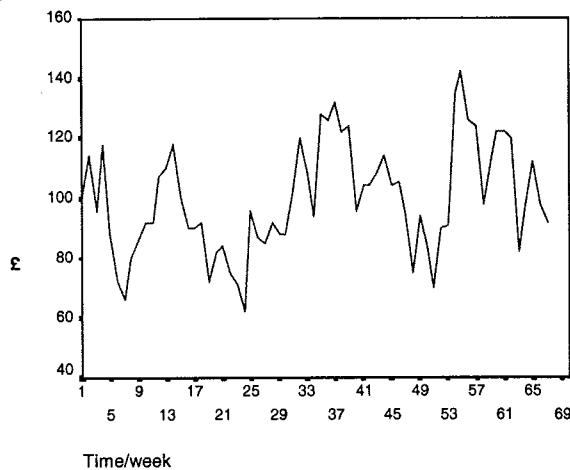
However, in figure 2.2.3.4 the movement is irregular and apparently random. Chaos theory supports the view that the roots of complex behaviour in a system (as illustrated above) can lie in the concept of sensitivity to initial conditions.

2.2.4 'The butterfly effect & sensitivity to initial conditions (SIC)'

One key concept in chaos terminology is the 'butterfly effect' (attributed to Edward Lorenz). This describes a situation or system where small apparently irrelevant or insignificant events cause chain reactions which emerge as large or even cataclysmic changes at the measurable level; this is often referred to as the 'sensitivity to initial conditions' (SIC).

Ruelle (1991, p41), illustrates the principle of sensitivity to initial conditions clearly with the analogy of the behaviour of bowling balls (see Figure 2.2.4). If one was to place a number of balls on a pitch, bowl another ball at them and record its path and then reconstruct the same pattern exactly including blemishes on the turf (clearly this would be impractical in reality). However if one 'initial condition' was changed; the initial path of the ball by one degree then the result would be that the subsequent path would become increasingly dissimilar. A slight change in one initial condition, other things remaining the same,[2] results in a very different outcome (indeed a blemish on the turf could cause this). In turn this helps to explain the inadequate predictive powers of some mathematical models; the further into the future they project the less accurate they become until their results bear no relation to reality. A small inaccuracy or omission in the specification of

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[2]The *ceteris paribus* assumption is not often used in chaos research since it runs counter to many of the assertions of the theory, however it is still useful in abstracted examples to illustrate certain points or definitions, as here.

the model is likely to mean increasing divergence over time with the observed reality. Lorenz began his speculations on chaos theory because his model of weather patterns became increasingly inaccurate the further ahead he required it to forecast (Gleick, 1987, Lorenz, 1993). Nonetheless there are many examples of chaotic models in economics and other disciplines. However, the additional problem in consumer behaviour is the predominance of variables and determinants that are essentially psychological, 'immeasurable', or problematic to measure, particularly over time. Of course models (even linear models) have explanatory power, however, they often fail to emulate or predict reality consistently[3] (other empirical implications are discussed in the following section). This notion also relates to the other chaos assertion that systems with very simple initial structures can exhibit complex behaviour, mathematically a quite uncomplicated dynamic equation can give rise to highly complex results as described above (see section 2.2.3).

Figure 2.2.4: Sensitivity to initial conditions
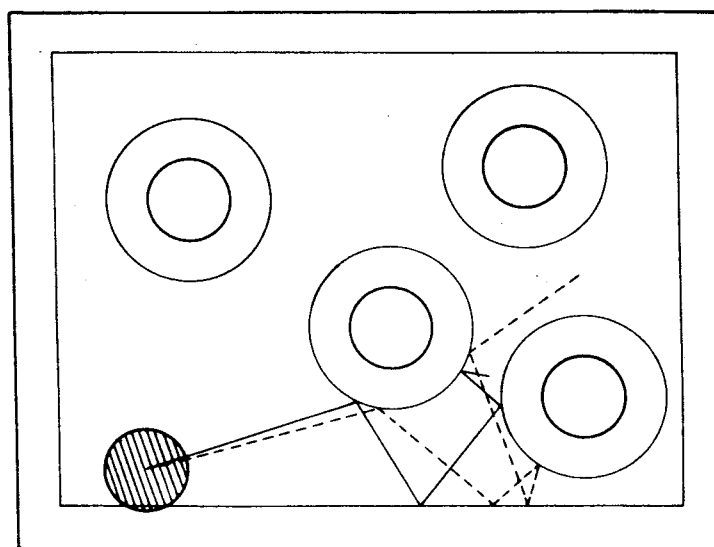
It does not require a quantum mental leap to see how this might have implications for the

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[3] Neural network and other nonlinear techniques have taken modelling in to a new era, although these observations on modelling are still valid.

way we describe the determinants of consumption and the acts of consumption, shopping, patronage etc. A small change in any determinant factor (measurable or otherwise) identified in consumer research may cause significant differences at the behavioural level. These determinants could be package colour, mood, the weather, the after-shave of a shop assistant etc, etc. This would appear on the surface of it to have associations with the situational view of consumption (Belk, 1975) and this issue is discussed more fully in chapters 3 and 6. Although the implications exceed this interpretation since all determinants (not just the situational) have the potential ability to be changed and therefore precipitate a different outcome. Whether determinants are seen as situational or not the explanations offered by the sensitivity to initial conditions concept reminds us that consumption is a highly context specific activity and that human behaviour is contingent on a myriad of factors. The consumer is essentially *unstable*. The individual consumer's inherent unpredictability might be best described in terms of his/her adherence to the principle of sensitivity to initial conditions (whenever that point of initial conditions is set or defined).

2.2.5 Interdependence and feed-back

In chaos theory variables are perceived to be incontrovertibly interdependent; they are never characterised as independent. In other words they are strongly influenced by feed-back. This suggests that the determination of variables is simultaneous and interconnected rather than solely sequential. This notion also permits the existence of multi-directional relationships in both theory and practice and breaks free of the 'flow diagram' perception of systems and processes. Therefore biological metaphors are more appropriate and more common than mechanistic metaphors in chaos theory and complexity theory.

The description of the multi-directional, non-discrete and non-linear nature of 'variables' and determinants is particularly well developed in psychology's exploration of chaos (Goerner, 1995). Cause and effect are no longer so easily divorced and determinants and 'dependent' factors are perceived to have complex inter-relationships. Determined or dependent variables or output often feed back into the system and influence its future course through its effect on its determinants. This can be clearly seen in a weather analogy where a thunderstorm may influence a pattern of weather that results in another thunderstorm at a later date. In a consumption context decisions and behaviour may have an impact on the determinant factors (e.g. mood, sense of identity, spending power) which feed back into future behaviour. In consumer behaviour we would tend to regard consumption as the 'output', but this choice is arbitrary in one sense. A psychologist may regard mood as the output, and an economist net real income and so on[4]. In one context mood would be the 'dependent' variable in another it would become an 'independent' variable. In consumer behaviour our initial conditions are the determinants of consumption only because consumption is the chosen point of focus. Accepting this rationale the division between determinants and determined variables is blurred, all factors have this dual role as they relate and counter-relate. This encourages the view of the consumer as dynamic evolving entity rather than a static receptacle or information processor. The acts of consumption are only one manifestation of the individuals psychological and social life, each act of purchase or consumption occurs in a unique context informed and determined by a myriad of factors and by past acts of consumption.

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[4] Likewise consumer researchers might be more likely to identify attractors (explained in section 2.2. 8) as states of consumption rather than of psychological well-being, or net real income etc.

2.2.6 Units of measurement

If prediction is problematic whether a modelling or monitoring approach is used, understanding of the system can be improved if the units of measurement are as disaggregated as possible. Crucially therefore chaos theory does not deem, for example, minute by minute observations to be any less significant than those found on a weekly or monthly basis. It contends that there is no reason to assert that monthly consumption fluctuations, for example, are determined whilst daily or hourly movements are random. It sees the apparently random short-term variations in a system as an integral part of any order discovered at the aggregate or average level. The preference therefore in empirical investigations of chaos is for disaggregated data wherever possible. This may seem elementary but it is surprising how many statisticians concerned with time series analysis regarded (and still regard) disaggregated data as 'noisy' before the advent of chaos. Application of chaos theory thus requires minimisation of data aggregation in order to maintain the essence of variation found, particularly if fractals (see section 2.2.9. below) are to be identified (Guess and Sailor, 1993). Every time series can have a trend line imposed on it or its elements can be aggregated up and the result may appear predictable and structured. However this process of approximation or aggregation *may* have obscured some form of underlying order or pattern at the disaggregated level which may have enriched understanding of the system as a whole.

Where variables are measurable chaos theory reminds us that the unit of measurement chosen will dictate the revealed form. For example the pattern of aggregated monthly sales over the year could look quite different than the pattern of weekly sales, whilst daily sales may reveal yet another form, hourly another and so on. Likewise individual purchase

patterns may also appear quite different to group patterns for the same brands or products. The more aggregated the data the more likely that any underlying chaotic form in the data is left unnoticed. In fact the potential implications of aggregation to obscure the underlying processes in data has been acknowledged, in a non-chaos context, in recent consumer research (Christen *et al*, 1997). The preference is therefore for data to be presented and analysed in as disaggregated a form as possible in order that any obscured structure or underlying form may be detected. There is no ultimate or optimal form of disaggregation of course, minutes can be sub-divided into seconds and centimetres into millimetres and so on, but generally the rule is the more disaggregated the better in order that chaotic phenomena and potential can be assessed. Data values themselves are building blocks for larger forms, as are fractals.

2.2.7 Fractals

The fractal concept is strongly related to other chaos concepts but is also an expanding new science in its own right. Again it is probably best introduced by an abstract example. The question 'how long is the coastline of Britain?', would yield the answer 1600 miles if measured in 200 mile segments, what would the measurement be if the segment length was an inch[5]? (after Smith, 1995). This simple example exposes the underlying principle of the fractal and further emphasises the importance of disaggregated measurement as discussed above. A fractal is a building block. A square can be divided in to four squares which can be divided again in to quarters and so on and so on (after Kolmogorov in Lorenz, 1993). This is the basic principal of the fractal, a repeated form which is

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[5]This example should perhaps assume that there is no tidal movement in order to make the point.

duplicated and structured so as to form a larger duplicate of itself[6]. In terms of time series this becomes more complex, repeated sequences of higher frequency and low magnitude could be reflected in the larger longer term structure of the time series (Gleick, 1987; Guess and Sailor, 1993) as Mandelbrot found in his analysis of cotton prices (daily price changes mimicked the monthly movement). The possibility of finding fractals therefore ties up with the preference for disaggregated data wherever possible.

Individual consumers might be described as fractals, microcosms of the macro-consumption superstructure. A social theory perspective of consumption might define the individual consumer metaphorically as a fractal. Alternatively individual patterns of consumption could mirror the patterns at the aggregate level in the same way that a fractal mirrors the form of the structure of which it is a component part. A fractal in a time series might occur as daily purchase cycles or patterns which are mirrored in an exaggerated form in a monthly cycle or pattern. Whatever the explanatory potential of the fractal concept, empirical application of fractal science to consumer behaviour represents a distinct and particular challenge.

2.2.8. Attractors and phase space

In simple terms an attractor is a graphical representation of a state of a system, usually in phase space (depicted below in Figure 2.2.8). System attractors can be studied in greater depth by the use of phase space. Phase space diagrams represent a unique form of analysis that are popular/essential when investigating potentially chaotic phenomena. An

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[6] A natural example would be the structure of the common fern, where each leaf echoes the shape and form of the whole plant.

attractor can be defined as the state of a system which *does not* occur again and again, or that is *approximated more closely* again and again[7]; it is a state or anti-state in a system. A positive attractor is a state to which the system moves towards, a negative attractor is a state which a system avoids. A non mechanical swinging pendulum slowly coming to rest would be an example of a system moving towards a positive point attractor (rest) and away from the negative attractors (the extremes of the swing). Strange chaotic attractors (after Lorenz 1993) can be defined as those states which encourage unpredictable 'chaotic' behaviour in a system. To extend the pendulum analogy, a chaotic pendulum would swing unpredictably, sometimes slowly, sometimes faster at irregular intervals, plotting the swing in phase space[8] would reveal the structure of the motion and expose any 'strange attractors'. Attractors are identified by the use of phase space diagrams[9], where the complete state of knowledge about a dynamical system at a single point in time collapses to a spatial plot point, the history of the system can therefore be 'mapped'. Alternatively the current value of a variable can be plotted against a lagged value from a previous time period (the application of phase space is as used in this thesis is illustrated in Chapters 4 and 5). The following example illustrated in Figure 2.2.8 extends the pendulum analogy to provide an introduction to the visual nature of phase space (a form of dimensional analysis).

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[7] Lorenz, 1993 gives a particularly comprehensive definition of the attractor concept and the strange attractor.

[8] These diagrams and the principles behind them are described again in chapter 5 before the pertinent analysis is presented.

[9] Or more indirectly their presence can be established through calculation of the largest Lyapunov exponent through the analysis of series data.

Figure 2.2.8: The attractor concept (after Gleick, 1987 p136).

Velocity is zero as the pendulum starts its swing. Position is a negative number, the distance to the left of the center.

The two numbers specify a single point in two-dimensional phase space.

Velocity reaches its maximum as the pendulum's position passes through zero.

Velocity declines again to zero, and then becomes negative to represent leftward motion.
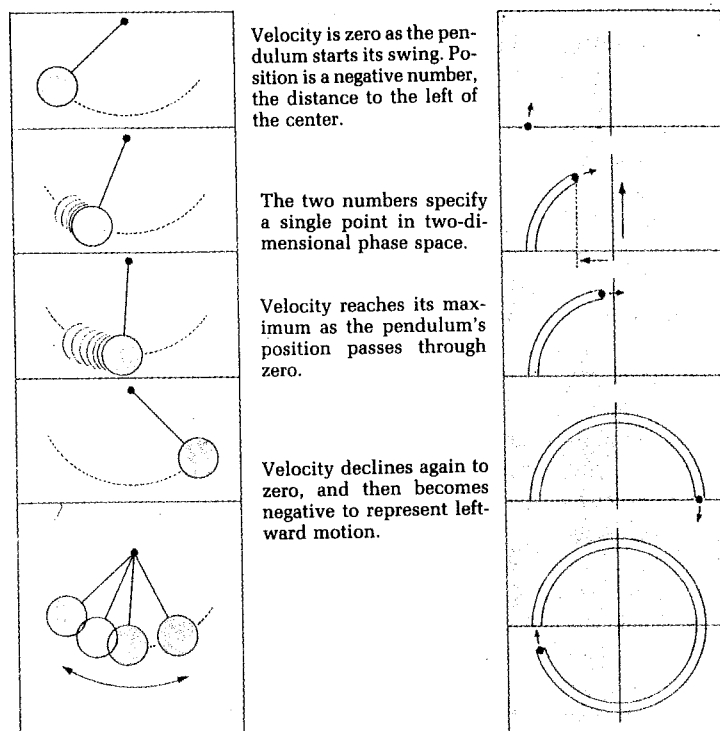
ANOTHER WAY TO SEE A PENDULUM. One point in phase space (right) contains all the information about the state of a dynamical system at any instant (left). For a simple pendulum, two numbers—velocity and position—are all you need to know.
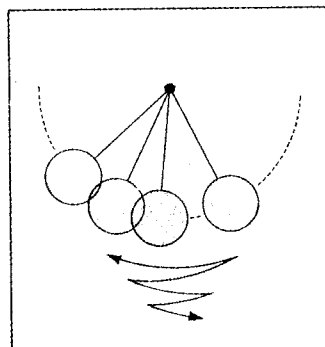
The points trace a trajectory that provides a way of visualizing the continuous long-term behavior of a dynamical system. A repeating loop represents a system that repeats itself at regular intervals forever.
    If the repeating behavior is stable, as in a pendulum clock, then the system returns to this orbit after small perturbations. In phase space, trajectories near the orbit are drawn into it; the orbit is an attractor.

The pendulums movement can therefore be seen in two ways the standard diagram and phase space. The axes in phase space representing velocity and position represent the swing as a circle or a regular cycle in phase space. Chaotic attractors are more complex in structure than the one in this simple example nonetheless the underlying concept is the same. An example of a chaotic attractor whose structure is more complex than the pendulum analogy is the so called strange attractor. In terms of phase space the so called

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strange attractor is globally stable but locally unstable, it is therefore typified by the creation of form without necessarily retracing previous mappings. Clearly if the pendulum is automated previous mappings in phase space will be re-traced i.e. the phase space circle depicted in figure 2.2.8 will be repeated.

In a consumption context then attractors might occur as either states of convergent or divergent behaviour or oscillation, perhaps of an irregular or complex nature. This concept could also be applied conceptually in an identity seeking context. Here an attractor might be a particular perceived identity or anti-identity, or as extremes in a pattern of purchase or patronage (e.g. most-bought brand and least or never bought brand). The path to the attractor may be irregular and obscure and ultimately the attractor may be a 'strange' or chaotic attractor. Obscured attractors of more complex form than the simple extreme values in a time series can be revealed empirically through the use of phase space diagrams if the 'output' data is quantitative (e.g. sales).

2.2.9 'Complex dynamics' and 'Complexity'

The investigation of the nature of the temporal evolution of non-linear systems (or time series) is the preserve of chaos, whilst strictly speaking complexity is the study of irregularity in space[1]. However complexity is frequently used to describe the length of a set of instructions that one would have to follow to depict or construct a system, although perversely as some commentators point out some systems with simple parts can exhibit complex behaviour (Waldrop, 1992). Within chaos theory complexity has many meanings, essentially though it seems to re-iterate the definitions of chaos; chaotic systems are complex in that they exhibit complex behaviour. This complex behaviour may

stem from complex initial conditions or from relatively simple structures and conditions or equations (as discussed above)[10].

2.2.10 Chaos is therefore...

Williams' (1997) summary of the attributes of chaos provide a useful distillation of many of the points discussed above.   Chaos is usefully summarised as the following, each point representing a condition or characteristic of chaotic phenomena or behaviour:

1. Chaos results from a *deterministic* process (i.e. not random but complex)

2. It happens only in *non-linear* systems.

3. The motion or pattern will look *disorganised or erratic.*

4. It happens in feedback systems.

5. It *can* result from systems with a simple structure (due to SIC).

6. It isn't the result of data inaccuracies (or noise).

7. It includes some form of order or structure (it obeys some 'rules' even if it does so in an unstable fashion).

8. The ranges of the variables have *finite* bounds, these bounds restrict the attractor (explained above) to a given range in phase space.

9. Chaotic series are hypersensitive to changes in initial conditions i.e. the butterfly effect - SIC.

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[10] A note on complexity theory: Complexity science and chaos are not the same. Chaos is concerned with the concepts and issues discussed in the previous section, whilst complexity theory delves into theories of evolution and self-organisation in systems as well as complexity. However it is impossible to see chaos as separate from complexity theory and the rest of complexity science, it is not. There is considerable overlap between the specific approach advocated in chaos research and other complexity approaches. More recently the lines between chaos and complexity have become blurred as the field has developed. Nonetheless the specific and seminal ideas generated from the original and ongoing investigations and discussion of chaos are still at the core of much of this work.

10. Forecasts of long term behaviour are meaningless (because of changing SIC and feed-back).

11. The Fourier spectrum (spectral analysis periodogram – these are described in chapters 4 and 5) is usually broad, but often with some more salient periodicity (i.e. behaviour tends to be more aperiodic than periodic, where periodic means regular cycle behaviour).

These conditions and characteristics are revisited in light of the results of the analysis in Chapter 5 (section 5.7.5).

2.3 Chaos theory and the natural sciences

Credit for the chaos theory's essential elements is not categorical, to a large extent it depends on what you read. In fact it embraces so many ideas and concepts that to credit it to one author would seem unjust. This said, Henri Poincare is most often cited as the founding father of the first principles of chaos (Poincare, 1913). He articulated the question or the suspicion that any system which was determined could not produce chance or random output, it might *appear* random, but it was not, i.e. never mistake complexity for randomness: 'Why is it that in a shower the drops of rain appear to us to be distributed by chance? It is again because of the complexity of the causes which determine their formation.' Poincare (1952) p73.

Since then during the 1960s, 70s and 80s a number of scientists (principally from mathematical backgrounds) working in such areas as physics, mathematics, meteorology and bio-ecology. Lorenz, Ruelle, Mandelbrot, Takens, Stewart and others established the principles described above through empirical investigation and theorising. This work was

often characterised by exploratory data-driven inductive research in the first instance rather than hypothesis testing and model building. New ways of examining data were devised with the emphasis being put on the actual behaviour of the output of the system.

> 'The emerging paradigm of chaos thus far has profound implications for the previously dominant view of a mechanistic and predictable universe. While a Newtonian universe was founded on stability and order, chaos theory teaches that instability and disorder are not only widespread in nature, but essential... Thus, chaos theory, as relativity and quantum theory before it, presents another strike against a singular commitment to the determinism of a Newtonian view of the natural world.' (Elliot and Kiel, 1996, p2.)

Certainly classical or Newtonian scientific traditions quest inexorably for order and for ordered explanations[11]. The acknowledgement and emphasis of disorder as order is one step forward which chaos theory can claim even if the concepts and methods subsequently employed can be questioned. Although ironically, chaos theory shares the Newtonian quest for order, the real difference is that it acknowledges that this order might be obscured or inaccessible.

It is difficult to assess the overall impact of chaos as it is being deployed and has been deployed and developed in a number of separate disciplines. It is often described as revolutionary, although curiously it is not diametrically opposed to orthodox science in so much as it still implies that systems and phenomena obey certain principles. In a sense it provides an explanation of the failure of some science thus far through its assertion that *everything* can be subjected to unyielding reductionist enquiry (these methodological issues are discussed in full in Chapter 4). Chaos theory is more concerned with challenging methodology than epistemology, it is complimentary and might be better

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[11]Gleick (1987) and Goerner (1995) are typical in their description of pre-chaos science (particularly Newtonian science) to them obsessed with regularity and neglectful of the 'disordered' or 'irregular', in other words many natural phenomena.

described as evolutionary rather than revolutionary. Overall the impact on the natural sciences within the practice of particular disciplines has been profound and widespread. This process is continuing and inevitably has spread to the social sciences.

2.4 Chaos and the social & behavioural sciences

2.4.1 The Function of this section

This section is concerned with the adoption and implementation of chaos theory in the social sciences, business disciplines[12] and behavioural sciences. Latterly particular attention is paid to applications in economics and psychology because of the greater amount of relevant work conducted within these disciplines and the contribution of these subjects as marketing's sister disciplines to consumer behaviour research.

Much of the literature in the social sciences is re-iterative (explaining the basic principles of chaos theory in each discipline) and of a conceptual and introductory nature. Nonetheless the function of this section is to identify the key ideas and identify common trends of thought within this literature and ultimately the objective is to start to answer the following question: might marketing and consumer research benefit from using and exploring chaos theory more seriously and systematically?

2.4.2 Chaos and social science: global significance

The social sciences have a long history of emulating and shadowing the epistemology and

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[12]The limited applications in marketing thus far are dealt with in section 2.4.6.

methodology of the natural sciences. This can be an asset and a handicap. The adoption of chaos theory can therefore be viewed as another stage in this process of emulation, although it can be argued that it has particular significance for the social sciences. The social realm would appear to be inherently non-linear and unpredictable, adding humans to a system would seem to guarantee complexity and unpredictability. In this sense there would seem to be obvious 'metaphorical value' (Eliot and Kiel, 1996) in chaos theory although this conceptual appeal is now being tested and applied. Conceptual application and the global significance of chaos theory to social science should therefore be dealt with first before any discussion of actual application and empirical investigation in any specific discipline.

A number of social theorists believe that social science cannot afford to ignore the new science of chaos and complex dynamics even if the implications are disquieting. Smith, (1995) in concert with the views of Dobuzinskis (1992) asserts that:

> 'Social science may be driven back to its roots of social philosophy and 'pure research' and eschew social engineering ...... All social researchers are aware of the fact that the phenomena they study are exceptionally complex ..... Chaos considerations force us to face the possibility that some 'negligible' terms can - in certain circumstances - become dominant'. Smith (1995, p35).

However, there is always an inherent danger in the social science's propensity to borrow from the natural sciences, particularly if this leads only to conceptual usage. Chaos if poorly applied only as a loose metaphor will contribute only new terms and schemas which add nothing to overall understanding i.e. the same things will be said in different way: '...the transmission of terminology from the natural sciences to the social sciences brings with it the danger to mistake semantic innovation for progress of knowledge.' (Fabian and Stadler, 1991. p98).

This viewpoint also lends credence to the assertion that a grasp of the mathematics of chaos as well as its metaphors and concepts is almost essential before its full contribution and worth to the social sciences can be realised. The vogue for qualitative, introspective and interpretive research might increase the acceptability of purely qualitative or conceptual application of chaos, despite the fact that it has more to offer as a form of quantitative enquiry in the first instance: '... many social scientist's rejected quantification with a vengeance and have opted for hermeneutic method in their research...' (Harvey and Reed, 1996. p295). Although as Harvey and Reed also acknowledge chaos owes it existence to the pervasive scientific attitude of the sixties and to a movement of 'post-modern' science (Young, 1991 and others – this debate is revisited in chapter 3). To embrace chaos only until it becomes overtly quantitative (i.e. only in a conceptual form) is difficult to defend, especially since it is essentially a mathematical theory[13]. This notion is reinforced when one considers the contribution of quantitative chaos research to econometrics and psychology.

The relationship between chaos and systems theory (which is essentially a superficial one, or even one of opposition) is acknowledged by some commentators (Dobuzinskis, 1992). Systems theory also has a dualistic tradition of self-consciously metaphorical and more empirical approaches. Prior to the advent of chaos theory some systems theorists made bold claims for their discipline. Ramo, (1969) claimed that the systems approach was no less than a 'cure for chaos' (that is the classical definition of chaos). Conversely Dobuzinskis makes equally bold assertions about the shortcomings of the 'naive positivist' social science methodology in light of the insights from chaos theory, declaring that

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[13]Whilst the last quotation is rather loaded towards a positivist quantitative view of social science, it illustrates that the social sciences are susceptible to the adoption of approaches dictated by a form of research fashion, this might be seen as part of the inherent identity crisis of the social sciences/business disciplines.

ceteris paribus is dead. This leads Dobuzinskis among others (Steier, 1988; Maturana, 1988) to assert that 'reflexive understanding' should replace notions of control and predictability, notions which are associated with systems theory and other established forms of social science research.

Ultimately the process of assessing the impact of chaos theory globally on the social sciences is very much in its early stages, and it is against this background that any further application in marketing or the other social sciences must be developed. Chaos theory has at present raised more questions than it has answered in the social sciences, and the debates therein encompass fundamental and more specific questions of epistemology and methodology. Many of these questions cannot be adequately addressed until there is enough work in each discipline of sufficient rigour and variety.

2.4.3 Chaos and economics

Economics has probably investigated chaotic phenomena more than any of the other social sciences (psychology excepted – assuming it can be described as a social science). Therefore economics requires a section dedicated to description of the work undertaken thus far. One of the earliest investigations into chaotic dynamics was conducted using cotton prices by the mathematician Mandelbrot leading him to identify time series fractals and establish that daily movements could not be seen as random whilst monthly movements could be seen as predictable (Gleick, 1989; Guess and Sailor, 1993). Since that time a growing faction of economists have acknowledged that many time series may be chaotic and therefore that chaos theory may have much to contribute.

Non-linear models have been common in economics for sometime and many econometricians are familiar with the inherent complexity of recursive interdependent systems. Many continue to build models in order to investigate chaos (e.g. Craig *et al*, 1991; . Brock *et al*, 1992; Medio, 1992; Rosser, 1996) as well as investigating time series in a more descriptive way. However Berry and Kim (1996), deploy a more descriptive truly innovative approach using phase portraits and descriptive time series analysis and as a result provide valuable new insights into old economic problems through revealing attractor forms and questioning notions of randomness (see also Sereletis, 1996 and Baumol & Benhabib, 1989). Price and Stacey (1994) provide a speculative discussion of the potential impact of chaos for economics in the longer term although they seem to assume a more liberal intellectual environment than that which currently exists in the econometrics dominated world of modern day economic theory. The modelling approach can be seen as contradictory to the essence of chaotic research because the effect of SIC starts to undermine the rationale for long-term prediction. However the chaos model proponents have demanded greater attention to chaos and complexity within their discipline. They are not advocating a paradigm shift (as Arthur cited below might have advocated) but they have started a real debate on specific issues amenable to chaotic investigation (e.g. Rosser (1996) has continued the attack on the Muthian view of rational expectations by employing chaos influenced models). Some 'extremists' have expressed the view that econometric modelling is doomed, that it has provided little in the way of true conceptual insights and has continually failed to predict accurately (particularly at macro-economic level), however these dissenters are on the margins of the discipline.

In 1979 Brain Arthur (see Waldrop, 1992) finally crystallised many ideas he had about complexity and economics. He questioned contemporary orthodoxy in economics through

construction of the following manifesto for a 'new economics'. The table below summarises the essence of these ideas, ideas which allow one to appreciate the possible and actual changes that an acknowledgement of complexity has wrought in some economic studies. As yet chaos theory has failed to produce the 'new economics', this is partly attributable to the only partial conversion of many economists who seem reluctant to abandon econometric modelling in favour of more descriptive quantitative methods.

Table 2.4.3: New and old economics

OLD ECONOMICS	NEW ECONOMICS
- Based on 19th century physics (equilibrium, stability, deterministic dynamics)	- Based on biology (structure, pattern, self-organisation, life cycle)
- People identical i.e. *homo economicus*	- Focus on individual life; people separate and different
- If only there were no externalities and all had equal abilities, we'd reach Nirvana.	- Externalities and differences become driving force. No Nirvana. System constantly unfolding.
- Elements are quantities and prices	- Elements are patterns and possibilities
- No real dynamics in the sense that everything is at equilibrium	- Economy is constantly on the edge of time. It rushes forward, structures constantly coalescing, decaying, changing.
- Sees subject as structurally simple	- Sees subject as inherently complex
- Economics as 'soft' physics	- Economics as high complexity science

After Arthur, (Waldrop, 1992, p37)

No doubt this table (because of its simplification and ideology) would cause furious debate among any group of economists. Whatever, it provides a point of reference for speculation on the possible impact of chaos theory on marketing beyond restricted application to specific phenomena.

2.4.5 Chaos and psychology

Within the discipline of psychology there is now a history of usage of chaos theory as a metaphor and as a mathematical method although the quality and rigour of applications varies (as discussed by Kincanon & Powel, 1995). Abraham and Gilgen (1995) provide a comprehensive collection of the many applications in psychology in their diversity of approach and application[14]. Overall there appears to be a fondness for application to situations *in extremis* or abnormal psychology in favour of applications to more prosaic and everyday psychological phenomena (e.g. Fabian & Stadler, 1991; Schmid, 1991). This is presumably because chaos theory intuitively appeals to those investigating conditions where unpredictability and extreme changes of behaviour are the norm. However, Duke (1994) advocates a wider and more considered application, and this holistic heritage and potential is also acknowledged in other tracts (Guess and Sailor, 1993; Goerner, 1995). This point of view is assisted by acknowledging potential connections with Gestaltism and other holistic forms of psychological inquiry. From the methodological point of interest there are a variety of applications; examples exist of modelling approaches (Heiby, 1995a), descriptive time series analysis (Heiby, 1995b) and phase space analysis (Haynes *et al*, 1995; Metcalf and Allen, 1995). Some of these have used brainwaves as the measurable output, or have used coded data form observations over time to generate chaotic models and phase space and other dimensional analysis (Gregson 1983 demonstrates that coding data to allow time series analysis is common in psychology). These analyses have uncovered underlying processes and have probed the concept of random behaviour.

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[14] Chaos has been from the analysis of brain wave activity in clinical psychology (examples in Basar, 1990), interestingly this helps to build up a picture of a complex dynamic brain, possibly causing complex dynamic behaviour. This volume also includes a number of examples of lagged phase space portraits.

Psychology (or many psychologists), perhaps more than any other discipline has embraced chaos theory with enthusiasm, certainly in comparison to economics the debate has been conducted from a much wider perspective encompassing specific points of interest and the implications for the theory for the subject as a whole. Within the subject there are now many references to the theory's application and potential. Researchers have claimed advantages from an epistemological, methodological, metaphorical and empirical standpoint. Moreover, since psychology is not as enamoured with mathematical modelling as economics there are more examples of descriptive and exploratory quantitative chaotic research. Whether it is welcome or not consumer research owes a debt to is sister discipline of psychology/economic psychology. The apparent absence of any substantive effort to explore chaos theory thus far in consumer research emphasises the need for the work undertaken for this thesis.

2.4.5 Chaos in other social science and business disciplines

Within disciplines examining organisational interaction and social interaction and human information exchange then mathematical application becomes more problematic, or at least harder to come by. This is largely attributable to the subjective nature or unquantifiable nature of variables and output variables. This is reflected in the nature of most expositions thus far in subjects such as sociology. Young, (1991) and Baker, (1993) are typical examples of sociology's attempts to come to terms with the implications of chaos. These can be characterised as philosophical discourses on the validity and nature of chaotic concepts rather than descriptions of empirical investigations. Interestingly Baker also re-iterates the postmodern credentials of chaos. Likewise management science

and organisational behaviour seem to have confined themselves to conceptual applications and discussions of the principles of chaos and their appeal in a social science context (e.g. Smilor and Feeser, 1991; Thietart and Forgues, 1995; Levy, 1994). Although Thietart and Forgues do advocate the empirical application of these ideas as well as their conceptual exposition, to date though examples have remained limited in number. The sensitivity to initial conditions concept seems to have particularly captured the imagination of converts in this field of study.

There is limited evidence that political science has also acknowledged the potential of chaos theory to enrich understanding (Saperstein, 1996) and to investigate specific empirical questions (McBurnett, 1996a). McBurnett's examination of expressed intentions to vote is of particular interest and significance since it could be viewed as a blueprint for chaotic attitudinal and behavioural research and displays the innovativeness required for the empirical application of chaotic ideas beyond the sphere of mathematical modelling. This is achieved through using phase space to investigate voting intentions over time.

2.4.6 Chaos in marketing and consumer research

> '....the complexity and flux of today's competitive environment appears to have rendered marketing impotent and unable to adapt'. (Brown 1995, p53.)

This statement is one of the more extreme examples of the acknowledgement of uncertainty and unpredictability in a dynamic marketing world. Uncertainty is an increasingly pervasive feature of contemporary marketing environments (Achrol & Stern 1988; Varadarajan *et al* 1992). According to some this is manifest in phenomena such as shortening product life cycles (Qualls *et al*, 1981; Olshavsky, 1980; Rosenau, 1988) proliferation of new media channels (Ozanne & Temple, 1994; Rowley 1994) and

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increasingly fragmented markets (Pine *et al*, 1995). However it is fair to say that the application of chaos theory in the field of marketing thus far has been very limited. Marketing has at present confined itself to preliminary broad-based speculation on the meaning of chaos theory's more basic concepts for the subject (Diamond, 1993; Herbig, 1990; Herbig, 1991; Mix, 1993; Nilson, 1995), with some exceptions albeit of a model orientated nature of investigation on test data (Henderson & Latham, 1995; Hibbert & Wilkinson, 1994; Winsor, 1995). This is summed up by Henderson and Latham: '..chaotic mathematics is taken increasingly seriously as an impediment to measurement, prediction and control. But in marketing, the issue is seldom encountered, except perhaps as a curio.' (Henderson & Latham, 1995 p309).

Hibbert and Wilkinson (1994) did attempt a speculative application of a 'chaotic' brand competition model though *only on test data*. Their conclusion that simple equations can give rise to chaotic behaviour if certain parameters are chosen does not represent a new finding as such. It is merely a transfer of the point made in section 2.2.3 regarding parameters in equations. This was already known, there is no reason that models used in consumer behaviour studies should be any different, indeed they are derived from models used in other applications where these discoveries about chaos were first made. However the Hibbert and Wilkinson (1994) application does suggest that descriptive analysis of output variables (e.g. phase space - referred to by them as return maps) can also be used attempt to explore brand choice processes. Thus far this has not been attempted and clearly represents an opportunity for the application of chaos in consumer research. Unfortunately the definitions of randomness and chaos implied in the Hibbert and Wilikinson paper are not entirely consistent with those given elsewhere. However this is seemingly the only paper within the field of marketing to acknowledge the existence of

phase space and these other forms of analysis. Hibbert and Wilkinson are also critical of marketing's inability to 'keep up' with developments in time series research elsewhere. This paper (and Winsor's (1995) speculative work on the value of chaotic style models to the theory of the diffusion of innovations), are the only attempts to *apply* chaos. However they are strictly speaking not empirical investigations, they only use test data. The work in this thesis is based on primary data of actual consumption.

Generally there is little evidence of a sustained, concerted and systematic exploration of chaos theory's meaning, particularly in consumer behaviour research, more akin to that undertaken in psychology and other social and behavioural sciences. The following chapter reviews relevant work from consumer behaviour in order to locate the work undertaken for this thesis. Clearly though chaos is best equipped to explore longitudinal processes in the empirical sphere since it is essentially a theory of time series. There are plenty of examples of time series research in marketing (though most of it using modelling based techniques), so there is a 'tradition' or precedence for time series research. Therefore there would appear to be justification for using the most recent innovations in time series research in marketing, indeed it is difficult to think why chaos should not be applied.

Consumption and consumers are inherently complex and often unpredictable. The disparate nature of consumer research is a reflection of this. Surely developments in complexity science should not be eschewed though, as appears to be the case at present. The consumer is a continually evolving entity not a static being. He/she is also subject to many 'initial conditions' or determinants of their behaviour as documented by consumer researchers. The power of these determinants varies from individual to

individual and from product to product *and* over time. Chaos theory is consistent with these assertions, it does not avoid notions such as complexity and instability, as is often the case in conventional consumer research, it embraces them and provides forms of analyses that can investigate them. Too often the approach adopted in marketing and consumer research assumes that there must be a simplified order or 'truth' underlying a variety of processes, there is no reason why this should be the case. It could be that this fallacy is due in part to the adherence to scientific methods. Perversely chaos theory, although born from the natural sciences, provides an alternative paradigm.

Previous applications of chaos theory in other disciplines have shown that methods and techniques of investigation must often be adapted and that the implications for the discipline vary from subject to subject. It is therefore not possible and is certainly unwise to predict what the effects on the discipline might be until empirical research is undertaken from a perspective informed by chaos theory.

2.5 Conclusion

The implications of chaos theory are still unfolding, even in the natural sciences, and its long-term impact is difficult to assess. Nonetheless the fact that psychology and economics (as sister disciplines of marketing) and the other social sciences are exploring chaos theory with cautious enthusiasm strengthens the case for systematic attempts at application in marketing and consumer research. As already stated consumers and consumption behaviour like other manifestations of human behaviour are often inherently unpredictable, non-linear or 'random'. If psychology has found value in using chaos to explore other forms of human behaviour why should consumption behaviour be an

exception? The impact of and interest in chaos theory in the social sciences demands that subjects like marketing and consumer research explore its potential.

This thesis represents a considered and systematic application of chaos theory to consumer research. The aim is to establish the value of applying chaos; to examine both its constraints and its potential to provide insights into consumption over time. If the understanding of complexity and non-linearity in consumption is to be enriched and extended then chaos theory is a tool that has to be explored and tested.

Chapter 3

Product Choice Behaviour

3.1 Introduction

The primary purpose of this chapter is to review the relevant work within existing consumer research; particularly product choice behaviour related. This is done principally from a chaos perspective augmented with existing critiques of various approaches. The aim is also to locate the research as far as possible prior to empirical research and to identify 'knowledge gaps'. Despite the fact that there is little evidence of work directly addressing issues raised by chaos theory, there is a great deal of research into various relevant aspects of product choice behaviour. Greater emphasis is given here to explanations of product choice and other concepts that attempt to explore behaviour *over time*. Issues relating primarily to the methodology of this thesis in respect of other consumer research are dealt with in the following chapter (Chapter 4 – Methodology).

As emphasised in the previous chapter chaos is essentially a theory of time series. It has the potential to enrich consumer behaviour research through conceptual application or through informing interpretive investigations (this is discussed further in Chapter 4 and Chapter 6) but it is first and foremost a theory of time series. Whilst interpretive studies often have a temporal dimension they do not provide time series data (Kemmer *et al*, 1998). Studies using quantified data and with a temporal dimension are therefore given priority here since this is the tradition of knowledge building that this thesis is most likely to contribute to. However the review is broader than this since many other issues arise when product choice behaviour is considered i.e. the concept of the rational cognitive consumer, definitional issues of loyalty, definitions of variety seeking. Indeed these issues are reviewed before the work on brand choice modelling and other relevant work are considered. These issues have to be addressed because of their possible significance to the findings of the thesis. One problem with consumer research is that it often appears to adopt a compartmentalised epistemology. It has been stated that the most obvious relevance of this perspective is to studies involved in the investigation of time series (particularly the brand choice modellers), but there is no good reason to exclude other relevant areas of investigation.

A lot of the work reviewed here is highly mathematical principally employing various forms of modelling techniques. Rather than becoming ensconced in obscure mathematical debates and presenting endless mathematical notation a more descriptive analytical approach is adopted. The aim is to examine and critique the underlying concepts and assumptions of these stochastic and explanatory modelling approaches. The nature of chaos theory is such that it lends itself more readily to a wider discussion of underlying concepts and assumptions. Chaos theory questions the foundations of

certain mathematical and statistical approaches rather than specific mechanics.

3.2. The decision process: the rational cognitive consumer?

3.2.1. The complexity of consumer research

Consumption and consumers are complex and, not surprisingly, this is reflected in the disparate nature of consumer research and is often explicitly acknowledged even by some of the more functionalist approaches (e.g. Nicosia 1966; Howard 1977; Ehrenberg 1988). For example Nicosia (1969) talks about the 'complex network of circular relationships' which govern consumption (p153). The consumer has been described and defined as an information processor (Nicosia, 1966; Howard & Sheth, 1969; Howard 1977), an agent of behavioural response (Foxall, 1990), an agent of situational response (Belk, 1975), an agent of symbolic exchange (Umiker-Sebeok, 1987), an agent of affective response (Hirschman & Holbrook, 1982; Holbrook & Hirschman, 1982), an agent of schematic processing (Stayman *et al* ,1992), an agent of ritual (Rook 1999a), or an agent of habit (East *et al,* 1993; Twomney, 1999[1]) among other perspectives (Holt 1995 characterises some of the more recent interpretivist approaches). Many factors influencing consumers' decisions and behaviour have been identified and suggested as diverse as identity, colour, mood, price, semiotic meaning, among many others. It is possible that chaos theory can contribute to the investigation of the complexities in consumption and provide some basis for reconciling some of these approaches.

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[1] Twomney (1999) identifies problems in discriminating between habit as opposed to loyalty, he also asserts that complexity perspectives may shed light on this issue (though only on internal processes).

Consumer research has tended to concentrate more on individual processes rather than group behaviour or aggregate data with the exception of the brand choice modellers (discussed in detail below) who focus on the product (in other words aggregate behaviour). This is but one of many bifurcations in consumer research but nonetheless is an important one, since it has served to alienate the brand choice modellers from other groups concentrating on individual processes. The ascendancy of cognitive psychology in consumer research has helped to feed this preoccupation through its emphasis on internal mental processes.

3.2.2 The challenge to homo economicus

Orthodox consumer research influenced strongly by neo-classical economics and cognitive psychology asserts that the decision making process is essentially rational (Nicosia 1966, Howard 1977, Howard & Sheth 1969) of which the consumer decision model (CDM) is typical. Its sees the process of consumption as calculative, mechanistic and often linear. Bettman *et al* (1991) provide a comprehensive review of the orthodox perspective on the decision process. Essentially the consumer is characterised as an information processor. This tradition has undoubtedly provided valuable insights but many of the models provided by this approach are purely conceptual and have not been estimated empirically as Ehrenberg (1988) asserts. Whilst many proponents of this school acknowledge that consumption is inherently complex the result is often conceptualisations of consumption which rely on structured flow diagrams of highly complex and multidirectional phenomena (e.g. Howard, 1977 & Nicosia, 1969) as in Figure 3.2.2. below. The instinctive assertion that they are inadequate is not good enough however as a rationale for research and a number of alternative (often critical) explanations and

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perspectives have been offered.

Figure 3.2.2: The Howard and Sheth model.
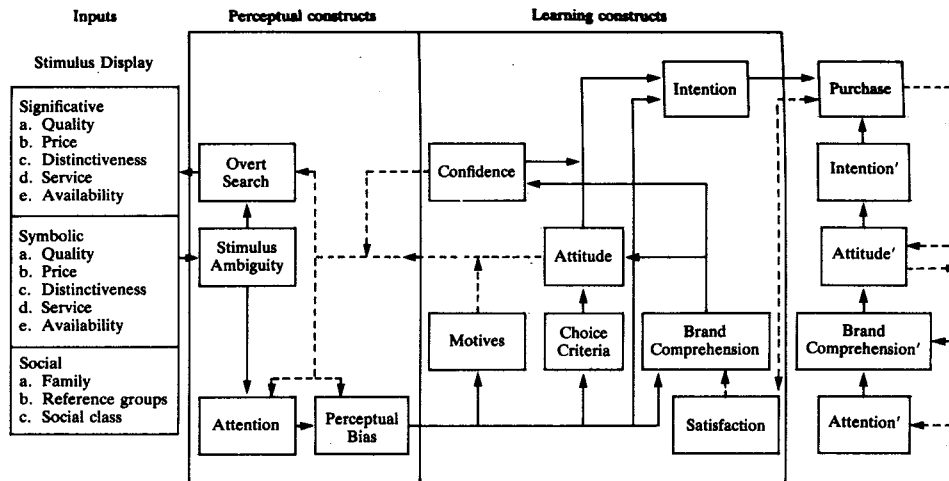
Source: Howard and Sheth (1969). *The Theory of Buyer Behaviour*. Wiley.
Note: Solid lines indicate flow of information; dashed lines are feedback effects.

Foxall (1990) is not alone in highlighting the 'elaborate use of unobservables' (p10), in such models. Bagozzi (1984) and Jacoby (1978) are among others to make these observations and describe these theories as untestable. Foxall (1990) also highlights the 'arbitrary nature of putative relationships among the variables' (p13). Even Nicosia (1966) himself acknowledges '... these notions (the cognitive models of consumption) are open to question' (p34 & 35). However the model does acknowledge the importance of feedback, something which chaos theory would support.

Whilst focusing on the internal processes of the consumer has provided insights there are some problems with the underlying implications of the cognitive approach. Characterising

consumption as essentially a rational decision process and focusing on the internal decision processes of the consumer means that some other important determining factors and perspectives have been, until more recently, eclipsed. As Firat *et al* (1995 pp43-44) declare: 'Consumer behaviour theories believe in consistency and orderliness of consumer behaviour... Thus, the general assumption has been that if and when informed about such characteristics of the consumer (e.g. cognitive mechanisms, behavioural responses, genetic traits) some meaningful prediction of their actions can be achieved'. Challenging notions of predictability and orderliness is consistent with a belief that chaos theory might be an appropriate means of inquiry in this context.

Arguably it is possible that consumption can be irrational. The cognitive school have tried to account for apparent irrationalities and ambiguities in 'planned' consumption. Although Malter (1996) describes impulse purchase in cognitive terms other more critical cognitive perspectives have tried to account for such behaviour (Cobb & Hoyer 1986). Classically though it has been consigned to the 'unplanned behaviour' zone. Whilst impulse purchase may be 'unplanned' it must still have determinants however obscure. Rook (1987 &1999b) sees impulse and planning as part of a continuum of consumption and therefore challenges the binary notion of planned versus unplanned behaviour[2]. This goes some way to acknowledging the inherent complexity, diversity and ambiguity in the individual decision process. The failure of many consumers to actively incorporate all acquired product information in their purchase decisions is also well documented (e.g. Cowley, 1995). Elliott (1994) and Elliott *et al* (1996) show us a rather different perspective on

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[2] The division between planned and unplanned purchase also raises the question of time scale. If a purchase is planned then over what period? Moreover whilst the causes of impulse purchase may necessarily be 'of the moment', there may be some underlying causes e.g. a predisposition to act impulsively caused by psychological make-up.

impulse purchase where it can have complex social and psychological drivers and can move towards addiction (this has been reinforced more recently - Friese, 1999). Whilst addicted consumers are seen as a special case it surely further demonstrates the importance of emotional, social and irrational motivators for consumption. Moreover the neglect of mood, hedonic, affective and other experiential factors as determinants of consumer behaviour has lead to a broadening focus in consumer research (e.g. Gardner & Hill 1988; Holbrook *et al* 1990; Hirschman, 1999).

Some attempts have been made to synthesise or reconcile the relative roles of emotive and rational drivers of behaviour. For example Elliott (1998) re-emphasises and clarifies the role that emotion might play in the consumption process. Another example (this time from the cognitive tradition) is the expectancy value model approach (Dabholkar, 1999). This work stems from Fishbein's and Ajzens's (1975, revised in 1988) work on the theory of reasoned action. This approach supports the view that both rationality and emotions have a role to play. Surely these roles will be context specific though? Crucially, from a complexity perspective, expectancy value based work acknowledges that the choice process is an ongoing and longitudinal process something that is often played down by other cognitive based approaches. Perhaps more significantly, again from a complexity perspective, is the acknowledgement of the central role of *feedback* inherent within the expectancy value approach. Feedback is almost taken for granted in complexity science; it is the norm.

3.2.3 Behaviourism and situationalism

The behaviourist perspective also demands attention, Foxall (1990) and Foxall (1999)

being typical recent examples of the position of this work. The behaviourist perspective is not underpinned by the same assumptions as the cognitive school regarding rationality. It focuses on behaviour as output rather than the cognitive determinants and in doing so allows for other explanations of behaviour. In this way it emphasises the importance of the environment in which the consumer operates, or more specifically the *interaction* between the consumer and his/her environment. Foxall (1990) is also critical of the cognitive orthodoxy, although he is careful not to dismiss its worth completely. The 'black box' notion often associated with behaviourism would seem compatible with a chaos perspective on the face of it. The black box interpretation of the human mind seems to suggest that the internal processes are highly complex and perhaps not 'knowable'. Therefore the external stimuli and behavioural responses are examined in behaviourist empirical investigations (often using experimental techniques developed in psychology e.g Shimp *et al*, 1991). Moreover Foxall (1990) appears to advocate time series as a worthwhile form of data representation in consumer research. Perhaps this is a legacy of the influence of behaviourist psychology where experiments often had a time dimension. However it is important to note that research which focuses on behaviour is not necessarily behaviourist. Behaviourism is best described as a school of thought not a methodology.

Research has also shown that situation is important and the resulting situational perspective has been adopted into the mainstream (Belk, 1975; Chow *et al* 1990; Umesh & Cote 1988)[3]. The importance of situation is looked at in more detail below (see section 3.6.3). Arguably the situational perspective falls within the realm of behaviourism since it

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[3] Laaksonen (1999) suggests that 'low involvement' purchases may be more susceptible to situational interactions. So-called low involvement purchases are the focus of this research.

suggest a stimulus-response scenario e.g. the smell of a shop puts a consumer off an intended purchase.

3.2.4 Other critiques of the cognitive school

The stochastic school are often critical of the cognitive approach. For example Ehrenberg (1988) is critical of the cognitive schools 'intuitive' approach (e.g. Howard & Sheth 1969). This exposes tensions between the stochastic probability approach to consumer behaviour and the cognitive tradition which are less well celebrated than the interpretivist-positivist debate for example.

More recently consumer research has been exposed to ideas influenced by social theory and postmodern modes of research (Peter 1991; Sherry 1991; Firat & Venkatesh 1995), this has presented consumption as a cultural activity and has moved the focus even further away from cognitive processes and the economic psychology approach. A methodological shift has accompanied this shift in focus. The deductive quantitative based methods of the cognitive school have been challenged by the qualitative methods favoured by the interpretivists. Nonetheless much of the work undertaken by the interpretivists is still *empirical*. However a great deal of consumer research is still within or influenced by the cognitive school, although it has tended to become increasingly fragmented and specialised.

There is a danger that the zealots of the interpretivist turn create their own climate of intolerance of alternative methodologies (something the cognitive school have often been accused of); for example a rejection of quantification in any form. Foxall (1995)

calls for a pluralist approach to consumer research arguing that 'science' and interpretation have their place. The way the debate between interpretivists and the so called positivists has developed has lead to unhelpful caricatures of each other's position emerging. The fact remains that a lot of interpretive research is empirical and that a lot of empiricist research uses 'interpretive' methods (sometimes *quantitative* interpretive methods).

Can chaos and complexity theory provide another critical perspective on orthodox consumer research? Chaos and complexity theory might be seen as part of the wider drift in the social science and business disciplines to post-structuralist and post-modern forms of inquiry (Cilliers 1998), as discussed in the previous chapter and in more depth in the following chapter (section 4.2). Whilst much of the work inspired by chaos is not interpretivist in the way that existing work in consumer research is, it is often inductive and more inclined to accept ambiguity rather than continuously try to dispel it i.e. identifying uncertainties as well as certainties.

3.3 The process has an outcome: purchase and consumption

However it comes about, people make choices and they buy things and they consume things. The process produces observable behaviour that can be recorded, analysed and described i.e. purchase, patronage, consumption etc. These outcomes are clearly of interest to the marketing academic and consumer researchers. This interest has lead to the body of work dealt with below in section 3.4. and 3.5.

Before this review is undertaken however an important distinction needs to be made. The terms purchase and consumption have distinct but often overlapping meanings within consumer research. Unfortunately some researchers use the terms interchangeably. Much of the work on brand choice modelling is done on purchase data. However Van Trijp (1995) among others emphasises the importance of being specific about consumption or purchase. Clearly it is possible for people to buy on behalf of others, or to buy and not consume, or to consume but not buy. So the examination of purchase habits comes with a caveat: purchase behaviour may only be a proxy for consumption behaviour and *vice versa*. Moreover seeing purchase as synonymous with consumption belies the complexity of the consumption process, which is far from over at the point of sale. The importance of this crucial distinction and its frequent neglect cannot be over-emphasised, this point is revisited in Chapter 4 (Methodology).

3.4 Brand loyalty and variety seeking behaviour

Within consumer research a substantial body or work has arisen to explain and explore both loyalty and variety seeking behaviour. Both areas of effort are attempting to account for behaviour effects *over time*. As Bawa (1990) acknowledges loyalty and variety seeking can be attributed to the same consumer for the same product. Nonetheless research into loyalty & variety seeking have not only remained somewhat divorced from each other, but the main body of loyalty research in particular has had little communication with the brand choice modelling school. Variety seeking research has a stronger apparent relationship with the brand choice modellers (since it is most often investigated using modelling techniques), however it still appears to be regarded as a discrete area of research. This is yet another example of the compartmentalisation in

consumer research. Given the inherent complexity of the subject perhaps this compartmentalisation is inevitable as suggested in section 3.2. above.

3.4.1 Brand loyalty

Any debate about consumption choice over time is clearly related to the ongoing debate about brand loyalty. This section seeks to put this large body of work into some context. Unfortunately loyalty seems to have been chosen in an arbitrary fashion to describe certain forms of consumer behaviour. Loyalty is a loaded word which has a variety meanings and associations dependent on a number of contexts. This ambiguity has tended to colour the debate about its existence and its effect.

Loyalty definition has received a great deal of attention in the marketing and consumer behaviour literature over the last few decades, although a consensus has failed to emerge. In 1978 Jacoby & Chestnut cited 53 definitions. The more recent reviews of the area highlight the disparate nature of research in this area and the problems of incompatible forms of measurement and approach (Pritchard *et al*, 1992; Samuelson & Sandvik 1997). Authors like Dick and Basu (1994) have tried to synthesise elements of previous approaches and provide a conceptual framework. However it is difficult for attempts at synthesis of the definitional literature not to: a) alienate significant sections of the definitional literature b) appear oversimplified or c) appear labyrinthine in complexity.

Nonetheless previous and current attempts to define customer loyalty can be classified as follows. This form of classification is consistent with that formulated in the recent

reviews cited (namely Pritchard *et al* 1992; Samuelson & Sandvik 1997):

1] Strictly behavioural:

Behavioural definitions essentially equate loyalty with repeat patronage, its most readily observable outcome and manifestation. As a result many of these studies have been primarily concerned with the delineation of repeat purchase parameters (Frank, 1962; Tucker, 1964), although customer profitability is an alternative measure (O'Connor, 1996). The problem with this approach is that the terms loyalty and repeat patronage are seen as interchangeable. Repeat patronage and purchase are terms which are more amenable to definition than loyalty and probably more easily transferable in terms of application to different sectors and industries. However, there may be many reasons for repeat patronage, among them; lack of choice, habit, low income, convenience etc. Surely these reasons cannot be equated with or subsumed into any definition of loyalty where greater involvement is assumed? In other words the loyalty may be 'spurious' (Dick and Basu, 1996). For example the habitual heuristic (Bettman *et al* 1991) can explain some loyalty/repeat purchase. Perhaps repeat patronage can be described as a necessary but not a sufficient condition for loyalty to exist. Andrew Ehrenberg's (1988) work and related work from others has added a stochastic dimension to the debate about behavioural loyalty, but is often not cited by those writing about behavioural loyalty (this is looked at in more detail in section 3.5.1). Moreover as far back as the 1950's Cunningham (1956) developed the concept of 'first brand loyalty' and 'loyalty proneness'. This more fluid interpretation of behavioural loyalty is supported by Ehrenberg (1988) and others.

The more extreme view expressed by advocates of this approach is that any internal processes are irrelevant; behaviour is the true statement of brand loyalty (Tucker, 1964). However, there remains a question mark over their use of the term loyalty. If loyalty equals repeat patronage what is wrong with the term repeat patronage? The perceived lack of depth in these behaviourally driven definitions suggested to some that there was an apparent need for an attitudinal dimension (Day, 1969; Jacoby, 1971) in order to shed light on the internal processes behind different types of behaviour. Certainly the loyalty concept is commonly used in a way which suggests that many instinctively feel there is more to it than repeat patronage (e.g. Bhote, 1995)

2] Attitudinal/Composite: These approaches assert that the attitudinal element is a key component (e.g. Olson & Jacoby 1971; Jacoby & Kyner 1973; Dick & Basu, 1996; Baldinger & Rubinson 1996). In these definitions repeat patronage is the behavioural manifestation of loyalty but it is under-pinned by attitude. However there is little consensus on the exact nature of this attitudinal component, and a considerable variety of measures and approaches are used and suggested (e.g. Bennett & Kassaijian 1972; Jarvis & Wilcox, 1976; Jain *et al* 1987). Essentially though they are all saying the same thing:- loyalty is a function of attitude. For example the following taxonomy is suggested in one instance; behavioural brand loyalty, attitudinal brand loyalty, multi-brand loyalty, and general brand loyalty (Olson & Jacoby, 1971). Another study asserts that loyalty is; a] biased (non-random); b] behavioural response (purchase); c] expressed over time, d] by a decision making unit, e] with respect to one or more alternatives from a choice of brands, as a result of a psychological/cognitive process (Jacoby & Kyner, 1973). The

latter condition represents the attitudinal component (effectively this reduces loyalty to non-random purchase over time by a person faced with a choice; and this starts to sound very much like a definition of repeat patronage). Alternatively Dick and Basu (1996) see loyalty as the relationship between relative attitude and repeat patronage. In this paper relative attitude is defined as the attitude to the brand relative to other brands through the influence of cognitive, affective and conative antecedents i.e 'reasoned action' - (see Ajzen and Fishbein, 1980). Dick and Basu (1996) present the following classification as their definition of loyalty: i] Loyalty (high relative attitude, high repeat patronage) ii] Latent loyalty (high relative attitude, low repeat patronage) iii] Spurious loyalty (low relative attitude, high repeat patronage) and iv] No loyalty (low relative attitude, low repeat patronage). Dick and Basu's (1996) conceptual framework deserves credit for its attempt to unify the literature and consolidate the concept, but many questions remain about the true nature of loyalty in differing contexts. Whilst these three approaches are valid in their own right they begin to demonstrate the variety of definitions that can be found in the literature.

The fact remains that loyalty is used in an often arbitrary way, perhaps we should accept that the meaning of loyalty is variable (Fournier & Yao 1997). East *et al* (1995) are not alone in questioning whether loyalty is a consumer attribute or is context/product specific. Even when it is taken to mean repeat patronage the question remains: what percentage threshold of patronage constitutes loyalty? Is it 50%, 79%, 90%, 100%? Surely this is contingent on a number of factors, such as: the number of viable alternative/competitor products, the particular market and other context specific factors. A universally acceptable percentage/loyalty threshold is not viable.

3.4.2 Variety seeking behaviour

On the face of it the literature concerned with variety seeking behaviour would seem to be examining the same processes as much of the work on loyalty; surely they are the mirror image of each other; if a consumer is not being loyal then surely he/she is variety seeking? This logic is flawed however, since there may be other reasons than variety seeking for inconsistent brand usage/choice. Van Trijp (1995) draws the distinction between derived varied behaviour (which might be due to other factors like situation) and variety seeking where variety is the goal.

In the same way that loyalty research often implies that repeat patronage is a conscious choice, variety seeking assumes that a less stable choice pattern is the manifestation of conscious variety seeking behaviour (Raju, 1983; Strahilevitz & Read, 1996). Clearly though it is possible that variety seeking is not conscious but could dictated by availability factors. However it is acknowledged in the literature that variety seeking is context specific and unlikely to be the only form of consumption exhibited by an individual (Van Trijp 1995). Certainly it is product category related and depends to some extent upon the frequency of consumption. There is also a body or work looking specifically at variety seeking in the food domain, the thematic focus of this thesis (e.g. Lahteenmaki & Van Trijp, 1995; Van Trijp 1995). Within this body of work it is acknowledged that consumers will seek variety beyond the principal brand attributes. In other words it is proposed that consumers will seek variety in terms of other attributes (principally

flavours)[4]. However flavours and varieties could be considered as part of the overall brand identity.

Sarigollu (1994) acknowledges that there is still dispute about the most predictive model in this case and implies that there are limits to prediction using such techniques, a viewpoint which would be supported by the adoption of a chaos perspective. Van Trijp (1995) also acknowledges the importance of feedback from previous consumption, something which would clearly be supported by a chaos theory derived approach such as this. Van Trijp (1995) also draws attention to some of the inadequacies of recent research in this area. His critisism of the work of McAlister & Pessesmier (1982) and Kahn *et al* (1986) for inconsistent use of variety seeking terminology would appear to be fair. Moreover Raju (1986) states that Jeuland (1979) and others assume that people seek variety always. Raju (1986) states that this is unrealistic, he suggests that the learning effect should be taken into account. This suggests that the consumer is continually evolving and is not a static entity; something that a chaos theory driven perspective would support. He also suggests that individual variation between consumers has thus far been underestimated. Once again this is a position which would

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[4] A note on food choice and non-brand attributes:
Marshall (1995a & 1995b) demonstrates that a myriad of factors affect food choice. On the whole the food choice literature mirrors the mainstream of consumer behaviour in content; with a cognitive tradition (Shepherd and Sparks 1994) and an emergent more intepretivist mode (Kemmer *et al*, 1998). To some extent though food choice has developed as a discrete area of study. Logue (1991), in her work on the psychology of eating and drinking argues, along with others writing on food choice, that varieties and flavours area as important as brands (if they can be divorced at all). There are dangers with looking solely at brands although brands are important and relevant as Van Trijp (1995) indicates. Van Trijp (1995) emphasises the importance of not ignoring 'non-brand' attributes such as flavour, he attaches particular importance to flavour in his study of food consumption variety seeking behaviour but also acknowledges the importance of brand and pack identity. However he is in a minority in more mainstream product choice research in acknowledging the importance of so called non-brand attributes. The emphasis in this chapter is on brand choice because that has been the focus of consumer research and it is the potential contribution of chaos theory to consumer research (as opposed to food choice) which this thesis seeks to address. Nonehteless Logue (1991) and others should not be ignored.

be supported by a chaos perspective where variation due to context is accepted as a factor to explain variation in behaviour. Different things influence different consumers to varying degrees.

The Optimal Stimulation Level (OSL) is a pervasive concept in this work (Van Trijp 1995; Strahilevitz & Read, 1996). This is an attempt to explain the degree to which individuals indulge in variety seeking behaviour and is derived from work in psychology on exploratory behaviour. Essentially it explains variety seeking in terms of the requirement to be stimulated. A lower OSL will mean a reduced tendency to consciously seek variety. Raju's objections above could be applied to the notion of the OSL; if it exists them it will be context specific and dynamic (unstable).

Overall the work on variety seeking goes beyond seeing this form of behaviour as merely a stochastic process. Attempts are made to underpin the mathematics with psychological constructs. Nonetheless most of the work is oriented towards model building rather than more exploratory or descriptive forms of investigation. Little attempt is made to marry up the work with research into customer loyalty. Models have been used to explain the co-existence of inertia (loyalty effects) and variety seeking in an individual's choice processes (Bawa, 1990). Bawa concludes that over half his sample of households exhibit 'hybrid' behaviour, a combination of loyalty and variety seeking in the three product classes chosen. This is one of the few pieces of work that consciously acknowledges the cross over between variety seeking and loyalty effects. In doing so it goes some way to an acknowledgement of complexity. However Trivedi (1999) is not alone in asserting that the future of variety seeking behaviour research belongs to the modellers. The question *why?* has to be asked in the light of chaos theory. There is no good reason why an

investigation of *form* is not valid i.e. descriptive analytical techniques.

3.5 Brand & product choice modelling

This section seeks to put the array of work on brand choice processes into some workable context. The aim of this section is to review contributions, identify particular shortcomings and then the areas where chaos and complexity can provide additional perspectives and insights. Research in this area has been heavily influenced by both the cognitive and/or stochastic traditions in consumer research. A great proportion of the effort has centred around the use of models of choice behaviour. However the work lacks overall structure and it is therefore better described as a collage than a systematic tradition. This is due in part to the inter-disciplinary nature of this area of interest where psychologists, statisticians, consumer researchers and economists meet in an uneasy atmosphere. The meeting place is strewn with a plethora of beliefs, leaps of faith, methodologies and techniques of investigation.

3.5.1 The Dirichlet Model

Andrew Ehrenberg's seminal work (1972, revised in 1988) on repeat buying using the Negative Binomial Distribution (NBD) Dirichlet model has inspired much similar research (Frisbie 1980; Goodhardt *et al*, 1984; Chintangunta, 1992; Uncles & Hammond, 1995; Uncles *et al* 1995; Fader & Schmittlein 1993; Bhattacharya (1997)). This work is so influential that it requires a section to itself.

Ehrenberg's aim was/is to formulate a theory of buyer behaviour from analysis of purchase data; essentially an inductive approach. Ehrenberg highlights the 'models without facts' approach of some in the cognitive tradition (notably Howard & Sheth, 1969) and the 'facts without models' approach of practitioners. The point made may be a valid one but modelling is not the only form of quantitative investigation as the following chapter illustrates. He suggests that looking at quantitative sales or purchase data means greater relevance to applied marketing as presently practised in commercial context (though this should not be void of conceptual back-up or ignore the previous work in the field). He also acknowledges the inherent complexity of the buying situation (Ehrenberg 1988, p17) but concentrates only on the analysis of an 'output' i.e. purchase.

The Dirichlet is a probability model; it attempts to explain and predict behaviour by assuming that it is a stochastic process underpinned some 'laws' of probability. The Dirichlet is a negative binomial distribution model (NBD) model (Goodhardt *et al* 1984 and Ehrenberg 1988 provide a comprehensive explanation of the mathematics). It implies that individual consumer's purchases over time follow a Poission distribution (reverse 'J' or a humpbacked skew distribution) but that different consumer's have different average rates of purchase (this is revisited in Chapter 6). It is a parsimonious model in terms of inputs. It requires; a] the average frequency of purchase of the product and the product category in some given period, b] The penetration of the product and the product category for that given period c] the proportion of the population buying the item in that period. From these inputs it obtains the following: x] Probability distributions for individual purchases y] Any aggregation of the probabilities as a brand performance measure z] In any time period of relative length. The fit is often very close for certain types of product under certain conditions.

However it is not really designed to investigate individual behaviour, it is best suited to looking at aggregate behaviour and is therefore product oriented. Crucially it is most often used to investigate purchase rather than consumption; even more significant in the context of this debate is the fact it concentrates on household purchase (all these factors are reviewed in detail below). It aims to explain the rate of repeat buying for a given product rather than variety seeking or multi-brand buying, although some attempts have been made to extend the method.

The success of the model in predicting behaviour is difficult to dispute under certain conditions. However, there are a number of assumptions, problems and acknowledged shortcomings. A number of these shortcomings are acknowledged by Ehrenberg himself and others. For example Bhattacharya (1997), although complimentary about the contribution of the Dirichlet model, acknowledges some shortcomings in terms of its predictive accuracy. Moreover if a chaos perspective is adopted other problems arise:

i] 'Stationarity' is assumed

According to statistical theory 'A series is stationary if its mean and variance stay about the same over the length of the series' (Anon 1993). Granander and Rosenblatt (1957) add that it is the result of a stable random mechanism within a stochastic process, whilst Priestly (1991) states that it exists in series whose properties do not change with time. Indeed the nuances of interpretation surrounding the concept of stationarity are a microcosm for the ambiguities that exist in traditional statistical theory. The Dirichlet theory applies only to the stationary situation. Stationarity is defined by Ehrenberg (1988) as there having been no change in the sales level of the

item being analysed (this assumption is described as 'simplified' by East & Hammond, 1995). Ehrenberg asserts that this is the most usual scenario in most markets something which can be disputed by recourse to POS scanner data for many fast moving goods (an example of such data is presented in Appendix IX). He goes on to assume that marketing inputs do not have any net effect on the sales, surely highly arguable. This relates to the another questionable assertion that there is no erosion of repeat buying for a brand over-time (although more recent Dirichlet research has investigated this question). How stationary a series appears to be also depends on the level of aggregation/dis-aggregation used. An aggregated monthly interval time series of supermarket sales of a product may appear more stationary than a daily interval series. One could therefore assert that stationarity is a property of the underlying process not of the series itself. Some statisticians argue that you can have degrees of stationary and that a series cannot be said to be stationary or not (Priestly, 1991).

ii]Individuals are 'random'

The theory rests on the basic notion that different consumers have differing long-run frequencies of purchase for a given product. It also suggests that this differing tendency to purchase manifests itself over time in a manner which is "more or less random" (Ehrenberg 1988 p79). In view of the chaos definition of randomness given in Chapter 2 this is particularly significant. It implies that individual consumers are stochastic agents. From a chaos perspective individuals would never be described as behaving randomly, they behave unpredictably and are determined. The results do shed light on aggregate or product based processes, but are not so good at investigating the individual. Unfortunately much of consumer behaviour theory relates to individual processes. This point has always alienated Ehrenberg's work from other consumer

research of which he has been critical: 'Buyer behaviour tends to be fairly regular at the aggregate level... ...but it is more irregular at the individual level'.) (p210-211, 1988). Chaos theory would support this at least in theory. This is often the case in reality: regularity at the aggregate, complexity at the individual level (or the disaggregated level), this important point is revisited in section 6.3.10. However the Dirichlet modellers go further than this:

> 'We take the view that individual purchases occur *as if random* in manner... ...This does not mean that we think a housewife times her purchases and chooses her brands random (e.g. by tossing mental pennies). Instead people have verifiable reasons for making a purchase. But taken *en masse*, purchases are capable of being modelled probabilistically at the individual level, even though true randomness lies only in the model'. Goodhardt *et al* (1984) p 622-623 (their italics).

Therefore the Dirichlet is not literally saying consumers are random even though the model infers this. The full implications of this statement are reviewed in the light of the findings of this work in Chapter 6 (section 6.3.7).

iii]It uses household level data

This is not a problem in itself but much of consumer research relates to individual processes, this serves to alienate work on the Dirichlet from other research. Moreover the term household and individual or *per capita* are used interchangeably by some Dirichlet researchers. For example Uncles *et al* (1995) state 'For brand choice it is assumed that each individual consumer habitually buys from a small repertoire of brands'(pG75). This is despite the fact that they use household level data. This is problematic since as Kirchler (1999) and others demonstrate the household purchase situation varies and is highly complex in its own right. Some households are composed of one person, though many are not. These terms should

not de deployed interchangeably. One should be clear whether one is concerned with households, individuals or aggregate behaviour if time series research is going to mesh more successfully with work form the cognitive, behavioural or interpretive traditions. Moreover as East (1997) points out household purchase is more likely to show multi-brand loyalty than individual purchase since members of the household can remain loyal to their own personal preference, but by doing so they add to what appears to be a brand switching at the household level.

iv]It looks at purchase and not consumption.

Again this serves to alienate Dirichlet related work from other consumer research where purchase is a stage in the consumption process.

v]Problems dealing with multi-brand cases.

The model has problems with mutli-brand cases. Considering the complexity of many market environments in terms of the available brands and types this is a serious drawback. This again is acknowledged by Ehrenberg and others working in the field.

vi]Problems dealing with very frequently bought goods.

On Ehrenberg's (1988) and other's admission, goods bought on a very frequent basis are not adequately described by use of the Dirichlet. However a lot of goods are bought on a very frequent basis; a number of food and drinks products for example. The Dirichlet is typically used to look at products like packaged coffee or detergent or toothpaste – products which are purchased possibly one a fortnight to once a month (e.g. Ehrenberg 1988), or store patronage (e.g. Uncles & Hammond 1995). One could argue that these household products are more often than not bought in a similar setting

on a regular basis i.e. the supermarket. Goods for individual consumption e.g. snack food may well be purchased in a greater variety of contexts. The fact that the Dirichlet finds such categories problematic suggests that alternative methods are required to investigate this category of good. Although chosen principally for methodological reasons (see Chapter 4) this is the category that is the concern of this thesis. This represents a further knowledge gap that this thesis addresses.

The Dirichlet advocates deserve credit for their acknowledgement of most of the above short-comings. Notwithstanding this critique the model has enriched understanding of the processes of brand choice, loyalty etc. Perhaps its most significant contribution is the fact that the Dirichlet lends credence to the view that households at least are loyal to more than one brand or that they utilise a *portfolio* or *repertoire* of brands. This more fluid interpretation of brand usage begins to cover ground between the work on loyalty and variety seeking reviewed above (section 3.4.1). It allows situations where loyalty and variety seeking can occur within one series. Terms such as *favourites* are often used by Dirichlet researchers rather than loyalty[5]. There is an inherent appreciation that the process of brand choice is a *dynamic* process, loyalty research often seems to suggest a static or stable process.

The rambling definitional debate on loyalty outlined above with its plethora of definitions and approaches and measurement scales has tended to neglect the contribution of the Dirichlet approach. The Dirichlet is not a panacea, it has

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[5] The Dirichlet also suggests that sole brand buyers (100% 'loyal' buyers) are usually light buyers. Therefore a product may be purchased more by a frequent purchaser for whom it is a favourite as opposed to a very loyal infrequent purchaser.

shortcomings but also important strengths common to many time series driven research techniques.

3.5.2 Other contributions to brand choice modelling

Many other researchers have made efforts to model brand choice processes. Again most fall into the stochastic tradition rather than looking at the determinants (i.e. price, situation etc). Wierenga (1974) provides a useful breakdown of earlier attempts at probability modelling and finds fault with all of them[6]. For example the homogeneous Markov model. In this model the probability that a consumer purchases brand A at a certain point in time depends on the brand(s) bought at the preceding occasion(s). The probabilities of moving from one brand to another are called transition probabilities that form the transition matrix. The buyers population is assumed to be homogeneous in the sense that all consumers have the same transition matrix. This approach was criticised by Ehrenberg (1988) since it implies a steady state equilibrium will be reached as in any Markov process. This criticism is again consistent with seeing consumption as a continually evolving and dynamic process. Whilst many of these models like the homogeneous Markov model have been developed and criticised by subsequent approaches they remain influential and highlight some of the fundamental problems with the stochastic approach to consumer choice. Some of the same problems arise that arise with the Dirichlet.

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[6] Early versions of probability models criticised by Wierenga (1974) are as follows i]The Homogeneous Bernoulli model: This model states that every consumer purchases brand A with the same constant probability - p. Clearly this is an over simple characterisation of the process of brand choice. ii]The Heterogeneous Bernoulli model: Same as i] except that different consumers have different values for p .iii] The Heterogeneous Markov model: Same as the homogeneous Markov model except that consumers are allowed to have different transition matrices. iv]Linear Learning model: At each purchase a consumer has a certain probability $- p -$ of buying a brand. After a purchase this probability is transformed in a way which is dependent on the brand bought at that purchase. Both this and the Markov model assume that the brand chosen at a certain purchase occasion has a crucial influence on the brand choice in subsequent purchases.

More recent work has produced more sophisticated models. Pedrick and Zufryden's (1994) work is notable for their use of explanatory variables, e.g. advertising exposure. The problem with including determinants like this is the questionable value i.e how is advertising exposure measured? Is advertising exposure a good proxy for the influence it has (see advertising effectiveness literature below)? Perhaps this is one practical reason why the stochastic approaches have been preferred to models that use determinant variables; determinant variables are difficult to measure and account for reliably. *Chow et al* (1990) and Umesh and Cote (1988) emphasis the importance of including situational variables although there is also a limit to the degree to which situational variables can be measured and quantified.

The rise of non-linear models reflects attempts to address the inherent complexity underlying these processes (Javalgi 1988; Christen *et al* 1997). Javalgi (1988) suggest that task complexity can influence the predictive performance of both linear and non-linear models of consumer choice. Although within the stochastic cognitive tradition there is at least some acknowledgement of the importance of complexity[7]. For example Schori & Meadow (1985) employed different models for different categories. The acknowledgement of the importance of context is notable as it begins to query the rationale for using models as generalisers of behaviour and moves towards the chaos theory supported notion that context is an overriding factor (because of its implications for variation in initial conditions).

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[7] The cognitive school has contributed specifically to this debate and modelling approach as essentially from a heuristics point of view. Mandrik (1996) uses heuristics to explain the how consumers make brand choice decisions. Hoyer & Brown (1990), see brand awareness as a choice heuristic to save time and effort.

More recently Baron and Lock (1995) and Gupta *et al* (1996) have acknowledged the challenge that scanner data represents. However there is a danger in seeing scanner data as 'the answer'. It does generate useful data but the question still remains as to how it should be exploited; the orthodox decision to employ modelling is still questionable whatever the data. Other techniques could be deployed in order to enrich knowledge of the processes involved (descriptive approaches examining the *form* of a series). Russell and Kamakura (1994) use individual level (micro) and aggregate level (macro) scanner data to explore brand competition on both levels. This sort of study at least innovates and points the way forward for similar research using scanner data.

A number of probability approaches to consumer choice have well documented constraints (some similar to those of the Dirichlet); many can only cope with two brand situations for example. Clearly this has restrictions for applications to many markets where a plethora of brands are available (see critique v] in section 3.5.1). Wierenga (1974) is notable however for his assertion that it is not just brands that are important. He asserts that other attributes like flavours (in the case of food) are also important product identifiers. Clearly what constitutes a brand is an important question. Many manufacturers have a number of sub-brands and arguably many products within the food domain are branded at the product level e.g. Doritos, Lilt, Snickers, the manufacturer brand often remains anonymous. The view that other product attributes should be considered (or even considered part of the brand identity) is supported by work specifically focused on variety seeking behaviour (Van Trijp 1995) reviewed above (see footnote 4 section 3.4.2).

Unfortunately one problem with many of the proponents of these stochastic based approaches is the unjustified belief that they are the only valid means to investigate the brand choice process over time. Wierenga (1974 p2) is too typical in his beliefs that:'..consumer behaviour is not deterministic.' and that: 'Brand choice processes are essentially stochastic processes'. These are bold, highly debatable assertions. How can consumer behaviour *not* be deterministic? Why should these processes be exclusively seen as stochastic? Of course they can be described in this way but there are a number of alternative mathematical descriptions e.g. a deterministic process, a logistic process, and a chaotic process among others. One can investigate these processes using stochastic techniques by all means, but at no point should the misnomer that this is the *only* valid form of quantitative investigation become an epistemological law.

3.5.3 Individual choice models

Individual choice models by definition focus on the individual process and might therefore be expected to have more of a chance of contributing to the wider work on individual internal processes and individual consumers' reaction with the wider environment. However a continuing problem with the modelling approach is that like the Dirchlet it speaks a different language (an essentially econometric/statistical language) from the rest of consumer research. Accepting the situationist perspective and other perspectives from consumer research and trying to incorporate them into these models or reconcile them is a difficult and complex task as Meyer and Kahn (1991) in their comprehensive review acknowledge.

Meyer and Kahn (1991) suggest that this area of research is characterised in the same way as other choice modelling research; as a collage of work rather than a systematic building process. They attribute this to the fact that the area is populated by researchers from different disciplines working largely independently of each other. Within this sphere discrete choice models (Tay, 1999) and multiattribute utility models (Nelson, 1999) have distinct but overlapping traditions, although all owe a debt to neo-classical economics. They also identify two traditions characterised by the following extreme viewpoints:

i] Individuals make choices by considering all relevant information available at the time. The chosen option will maximise some utility function defined across this information set (e.g. Luce 1959; McFadden 1981).

ii] Individuals are inherently limited in their ability to process information and make choices through heuristics (e.g. Tversky & Sattath 1979).

Tradition i] is open to the well rehearsed critiques concerning the assumption of perfect knowledge and information searching as a model for how consumers behave. It cannot account for impulse purchase, hedonic consumption etc. Utility maximisation is a problematic construct as discussed below. Tradition ii] might appear more realistic to critics of the information search school but the assertion that heuristics are the key to understanding consumer behaviour would meet with a barrage of objections from the myriad other perspectives cited in section 3.2. Moreover surely it depends on context?

Despite different premises, work in the empirical sphere has converged upon the use of utility maximisation models. Manrai (1995) reviews the use of these models and again emphasises the debt to utility maximisation theory (as Meyer & Kahn, 1991 do).

However utility maximisation is a tautology, it does not help use explain why consumers derive satisfaction from various attributes it merely asserts in its simplest form that consumers will acquire things that satisfy some need. It essentially states that if a product is acquired then it must maximise utility, if it maximises utility it will be acquired. Under this condition then a consumer who buys cat food but does not have a cat can be accounted for merely by asserting that they must derive some utility from cat food purchase. Moreover how does a consumer know when his/her utility is maximised?

Ultimately Meyer and Kahn (1991) admit that models still leave a great deal unexplained even if the premises on which they are based are accepted. Once again the inherent complexity of the consumption process is acknowledged, and once again an investigation of the form of any time series has apparently been neglected without any justification being offered.

3.5.4 Other approaches: moving towards chaos

Whilst marketing and consumer research have indulged in speculative work on chaos theory (see section 2.4.6) there is little or no evidence of empirical application. However there are some other studies which have applied a more critical angle on the temporal evolution of brand and product choice processes[8]. However they are not undertaken by academics who would necessarily describe themselves as consumer researchers primarily.

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[8] Even within the more conventional work deploying stochastic models there are insights into the instability which underlies stability at the aggregate level: '... a great amount of brand switching is observed under conditions in which the market shares are almost constant'. (Bass *et al* 1976 p1051). This acknowledges that at the individual level instability of choice is often the norm despite stable sales at the aggregate level. This issue is revisited in depth in Chapters 5 & 6 of this thesis.

Gaertner (1987) explores the aperiodic nature of some consumer behaviour. Although he deploys models using sample data he shows that behaviour generated by them can be unstable and aperiodic. Unfortunately he does not extend this to a real data set and therefore reflects the contribution of Hibbert and Wilkinson (1994) previously cited. Another study by Granovetter and Soong (1986) begins to draw the subtle distinctions between random and complex behaviour in a consumption context through an exploration of interpersonal effects on consumption. Granovetter and Soong (1986) show that models with simple assumptions can give rise to chaos (as stated in section 2.4.6 this is merely a re-iteration of what was already shown in previous chaos research), again there is a sense of reflection of Hibbert and Wilkinson's contribution (1994).

The two studies cited above appear in journals that might be regarded on the periphery of consumer research (Gaertner (1987) in a mathematical journal and Granovetter & Soong (1986) in an economics journal). However the fact that relevant work appears in such disparate journals only serves to emphasise the complexity and scope of consumer behaviour research. The dates of these pieces of work also suggest they have not been followed by systematic research of the questions they raise, possibly because they are outwith the mainstream of publications for marketers and consumer researchers. Questions regarding periodicy and aperiodicy, randomness and complexity are addressed by this thesis however.

3.6. Measuring the effects of determinants

Seemingly only a small number of the models cited above incorporate determinant variables like price, advertising and situational effects. A number of studies have

investigated these effects although not always with a temporal element (as is the case with the brand choice modellers – hence the priority given to them). A chaos perspective would support the view that many other determinants could be identified e.g. the weather, personal preferences, mood, culture etc. There is a tradition of research into the influence of some of these determinants, at least those traditionally considered to be the most powerful or of most interest to the marketer. Nonetheless the notion that these are always the most powerful or the only ones cannot be supported by any adherence to a chaos theory perspective. As Foxall (1990) asserts, many unobservables have an impact on the consumption outcome.

3.6.1.Price & price promotion

As with the utility based choice models the core theory of price is based on neo-classical economic theory. A number of investigations in marketing and consumer research have suggested that when psychological factors are considered price perceptions can be more contradictory and complex than economic theory might suggest. In some cases price awareness has been shown to be very low indeed.

A number of brand choice models have tried to account for price effects in brand choice and specifically price promotion effects. Krishnamurthi et al (1995) suggest that the price effects may vary from brand to brand. Again this adds weight to a complexity perspective on chaos where context is paramount. Takada & Chen (1995) suggest that price promotion does increase sales and that larger families will tend to be more susceptible to these kinds of promotions. Hunt and Keaveney (1994) suggest that the effects of price promotions on brand image may not be desirable i.e. may be negative

over the long run. This emphasises the fact that in systems susceptible to feed-back determinants can have positive and negative effects. The picture is further complicated by Mela *et al* (1997) who suggest that consumers become more price and promotion sensitive over time because of reduced advertising and increased promotions. This point of view is supported by Papatala and Krishnamurthi (1996) who use a model to investigate one product category and conclude that increased purchases using coupons erode brand loyalty (defined here as repeat purchase) and increase price sensitivity. Moreover Allenby and Lenk (1995) suggest that frequent buyers are more susceptible than infrequent buyers to price promotions and are more price sensitive generally. Many of these studies only study a restricted group of products or even one product category. Taken as a whole though their conclusions give some insight into the underlying complexity of the effects of price and promotions. The crude effects of price are not disputed, but the mechanisms for the individual vary and are complex.

3.6.2. Advertising

The processes by which consumers are affected by advertising have also come under scrutiny in marketing and consumer research. A great deal of this work has tried to assess the effectiveness of adverting and determine the factors which can either moderate or accentuate the success of advertising campaigns. Again this body of work could legitimately require at least a chapter to itself, the aim here is to provide some flavour for this research within the context of this thesis.

Franzen (1994) seems to link advertising strongly with the usage of brands and brand loyalty suggesting that effective advertising should encourage repeat purchase based on

an underlying positive attitude. The complexity of the process of advertising is explored through studies like Shavitt & Lowrey's (1992) examination of the interaction between personality types and product types. Hornik (1989) studies recall in an established tradition of advertising research although recall may not translate into sales. There is also a cognitive tradition in advertising research recently evidenced by Scholten (1996). Studies like Kanetkar *et al* (1992) suggest that advertising exposure can either increase or decrease price sensitivity to particular products, this would appear to be consistent with a chaos theory perspective where causal relationships are often seen as unstable or variable.

The question of what constitutes adverting effectiveness remains unproven. Is it an attitudinal construct, behavioural (i.e. measured by increases in sales) or is it a combination of emotion, attitude and behaviour? More recent work suggests that linear, cognitive views (the so-called linear-sequential conceptualisations) reveal only a very small part of the process (Elliott & Ritson, 1995). The notion of co-creation of meaning has encouraged the view that effectiveness is a two-way process contingent on the viewer and the advertisement. This suggestion of an *interdependent* relationship is consistent with the concept as described by chaos theory in the previous chapter (see section 2.2.5). The debate about advertising effectiveness whilst inconclusive serves to underline the inherent complexity of this area of research.

Certainly quantifying advertising effectiveness beyond looking at sales response to campaigns remains elusive. The effect on individual consumers remains equally impenetrable. It is very difficult to establish the subconscious and complex processes that determine how an individual is affected or not by advertising. The only assertion

that can be made with any certainty is that advertising can affect purchase, quite how remains ambiguous and context specific – varying from product to product and consumer to consumer and from advert to advert.

3.6.3. Situation

Belk (1975), Chow *et al* (1990) and Umesh and Cote (1988) among others emphasise the importance of including situational variables in brand choice models although there might be a limit to the degree to which situational variables can be measured and quantified as stated above (see also section 3.2.3). By their nature situational factors are myriad and many are beyond meaningful quantification i.e. the potential effect of a sales persons perfume on a purchase decision is highly problematic to determine and measure. Indeed there is some controversy about what constitutes a situational variable. Belk (1975) would assert that all factors including psychological factors contingent on situation could be included in any definition. However stricter definitions exist that define situational variables as time and space factors only (i.e. excluding psychological factors such as mood). Whatever the preferred definition the situational view highlights the fact that the purchase or consumption state is essentially unstable or susceptible to a number of influences over which the consumer may have no or little control. The consumer can obviously exert some control over their reaction to situation, but this control is reflexive and interactive.

Chaos theory would support the view that many factors (some apparently trivial) may have a powerful effect on outcome, and this is the essence of situational theory. As discussed in section 2.2.4 this is articulated in the sensitivity to initial conditions (SIC)

theory. There would seem to be some similarity between the situational perspective and any chaos concept of SIC. Both of these concepts suggest or imply instability through susceptibility to impacts on behaviour from unpredictable influences. The question of the synergy between SIC and the situational perspective is developed in Chapters 5 and 6 in light of the results of data analysis.

Work in retailing influenced by perspectives informed by environmental psychology has suggested numerous influences on the purchase decision in the retail environment. For example store atmosphere can have a powerful effect on behaviour (Greenland & McGoldrick 1994; Hesse *et al* 1997). If this work is accepted as valid then it would seem to support the situational perspective. Moreover much of this work concentrates only on the purchase environment, clearly consumption can be influenced by factors outside this environment. Any number of factors can potentially have an impact on our behaviour; we cannot exert absolute control our environment. Factors such as the sensory environment, availability, the weather, the social environment we inhabit at any one time, even the news could all provide situational impacts. The list of situational variables is therefore potentially infinite. Purchase and consumption are complex activities, of course some factors may provide an overriding effect at any one time but this is unlikely to be the case consistently. The issue of whether it is desirable or possible to account for all situational factors must also be raised. Some are relatively easily accounted for or measured (e.g. time of day) others are inherently inaccessible to the consumer researcher. However the inaccessible determinant may be no less powerful than the readily observed determinant. The task of attributing various outcomes to various situational factors is therefore fraught with difficulties. Even if a statistical relationship exists between a measurable situational variable and a measurable outcome this does not necessarily prove a cause and effect

relationship (as discussed in section 2.2.5).

Overall the existence of situational factors substantially adds to the stock of immeasurables and obtuse variables already overflowing with the various psychological variables that might influence the consumption decision.

3.7 From Literature to Research

The Dirchlet model (as one example) apparently shows us that consumer behaviour can be modelled and predicted (Uncles & Hammond, 1995; Chatfield & Goodhardt, 1975; Ehrenberg, 1988), and in the first instance this would seem to contradict the view that chaos theory has something to offer. The Dirichlet can help to explain and sometimes predict (though it is not really a projective technique) but only under certain assumptions and conditions which are not always met in the market place (as discussed above). Moreover the explanation of behaviour offered gives little insight into the processes of choice as they relate to the individual. Furthermore, it is not designed to predict individual behaviour. Some forms of consumption behaviour are highly predictable others are not, surely it is the unpredictable that requires the more innovative observation and research e.g. very frequently consumed goods (identified as problematic by Ehrenberg 1988)?

The fact remains that models do not mimic reality, predictive powers are limited. Why is this so? A possible answer lies in the sensitivity to initial conditions concept described earlier in Chapter 2 (section 2.2.4). A small change in the value of one input and the outcome can change drastically. If some determinants (possibly the unobservables or unmeasurables) are actually excluded from the analysis then clearly their influence will

remain mysterious and within the domain of the percentage not explained by the model. It is impossible to account for all determinants in models designed to predict human behaviour. Notwithstanding this view of models using determinants, the determinants themselves should not be ignored. Obviously some determinants might be expected to be more powerful more often than others at any one time, certainly some determinants are of more interest than others in a marketing context.

Like many others Erdem and Keane (1996) employ a stochastic model to explain behaviour, but acknowledge 'noisy' signals in the market place. The noise concept is problematic however, who decides what is noise in the consumer communication process? The chaos view of noise is that it is valid data. 'Noisy' data may well be as capable as informing as 'clean' data and may well reveal forms in that data which would be lost using any filtering of data cleaning techniques. According to chaos theory 'noise' is often a symptom of a complex process.

The disparate nature of the work on determinants would seem to support a chaos perspective i.e. many potential determinants of consumption are cited. The situation is complex. In consumer behaviour we would tend to regard consumption or purchase as an 'output', but this choice is arbitrary in one sense. The mathematics can become divorced from the subject but it is only one representation of the individual's actions. In consumer behaviour our initial conditions are the determinants of consumption only because consumption is the chosen point of focus. At a more philosophical level this also reminds us that models of purchase or consumption are somehow implying that purchases or consumption events are somehow *the* output of someone's life, rather than *an* output (see Chapter 2 section 2.2.5). If this is not implied then the other inference is that a person's

consumption is somehow disconnected from everything else. A chaos perspective would argue that everything is capable of influencing their consumption, not just advertising exposure, situation and price (or other commonly used determinants or 'variables'). The list of determinant variables in any such model could therefore be infinite.

Part of the problem in reconciling all of the literature above is the fact that a lot of it is conducted in isolation despite conceptual cross-over. They all have something to offer a debate about consumption over time and chaos' contribution but synthesis and interplay has been minimal and is increasingly problematic because of the variety of epistemologies and methodologies employed. Moreover as stated above the fact that much of the work on brand choice modelling and variety seeking looks at purchase rather than consumption is an important problem. Most of the more conceptually laden consumer research investigates consumption rather than just purchase. If this particular example of comparmentalisation is to be overcome then more work needs to be done on brand *consumption.*

Generally the literature review revealed little *descriptive* quantitative analysis of behaviour. Modelling invariably seemed to be the preferred approach whatever the focus of any investigation. There is a lack of work investigating the *form* of time series, models are almost always the preferred choice. There are very few examples of the more sophisticated descriptive time series techniques being used as principal source of analysis. A chaos and complexity informed perspective also highlights particular shortcomings with the work, some of which have already been acknowledged whilst others are less commonly cited. One of the problems here is that chaos challenges some concepts and orthodoxies in conventional statistics. Statistics often presents itself as a cut and dried

science; this is not the case. Many of the underlying assumptions and theory are questionable, not wrong, but open to question. Likewise the approach adopted here is also based on concepts whose validity is questionable, nonetheless they are no less valid than conventional statistics *a priori*. Generally the review served to support the view that there was the need for and the absence of a more descriptive chaos driven approach. Ultimately though the validity of the perspective cannot be judged prior to the empirical research. This review also reveals ambiguities in definition in terms of individuals and households that should not exist. Individual choice must mean just that and not imply household decisions. The household will influence the individual and *vice versa* but these terms are not interchangeable. There is also evidence to suggest that individual choice behaviour over time has been neglected as an area of study.

Chaos and complexity theory are almost completely ignored, despite the fact that a number of previously identified critiques of established work are consistent with the adoption of a chaos perspective i.e. the importance of feedback, context, immeasurable variables, situation/initial conditions and the inherent complexity of the consumption process. Therefore the conclusion of this review must be that there is scope for an expeditionary investigation of chaos theory and consumption exploring the form of consumption time series. These perceived 'knowledge gaps' lead to the study of the form of individuals' consumption of frequently consumed products subsequently described in the next two chapters.

Chapter 4

Methodology

4.1 Introduction

As stated in chapter 1 there was no hypothesis as such, rather the research aimed to address the following question/s:

- Are chaos theory's analytical techniques an appropriate mechanism for investigating consumption?

By implication therefore it also addresses the following question:

- Is individual consumption or consumer behaviour ever chaotic (as described by chaos theory)?

The fact that there was apparently no precedence for an empirical application of chaos theory to consumer behaviour on the one hand provides apparent freedom in the research design process. However it also means that the research cannot rely on any established tradition in consumer behaviour or marketing. Nonetheless there is a considerable body of

work in the natural sciences and a modest body of work in the social and behavioural sciences to draw on, as Chapter 2 demonstrated, and this chapter seeks to emphasise.

The first aim of this chapter is to review recent debates about chaos research and methodology. Recent debates concerning consumer research methodology are also reviewed briefly and their impact on this work is assessed. The subsequent methodology and methods employed, including the chosen analytical techniques, are then discussed and justified.

4.2 The methodological location of chaos theory

Gleick describes chaos as a descriptor of the 'global nature of systems' (1987, p5) and therefore infers that he is not averse to the grand theory view of science, a traditional Newtonian trait. Lyotard (1984) among others however describes a rejection of classical modernist science and its association with the grand narrative (the explanation of everything in a theory). He accepts that answers may not be found and that a more fragmented view of knowledge is necessary (chaos theory could be described in this way). On the surface this is consistent with Gleick's assertion that chaos has the potential to reverse the 'crisis of increasing specialisation'. To many sympathetic scientists chaos is a holistic method capable of advancing explanations of whole systems (Stewart, 1989). Some postmodernists like Lyotard assert that for some questions there are no answers, whilst Gleick (1987) asserts that chaos theory states that there are answers, it is just that they may be too complex to identify. Acknowledging something is difficult is not he same as asserting that it is impossible however, and here is the real difference. In this sense the chaos theory approach is a positivist approach (although it can be applied on a

purely conceptual basis). Answers can be found, but they must be earned, and they may come in the form of enriched understanding rather than absolute truth. This might be best described as a 'complex positivist' approach, not necessarily diametrically opposed to relativist ideas or a more fundamentalist positivist stance. Moreover it can be argued that the acknowledgement of complexity in turn acknowledges the need for pluralistic forms of inquiry.

Calls for pluralist research notably Feyerabend (1970) acknowledge the need for interplay between contradictory concepts and methodologies, the potential of chaos through its acknowledgement of complexity to facilitate this exchange is a possibility. Chaos acknowledges that science has displayed inadequacy hitherto and that some 'grand theories' have been poor descriptors. It does not deny fragmentation, it allows the potential for communication between competing theories and provides some explanation of how competing theories can co-exist and be valid. Chaos theory itself is open to description as a grand theory, but if so it is a grand theory composed of many fragmented components, sub-theories and concepts.

Young (1991) has suggested (along with Brown, 1995 and Dobuzinkis, 1992 among others) that chaos is part of a the post-modern drift in scientific method. The post-modern credentials of chaos theory are debatable however (Price 1997), and this view is supported by Eve (1997) who believes that chaos is a development within traditional methods not an alternative post-modern approach. There are pitfalls with describing chaos theory as post-modern science since it is within the scientific tradition. Price (1997 p3) states that:

'A common misconception about the theories of chaos and complexity is that they are in some sense 'postmodern science'. But the constellation of ideas that falls under the general heading of 'postmodern' is typically not positivistic, not empirical – not what we generally conceive of as scientific lines of inquiry... ...chaos and complexity (whilst recognising the need for a modification of the reductionist classical model of science) remain grounded within the 'scientific' tradition.'

This view maintains the value of empirical investigation but acknowledges that some interpretations of 'truth' are illusory or evasive and certainly that it is complex. Essentially it depends on the interpretation of chaos theory by the researcher. A structuralist may see it as the impetus for the construction of more complex axioms, models and laws whilst an interpretive researcher may use it to enrich understanding of a process in a manner more consistent with a post-structuralist approach. Nonetheless chaos might be more consistent with the post-structuralist perspective of social science rather than post-modern as Cilliers (1998) suggests. Cilliers does give tacit support for seeing chaos as postmodern science in so much as it appears to be inconsistent with the use of 'metanarratives', however chaos might be open to the charge of attempting to be/become a metanarrative[1].

Chaos theory is a broad and rich conceptual resource. In the same way that postmodernism or Marxism are interpreted and used in a number of ways (sometimes conflicting ways) chaos can be used to justify a number of viewpoints at the conceptual level.

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[1]Brown (1993) describes a return to the grand theory despite postmodernity.

4.2.1 Methodological implications of chaos in the social sciences

Many of the methodological points of debate are -focused and distilled by the work of Gregersen and Sailor, (1993). They established six implications for social science research as a result of their theoretical work into chaos in social systems. These propositions merit exposure and evaluation since they summarise the possible contribution and ramifications of chaos theory discussed by many of the other commentators cited. In particular they focus directly on the practical impact of chaos theory on social science methodology and method. Although they make a number of questionable assumptions and assertions about the impact of chaos, they are worth reviewing as a touchstone for this debate:

Implication 1: As long as social sciences rely on cross-sectional studies, it is unlikely that they will discover and model the chaotic nature of social systems.

This pre-supposes that social systems are chaotic, whilst there is a growing body of evidence to suggest that this is the case in many instances, it is unlikely to be the case for all phenomena.

Implication 2: Poor analytical results are to be expected when analysing chaotic systems with standard statistical methods.

Chaos does require particular forms of analysis, any conventional techniques will prove inadequate because of their underlying assumptions. This is an important point and indeed chaos research has adapted and developed its own portfolio of analytical methods.

Implication 3: Simulation and modelling could be used to study chaotic or complex social systems, but do not expect them to be able to mimic any actual behaviour.

This is a particularly pertinent point in the context of the work subsequently undertaken. To model or not to model? Certainly a chaotic system will be very difficult to model accurately, especially in the field of human behaviour. However, it is likely that models still have a role to play in enriching understanding of stages or underlying causes of certain processes. There is a strong case to be made for abandoning modelling and investigating 'output' variables instead and feeding these results back in to theory i.e. a data driven approach. These issues are discussed in more detail below.

Implication 4: Statistical techniques will remain useful, but will have a different role in the analysis of chaotic systems.

This point leads in particular to an important debate about the difference between prediction and understanding. Prediction of complex dynamic systems is questionable in anything but the very short term (and this is often the case with much human behaviour). 'Chaosaticians' tend to argue that enriched understanding is more valuable than prediction, indeed that long term prediction is a 'holy grail' in many instances; certainly understanding should come before prediction.

Implication 5: Qualitative methods will increase in importance when studying potentially chaotic phenomena.

This is a particularly vogue point in terms of a number of methodological debates not least in marketing and consumer research (see section 4.2.2 below). Gregersen and Sailor assert with some justification that many human behaviour or cognitive related

variables are essentially unquantifiable or immeasurable (except in abstracted terms devised by the researcher). It could be argued therefore that quantitative methods become questionable in some instances. There are problems with this rationale however. Firstly it tends to equate quantitative investigation with modelling, and secondly it relies on assuming that phenomena are chaotic or complex dynamic on some anecdotal evidence or intuitive assertion. Certainly many research questions or consumption phenomena are not amenable to any quantitative investigation and preclude such analysis, but chaos is primarily a mathematical concept concerned with the evolution of phenomena through time. It would therefore seem perverse to eschew any mathematical application *a priori*. Eve (1997) sees the assertion that chaos advocates that empirical social science is impossible as fundamentally flawed. For example one could argue that the first step would be to examine the validity of the assumption that a system is potentially chaotic, if you can establish that it *is* chaotic by quantitative examination of the quantified output variable (e.g. daily sales), then you can consider how to investigate the origins and processes which produced that outcome in the knowledge that it is chaotic or not. If it was found to be chaotic then a strong case could be made for qualitative analysis rather than quantitative measurement of 'unmeasurables'. However, chaos does not constitute a *carte blanche* for qualitative research *per se*, since it might be possible to perform some initial or more detailed quantitative investigation.

Implication 6: Social science must develop a definition of 'understanding' when analysing chaotic systems.

This implication re-iterates many of the points made above. Gregersen and Sailor, assert that the debate between qualitative and quantitative researchers has often been

about the relative desirability of understanding *vs.* prediction respectively, particularly when research with a temporal dimension is undertaken. Descriptive studies might therefore be seen as the only way to progress the understanding of any social chaotic phenomena, although this might include *quantitative* descriptive work.

4.2.2 Qualitative vs. quantitative

Chaos research is often qualitative in that it seeks to investigate the *general character* or *form* of a system's long-term behaviour, rather than seeking numerical predictions about a future state. However it achieves this qualitative assessment by means of quantification. This indicates one problem with the terms quantitative and qualitative: they are not mutually exclusive. The potential limitations of a purely qualitative/interpretive approach (similar to those used in some contemporary consumer research) as a means of empirical investigation of chaos are best illustrated in an example of how an aspect of chaos might be investigated without any quantification. The sensitivity to initial conditions might be explored through interview by trying to establish how a consumer arrives at various decisions and whether they felt small changes in determinants affected behaviour. The reliability of the consumer's memory and speculative nature of this technique would be difficult to relate back to chaos theory; a mathematical theory. Although some feel that chaos reinforces the need for qualitative analysis they do not suggest how chaos itself can be analysed without quantification. In fact no-one has attempted this. Furthermore it is worth noting that the distinction between interpretivism and positivism is not the same as the line between quantitative and qualitative method (Kincaid, 1996) as some consumer research appears to suggest. Quantitative research can also be *descriptive* and *interpretative.*

Another option worth noting is that of purely conceptual application similar to those employed in some sociological investigations of chaos. Although as Elliott and Kiel (1996) point out to eschew mathematics at any level is difficult to justify, that is not to say that conceptual application has no place – it has. However some disciplines have already displayed a tendency to rely too heavily on purely conceptual application of chaos theory e.g. sociology. This is in danger of reducing chaos theory to a collection of metaphors, or worse still reducing it to just semantic innovation if the application is trivial. Conceptual application can bring important insights but there is no reason why chaos theory should be confined to conceptual application in the social sciences and business disciplines.

Chaos theory is a mathematical theory and needs to be investigated mathematically. Of course it can be applied conceptually, but in the empirical sphere it is best suited to the analysis of some readily measured or observed phenomena e.g. sales, patronage or consumption. Smith (1995), Faber and Koppelaar (1994) and many others eschew this important point Chaos theory does not just have metaphorical power it represents a new way of thinking about and using mathematics, statistics and data in the context of social science investigation. Chaos can add something independently to theory formulation but can add more if accompanied by some indication of the extent to which it is present. Whatever, its appropriateness or otherwise for application in marketing deserves further enquiry. So despite being described as 'post-modern' science by some, chaos is a theory formed from and responsible for new quantitative analytical techniques. An analysis of some quantification of behaviour or an attempt to construct a chaotic model of the process in question is invariably the next step after any conceptual application in the social sciences.

4.2.3 Existing consumer research methodologies

Marsden and Littler (1998) state that there are five key consumer behaviour perspectives: the cognitive, behavioural, interpretive, postmodern and trait. Whilst this taxonomy is debatable, it raises the question of where this work is located. This work undertakes behavioural observation but it is not necessarily behaviourist. Conceptually *a priori* it is not necessarily in conflict with any of them. It is able to enrich critiques of any one of them as chapter 3 demonstrates but it does not refute the validity of the entire perspective. However it is possible that the results of this work may raise questions about any or all of these perspectives.

Recent debates about the epistemological and methodological direction of consumer research have centred around the relative merits of 'interpretive' *vs* 'positivist' approaches (Peter, 1991; Sherry, 1991; Foxall, 1995; Wind *et al*, 1991; Venkatesh,1999). The implications of this debate for an application of chaos theory should be addressed[2]. Interpretivism is often (rightly or wrongly) associated with post modernity and as already stated some see chaos theory as an example of postmodern science (Young, 1991; Dobuzinkis, 1992; Brown, 1995). But is it a theory amenable to interpretive methods? Purely qualitative empirical use of chaos theory is questionable as the previous section suggests. The generators of chaotic behaviour (people, groups) might be investigated qualitatively as Gregersen and Sailor (1993) suggest, but chaotic behaviour (the 'output') can only be assessed in a manner which connects the work with chaos research by using some form of quantitative approach. This might involve interpretation and qualitative assessment, but of quantified data. Eve (1997) provides a

useful summarisation of the myths of chaos and these illustrate not only misconceptions of meaning but misconceptions of potential and application more in tune with the ethos of this thesis i.e. investigation before declaration. Chaos advocates observation of phenomena and monitoring and in this sense is related to techniques such as grounded theory (Silverman 1993). The rationale for this is based on the notion that if they are chaotic then they are too complex to predict and should therefore be monitored.

4.3 Selecting an analytical approach

Accepting the need for quantitative assessment in the first instance restricts the possible application of chaos in the empirical sphere. Moreover chaos research design depends on the forms of analysis which are to be deployed. The data must be in a form that can be readily analysed quantitatively. Therefore it is expedient if the possible forms of analysis are identified before the data is gathered. However, as previously stated, there are two traditions within chaos research:

i] Modelling (Although there are also many different modelling approaches with different objectives (Harvey and Reed, 1996)) and the two traditions of chaos model identified by Cilliers (1998) : as a) rule based and b)connectionist (explained below).

ii] Descriptive and exploratory approaches of key 'output' variables. These explore behaviour of quantifiable output using exploratory techniques.

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[2] Hunt & Arnett (1999) among others feel that this debate is often impoverished and over-simplified.

The choice of whether to use either or both of these methods represented the next decision in the research design process. Whatever the merit of modelling and more descriptive monitoring approaches, they are in many respects addressing different questions. A model is often attempting to identify the relative power of determinants whereas investigations of a one variable series through time are attempting to comment on and characterise the 'output' *whatever* the determinants i.e. its form. Some models attempt to explain and predict present and future behaviour by past using behaviour (Chatfield & Goodhardt, 1975; Ehrenberg, 1988; Uncles & Hammond, 1995), although there are particular problems with this approach as discussed in Chapter 3. Of course models (even linear models) have explanatory power, however, they rarely emulate or predict reality consistently. Neural network and other nonlinear techniques have taken modeling in to a new era (Cilliers, 1998) although these observations on conventional modeling are still valid.

Some authors (Faber & Koppelaar, 1994) have asserted that in order for chaotic models to have external validity there must be an attempt to formulate theories of chaotic social interaction. Whilst there is a seductive rationale to this one can go a stage further and assert that model building is questionable where chaos exists. The tendency to chaos (or the absence of chaos) should be measured/assessed before notions of model building or theory formulation are adopted. Therefore any chaotic social science research should start from the initial investigation of whether a phenomena is or isn't chaotic, by analysing output variables (prices, sales, votes etc) and there are a number of examples of this (e.g. Haynes *et al*, 1995; Heiby, 1995b; Metcalf & Allen, 1995; McBurnett, 1996a). After this the researcher can then decide whether it should or could be modelled effectively or whether to opt for qualitative methods of research. Overall the process should be data

driven.

Eve *et al* (1997) and Back (1997) see modelling or specifically non-linear dynamic modelling as part of the hegemony of scientific method (of course there is always an inherent contradiction in the adoption of these more extreme views from a standpoint inspired by chaos theory which is itself a product of scientific method albeit enlightened and eclectic methods). They argue that the undermining of the linear cause and effect paradigm which chaos begins renders the deductive linear modelling approach redundant.

The problems associated with any acceptance of the pre-eminence of interdependence means that modellers applying chaos have to negotiate a tricky path in order to defend their rationale for using models. Cilliers (1998) states that models, in order to be completely accurate, would have to be as complex as the systems they are trying to enlighten. Price (1997) is yet another commentator putting the case against conventional modelling techniques. Jaditz (1996) points out that in an economics context models often fit well using sample data (past data) but have limited forecasting powers.

The fact that variables can potentially have strong explanatory functions is not disputed. However the problem in linear or non-linear regression in distinguishing between interdependence and dependence is not as conclusive as it might be. Variables chosen as determinants imply that they are themselves independently determined from the so-called dependant variable. For example advertising spend and consumption can be functions of each other, they enjoy a two-way relationship, which therefore is the determinant variable? The question then raised is what is a model explaining or showing? A statistical relationship is not sufficient evidence of a determining relationship, the real world is

complex, recursive and interdependent. More sophisticated modelling, much or it influenced by complexity theory attempts to address these concerns, with some success (Baumol & Benhabib, 1989; Brock *et al*, 1992; Craig *et al*, 1991; Medio, 1992; Heiby, 1995a; Rosser, 1996). Cilliers (1998) among others suggests that connectionist models (e.g. neural networks) are more appropriate for chaotic investigation.

However, even connectionist models require input or 'determinant' variables, although they are able to take into account their inherent interdependence. In the social sphere and in the case of consumption many 'unmeasurable' variables have an impact. As discussed in Chapter 3 determinant variables are not easily quantified or 'measured' on an ongoing basis (e.g. mood, situation, previous satisfaction with product) in comparison with the ease with which the 'output' can be measured (e.g. patronage, purchase, consumption). This requires further engineering of the data to adequately emulate reality. A model of consumption for an individual therefore would have to include a number of subjective elements and dummy variables, the parameters of this model would vary according to situation and product and time. This unstable model is almost impossible to identify, although some attempt can be made to identify the more powerful elements within the model (advertising and price being two acknowledged potentially powerful determinants). This problem is accentuated if the individual was to become the focus of the research. The effectiveness of advertising will vary from individual to individual from product to product etc. Chaos theory allows the acknowledgement of these instabilities and suggests that in a social science context where immeasurables are ubiquitous then analysis of the readily observable output variable (the preferred term to dependent, since many variables are inter-dependent) is another method worthy of greater attention.

The concept of the sensitivity to initial conditions serves to highlight more dangers in some mathematical models in consumer research, particularly in respect of their power to predict. A small inaccuracy or omission in the specification of the model is likely to mean increasing divergence over time with the observed reality. The monitoring rather than the modelling option is deployed in many disciplines confronted with complex systems and phenomena e.g. meteorology and seismology. Techniques developed for the investigation of chaos and other time series allow us to look at the pattern of consumption time series in their own right rather than as part of a model. Techniques exist which allow the tendency to periodic, aperiodic, cyclical or chaotic behaviour to be assessed i.e. spectral analysis (e.g. McBurnett, 1996b) and phase space diagrams (e.g. Berry & Kim, 1996; McBurnett, 1996a).

Descriptive forms of quantitative analysis require interpretation however and this is the price of their lesser imposition on the data than hypothesis testing and modelling techniques i.e. many such techniques are in danger of imposing order on a series. Perhaps the more fruitful starting point is to let the series speak for itself in its most disaggregated form. It is notable how few researchers and practitioners do not present time series plots of the data in the most disaggregated form available and only present the modelling stage. If this is done then the data may well keep some of its secrets. It has always been considered good practice in subjects such as econometrics to plot all variables in the most disaggregated form available. In chaos theory it is essential; initial judgements about the nature of a time series can be made from the time series plot alone.

The need therefore seems to be for the investigation of observable value time series in the first instance. Consumption or purchase recorded as output in this context is just one

manifestation of a complex life, not *the* output (although consumption and purchase should never be regarded as synonymous as section 4.4.2 emphasises). Nonetheless it is a readily observable manifestation of behaviour. By buying or eating a bar of chocolate or by walking into a shop the consumer is doing something observable and measurable. Therefore option ii] was adopted.

4.4 Data Requirements

The fact that much of consumer behaviour theory relates to individual processes, rather than aggregate processes (e.g. national or regional or reference group consumption), encouraged the view that individual consumption should become the primary focus as discussed in Chapter 3. Brand choice modelling does concentrate on the aggregate or the product but it has shed some light and made some assumptions about individual action. The decision to concentrate on consumption as opposed to purchase (discussed in section 3.2.5 of Chapter 3 and below in section 4.4.2) also supported the requirement for focus on individuals. Aggregate consumption as opposed to purchase is difficult to assess unless one assumes that all purchases are consumed.

Time series used in chaos research ideally should have a large number of observations for a given period of time. The greater the number of observations the greater the potential for patterns or other forms to be revealed in the data. From a consumption point of view the shorter the period of time the lesser the potential effect of some determinants in consumption; lifestyle changes, climate change, new product launches, significant societal events etc. These are likely to produce changes in brand consumption in the longer term. It could be argued that whilst they further demonstrate

the complex influences on consumption, that they also make inferences about form or patterns more problematic. So the preference in terms of a chaotic investigation of consumer behaviour would be for a large number of given observations within a relatively short period of time. The Nirvana in chaos research is for series with thousands of observations of very good quality (i.e. reliable) (Eckman & Ruelle, 1992). However a number of authors acknowledge that this is very difficult to achieve particularly in the social sciences and business disciplines (e.g. Hibbert & Wilkinson 1994).

Chaos cannot be readily and conclusively 'tested' for however, it is relatively easy to disprove its existence rather than the contrary (Williams, 1997). Some argue that the calculation of Lyapunov exponents provides the most conclusive indication of chaotic behaviour, but the series must be very large (thousands of observations) and of very good quality (Eckmann & Ruelle, 1992), however this is disputed (Williams 1997). The various analytical techniques are reviewed at the end of this chapter. In a consumption series of thousands of consecutive observations represents a holy grail. Scanner data does represent an opportunity to access such series but this records household purchase only, not individual consumption. From the outset it became clear that such series would be difficult to come by, nonetheless there are many examples of effective chaos research in the social sciences using much shorter series (e.g. 50-100 observations) as long as the appropriate techniques of analysis are employed. The primary data was therefore collected in order that it would be amenable to these techniques.

The decision was made to obtain data for products that are consumed on a very frequent

basis (likely to be purchased and consumed by an individual at least on a weekly basis) i.e. food and drink products. This meant that the number of observations could be maximised within a given time period in any primary data collection. Frequently consumed products would also be expected to have a faster moving 'cycle' or form, and therefore a more observable form. For example it would *a priori* seem more reasonable to expect a faster moving consumption cycle, pattern or form in the consumption of a brand or type of canned drink consumption than the consumption of stereos. Moreover Ehrenberg (1988) asserts that the pattern of brand choice for very frequently consumed goods are not explained by the Dirichlet and generally remain under researched.

4.4.1 Brand as an attribute but not the attribute

Since chaos theory advocates disaggregation it would be an anathema just to concentrate on the manufacturer brand only. Therefore individual *product* choice is the focus. The objective of this work is to examine brand/type usage in detail. Diet Coke is distinct from Coke, it is marketed discretely despite having obvious relationships to other Coke products; it is a separate product/brand. The diet element or the flavour or any other key attribute effectively makes the product a different brand or sub-brand. The rationale for using varieties as well as brand characteristics is reinforced by the work of a number of food choice researchers and consumer researchers e.g. Marshall (1995a) and Logue (1991), Van Trijp (1995) and Wierenga (1974). There is a potential problem in concentrating on manufacturer brand or sub-brand only. Indeed manufacturer brands are often inconspicuous with many food and drink products. With food there are a number of conspicuous attributes (e.g. , taste, texture, sugar content etc) as well as the more ephemeral but no less important brand 'values' (see section 3.4.2). Moreover one could

argue that flavour *is* a brand attribute of part of the brand identity for the product groups investigated here e.g. Coke. Van Trijp (1995) attaches particular importance to flavour in his study of food consumption variety seeking behaviour but also acknowledges the importance of brand and pack identity.

The acknowledgement of the importance of the 'additional' attributes is reflected in the use of the term *product* (or brand/type in the diagrams in Chapter 5) to describe the data subsequently analysed.

4.4.2 Consumption not purchase

As already stated the decision was made to target consumption rather than purchase. In many instances these two events would follow in quick succession, particularly for the categories of goods investigated in this thesis. However the principal reason for this choice was that purchase may be for the household or other individuals. Even loyalty card based scanner data of individual purchase would only provide information of their shopping at one location rather than all purchases of the product (although potentially providing long time series). Moreover the conceptual focus in consumer behaviour is more often the *individual* not the *household* and as already stated research on household level behaviour would have less interplay with the bulk of previous consumer research (see section 3.5.1 point ii]). Kirchler (1999) describes the complexity of the household level decision and the interactions therein. Household purchase and individual consumption are interdependent but not synonymous. An individual will consume from what is available from the larder when at home although may well have a say as to what is made available (purchased). Out of the house the individual will have more

autonomy and is dependent on retail availability of the desired product. If consumption is tracked then brand preference, whatever the purchase context, can be monitored effectively. However monitoring consumption is more problematic then monitoring purchase. Overall this work reinforces the case for focussing on individual *consumption* rather than household *purchase* since it supports the view that conceptually household consumption is a discrete and particular area of study.

4.4.3 Secondary consumption data

Secondary consumption data sets were explored as a possibility. There was a general reluctance to release this type of data from the companies approached including the market leader in this type of research (Taylor Nelson Sofres). However participants in the Taylor Nelson family food panel are 'rested' some of the time and do not constantly fill in diaries (Kent, 1989). The total number filling in diaries at any one time is constant as is the socio-demographic profile. Nonetheless any series obtained from Taylor Nelson for individual households could be discontinuous. Continuous series were needed in this case. Once again there is also a problem with the fact that such data is collected at the household level.

The decision was therefore made to collect primary consumption data based on individuals' product choice. Notwithstanding the fact that chaos theory is apparently neglected in consumer research, this sort of study is also rare in the academic sphere. The vast majority of any time series research is done on purchase data. Moreover diaries are not a common form of data capture in marketing academia.

4.5 Designing and implementing the diary study

Diary data solves the problem of disaggregation if the respondent is required to record each consumption event; it is therefore as disaggregated as it can be[3,4]. A diary study was therefore designed to examine individual's consumption of frequently consumed food and drink products. The primary aim of this part of the research was to provide data that would be suitable for the exploratory forms of analysis used in chaos research in other social sciences.

4.5.1 Previous studies and desk research

A thorough literature review of previous academic diary research in the social and behavioural sciences and desk research into consumption within the product groups[5] was undertaken. The table in the following section gives more details of the findings of this review, other inferences from the review are reported below. The data provided by the diary was designed to be quantified and analysed quantitatively. So prior to data collection a method of quantifying brands/varieties (products) using a weighted scale was developed (this is described in full in the next chapter before these plots are presented). This conversion process was tested (after the pilot study) and was found to be amenable to

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[3] The debate about empowering the respondent in consumer research (Marsden & Littler 1998 among others) is not an issue here since they record their actions; the subject is not their inner life but an observable 'output'.

[4] As far back as the forties Churchhill (1942) advocated panel type data collection to shed light on loyalty and brand choice processes.

[5] Telephone and face to face interviews were also conducted with the following individuals: Executive, Taylor Nelson AGB; Advertising Executive Scottish TV. Commercial Information Executive, Tesco,. Senior Product Manager, IRI Infoscan. Advertising Executive, Greys Advertising. They were consulted about sample structure and the product group characteristics.

the chosen methods of analysis.

The principal objectives of the study were reliability, length of series and breadth of coverage (people and products i.e. detail). All of these had to be balanced, and 'traded-off' against each other to some extent. As already stated the optimum for this research is a high number of observations over a relatively short period of time. After a survey of previous diary study research, principally in psychology, the maximum practical time scale was set at three months. This exceeded the median length of comparable academic diary research by some way; ranging from five days (Clavien *et al*, 1996) to four months (Johannes *et al*, 1995). Any attempt to exceed this period would have been more likely to run into reliability problems. Some market research agencies do exceed this time scale in their research, however their monitoring resources are far in excess of anything the lone researcher can manage also, as already explained, respondents are often rested leading to discontinuous series at the individual household level. Food diaries however are usually kept for relatively short periods of time, principally because they require far more detail about the eating regime of the individual than was required in this instance (e.g. 3 days - Colman *et al*, 1995; 1 week - Towers *et al*, 1994; 2 weeks-Lawton *et al*, 1995). They tend to require the informant to record *all* food consumption. The detail required for each diary entry is also another factor and should be kept to a minimum in order that the diary does not become too much of a burden for the respondent. This is another factor which has to be traded off against the duration of the study; the more complex the diary the less the duration appeared to be the rule which emerged from the analysis of previous diary research.

Generally diary design in other studies was practical and as parsimonious as possible

(the diary design used is given in Appendix II). Clearly if someone is required to fill in a diary on a repetitive basis then the more straightforward and less time consuming it is the better. Moreover as Heisenberg's uncertainty principle asserts; when you monitor something you tend to change it. The less obtrusive the monitoring the better in any behavioural study (beyond this there appear to be few other universal rules in diary design as long as it provides data in the format you require). In view of the above the decision was made to require each respondent to only record one product group e.g. soft drinks. This one product per person strategy would mean that they may exhibit behaviour of one type which is not shared in other groups of products they consume. This was offset by looking at a number of individuals for each product group. Another factor which reduces ambiguity and increases the likelihood of accuracy in this context is the fact that the respondent is required to record an actual event not abstracts as they are required to do in the many psychological diary studies cited.

4.5.2 Product category and target group selection

The products were chosen because they were very frequently consumed (possibly several times a week) and would yield the maximum number of observations within the set time period. This addresses the group of products identified as problematic by the Dirichlet modellers, and therefore addresses the knowledge gap discussed in previous chapters and the need for as many observations as possible in a given period. In all five product groups, identified as discrete in terms of desk research and in terms of secondary retail data sets obtained[6], were selected. The products were selected primarily because of their

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[6] This data is presented in Appendix IX and X. Due to the reservations about using purchase data it was not used in the analysis but was used as background research.

potential to provide the required number of observations within the given time period. They are also all products where individual preference is important. Clearly the purchase may be made by other members of the household as stated above, but these product categories are not likely to be too closely associated with family meal events. They are more likely to represent individual preferences and to be consumed in out-of-home contexts as well where individual preference is more likely to be manifested.

The gender and age ranges represent the primary consumers for each product group according to desk research after consideration of other constraints. Minors were deemed to be potentially unreliable sources of data. The decision was also made to target the working population age group. The over 60's might be said to be unrepresentative because of obvious lifestyle changes. However the groups are diverse enough in terms of gender and age to be considered significant in terms of subsequent inferences about the wider population considering the longitudinal nature of the study. The product groups and composition where as follows:

Group 1 SOFT DRINKS: Females & Males, 18-60.
Group 2 SAVOURY SNACKS: Males & Females, 18-60.
Group 3 BEER: Principally Males, 18-60.
Group 4 YOGHURT: Principally Females 18-60.
Group 5 CHOCOLATE: Males & Females, 18-60.

For each category the consumption (i.e. eating or drinking) of individually packaged portions was the focus of the research. Each respondent was required to record consumption in only one product group to minimise the burden considering the length of the study.

4.5.3 Piloting

The diary design and monitoring techniques were tested on five beer drinkers and five soft drink consumers before the study sample was recruited. The pilot study respondents were asked to record their next 100 instances of consumption of products in those categories rather than for a set time period as in the main study. The original format was in the form of A4 sheets this was revised in the main study in favour of a A6 (¼ A4) size portable booklet. The pilot study was a success in that it provided reliable analysable data. Nonetheless other problems with and improvements upon the pilot format were identified and the subsequent study was revised accordingly. For example the diaries used in the principal study included situational data, place of consumption and meal event/event time of day (see Appendix II) and monitoring was more frequent and reinforced with incentives (these and other measures are described below).

4.5.4 Sample selection

Many diary studies select samples on a convenience basis. Clearly there was a need here for the sample to be representative of the UK consumer as far as possible bearing in mind geographical and practical constraints of distribution and monitoring. It should be noted that the samples for longitudinal studies are often small in relation to samples required for 'static' statistics. The advantage or 'prize' is clearly the fact that the time dimension is observed. The sample was recruited to reflect the population of the study area (Stirling and central Scotland). Places of work were selected and targeted for recruitment in the belief that a group would create a cohort feeling and encourage more accurate diary filling. Places and type of work are also a way of categorising the population of the Stirling area,

although it is acknowledged that the variety of lifestyles, attitude and domestic background might be found within each place of work. After permission was obtained from employers an initial meeting was set up. The following types of work place were targeted and respondents were recruited:

A Plastics factory; An auto fitters; Accounts department of a public sector employer; A telephone exchange; A computer retailer; A local dairy; A local charity; The University- various departments (no academic staff). Other individuals were also approached to ensure that there was a mix of gender and age in accordance with the parameters outlined above.

4.5.5 Sample size and duration of the study

The total sample size was again well within the maximum (142 - Punamaki & Aschan, 1994) and minimum (14 - Bernsten, 1996) identified in other comparable diary studies. Studies with more respondents tend to be run over a shorter space of time however. Examples of sample sizes and the corresponding lengths of the studies are listed in the following table.

Table 4.5.5.1: Examples of sample sizes and duration from recent diary research

Sample size	Duration	Study
12	2 weeks	Lawton *et al*, 1995
14	6 weeks	Bernsten, 1996
30	2 weeks	Parkinson *et al*, 1995
34	1 week	Kember *et al*, 1995
36	1 week	Towers *et al*, 1994
49	8 days	Martin & Watson, 1997
49	4 weeks	Williamson & Barrow, 1994
50	1 week	Schredl *et al*, 1996
63	2 weeks	Allen *et al*, 1992
74	4 months	Johannes *et al*, 1995
125	1 week	Tidwell *et al*, 1996
142	1 week	Punamaki & Aschan, 1994

Overall 60 respondents (12 in each product group) over three months represented the optimal trade-off between numbers and time and represents a sample size and duration. These figures are well towards the maximum illustrated in the table above, surpassed only by the Johannes *et al* study (1995) in terms of both variables. In terms of cross-sectional research without a temporal dimension this sample may seem small. However the longitudinal element must be considered. The number of respondents multiplied by the number of diary entries is a truer reflection of the overall size of the study (in this case numbering 2,680 entries in total). In longitudinal research the 'prize' is the temporal element, and sample size is often relatively small as illustrated above. The final composition of the sample in terms of age and gender is illustrated in the following table[7].

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[7] A full breakdown of the sample can be found in Appendix I, that is those informants whose diaries were usable. Seven were eliminated from the research for reasons given below.

Table 4.5.5.2: Sample profile: gender ratios and age ranges

Group	Male/Female ratio	Age range
Soft drink	5/7	19-52
Savoury snacks	4/8	23-50
Beer	11/1	25-55
Yoghurt & Desserts	2/10	23-60
Chocolate snacks	6/6	24-51

4.5.6 Diary design

Diaries were made portable to aid accurate recording as they could be carried about the person enabling recording anywhere. They were anonymous and unobtrusive in design (A6 - 1/4 of A4) so that writing in them did not arouse interest or embarrassment. This was a particular concern for the beer and chocolate diaries where high consumption might arouse unwanted derision or concern.

Respondents were told that they could either fill in the diary each time they consumed a relevant item or they could fill it in at a set time each day. Both of these techniques have proved reliable in other studies (e.g. Terry, 1988). The hope is that after the initial period the diary just becomes a part of the respondents day and is less and less conspicuous, in much the same way that a participant observer merges into the environment that he/she is studying (Silverman, 1993).

Written instructions were also included to reinforce the face-to-face instructions. The respondents were asked to record the brand, pack size and other details; the date and general time and the location of consumption. Any more detail would have made the diaries too conspicuous in terms of influencing the consumption event. These details took

only a few seconds to record (most respondents reported filling them in as second nature after the first week or so). An example page in an identical format to the blank pages in the diary was also provided (see Appendix II). Respondents were also required to record demographic and other information. The diaries also included a letter of introduction and contact details, this also reinforced key instructions concerning legibility, accuracy etc (this can also be found in Appendix II).

4.5.7 The process of distribution

The data requirements were explained although the subjects were told that the study was concerned with consumption rather than specifically being told that it was about consumption patterns. Only subjects who expressed enthusiasm were approached. The belief that personal rapport and contact would lead to a greater commitment to the study meant that this approach was preferred to posting diaries or another remote launch. Filling in the diaries was explained and diaries were left with the respondents. This style of launch meant that not all diaries could be distributed within a short space of time so the study was launched on a rolling basis over three weeks. The subjects were asked to select the product group that they felt would be recorded most accurately. Potential informants who stated that they were occasional consumers were not recruited on the basis that they would not produce series long enough to analyse. As stated already subjects were allowed only one product group in order that records were as accurate as possible and inclusion in the study was not too disruptive to their consumption generally.

4.5.8 Timing

The study was conducted between the latter part of February and March, April and May (and into the beginning of June) in 1997. These months were chosen because of the lesser likelihood of holidays abroad (which would disrupt the 'normal' form of consumption if indeed any form existed) as well the lesser likelihood of extremely hot or cold weather (which is an acknowledged important influence on the consumption of food and drink). Clearly the weather will vary as will many other factors over this time period and will have an impact on consumption. As already stated a chaos perspective would accept that any factor in the informant's life could influence their consumption of these products. It is impossible to monitor all these possible influences but this does not render an investigation of form meaningless, on the contrary. However informants were questioned about any forthcoming salient life changes (such as job changes, marriage etc) and were not selected if such events were imminent.

4.5.9 Monitoring

Each respondent was revisited within a week in the first instance then after another two weeks then in another four weeks then at the end of the study. The aim was to make sure that diaries were being filled in accurately. Clearly the accuracy of the diaries was not easy to determine. However ten entries in one week and none in the next would arouse suspicion. This approach kept up the personal contact and relationship approach and enforced a sense of obligation on the part of the respondent. The respondents were also informed that all completed diaries would be entered into a prize draw, an appropriate prize being available for each category. It was hoped this would be another factor

encouraging accuracy and commitment. Very few (three) admitted that they had not filled in the diary to the best of their ability or felt that it had changed their pattern of consumption (respondents were asked not to look back at previous entries during the course of the study). Diaries from respondents who did indicate problems or admit possible inaccuracies were completed but were not used (they were not informed of this). Three respondents defaulted because of either long holidays abroad (which might obviously involve the consumption of unusual products/brands) or illness and were excluded from the analysis, one diary was mislaid. Overall 53 diaries were deemed of a high quality (an 88% response rate). This still represented a very good response rate for such a long period of monitoring in comparison to the other studies cited above.

4. 6 Interviews with respondents

The depth of the collected data was enhanced by consulting and interviewing the respondents. Exploratory research can be greatly enhanced by triangulating and collaborating different sources with one another (Geertz 1979; Wilson & Hutchinson 1991; Silverman 1993). In order to achieve this interviews were planned with a proportion of the sample *after* the data had been analysed. The respondents would have the weighted plots (described below and in the next chapter) presented to them, have the basic method explained and be asked to comment on their revealed form or provide explanations for particular forms of behaviour (e.g. a sudden change from stable consumption to 'variety seeking'). This would enable the respondent to cite reasons or justification for apparent/pseudo chaotic behaviour (should such patterns be found).

4.7 Analytical methods

As already explained these were selected before the process of data collection was initiated in order that the data would definitely be compatible with such forms of analysis. The following were identified and selected (or in the case of the weighted time series *devised*) after a review of techniques employed elsewhere in social science chaos research where comparable problems have been encountered. One form of popular analysis could not be used because the series were too short for Lyapunov exponent and correlation dimension analysis (Nerenberg & Essex 1990; Eckmann & Ruelle, 1992; Fraedrick & Wang 1993; Pisarenko & Pisarenko 1995). The Lyapunov is a form of dimensional analysis, but so is phase space and phase space maps were used. The Lyapunov exponent calculation or correlation dimension tests require series of vast length (thousands of observations). The Lyapunov is essentially a measure of instability within a system. However De Greene (1996) highlights the ambiguities of even Lyapunov analysis, and it seems that that chaos has no conclusive test, in some senses it would seem contradictory to be otherwise. It should be emphasised that chaos is still the subject of emerging and continuing debate in the vanguard fields of physics and research mathematics. Nonetheless the following techniques provided ample opportunity for rigorous analysis of the data gathered.

What follows is a brief description of the forms of analysis chosen and deployed in order that their selection and subsequent impact on the research design process can be appreciated. More explanation of their nature and deployment is included in the analysis chapter. The next chapter also includes examples of these analyses on dummy data-sets. These are presented with the analysis of the acquired data-set in order to facilitate an

understanding of the insights that each can bring. The selected methods were:

Weighted Time Series (WTS):

Weighted time series (WTS) plots. This is a form of data transformation to convert diaries to time series, it was required to enable the other analyses to be conducted. However it also represents a form of analysis in its own right. It was devised by the author.

Spectral Analysis:

Spectral analysis serves to illuminate hidden and more obvious periodic forms or repeated cycles in the data. Some chaotic series (e.g. the Lorenz system) are aperiodic, others (e.g. the logistic map) contain a vast number of cycles as McBurnett (1996b) points out. Williams (1997) also highlights the insights that spectral (Fourier) analysis can give to any time series including those that are potentially chaotic. Spectral analysis is an accepted method of investigation of chaotic phenomena in both natural and social science contexts (McBurnett, 1996b).

Phase space:

As Williams (1997) and others point out, chaos is often best addressed by some form of dimensional analysis and that this is desirable/essential and that phase space is an excellent option. Lagged phase space is used here because if requires only one variable and can be applied with very few data points, although the longer the series

the better (it plots data values against lagged values). Phase space diagrams have been used and advocated by a number of social science researchers examining chaos (e.g. Berry & Kim, 1996; McBurnett, 1996a; Dooley *et al* 1997; Williams 1997; Eve 1998).

4.8 Conclusion

It should be understood that not only is there a dearth of chaos research in consumer behaviour but that chaos theory and the science of complexity are still evolving. Application in the social sciences in general, whilst increasingly imaginative and comprehensive, is in its infancy. This applies to the analytical techniques that are developing and have been developed to investigate chaos. During the course of this thesis a number of works emerged in the social and behavioural sciences and the natural sciences. This piece of work is part of the same process. Debates about these techniques are still being conducted. Nonetheless the methods were chosen in order to probe the data to the maximum degree practical and appropriate at the time the field research was undertaken.

Whilst the questions posed in Chapter 1, and reiterated at the beginning of this chapter might seem broad in scope, the decision process outlined above in conjunction with review of the consumer research literature provided the focus. As stated at the beginning of this chapter 'the fact that there was apparently no comparable precedence for an empirical application of chaos theory to consumer behaviour on the one hand provides apparent freedom in the research design process'. Whilst there is freedom in the research design process and the conceptual focus for the research a target has to be set. The

research design might seem prosaic in comparison to the aim of this thesis. However it is not possible or practical to examine *all* possible applications of chaos theory simultaneously. The work on chaos in psychology demonstrates that a concerted effort requires many researchers to come onboard. The application described here was chosen in good faith, in the belief that (in light of the literature reviews in Chapters 2 and 3) it was the most justifiable application for an expeditionary investigation of chaos. Clearly another researcher might have pursued a different course of action. Whatever, the aim of the last two chapters has been to illuminate the process by which *this* study came into being.

As always the research design process can be represented as a dialogue between the ideal scenario and pragmatic necessity. It does not pretend to be a perfect process. Nonetheless the research design process aimed to provide data comparable to that used in other social science chaos research; in this sense it was successful as the following chapter demonstrates.

Chapter 5

Data Analysis & Findings

5.1. Introduction

This chapter seeks to present the results of the research in terms of the key research questions/objectives relating to the viability of a synthesis of chaos theory and consumer research. A synthesis of the findings with the literature relating to product choice is undertaken in the following chapter in order to explore the wider implications of this work. This chapter draws principally on the literature review of chaos conducted in Chapter 2.

The data analysis was approached systematically in the manner that had been planned and is described in the previous chapter. The diaries were converted into time series in the manner outlined below. These time series were then subjected to spectral (periodogram analysis) and lagged value phase space analysis – two techniques employed and advocated in emergent social science chaos research (McBurnett, 1996a

& 1996b; Dooley *et al* 1997; Williams, 1997). Selected informants were also interviewed and asked to comment on any perceived consumption patterns and provide explanations of any forms of revealed behaviour.

Clearly retail availability of some of these products will be one of the many factors which will affect consumption over time. If a preferred beer isn't there you can't have it. This thesis was never intended to refute the view that in some instances there will be powerful or overriding influences. However if a product sought is not available then other factors will determine the second choice. This thesis argues that many things can potentially affect product choice, these will vary from individual to individual, from product group to product group and from one time and place to another time and place. In order to state that there are always (for all products in all situations for all individuals) the same overriding factors one would have to refute a lot of research to the contrary as Chapter 3 demonstrates. The determinant factors themselves are all likely to be subject to variation or volatility; they are dynamic not static. Ultimately it is highly problematic to determine whether there was an overriding factor for each individual or whether that factor was availability, price promotion, advertising effectiveness, impulse or whatever, particularly over time.

The goods selected for this study can all be consumed in many contexts including at home. Again this will influence product choice, your home snack may be different form the one you have at work. However you do have the choice of taking one to work, if you desire, or anywhere else for that matter. Moreover location of consumption is just one factor of context. The importance and variation of context is supported by a chaos perspective through the concept of SIC. As stated in this previous chapter situation was

recorded in the diary but on the whole didn't explain a great deal i.e. correlation with product consumed was not very significant over the whole sample, neither was time consumed or meal event as recorded in the diary (see section 5.8). The point about the position of this thesis with respect to determinants made in the previous paragraph cannot be over-emphasised. It is not the function of this chapter to explore the relative power of determinants, nor is it the function of this work to assess probability. The function is to explore the form of the series from the perspective of chaos theory. There is plenty of work that has addressed determinants and probability, and many important insights and contributions have been made (see Chapter 3).

Finally there may be an issue with the 'accessibility' of these results. Spectral analysis and phase space are suited to the analysis of chaotic systems. The expeditionary nature of this work means that the forms of analysis may appear unfamiliar and possibly obtuse to the marketer or consumer researcher. In light of this possibility this chapter contains analysis of test data to facilitate understanding of these techniques. Each section of analysis also begins with an explanation of the technique. However the *application* of the techniques should not be 'simplified' as such in order to facilitate understanding at the expense of the efficacy of the analysis.

5.2 Descriptive statistics

The following tables provide the descriptive statistics form the acquired data set. Before the more sophisticated analysis was undertaken, this was done as part of a knowledge building exercise. The aim was to build up to the more unique forms of analysis whilst adhering to good practice in terms of conventional statistical analysis.

Whilst the aim of this work was to test some concepts new and controversial to statistical analysis, this does not imply that more elementary descriptive analysis should be by-passed. Complexity perspectives will often make recourse to more basic forms of analysis since they are in many respects less far 'removed' from the raw data. One drawback with these figures however is their inability to give much insight into the evolution of the system over time.

Table 5.2.1: Descriptive statistics: soft drinks

Respondent	Favourite product (brand/type)	Favourite as % of total	Total No. of units consumed	Total No. of products (brand/types)
SOFT DRINK				
SD01	Diet Irn Bru	20.8%	77	9
SD02	Diet Irn Bru	33.8%	210	13
SD03	Diet Orange Tango	36.1%	36	6
SD04	Diet Irn Bru	73.5%	83	6
SD05	Irn Bru	28.9%	97	11
SD06	Diet Irn Bru	24.1%	29	8
SD07	Diet Orange Tango	48.3%	60	8
SD08	Diet Irn Bru	29.7%	64	10
SD09	Irn Bru	33.3%	120	8
SD10	Strathmore	29.4%	50	13
SD11	Diet Coke	57.1%	14	3
Sub-Group Averages		37.72	76.4	8.60

The sub-group averages for the soft drink cohort provide a useful summary of that group. Informants consumed around 1 can or unit per day[1] and were over 37% loyal to there favourite product on average ranging from 21% to 48% (if loyalty is accepted as a behavioural manifestation i.e. repeat purchase). Their average repertoire of brands/varieties was just under 9, ranging from 3 to 13.

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[1] Individual packed units or individual portions: For beer this included pub measures as well as cans and bottles. Soft drink measures were also included if branded.

Table 5.2.2: Descriptive statistics: savoury snacks

Respondent	Favourite product (brand/type)	Favourite as % of total	Total No. of units consumed	Total No. of products (brand/types)
SAVOURY SNACKS				
SS12	McVities Mini Cheddars original	18.8%	16	10
SS13	Quavers Cheese	7.8%	77	40
SS14	M&S ready salted	38.2%	43	4
SS15	Planet Fish n' Chips	32.1%	28	14
SS16	Smiths Square cheese and onion	44.8%	58	10
SS17	Walkers ready salted	32.2%	87	26
SS18	Tesco Ready salted	22.2%	18	8
SS19	Doritos Original	38.7%	31	8
SS20	Roysters cheese & ham	11.4%	35	20
SS21	Walkers Cheese onion	16.7%	12	10
Sub-Group Averages		22.42	40.5	15.00

The savoury snack cohort consumed around half a unit/pack per day and are only 22% loyal to their favourite product on average ranging from 8% to 45%. This is reflected in their larger average repertoire of brands/varieties compared to the soft drink cohort i.e. 15 brands/varieties on average ranging from 4 to 40.

Table 5.2.3: Descriptive statistics: beer

Respondent	Favourite product (brand/type)	Favourite as % of total	Total No. of units consumed	Total No. of products (brand/types)
BEER & ALCOHOL				
BA22*	Somerfields German Pils	23.4%	94	25
BA23	Tennents lager	53.1%	81	8
BA24	Harviestoun	18.2%	22	12
BA25	John Smiths bitter	26.4%	106	18
BA26	Tennents lager	40%	65	8
BA27	McClay 70/-	53.8%	39	4
BA28	Guinness	11.7%	111	23
BA29	Tennents Lager	51.9%	135	6
BA30	Belhaven Best	48.4%	62	4
BA31	Guinness	41.5%	106	16
Sub-Group Averages		36.84	82.1	12.4

The beer cohort are about as loyal to their favourite product as the soft drinkers and on average display a larger repertoire of products (12.4 on average ranging from 4 to 25). They consumed one unit per day on average.

Table 5.2.4: Descriptive statistics: Yoghurt and packaged desserts

Respondent	Favourite product (brand/type)	Favourite as % of total	Total No. of units consumed	Total No. of products (brand/types)
YOGHURT				
YD32	Co-Op Cho trifle	14.8%	27	15
YD34	Safeway FF	40.7%	27	6
YD35	Milbona peach & mara	30.6%	72	24
YD36	Safeway Apri	7.6%	66	27
YD37	Tesco toffee	17.6%	34	12
YD38	Tesco Blue	30%	20	8
YD39	St Ivel Twin Pot apple & Custard	12.9%	31	20
YD40	Somerfield peach & passion friut	10.9%	46	22
YD41		10%	42	12
Sub-Group Averages		19.4%	40.50	16.20

The yoghurt and packed desert eaters are the least loyal on average (19.4% ranging from 8% to 41%) and have the largest repertoire of brands/varieties (16 on average ranging from 6 to 27). On average they consumed around half a unit per day.

Table 5.5.5: Descriptive statistics: chocolate snacks

Respondent	Favourite product (brand/type)	Favourite as % of total	Total No. of units consumed	Total No. of products (brand/types)
CHOCOLATE				
CC42	Kit Kat	25%	24	9
CC43	Kit Kat	22.2%	27	13
CC44	Asda Puffin	22.2%	27	13
CC45	Kit Kat	23.1%	26	13
CC46	Flytte	19.2%	26	15
CC47	- Joint Fav'	8.7%	23	18
CC49	- Joint Fav'	-	4	4
CC50	Aero - Plain	36.4%	22	10
CC51	Kit Kat	23.%	34	11
CC52	Snickers	30.4%	23	7
CC53	Snickers	100%	13	1
Sub-Group Averages		31.02	22.6	10.36

The chocolate snack cohort were less than one third loyal to the favourite product and consumed one portion every three days. Their repertoire of products was comparable with the other groups (ranging from 1 to 18). This group had the distinction of containing the only 100% loyal informant (CC53).

Overall 'loyalty' towards first choice products was less than expected. The size of the 'evoked set' (poolsize) or repertoire of brands was larger than anticipated from previous research (ranging from 1-40). This might be due to the fact that consumption (product usage) is the focus rather than purchase (this point is developed in the following chapter). The soft drink and beer cohorts provided the longest series although all of the cohorts provided series long enough for some form of meaningful time series analysis particularly in respect of the weighted time series and the phase space portraits.

5.3 Weighted Time Series

The weighted time series (WTS) plots are a form of data transformation. This was also required to enable the other analyses to be conducted. It also represents a form of analysis in its own right. The most comparable technique used in a consumer research context was employed by Wierenga (1974) to look at 'poolsize' choice groups. However that study did not use a weighting element as he looks at different 'output' that is already quantified i.e. the number of brands in a consumer's evoked set at any one time. Moreover the aims of that study were completely different (i.e. Wierenga's work was not informed by chaos theory). The similarity with this work is superficial but Wierenga's plots are a rare example of descriptive time series and their use in consumer research.

The key variable was clearly the product consumed. A method was devised which assigned ascending values to the least consumed i.e. most consumed was valued as 1, next as 2 and so on i.e. a weighted value (see Appendix IV for the values for the products used in the key example plots below) [2]. Where products were consumed the same number of times then the first consumed in the sequence was given the lower number. The values were then plotted in the sequence they were consumed, the vertical axis (ordinate) showing the weighted value, the horizontal (abscissa) showing the consumption event in sequence (time – labelled as case number here)[3].

The complete set of weighted time series can be found in Appendix III. Particular cases of interest and the most illustrative plots are presented here to give some insight into the nature and variety of the results. The following abbreviations are used: SD for soft drink, SS for savoury snacks, BA for beer (and substitutes e.g. cider), YD for yoghurts and desserts, and CC for chocolate snacks. The two digits after these abbreviations denote respondent numbers to facilitate cross-referencing with appendices. For stylisitc reasons the WTS are all presented as approximately the same size, clearly the relative numeric size of the axes vary according to the number of different product types

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[2] The fact that values are discrete not continuous has implications for the analysis as outlined throughout this chapter.

[3] Since the brands/varieties consumed are presented sequentially the time gaps between them will vary i.e. date and time of consumption. The time axis is therefore somewhat stylised, however this is necessary in order to examine the brand/variety usage. If the consumption was plotted with dates then the problem arises of more than one unit being consumed on one day in many instances. Moreover where no units are consumed for some days the line between the two intervening points would represent 'spurious' values. Although a series of coloured plots or dots would overcome this problem it would not constitute a time series which could be analysed as required. The other option would be to have a time axis of lesser intervals (e.g. every half hour) although the number of zero values would make the series very problematic to analyse. Nonetheless date and time of day were recorded and used in the analysis as described below. The chosen method of representation allows such analysis and means that the periods of time between consumption events becomes yet another variable or possible influence on the choice made. This form of data transformation also makes conventional time series analysis problematic, not withstanding the conceptual problems of combining traditional analysis with a chaos driven approach.

consumed and the total number of units consumed (case numbers/time). Appendix VII

shows two diagrams in relative scale (and their two corresponding phase space plots).

The first observation regarding the weighted series plots is the great variety of forms

and 'patterns'[4]. Many display oscillations between favourites and less favoured

products but this oscillation takes a variety of forms. Others are void of this oscillation

and show other forms of series progression. Arguably the most striking form is the

apparent long-term memory variety seekers who seem to continuously swing between

their favoured brands and brands/varieties that they only consume once within the

whole length of the series. The fact that they consume a number of brands/varieties

once means that the weighted values give the 'climbing' appearance in the series (i.e.

the first one consumed once has the lower value than the next when both are consumed

the same number of times i.e. because of the method of coding described above). Five

informants displayed this type of behaviour particularly clearly (three of them in the

savoury snack cohort).

Examples of the climbing variety seekers ('Climbers'):

Figure 5.3.1: WTS for SS13   Figure: 5.3.2 WTS for SS17
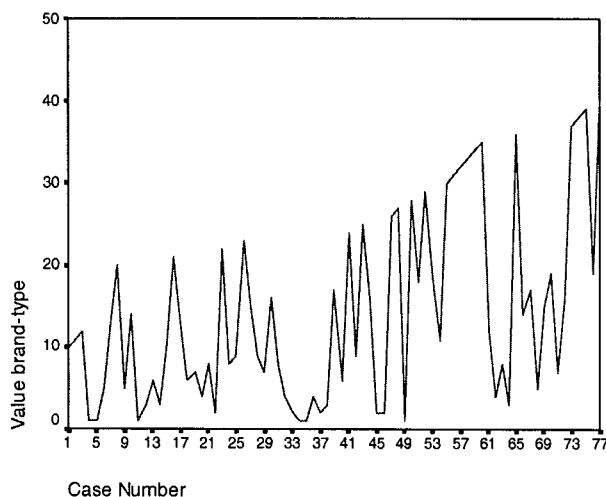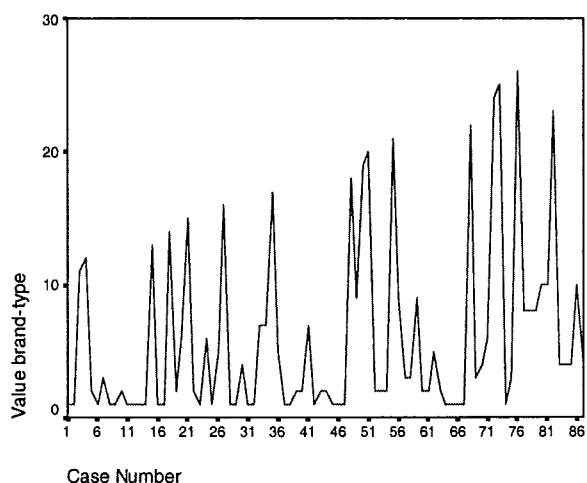
[4] The series on the whole are not stationary. As Jenkins and Watts (1969) state stationarity can often be
determined by 'visual appearance or from *a priori* knowledge of the phenomena being studied' (p151).

Figure 5.3.3.WTS for SS20   Figure 5.3.4. WTS for YD35
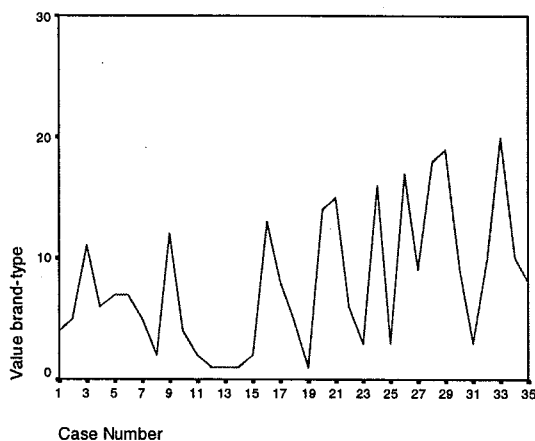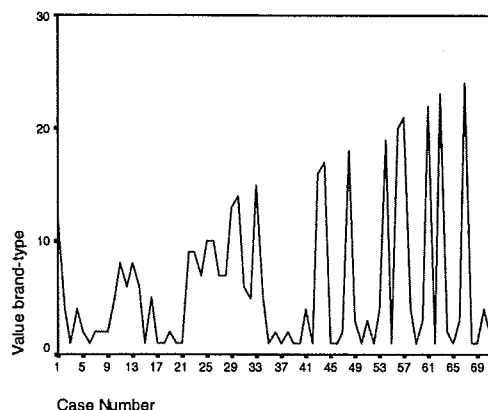
Figure 5.3.5: WTS for CC45
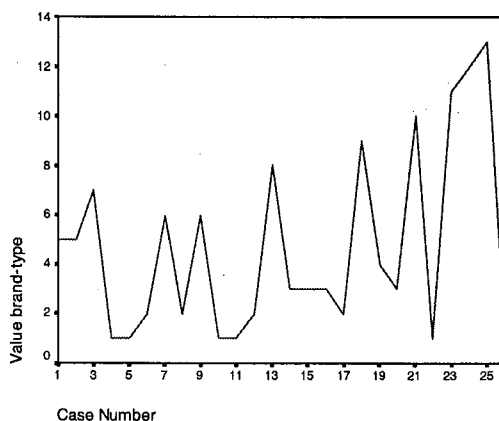
These plots seem to suggest that there is a systematic effort to seek out brands/varieties

previously not consumed in the series, oscillating between unusual varieties and

established favourites. They seem to imply that the memory is long term unless the

avoidance of the less favoured varieties is coincidental (which seems unlikely). The

implications of this finding for research into variety seeking is explored in more detail

in Chapter 6. These series are also representative of some underlying order to the

consumption choice process albeit an unstable form of order. They demonstrate the

value of the approach chosen and raise a number of questions about complexity in consumption and consumption more generally.

The more common type of behaviour displayed was the non-climbing oscillation however, although the exact form of the series varied considerably. The following plots provide some indication of the nature of this perceived group. The implications in terms of interpretation of attractors is discussed when the phase space analysis is presented below in section 5.6.

Examples of choice oscillation ('Oscillators'):

Figure 5.3.6: WTS for SD01
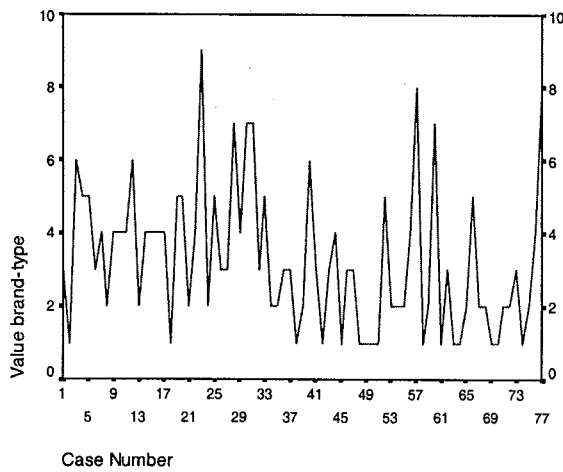
Figure 5.3.7: WTS for SD02
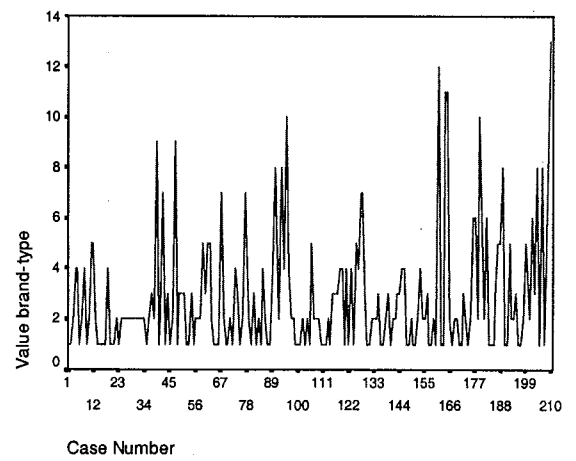
Figure 5.3.8: WTS for BA28
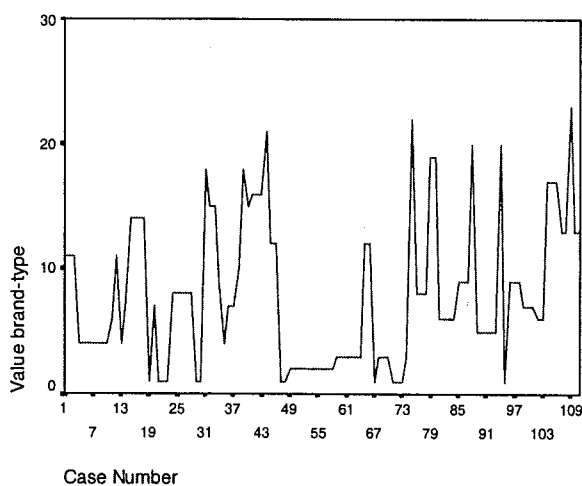
Figure 5.3.9: WTS for SS19
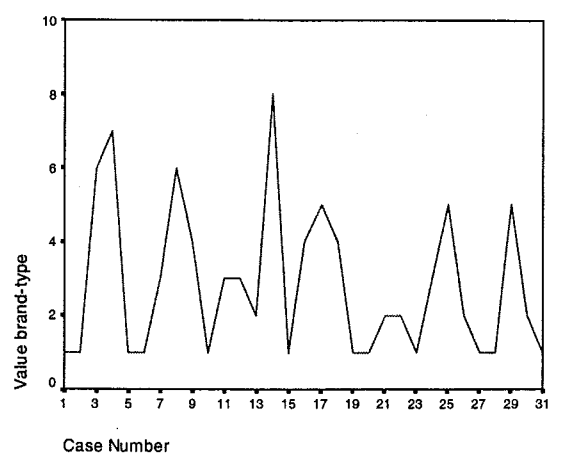
Some of the informants seemed to exhibit behaviour with definite phases, involving climbing behaviour, adherence to favourites and/or oscillation. Indeed many of the informants assigned to other groups in this typology could be justifiably included in this group. The following plots provide some examples of the variety of these series.

Examples of staged product choice behaviour ('Stagers'):

Figure: 5.3.10 WTS for BA22
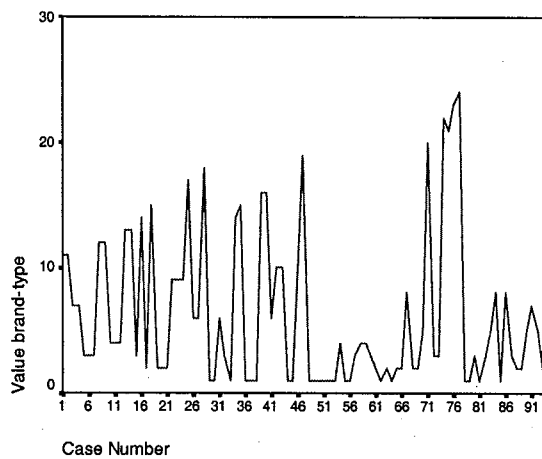
Figure 5.3.11 WTS for SS15
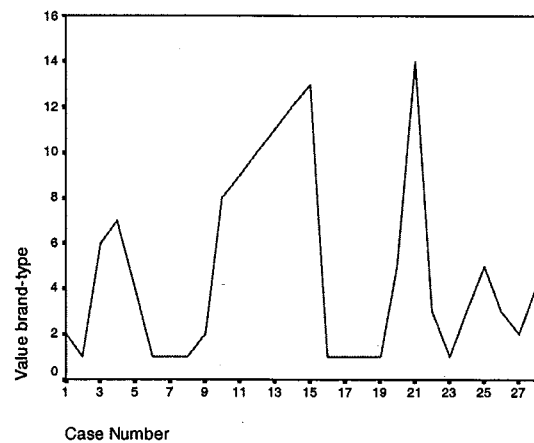
Figure 5.3.12: WTS for BA26
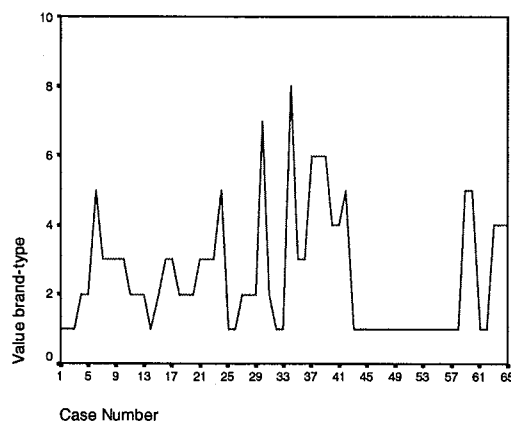
There was also evidence of session behaviour, arguably a sub-group of the definite phase group. The beer drinkers not surprisingly displayed this form of behaviour with product choices in identifiable phases of stability. However these sessions of preference

for particular products often extended over one session of consumption on a particular day i.e. the preference was carried over to another day. Moreover this form of 'flat-topped' oscillation behaviour was found in the other cohorts (evidenced by SS14 figure 5.3.13 below).

Examples of flat-topped (staged) oscillation ('Sessioners'):

Figure 5.3.13: WTS for SS14   Figure 5.3.14: WTS for BA25
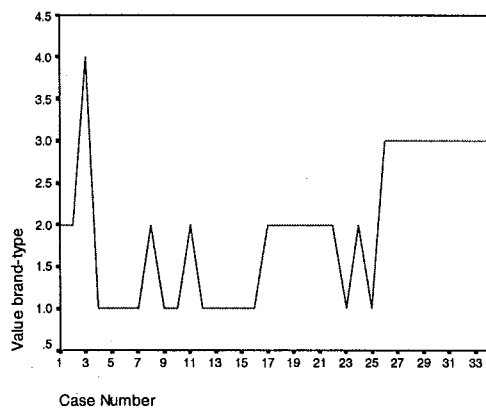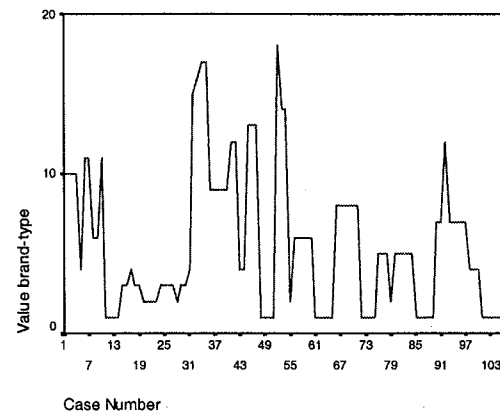
There was also some evidence of steady state behaviour where periods of erratic behaviour consuming less favoured products were followed by comparative stability and the consumption of overall favourites; or variety seeking followed by return to more favoured products (this could of course occur the other way round with a period of favoured product activity followed by a phase of less favoured products). This occurred at varying times within the series and was often followed by a return to a more volatile form of behaviour. This would move the informant towards the 'stager' group. The following examples all show the steady state at the end of the series.

Examples of steady state choice behaviour ('Steady staters'):

Figure 5.3.15: WTS for SD10
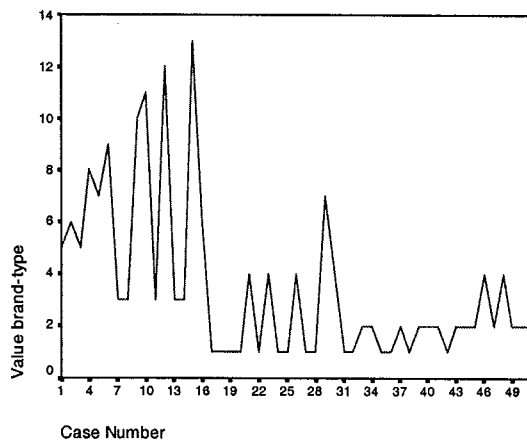
Figure 5.3.16: WTS for SS16
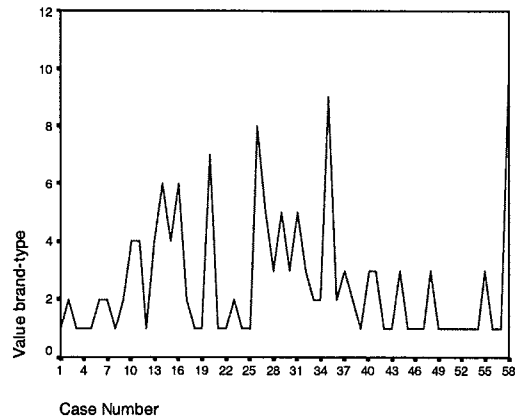
Figure 5.3.17: WTS for YD36
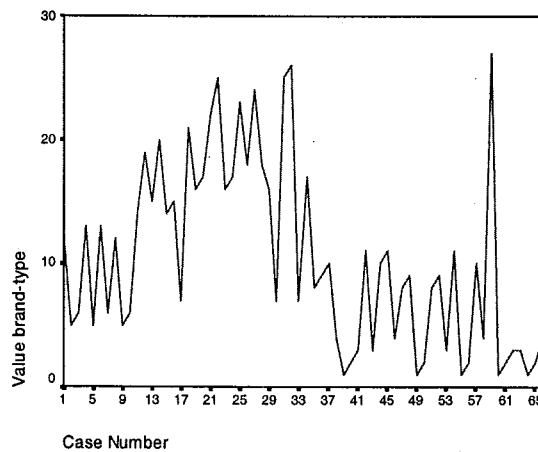
There were also some noticeable differences between product groups. For example the chocolate cohort were almost all erratic oscillating consumers, however the forms of behaviour *within* all the other groups is marked as the selected plots above demonstrate and reinforced in Appendix III. The five types identified can be found across the five product groups as the examples above illustrate.

Any stricter typology than that presented would not do justice to the richness and variety of the revealed forms of behaviour as illustrated in Appendix III. Some

informants are not easily associated with any of the five types identified. It should also be emphasised again that there is cross-over between the type groups identified (e.g. oscillation in the climbing variety seekers and climbing sections in other informants not identified as climbers here). Other typologies are defensible and to some extent will depend on the interpretation of the individual, however if there is an overall finding from this stage of analysis it is a} the variety of series and b} the fact that specific types of series can be readily identified.

5.4 Interviews with informants

Although the interviews were conducted after all the other forms of analysis the results are discussed here after the WTSs. This is because the interviews used the WTSs, therefore insights from the informants relate to them more than the other data representations.

Thirteen of the informants were interviewed[5] for the reasons outlined in the previous chapter after all quantitative analysis had been conducted. They were all shown their weighted plot series after a detailed explanation of how to comprehend it they were asked to provide explanations for any perceived forms of behaviour in dialogue with the interviewer. The interviews were recorded on tape. On the whole few categorical explanations were given. For example most did not feel that location or time of day as recorded in the diary were overriding determinants of which product to select (this is supported by the cross-correlation analysis – section 5.8). The three 'climbing' variety seekers interviewed said they did not consciously try to find products that they had not

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[5] SD01, SD02, SD04, SD05, SD10, SS13, SS16, SS17, BA26 BA28, BA31, YD35, YD36, CC51.

had for sometime although they did seem to acknowledge the need for some variety in their consumption. Most described the process of choice as an 'unthinking' or habitual process and most were surprised at the number of varieties they had consumed and the number of times they changed their behaviour. Many displayed misconceptions about their consumption belied by the data from their diaries. Almost all expressed surprise regarding the overall number of brands/varieties consumed, they had previously felt that their repertoire was somewhat smaller (despite the raised awareness that might be expected from being in the study). A number asserted that they believed that the diary would show that they always had the same product at home and a different one at work whilst the diary invariably showed that this was not the case.

Clearly the interviews (and the whole of this research) are about something which these people do not consciously think about a great deal. Dabholkar (1999) among other consumer researchers acknowledges that individuals may not consciously know (appreciate) how they make decisions. The decision to buy a packet of crisps is not a salient life decision and it is not surprising that after a few months had elapsed that informants found it problematic to explain their own past behaviour in any detail. However it should be remembered that the interviews concerned an activity that they were still indulging in at the time of the interview. An alternative approach would have been to require the informants to justify each consumption event as they happened (i.e. in the diary), clearly this might be even more likely to influence their consumption and would have made the diary too much of a chore. Moreover it might well have provided spurious data as many of these choices are not easy to comprehensively explain: indeed this is a key factor in the rationale for this research. Phrases used in the interviews like "I just buy what I fancy" are as likely to be used at the point of consumption as later on.

5.5 Spectral Analysis

Spectral analysis serves to illuminate hidden and more obvious periodicies in the data. Some chaotic series (e.g. the Lorenz system) are aperiodic, others (e.g. the logistic map) contain a vast number of cycles as McBurnett (1996a) points out. Williams (1997) also highlights the insights that spectral (Fourier) analysis can give to any time series including those that are potentially chaotic. Spectral analysis is an accepted method of investigation of chaotic phenomena in both natural and social science contexts (McBurnett, 1996b; Williams 1997). Spectral analysis allows the frequencies within the series to be measured in order to detect any recurrent regular cycles in the data. A full and mathematically rigorous exposition of spectral analysis is outwith the function of this section, however the following brief explanation encapsulates the essence of the technique (see Priestley, 1981 for a comprehensive survey of the technique).

Put simply, spectral analysis is concerned with the rhythm of a series. A spectral analysis of a series yields a description of that series in terms of the cycles of different period (length) or frequency that generates the series. This is represented graphically in a graph called a periodogram, depicting the estimate of the amount of variance of the series accounted for by cycles of each frequency. The horizontal axis of the spectral plot shows the frequencies into which the series decomposes, whilst the vertical axis shows the relative weight or importance of each detected frequency (this is depicted on a logarithmic scale in order to view the results in more detail)[6]. The actual frequencies

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[6]Various 'smoothing' techniques can be deployed in spectral analyses of data although these are not favoured in the examination of chaotic phenomena, where the relevance of the 'smoothing' concept is seriously in doubt (McBurnett, 1996b). The intention is not to model the series but to measure the data in its natural state.

are selected in order that the length of the series contains a whole number of cycles at each frequency, these are called the Fourier frequencies (after the mathematician who discovered them). The lowest Fourier frequency has zero cycles, this represents a 'cycle' that does not vary (i.e. is constant). The next lowest completes one cycle during the whole observed length of the series, whilst the highest (or most rapid) has half as many cycles as the number of observations (e.g. a series with a regular 'up-down' oscillation will have only one peak at 0.5 on the periodogram – see figure 5.5.1a and b below). Moreover, the total number of complete cycles cannot exceed 50% of the number of observations e.g. if you have 100 observations you cannot possibly have more than 50 complete cycles. Frequencies are measured in terms of cycles per time period, or cycles per observation. All of this translates to the following rule of thumb: A 'smooth' 'slower' series will have more variation accounted for by low frequency variation whilst a 'rougher' 'faster' series will have more variation accounted for by high frequency variation.

Some example plots are presented here in order to illustrate the value of the technique:

Example A : Regular switching between two products:

Figure 5.5.1a: Series A
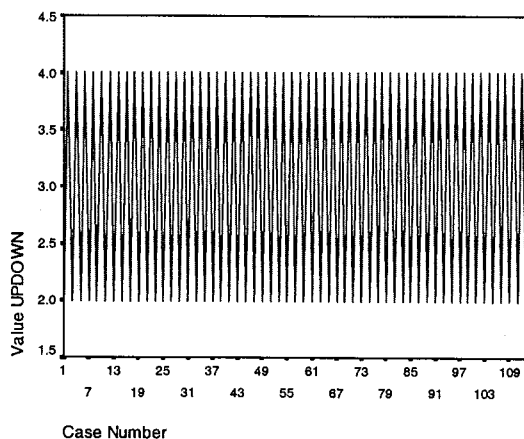
Figure 5.5.1b: Spectral plot A

Periodogram of UPDOWN
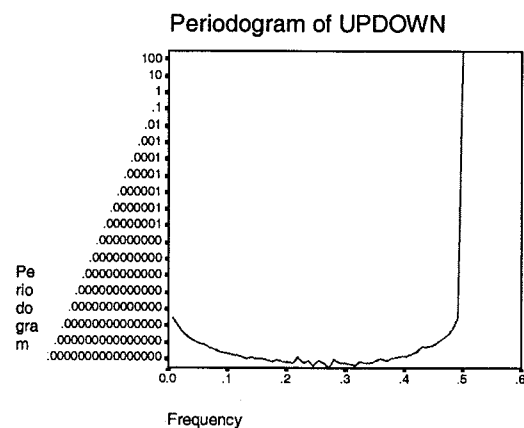
Example B: Regular switching between four products:

Figure 5.5.2a: Series B   Figure 5.5.2b: Spectral plot B
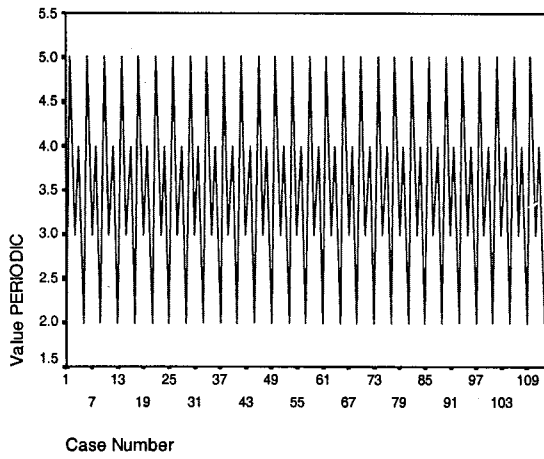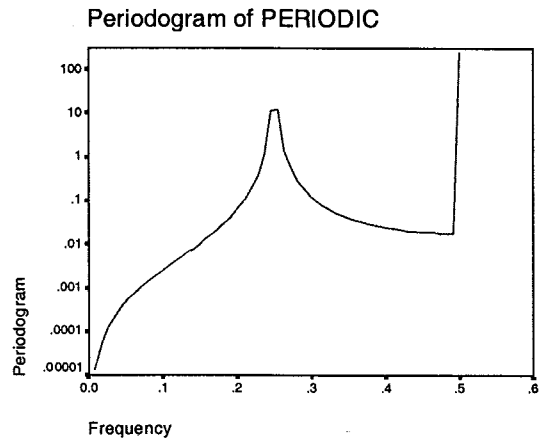
Example C: Product switching resulting in total brand loyalty:

Figure 5.5.3a: Series C   Figure 5.5.3b: Spectral plot C
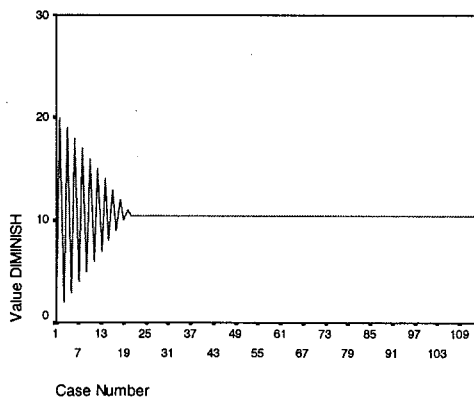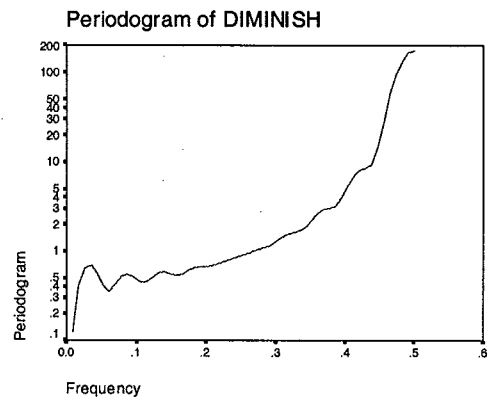
Example D: Regular switching between six products:

Figure 5.5.4a: Series D   Figure 5.5.4b: Spectral plot D
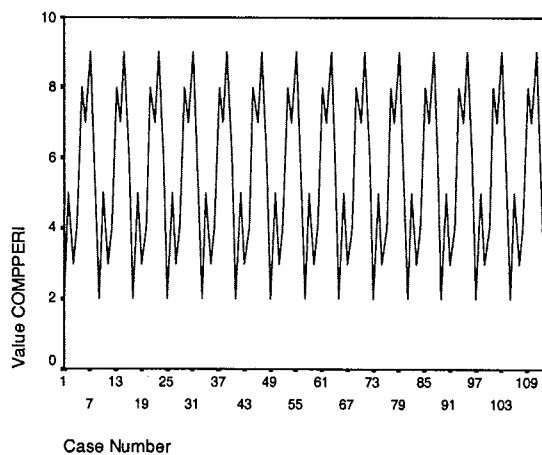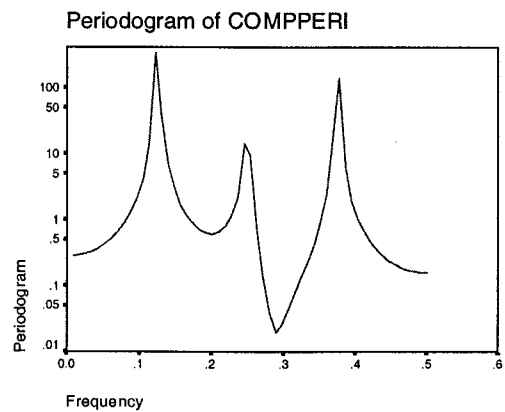
The spectral plots of each series clearly show the number of stage cycles within the series. The number of regular (periodic) cycles in the example series are readily identifiable without recourse to the periodogram plots. Example A is a one cycle series and shows one peak on the spectral plot, whereas D is a three stage series, depicted by three peaks on the spectral plot. However if cycles are irregular or aperiodic then the spectral analysis will become more ambiguous. Ambiguous or inconclusive spectral plots point towards the existence of an aperiodic and complex process consistent with either randomness or chaos.

The complete set of series amenable to spectral analysis[7] is presented in Appendix V. The following were typical of this phase of the analysis. A plot from each of the five perceived groups from the typology outlined in the section relating to the weighted plots (5.3) are shown here. The same plots are used in the section describing the phase space analysis so that the progression of the analysis overall can be appreciated.

'Climber' example:

Figure 5.5.5a: WTS for SS13   Figure 5.5.5b : Spectral plot SS13
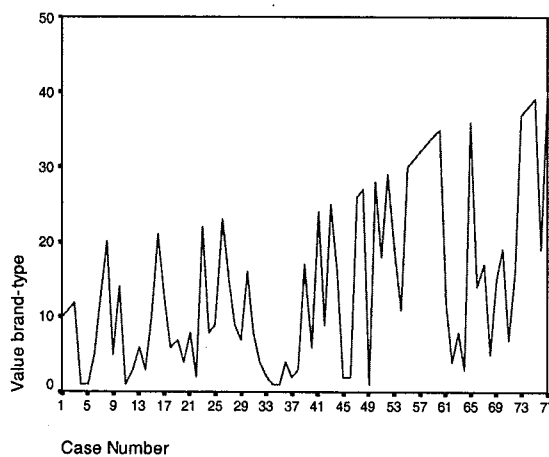
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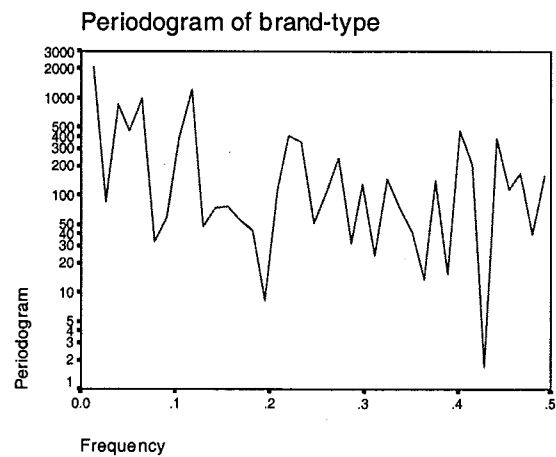
[7] Although most series are towards the *de facto* minimum number of observations for spectral analysis (Priestley 1981). The theoretical minimum is two observations, the view seems to be that series less than 100 observations will yield questionable series. Certainly series under 50 observations should be excluded and have been in this case. It should be emphasised that there is no consensus in the literature in terms of the minimum viable sample.

'Oscillator' example:

Figure 5.5.6a: WTS for SD02

Figure 5.5.6b : Spectral plot SD02

Periodogram of brand-type
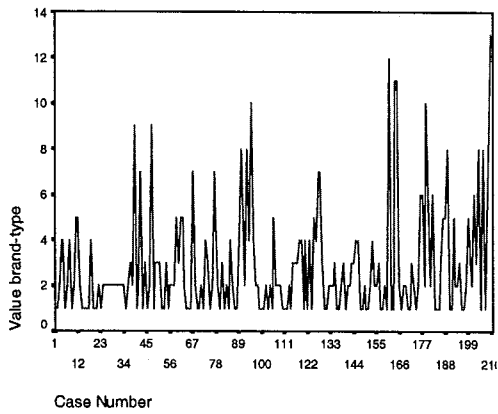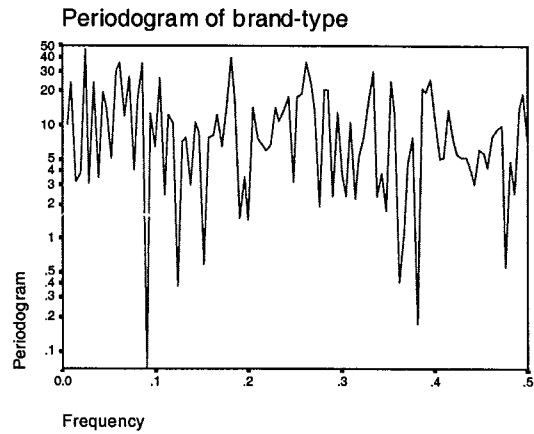
'Stager' example:

Figure 5.5.7a: WTS for BA22

Figure 5.5.6b: Spectral plot BA22

Periodogram of brand-type
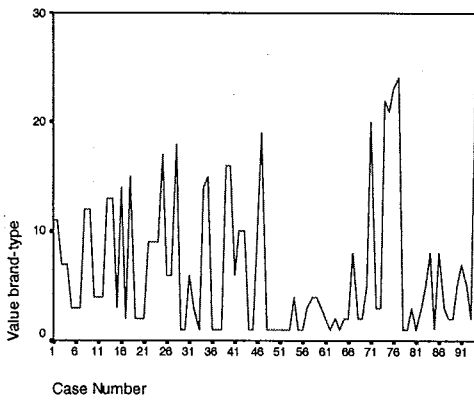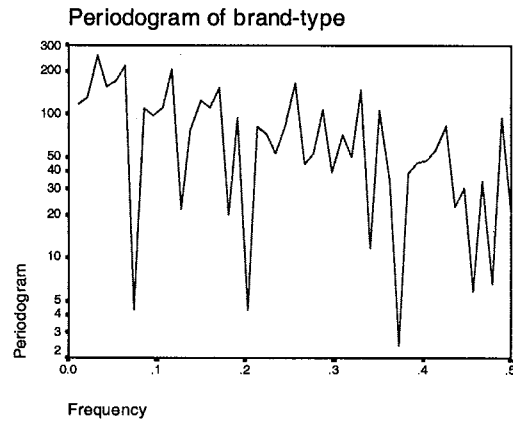
Flat-topped oscillator 'sessioner' example:

Figure 5.5.8a: WTS for BA25
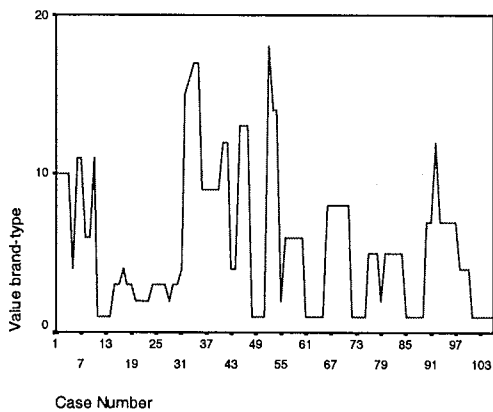
Figure 5.5.8b: Spectral plot BA25

Periodogram of brand-type

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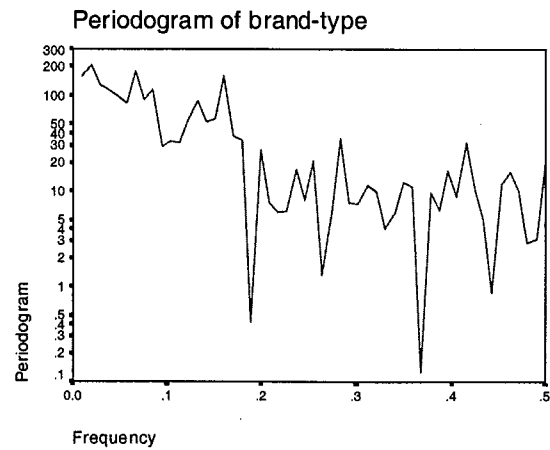
'Steady stater' example:

Figure 5.5.9a: WTS for YD36   Figure 5.5.9b: Spectral plot YD36
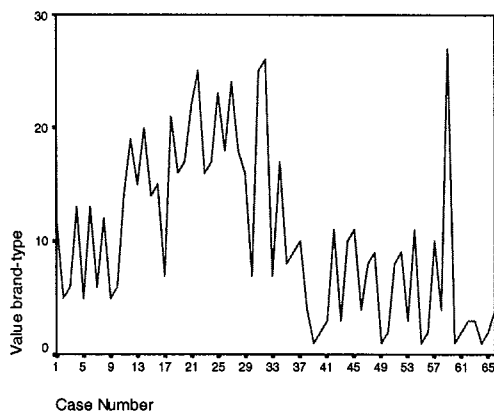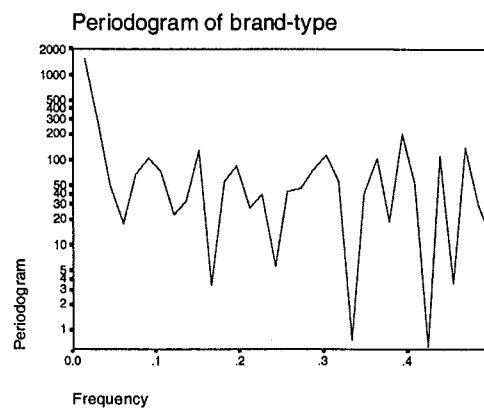
The peaks at around the zero are 'spurious' (on the frequency axis) and are caused by the fact that no filtering technique was used. The absence of filtering is consistent with the use of spectral analysis for identifying chaotic or complex phenomena (McBurnett 1996b). In almost all of the series analysed there were few salient cycles apparent. The plot for BA25 does seem to show a couple of salient peaks but these are likely to be a result of the fact that certain values are repeated sequentially (the session nature of the series). The spectral analysis showed little coherent evidence of regular (periodic) cyclical behaviour overall. This represents a quite striking phenomena i.e. the apparent absence of repetitive or regular periodic cycles of behaviour within the sample (as far as that recognised by spectral analysis is concerned). Clearly individual brands are used on a repetitive basis but the overall form of behaviour is not cyclical or periodic in a regular form. As already noted spectral analysis is more conclusive for longer time series, many of the series acquired in this research are relatively short and this can increase the chances of spurious periodogram peaks. However some series are relatively long and even these show little evidence of cyclical behaviour (e.g. all the plots in the figures above – 5.5.5a – 5.5.9b). Nonetheless the spectral plots were cross checked with

the phase space portraits (PSPs) with distinct repeated forms (suggesting cycle behaviour). The phase space analysis described below sheds light on the nature of the cycles within the data and helps to explain the nature of the spectral plots.

5.6 Phase Space Analysis

As Williams (1997) and others point out, chaos is often best addressed by some form of dimensional analysis and that this is desirable/essential and that phase space is an excellent option. Other forms of dimensional analysis were constrained by the number of observations available however. Lagged phase space is used here because it requires only one variable and can be applied with very few data points, although the longer the series the better.

Phase space diagrams as described earlier and in this chapter were selected in order to explore the attractors in the series, or indeed to see if there was any evidence of system attractors in the data. Phase space diagrams are ideally constructed by knowing all the determinant variables (Gleick, 1987). However, this was not feasible in this case for the reasons previously outlined. For example the pendulum analogy and phase portrait in Chapter 1 (figure 2.2.9) is constructed from the velocity and position of the pendulum. In this case there are a number of other determinants and they have not been measured or recorded. However there is an alternative route to creating a phase portrait and one advocated in a social science context where determinants are often ambiguous or immeasurable. This is achieved by plotting the value of the observation against a lagged value in two or more dimensions (Berry & Kim, 1996; McBurnett, 1996a, Williams 1997; Dooley *et al* 1997) i.e. *lagged* phase space (sometimes referred to as

pseudo phase space). The evolution of the process can be seen in a way that reveals attractors or other underlying forms. Its key advantage is that it only requires the observed 'output' variable.

Lagged phase space uses the *embedding dimension* approach where the embedding dimension refers to the number of lags used in the plot (not the magnitude of the actual lag). In this case only one dimension is used. In phase space with one embedding dimension (therefore plotted in two dimensions, t and t-1) then the total number of points will equal the number of observations in the series minus one (because of the lag). If two embedding dimensions are used (i.e. a 3d plot as in Appendix VI with t plotted against t-1 *and* t-2) then the number of data points in phase space will equal the number of observations in the series minus 2. The analysis presented here uses one embedding dimension and therefore is in two dimensions. Two embedding dimensions were also used and these 3D plots are presented as 2D rotations in Appendix VI. Clearly these cannot be represented optimally here, however they tended to reinforce the findings of the one embedding dimension analysis.

In the figures below the product assigned numerical values as used in the WTS are plotted (on the vertical axis) against the corresponding value for the previous time period (on the horizontal axis). The same example plots as used above demonstrate how phase space (t-1 lagged phase space) represents the four example series in terms of their underlying form.

Example A : Regular switching between two products:

Figure 5.6.1a: Series A
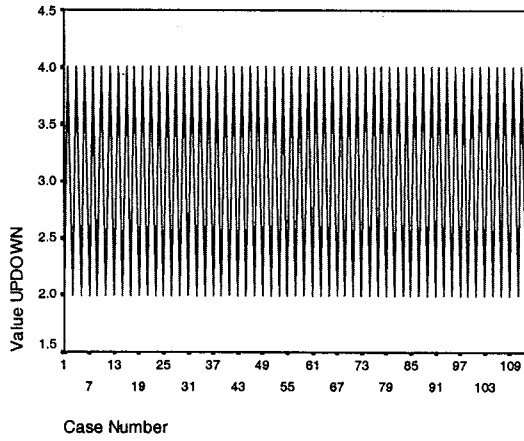
Figure 5.6.1b: Phase space plot A
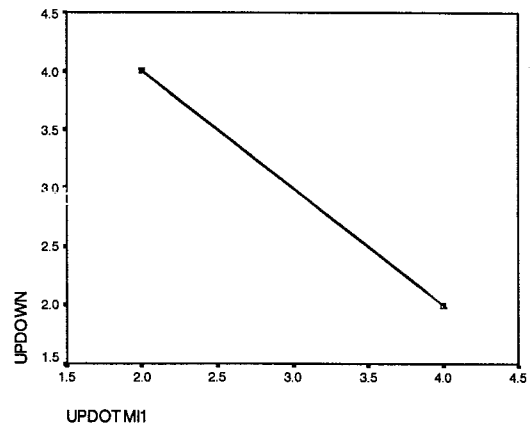
Example B: Regular switching between four products:

Figure 5.6.2a: Series B
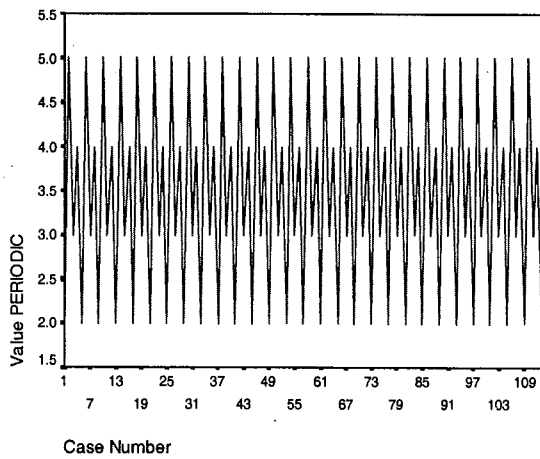
Figure 5.6.2b: Phase space plot B
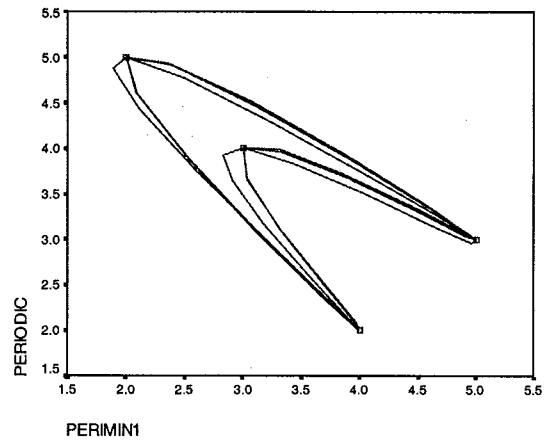
Example C: Product switching resulting in total brand loyalty:

Figure 5.6.3a: Series C
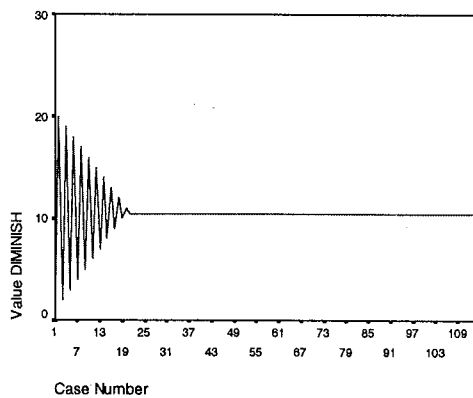
Figure 5.6.3b: Phase space plot C

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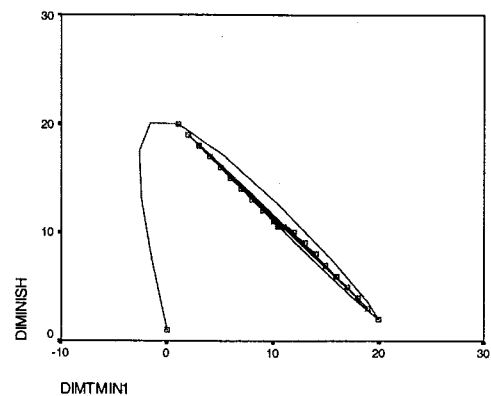
Example D: Regular switching between six products

Figure 5.6.4a: Series D
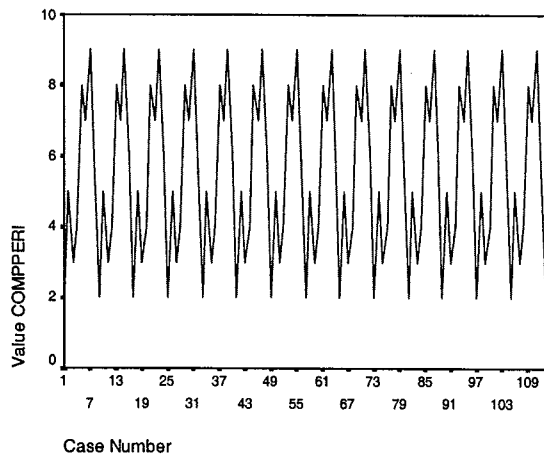
Figure 5.6.4b: Phase space plot D
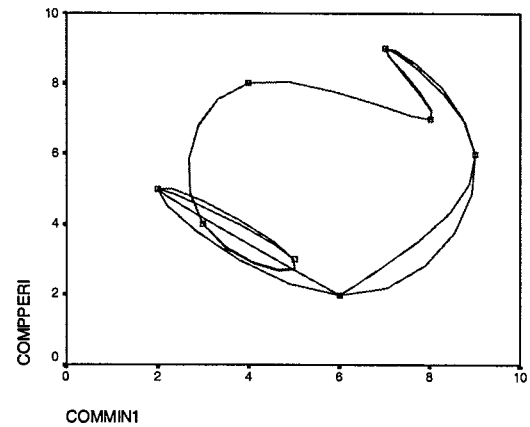
These example phase space plots or portraits (PSPs) demonstrate how phase space can provide an alternative representation of the form of a series. The PSPs for series B and D clearly demonstrate the cycle behaviour and the how it can be represented by different shapes in phase space. In more complex series phase space can reveal other underlying forms in data that are often not apparent through recourse to the time series plot itself. This form of analysis relies on visual interpretation unless the series are long enough to be subjected to a correlation dimension test. Once again five illustrative examples are presented from each of the five groups identified in the WTS analysis as used in section 5.5 (i.e. SS13 – 'climber'; SD02 – 'oscillator'; BA22 – 'stager'; BA25 – 'sessioner' and YD36 – 'steady stater').

Phase space analysis was undertaken using various lags. However the t-1 lag is the most intuitively justifiable since the last unit consumed is likely to have the greater influence on the next unit consumed (if indeed it has any affect at all). Other lags were used but results reinforced the findings of the t-1 analysis[8] rather than adding a

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[8] The number of repeated values was also a problem with other lags, due to the discrete value nature of the series.

significant new dimension. The complete set of t-1 phase space portraits can be found in Appendix III with the accompanying WTS. The points in phase space are joined by interpolation lines to illustrate the progression of the series[9].

'Climber' example:

Figure 5.6.5a: WTS for SS13
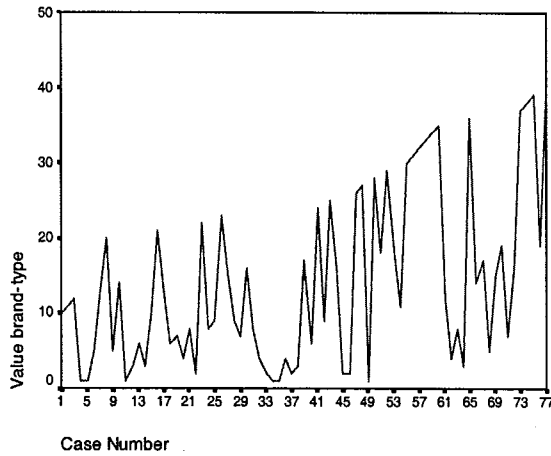
Figure 5.6.5b: PSP SS13
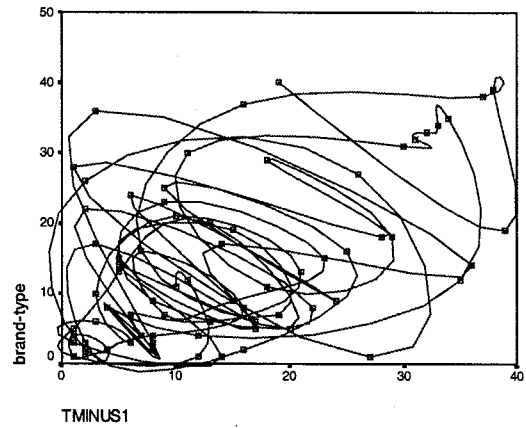
'Oscillator' example:

Figure 5.6.6a: WTS for SD02
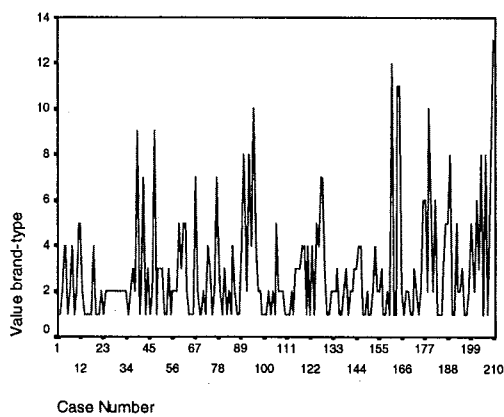
Figure 5.6.6b: PSP SD02

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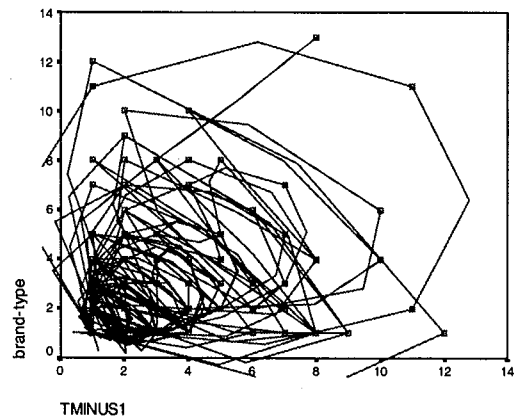
[9] Splined interpolation lines were used because they do not superimpose or obscure as much as linear ones. This makes the progression of the phase space activity easier to read and interpret although there is a caveat in terms of the appearance given. The actual data value points are made clear to overcome the potentially misleading nature of the interpolation lines.

'Stager' example:

Figure 5.6.7a: WTS for BA22
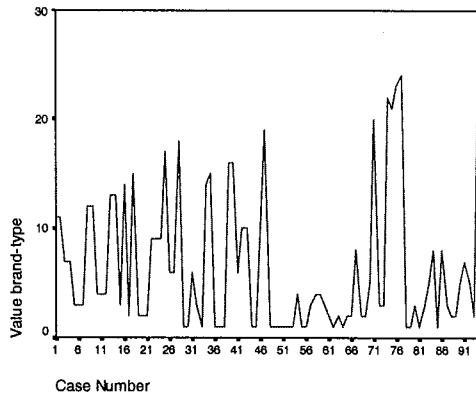
Figure: PSP BA22
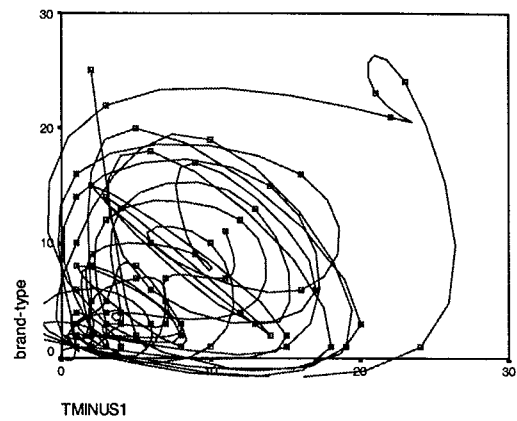
Flat-topped oscillator 'sessioner' example:

Figure 5.6.8a: WTS for BA25
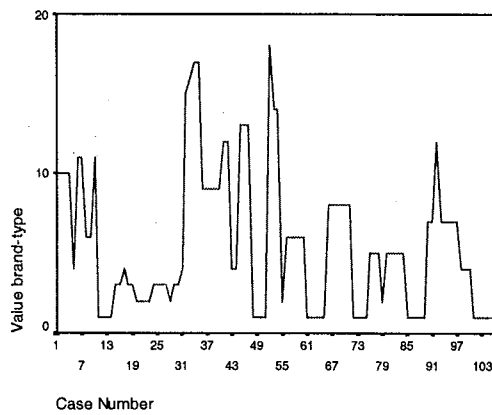
Figure 5.6.8b: PSP BA25
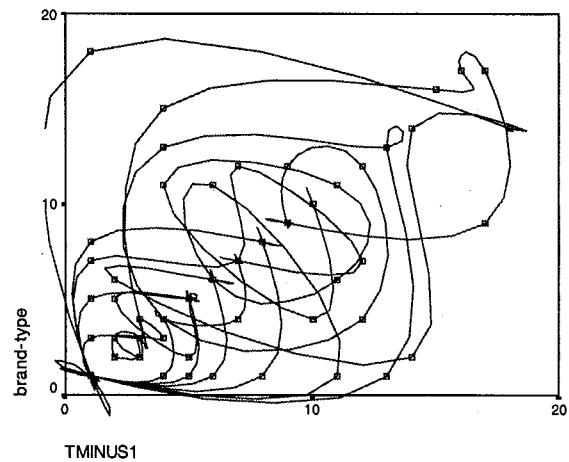
'Steady stater' example:

Figure 5.6.9a: WTS for YD36
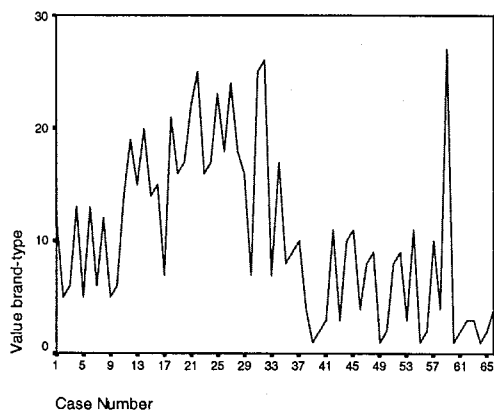
Figure 5.6.9b: PSP YD36
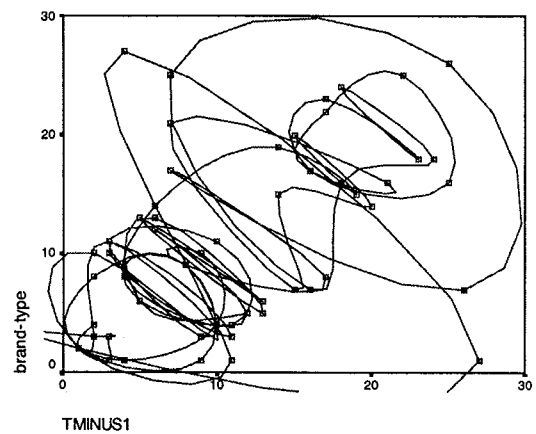
The 'climbers' or climbing within a series produces spiralling within phase space. Oscillation produces a swirling 'cone' type form. Staged behaviour produces general variety in the PSP depending on nature of those stages e.g. climbing activity with session behaviour will produce spiralling and linear forms. Steady state activity generates a tendency for two 'orbits' in phase space (clearly seen in figure 5.6.9b).

Whilst the examples above give some indication of the differences between the typology identified from the WTSs the variety of PSPs and their meaning and significance requires further and closer attention. As with the weighted plot time series the phase space plots demonstrate a notable variety of forms not confined solely by the five group typology identified above.

Clearly the favourite product consumed after the favoured product sequences give the most obvious positive attractors (point attractors in the series). The favourites consumed after other (but differing) favourites cause an attractor system in many of the plots (subsequently referred to as the 'favourites attractor'). It is a collection of point attractors. This means that the attractor itself is complex in form i.e. more complex than a simple point attractor (e.g the point attractor showing 2 consumed after 2). In this case the negative attractor is the area most avoided in phase space, most commonly the middling favourites plotted against (followed by) middling favourites. The 'favourites' attractor varies in power between plots; in some it is very strong (e.g. SD04 in figure 5.6.10a and b), in others it is almost non-existent (e.g. SS20 in figure 5.6.11a and b). In this context behavioural loyalty equals a strong point attractor at $1 - 1$ in the phase space, which here could also be seen as a tendency to *stability*. Again SD04 is a good example of this (figure 5.6.10a). A weak attractor at 1-1 or a weak favourites attractor

might be seen as a pronounced tendency to complexity, instability and chaos. Figure 5.6.12a and b depict 100% loyalty as evidenced by CC53. This is the ultimate form of stability i.e. a point attractor only. Comparison with the other PSPs in the data set emphasises how instability is more the norm than stability.

Example of a strong (positive) favourites attractor:

Figure 5.6.10a WTS SD04
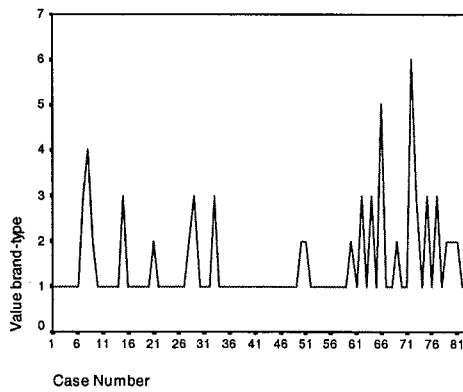
Figure 5.6.10b PSP SD04
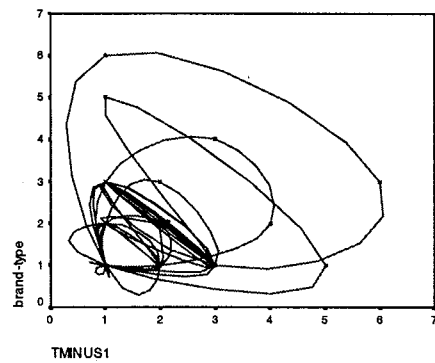
Example of a weak favourites attractor:

Figure 5.6.11a WTS SS20
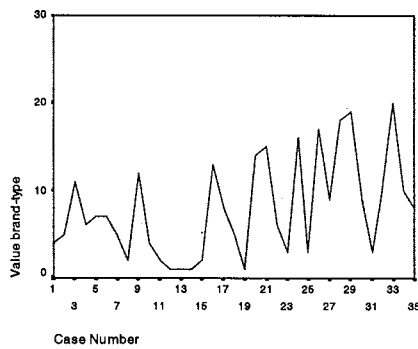
Figure 5.6.11b PSP SS20
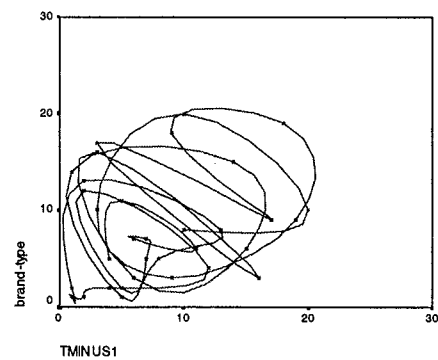
Total loyalty and stability – point attractor only:

Figure 5.6.12a WTS of CC53
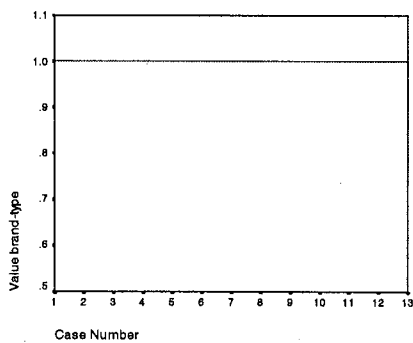
Figure 5.6.12b PSP of CC53
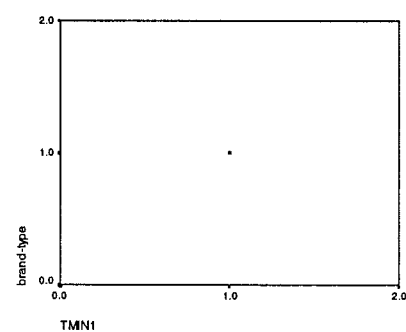
Overall there are a number of distinguishable and more complex characteristics in the PSPs, as Appendix III demonstrates. However characterising this activity overall is problematic because of the complexity of the plots and the variety – each plot is unique (or has its own phase space signature). The variations in the PSPs are not accounted for adequately by membership of the five groups identified above or the membership of the product type groups. However some generalisations of the forms revealed is required in order to assess the overall tendency to chaos within the sample.

The spectral analysis pointed towards ambiguous or complex cycle activity. The orbital nature of the PSPs is evident and often involves and attractor system around the favourites. However this orbit is complex, and this is caused by some unstable cycle activity. The 'swirling' nature of many of the phase space plots is caused by the oscillation between favoured brands and less favoured brands. Although any cycles are unstable or short or both. A circular form (or other distinct geometric shapes as in figure 5.6.2b) in the plot shows one complete cycle (wave form) within the data. 'Spiralling' is also associated with any 'climbing' variety seeking (e.g SS17 figure 5.6.12a and b below). Although climbing behaviour occurs in many of the series for shorter amounts of time than those assigned to the climber group where it occurs throughout the series. 'Figure eights' as depicted in YD36 (figure 5.6.9b) are a sign of steady state behaviour or definite phases within the series progression.

The following provide further examples of the variation of the complex orbital forms:

Figure 5.6.13a WTS SS17
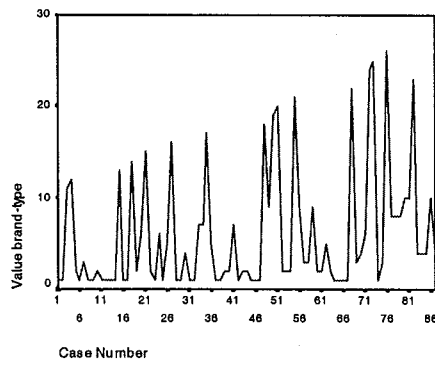
Figure 5.6.13b PSP SS17
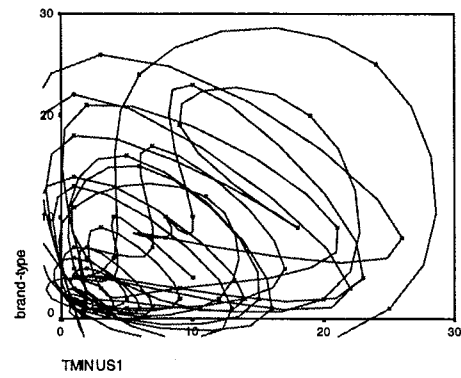
Figure 5.6.14a WTS SS19
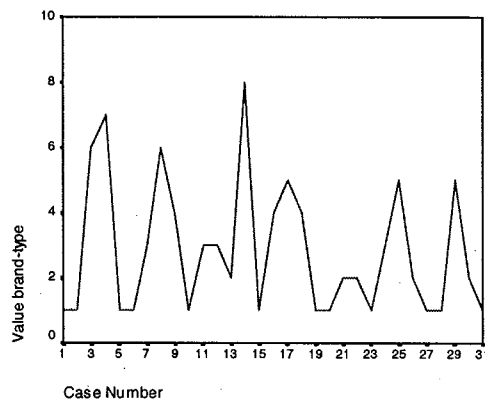
Figure 5.6.14b: PSP SS19
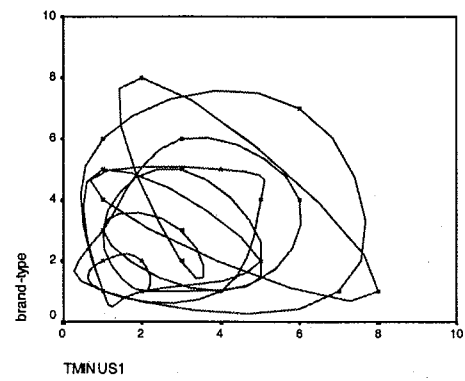
Figure 5.6.15a WTS BA30
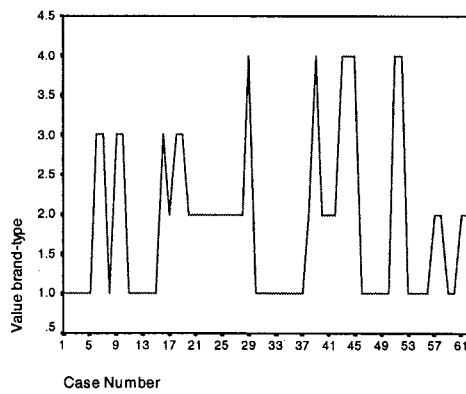
Figure 5.6.15b PSP BA30

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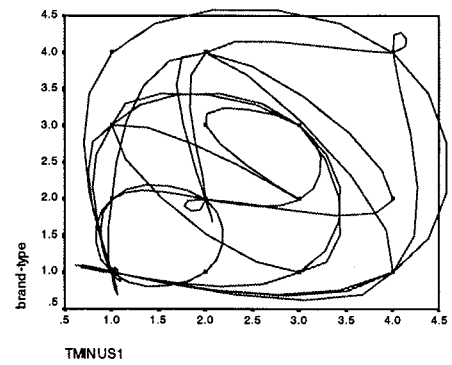
Figure 5.6.16a: WTS SD09   Figure 5.6.16b PSP SD09
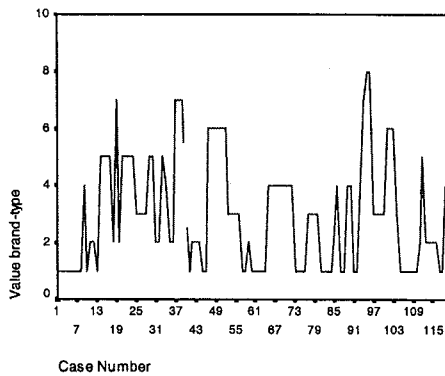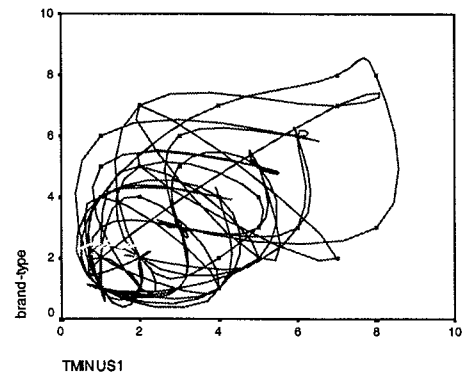
The 'favourites' attractors act as foci for the orbital activity as far as the less popular

products are concerned. This orbital activity is erratic and irregular in the data-set as a

whole and individually. Product usage can therefore be described in orbital terms and

this fact is discussed in more detail in Chapter 6. The negative attractor i.e. any space

in the middle of the phase space represents the centre of this orbit (we orbit the sun but

we do not move towards it – it is a negative attractor). An orbit biased towards the

favourites is therefore depicted as 'off balance' in phase space. The favourites attractor

might be said to have a greater 'gravitational' pull than other consumption sequences.

However there is a caveat to such generalisation; the variety of forms within each

identified group is marked. Each informant has their own distinct 'signature' in phase

space.

Taking the sample as a whole the variety of PSPs is striking. There are few strong

similarities in form between the cohort groups (product groups). Overall the phase

space analysis tends to enlighten, complement and reinforce observations made during

the analysis of the weighted plots. Considering the fact that this work deals with

discrete values and not continuous value series the complexity is extreme. Indeed they

could be described as 'randomised' (pseudo-random - Lorenz 1993). A 10x10 plot has

100 possible data points. Visiting them all would mean the series was mathematically random. Williams (1997) demonstrates that a phase space plot of a truly random process has no form at all, each phase space co-ordinate has an equal chance of occurring as each data value does. Visiting a number of these points in a complex fashion points towards chaos. The degree of complexity is also marked considering the series here are relatively short. As De Greene (1996 p284) notes: 'In deterministic chaos the output wave forms or the phase portraits of a model look stochastic or unexpectedly complex...'. Moreover they share the characteristics of the classic 'strange attractor' (Lorenz, 1993); they appear globally stable and locally unstable (see section 2.2.8).

5.7 Reviewing the application of chaos theory: Are the series chaotic?

There is strong evidence to suggest that consumers behave in a manner that can be described as chaotic at least some of the time. The series individually and as a whole display enough characteristics of chaotic series (sudden changes in character, erratic movements, variety overall) to suggests that the underlying processes that produce them are complex dynamic and consistent with many of the assertions of chaos theory. The case for interpreting the behaviour as symptomatic of chaos or consistent with a chaos theory interpretation is reinforced below.

5.7.1 The absence of periodic or regular behaviour

The lack of periodic (regular cycle) behaviour (characterised in the spectral analysis plots) is the most striking indicator of this. The series are on the whole aperiodic,

where cycle behaviour occurs it is often transitory and unstable (supporting findings found in some more conventional approaches – Gaertner 1987). At this juncture it is worth revisiting Williams' (1997) clarification of the mathematical meaning of randomness:

-every possible value has an equal chance of selection

-a given observation is not likely to recur

-any subsequent observation is unpredictable

Whilst the series here show unpredictability, observations do recur – so these series aren't random and again fit better with notions of chaos and complexity. Random implies arbitrary or meaningless action without systematic factors. A reinterpretation of what appears to be 'random' behaviour might suggest that it is behaviour on the edge of chaos. They are 'randomised' (after Lorenz 1993) i.e. they show some of the characteristics of random series but not all of them.

There also has to be a question mark as to whether consumer could ever be regarded as behaving in a random fashion. Consumers cannot be truly random can they, as defined in Chapter 2? Consumer decisions are made on some basis however impenetrable and by this measure they are not random. If it is accepted that these forms are 'randomised' or complex but not random then chaos becomes a likely explanation. If one argues that these series are random then an important conceptual or philosophical point arises. How can consumers be said to be random? To assert that they are random infers that their actions are not determined and therefore that consumer behaviour or mathematical representations of consumer behaviour are not deterministic. They are subject to

myriad potential determinants of their behaviour as this thesis has demonstrated (see Chapter 2 and 3), but this does not make them stochastic agents of pure chance. This thesis would support the view that the assertion that consumers are capable of behaving randomly is practically indefensible. Consumers can behave in a predictable or regular fashion in some instances but they cannot behave randomly. Their actions are a] determined by myriad factors and b] they can exert a degree of control over their actions – two important conditions for deterministic chaos to occur in human behaviour (Dobuzinskis 1992). If the outcome of this was ordered predictable[10] action then chaos could not be an explanation. However for the vast majority of the informants this does appear to be the case. This chapter demonstrates as far as possible under the various acknowledged restrictions of the data and the current boundaries of knowledge regarding chaos theory[11], that consumer behaviour can be chaotic.

5.7.2 Consistency with the concept of sensitivity to initial conditions (SIC)

Conceptually the appeal of this notion in terms of consumer behaviour is compelling. As stated before the situational perspective provides the touchstone for this concept. Indeed Laaksonen (1999) suggests that so-called 'low involvement' purchases may be more susceptible to situational interactions. The instability (lack of periodicy, lack of stationarity) of the series is striking and the explanation of sensitivity to initial conditions is seductive. However proving that the SIC is the explanation of this

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[10] Prediction in terms of probability is not a binary concept; things are not either absolutely predictable or not predictable. Probability demonstrates prediction has degrees. It is used here to mean prediction of the next value with certainty, not the likelihood of occurrence.

[11] It was not the intention of this work to contribute primarily to the existing (and developing) body of knowledge regarding chaos theory. The intention was to contribute to the field of consumer research through the fusion of chaos and consumer behaviour. However it is inevitable that some contribution to the understanding of chaos theory to human behaviour studies more generally is made.

instability is a more problematic notion. In order to do this some measure of the effect of various determinant variables would have to be made. The problems associated with this in practical terms and in terms of the ethos of complexity research have already been discussed.

5.7.3 Attractor forms

Even non-complex systems have attractors as the example in Chapter 2 illustrates. However there is lack of common forms in phase space analysis shown above. They reveal that any form such as oscillation is *unstable*: they are globally stable but locally unstable. The 'randomised' complex nature of the phase space diagrams suggest that the behaviour is continually evolving, that even the conditions dictating the determinants are unstable. This is consistent with the points made previously about interdependence (see section 2.2.5) i.e. consumption is integral to all other aspects of that person's life and the associated determinants; it is susceptible to powerful feedback.

5.7.4 Fractal forms

There is little or no evidence of discernible fractal forms but fractal theory is very much a sub-theory of the main body of chaos theory and has little bearing on the question of the applicability of chaos to the consumption series overall. The absence of fractals does not mean that the series cannot be described as chaotic. Fractals are one form of underlying order. Nonetheless the apparent absence of fractal forms is a notable finding in itself.

5.7.5 More Chaos than not

Overall the evidence from the data analysis provides more evidence of chaotic and complex system behaviour than the contrary. If Williams' (1997) tenets of chaos as introduced in Chapter 2 (section 2.2.10) are reviewed then none are belied in this research (although some rely on conceptual application or critique as per Chapter 3 i.e the discourse of chaos theory):

1.   'Chaos results form a deterministic process'.

This thesis would contend that consumption is a deterministic process. It can be *described* stochastically but it *is not* stochastic as discussed above.

2.   'It happens only in non-linear systems'.

Whilst there is some evidence of linearities within some of the series the general character of the series individually and as a whole is certainly non-linear.

3.   'The motion or pattern will look disorganised or erratic'.

The series above can certainly de characterised as erratic.

4.   'It happens in feedback systems'.

This thesis argues that any assertion that consumption has no feedback effects is untenable. As far back as the 1960s and since the cognitive school acknowledged the importance of feed-back to consumer behaviour as do other approaches (e.g. Howard and Sheth 1969; Van Trijp 1995; Dabholkar 1999).

5.   'It can result from systems with a simple structure'.

It can, but this thesis contends that the 'structure' of consumption is complex with myriad determinants contingent on context. It can result from systems with a simple structure but also with a complex structure.

6.   'It isn't the result of data inaccuracies'

The reliability of this data is believed to be high. Moreover the method of assigning values means that other measurement problems are eliminated from the process.

7.   'It includes some form of order or structure'.

There is evidence of a variety of complex structures in phase space. Where 'order' occurs it is unstable and irregular e.g. the climbing variety seekers WTSs. Moreover the series are not random, they have a structure, but a complex irregular structure. They therefore obey some 'rules' or have some outcomes that are unlikely or highly unlikely to occur (e.g. brand/types never consumed after others).

8.   'The ranges of the variables have *finite* bounds, these bounds restrict the attractor to a given range in phase space'.

The attractors indicate that the series are not random but that any attractors often have complex forms.

9.   'Chaotic series are hypersensitive to changes in initial conditions'.

This thesis argues that this is highly likely in a consumption context. This is

particularly supported by the situational perspective of consumption.

10.   'Forecasts of long term behaviour are meaningless'.

You can predict the probability or likelihood of values occurring, but forecasting

of these series is likely to be inaccurate. A standard forecasting technique was

tried on the first 50 values of the five typology example series in order to compare

the prediction with the actual series progression. However severe conceptual

problems were encountered[12].

11.   'The Fourier spectrum (spectral analysis periodogram) is usually broad,

but often with some more salient periodicity'.

On this evidence most of the spectrums are broad i.e. show a number of cycles.

This is because the series are complex. There are not many salient periodicies in

the data-set as a whole.

5.8 Other possible forms of analysis

Clearly the data set could have been subjected to other forms of analysis[13]. Many other

techniques are based on statistical assumptions that are not compatible with the

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[12] Techniques such as exponential smoothing are not appropriate as long range forecasts. The discrete value nature of the series and the 'stylised' nature of the time axis precluded seasonal decomposition or other techniques.

[13] Some cross correlation and autocorrelation analysis was undertaken to investigate the relationship between variables and between lagged values in the weighted series. These were restricted however because of the limited number of values in some series i.e. the structure of the series being composed mainly of discrete values. Moreover some series were too short for meaningful correlation analysis. The results of the cross-correlation analysis is presented in Appendix VIII (this was done using the standard default procedure in SPSS). Strictly speaking cross-correlation analysis should only be used on stationary series (Anon 1993). To recap from Chapter 3 according to statistical theory 'A series is stationary if its mean and variance stay about the same over the length of the series' (Anon 1993). The use of the word 'about' is significant as it reflects the ambiguity surrounding stationarity. A series is a realisation of a

assumptions of chaos (Williams 1997). Other forms of analysis recommended for complex or chaotic phenomena have data requirements that could not be met here (as discussed in Chapter 4 and earlier in this chapter). The case against a modelling approach in this case was made in the previous two chapters. The forms of analysis chosen will show the salient elements of a time series data set and will give insights into chaotic or complex behaviour where it exists given the constraints of the series. Moreover the chosen methods of analysis are at the limit of acceptable forms of chaos analysis given the constraints of this data-set.

5.9 Conclusion

Other implications for marketing and consumer research are considered in the following chapter. Whilst it is not possible to be one hundred percent conclusive in the key assertion that the series appear to display key attributes of chaos there would seem to be enough evidence to suggest that this is the case. If accepted this is clearly a very significant finding since it infers that a wider conceptual and empirical applications of chaos theory is viable. Certainly the degree of unpredictability, volatility and variety of behaviour was considerable and greater than anticipated after the literature review described in Chapter 3. Moreover it should be born in mind that only one product per person was examined, it is quite feasible that for other products the informants might exhibit quite different behaviour, thus adding to the overall complexity of their

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process which is either stationary or not. However some statisticians argue that you can have degrees of stationarity and that it is not a question of its complete absence or not. Certainly many of the series do not appear to be stationary. This ambiguity casts doubt over the reliability of the table in Appendix VIII. Autocorrelation analysis was thought to be questionable since the number of repeated values (favourite brands/varieties) in each series was too great is these discrete value series. Moreover the lagged phase space analysis described above gives insights into any lag processes in the series. There is also some ambiguity about the underlying assumptions of autocorrelation coefficients and their compatibility with a chaos theory perspective.

aggregate behaviour. Moreover if the informants were monitored over a longer period of time then they may exhibit quite different forms of behaviour perhaps displaying all five of the typology behaviour patterns identified.

At this point it is opportune to review the research objectives as described in Chapter 1:

- Are chaos theory's analytical techniques an appropriate mechanism for the investigation of consumption?

By implication therefore it also addresses the following question:

- Is individual consumption or consumer behaviour ever chaotic (as described by chaos theory)?

This thesis contends that on the evidence presented here both should be answered in the affirmative. This has a number of implications for consumer research (these are discussed in the following chapter).

Chapter 6

Discussion & Conclusion

6.1 Introduction

This section seeks to relate key issues arising from the data analysis with issues arising from the two literature review chapters (principally Chapter 3 – Product Choice Behaviour) and the chapter regarding methodology (Chapter 4). The key objectives of this thesis and the efficacy with which they have approached and answered were addressed at the end of the last chapter. If they are accepted then a number of important implications for various aspects of consumer research arise. It is the function of this chapter to address some of these issues.

In the first instance it is pertinent to review the salient methodological issues that arise through this study since they have some bearing on the core findings relating to chaos theory and consumption and consumer behaviour more generally. The necessity for innovation in this thesis inevitably raises a number of methodological issues. Some of

these were dealt with in the previous chapter i.e. those that are central to an understanding of the presentation of the analysis.

6.2 Methodological issues: a retrospective

6.2.1 The nature of the series reported justifies a chaos approach

Generally the series show little evidence of periodic or what would be conventionally understood as ordered behaviour. This justifies the nominated approach whatever the specific findings with regard to chaos theory in terms of its purer definitions. Essentially it suggests that you will not find complex behaviour if you don't look for it. Smoothing, filtering and aggregating techniques will inhibit any examination of issues raised by complexity science, since they are not equipped to search for it (McBurnett 1996b).

6.2.2 Unexpected findings

Non–modelling complexity research implies an inductive approach, in practice this means you're more likely to find characteristics within the data that have not been looked for or expected e.g. the 'climbing' variety seeking behaviour in this study. The discovery of the apparent 'memory' to some variety seeking behaviour (discussed below) was a subsidiary finding that justifies the data driven, inductive and descriptive approach adopted whether chaos is the subject of investigation or not.

6.2.3 From complexity to reductionism

There is, on the surface of it, and inherent contradiction within this work and other forms of investigation into chaos and complexity. This study has reduced complex human decisions and behaviour with all its myriad determinants to structured time series. But this is the inevitable consequence of any empirical research, in the final event analysis requires that text, figures or quantitative data is adulterated and reduced to some degree. Chaos research is no different except that it has continual regard for the inherent complexity of its subject; it acknowledges that reduced data is a *representation* of the system, not a *reconstitution* of the system.

6.2.4 Interdependence and feedback - again

A revisit to the interdependence question (which is so central to an understanding of chaos and a chaos interpretation of these results) should therefore be made in light of the work undertaken. The question, 'what has been monitored?' is one that deserves consideration and refers back to the discussion of interdependence in Chapter 2 and elsewhere. At no point is the assumption made that snack consumption is *the* output of the informant's life. The data gathered represents not *the* output but *an* output.

6.2.5 Reliance on interpretation

Despite being a quantitative study, qualitative judgements and interpretation of the data is subject to some of the same notions as the interpretation of text (Geertz 1979, Silverman, 1993). It would be quite possible to argue that some of the data presented

here and in the appendices infer findings somewhat different from those discussed in this chapter. This is more likely to be the case if a different theory of time series evolution were to be explored. The difference with this application is that chaos, as a theory of complexity, allows for nuances in interpretation more readily than approaches supported by 'traditional' means of time series research. Nonetheless the reliance on the interpretation of the data by the author should be acknowledged.

6.2.6 Methodological restrictions

The continued application of chaos in some of the social science and business disciplines may be inhibited by the lack of access to data which provides series long enough for other dimensional analyses. Scanner data has the potential to provide such series for consumer research but it relates to one shopping location only (hence the diary approach adopted here). Chaotic investigation is restricted therefore. Natural science can increase the number or frequency of observations more readily in many cases than social science i.e. the temperature of a bath can be taken every second or continuously, studies involving human behaviour have greater restrictions. This study could not increase the number of times an individual purchased a certain product. It could only be conducted over an extended period, although as discussed in Chapter 4 dairy research has its limits in this respect.

Early on in the thesis the rationale for empirical investigation driven rather than conceptualisation driven approach was justified. This thesis has demonstrated that some forms of analysis most closely associated with investigations of chaos elsewhere in the social and natural sciences can be used to investigate consumer behaviour. The

fact that chaos, like any other approach, brings with it limitations in terms of data requirements and analysis has also been acknowledged.

The absence of similar work in the field of consumer research afforded both an opportunity and potential danger. The danger being that the project might lack focus. The empirical necessities of chaos investigation provided that focus. Decisions about the use of quantitative or qualitative data and analytical techniques were made in light of the literature available at the time. However it is conceivable that other quite different approaches could be adopted and justified.

6.2.7 From chaos theory to complexity theory

The forms of behaviour in this research although consistent with many of the concepts of chaotic behaviour suggest that a more generalised complexity science approach has something to offer. This reflects the merger of chaos and complexity theory elsewhere in the social and the natural sciences. The form of the phase space diagrams suggests that complexity theory ('The study of emergent behaviour exhibited by interacting systems operating at the threshold of stability and chaos', credited to William H. Roetzheim) may have a place in the investigation of consumption phenomena. Complexity theory may at least add to the understanding in consumer research at the conceptual level if not at the empirical level.

6.3 Implications of this work for consumer research

In the previous chapter the assertion that there is value in a chaos theory approach to was explicitly and implicitly made. The various findings relating to the core research objectives were also reviewed. However the work raises and addresses a number of other issues of relevance to work elsewhere in consumer research. These issues are discussed here.

6.3.1 Implications of the five group typology

The typology identified in the previous chapter is an important finding in its own right. However it is not a typology of *people* but of *behaviour*. It is conceivable that all five behaviour patterns could happen for one product group and one individual within one year. The only work bearing much relation to this typology is that similar to the work of Bawa (1990) looking at hybrid behaviour (variety seeking and loyalty). Clearly there is scope to replicate the methodology used here for other frequently consumed products in other contexts. Individual choice models and other modelling approaches do not appear to account for this variety of behaviour types. Moreover it is quite possible that other behaviour types might exist and be amenable to identification. Perhaps the term product usage or brand usage is more appropriate than terms like loyalty or variety seeking. Trivedi's (1999) assertion that the future of variety seeking research belongs to the modellers can be challenged on this evidence.

6.3.2 Variety seekers with long memories?

The apparent long-term memory of some variety seekers requires particular attention and is one of the most salient findings of this work. In interview all the relevant informants seemed unaware that they consciously or wilfully tried to avoid products over such an extended time period as reported in section 5.4. Nonetheless there are a number of individuals who are continually seeking products that they have not consumed before within the study period (whilst returning to favourites in between). The existence of long term subconscious memory in some instances is a logical possibility although further research would be required to establish how this type of behaviour occurs or whether it is present elsewhere. Raju (1986) and other work on the learning effect in variety seeking, indirectly acknowledges the evolving dynamic nature of variety seeking. The question of how long a variety seekers memory is remains unproven here but the issue is raised. It is not clear from this work whether variety seeking is derived or conscious (after Van Trijp 1995). However the interviews with the informants suggested the climbing variety seekers consciously seek variety to some extent.

6.3.3 Situational perspectives of consumption

Sensitivity to initial conditions (SIC) is a logical and plausible explanation the nature of these series and meshes conceptually with the situational view of consumption. The results certainly do not countermand the assertion that SIC may be present and that an important chaos concept has relevance here. Work into the situational perspective of consumption previously cited (Belk 1975; Umesh & Cote 1988; Chow *et al* 1990) could

be used as a foundation for an extension of the understanding of such events by using the concept of SIC. Situational factors are only one example of SIC however, they are not synonymous with each other. So SIC is not merely 'semantic innovation' rather situational variables and the situational perspective would represent a sub-set of the SIC concept. SIC shows use that small changes in determinants can enact large changes at the measurable or observable level, whereas the stituational view of consumption concentrates on the immediate determinants. SIC acknowledges the importance and similar potency of underlying determinants and many other non-situational determinants. SIC adds something to our understanding of consumer behaviour beyond what the situationalists suggest by showing that 'trivial' non situational factors might have powerful effects.

6.3.4 Impulse purchase

Clearly impulse purchase is one of many possible explanations for the series presented in Chapter 5 (although they record consumption). This work sheds limited light on the process of impulse purchase in comparison to other studies (see Rook 1999b); although the interviews provided evidence that impulse was *a* factor. Clearly it is possible that the product groups here are often purchased on impulse and then consumed. The choice of a particular brand or variety may also be susceptible to impulse even if consumption is deferred. However it is inadequate to attribute the outcomes presented in the previous chapter to impulse alone since this would diminish the potential impact of the many other potential determinants previously mentioned. Moreover very little is understood about the mechanism which leads to impulse purchase and whether it is accurate to describe it as impulse at all.

6.3.5 Observations on variety seeking vs. loyalty

All of the sample bar one could legitimately be described as displaying variety seeking behaviour in terms of orthodox consumer research. As stated in Chapter 3 (Bawa, 1990) concludes that over half his sample of households exhibit 'hybrid' behaviour, a combination of loyalty and variety seeking (although he looks at different product groups and uses *household purchase* data). However it is consistent with the results of this research into *individual consumption* behaviour. Certainly work which acknowledges that people have 'favourite' brands and that loyalty might be manifest as the preference for favourites also supports the reported findings here (e.g. Ehrenberg 1988; East *et al* 1995) as does Cunningham's (1956) concept of 'first brand loyalty'. The concept of the power of the favourites attractor (see section 5.6) as an indicator of loyalty proneness adds a new dimension to this however. Moreover the power of this attractor is likely to change from product to product and even over time for an individual as the 'steady staters' demonstrate. East *et al* (1995) among others question whether loyalty is context and/or a product specific factor; the work presented here would contend that both context and product (and many other factors) are likely to be important in determining variations

The degree of loyalty or disloyalty found in this study also depends on which definition of loyalty is adopted (as described in Chapter 3). An attitudinal or emotive based definition might claim that the preference for certain favourites within the series constitutes loyalty. If loyalty is taken as synonymous with repeat purchase then it is the parameters of repeat purchase that constitute loyalty that need to be defined. By whatever such measure though none of the sample in this study are highly loyal as the

descriptive statistics in the previous chapter illustrates (with one notable exception – CC53). The more accurate way of seeing their brand usage is in terms of *favourites* and *repertoire*.

This work is not necessarily diametrically opposed to the work of Ehrenberg and the like. The Dirichlet model works on aggregate (group) data, and its users seek to investigate probability not describe and explore *forms* of series as this research does. Indeed many of these findings are consistent with the work of Ehrenberg (1988) and other Dirichlet advocates despite the fact that aggregate household purchase data was the focus of that work. At no point does this thesis contend that there is no relationship or a weak relationship between purchase and consumption it merely clarifies their differences and difficulties of examining each and emphasises the key importance of not regarding them as synonymous. Dirichlet modelling research tends to lend credence to the view that households are loyal to more than one brand or that they utilise a *portfolio* or *repertoire* of brands as this work suggests; most consumers are multi-brand buyers (Ehrenberg & Scriven 1999). However Uncles *et al* (1995 pG75) state that 'For brand choice it is assumed that each individual consumer habitually buys from a small repertoire of brands'. Depending on the meaning of 'small' this study would seem to suggest that for very frequently consumed products this is not the case, at least as far as individual consumption is concerned (the product repertoire range is from 1 to 40).

Dekimpe *et al* (1997) admit the variability of loyalty with in the short term, this study would seem to support this assertion. Moreover Raju (1986) states that individual variation between consumers has thus far been underestimated, again this work would seem to support this related assertion. This is evidenced by the typology and its implicit

variation, the variation in first brand loyalty and the varying power of the favourites attractor.

The favourite products sought as well as varieties which are avoided represent attractors in chaos parlance. Certain products are used as touchstones for variety seeking or unstable behaviour during the evolution of their consumption by almost all the informants. This provides us with an alternative way of seeing brands as being used as part of *system* of brand usage; moreover an inherently unstable system. The fact that the manufacturers regard their brands as rivals does not mean that the consumer shares this view. He/she apparently use brands and varieties in an idiosyncratic manner (evidenced by the diversity of WTSs and PSPs). Loyalty is a loaded term and fallaciously implies that the power lies with the vendor or the products.

The fact that chaos highlights the role of negative attractors is also significant. Perhaps we can learn as much about an individual's consumption from the brands/types that they never consume or the phase space at the centre of many PSPs in the previous chapter. Consumer research tends to concentrate on positive attractors rather than anti-states or negative attractors.

Unfortunately this work has also found some evidence of the rather loose or inaccurate and inconsistent use of the terms purchase and consumption and household and individual in the consumer research literature. All can be justifiably investigated and they may shed light on each other and mirror each other but they are *not* interchangeable or synonymous.

The inclusion in this research of the varieties and flavours and the insights that this approach provides might also suggest that research in marketing and consumer behaviour is sometimes *too* brand obsessed or that the definition of a brand is sometimes too narrow at the empirical level. Of course the manufacturer brand is often important but it is not the only product attribute which is readily identifiable and influential. It is clear why marketers are interested in the processes associated with manufacturer brands but consumer researchers should be prepared to acknowledge other salient product characteristics which the consumer may include in their interpretation of a what constitutes a brand (Malhorta, 1987)

6.3.6 Stochastic consumers?

As stated in the previous chapter you can describe or *represent* consumer behaviour stochastically but ultimately consumption is a deterministic process; it cannot *be* a stochastic process. Human beings are not agents of pure chance, they exert reflexive control over their actions. This point could easily lead to a metaphysical discussion of free will, but that would obscure the point (see section 6.2.8). Chaos theorists would not contend that control is absolute but that it is the interaction of the consumer's psychology and external determinants that produces the behavioural outcome. However this is not necessarily synonymous with a behaviourist perspective of consumption (if Foxall 1990 is regarded as typical), although it clearly bears some resemblance to the basic premises of that approach.

6.3.7 Co-existence with other approaches

Some of the findings confirm previous work, complexity perspectives like chaos are unlikely to de-bunk all that has gone before. Arguably they are more likely to enrich and extend existing understanding and raise questions and issues than refute previous work.

This approach is superficially 'opposed' to the cognitive school in respect of their adherence to rationality (and more often that not linear progression) and their concentration on the internal processes of the consumer. This work supports various criticisms of the cognitive school as discussed in Chapter 3 but it also supports its acknowledgement of feedback, complexity and the evolving nature of consumption.

The probability modelling approach and the findings and approach of this thesis might also seem superficially to be at odds with each other. It is more accurate to assert that they are asking different questions. Predictability is characterised as probability for Dirichlet modellers (predictability is defined stochastically – see Ehrenberg & Scriven 1999), whereas predictability is characterised as form or absence of form in chaos. Chaos is concerned with the aesthetics of the series i.e. with their form. The probability that the next value is a certain number is not the issue, it is the overall revealed form of the series that is of interest. The appeal of chaos is that is does not necessarily have to contradict other approaches. Addressing different questions can add to the reinforcement of previous studies as well as new insights. Nonetheless the continuing difficulty of prediction of *individual* behaviour despite Ehrenberg's and similar work is

unquestionable. Individual processes are inherently unstable; this thesis reinforces this assertion.

The adherence to modelling techniques (whilst it has undoubtedly provided insights as acknowledged throughout this thesis) in some areas of study within consumer behaviour is almost unquestioning. Trivedi's (1999) assertion (and similar dogmas) that the future of variety seeking research belongs to the modellers is not helpful. Why should other approaches be marginalised when the case against them has not even been made? Striking the balance between innovation in methods and not ignoring or debunking all that has already been achieved is not easily done. However tolerance of other approaches is surely a more constructive way forward for a subject whose focus is so complex and indistinct.

6.3.8 Conceptualising the chaotic consumer

This approach only provides insights into the 'internal' processes of the consumer by *implication*, but again it aims to address different questions from the cognitive driven research (or for that matter semiotic, affective or social theory driven research). However acceptance of the validity of this work and the applicability of chaos more generally in this context requires some acceptance of a re-conceptualisation of the consumer and the consumption process.

Cognitive theories of consumption and some cultural based theories imply that the consumer is in control of the process of consumption. As individuals we like to feel that we are ostensibly in control, but this is a problematic notion (in part though this has to be true to some extent). However if the consumer is conceptualised as a varying parameter

model, parameters (as well as variables) varying with each transaction then this premise is called into question. Mood, cognitive processes, situation, etc will all have an impact, but at different times, for different individuals, for different goods the impact of each will vary. The concept of the chaotic consumer operating in the chaotic environment arises; the one creates the other in a continually coalescing process. An alternative metaphor is the skipper at the helm of a fishing boat; he can dictate the path of the vessel to large extent but he is not in control of all of the determinant factors (wind, current etc). Moreover the influence of the factors that compromise his control vary over time. During a thunderstorm his control is less apparent. In the parlance of one chaos commentator the skipper practices 'reflexive understanding' (Dobuzinskis 1992). In the same respect the consumer has control, but not over everything – not over the weather and its physiological and consumption effects for example. The illusion of control has been investigated within the realm of consumer research and economic psychology (see Lange & White 1999) although from a non-chaos perspective. This field of research can only be enriched by the inclusion of insights from chaos theory.

6.3.9 Context: Individual choice is complex whatever the causes.

The situational perspective suggests that exogenous factors can influence behaviour but chaos would see these influences as endogenous; the individual does not exist in isolation to his/her environment although the cognitive non-cognitive divide in consumer research implies that this is the case. The importance of context can never be over-emphasised. A number of strands of consumer research are guilty of neglecting this factor. There is evidence that this is now being acknowledged more widely for example Nelson (1999) asserts that multiattribute utility models have hitherto ignored

context. This view supports and is supported by the culturally influenced and sociologically influenced research into consumption i.e. there is a limit to how much we can look at consumption in isolation. It is not a discrete part of our lives and is inextricably influenced and connected with all other aspects of our life.

6.3.10 Bridging the micro-macro gap

On the surface of it there appears to be a situation where highly unstable individual behaviour in a variety of forms often gives rise to *relatively* more stable series at the aggregated sales level (see Appendix IX and Appendix X). Brands are purchased by individuals, therefore the processes of the individual buyers become the aggregate patterns of brand consumption. How individual consumption and brand purchase for a particular good relates to the aggregate level of consumption is a question which chaos is well equipped to help reconcile it would seem. Chaos does not indulge in the paradoxical perception that individual behaviour is random, whilst seeing aggregate behaviour as inherently more predictable or stable (suggested in some probability approaches). Richards (1996) notes that there is often mystery between the observations of individual process and the group process and that chaos may have the tools to shed light on the intervening 'black box'. As Ehrenberg says, 'buyer behaviour tends to be fairly regular at the aggregate level, but is more irregular at the individual level' (1988, p210-211). How the one leads to the other remains an enigma, although chaos theory might hold some of the answers[1].

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[1] During the process of analysis for this thesis attempts were made to aggregate the data set in order to shed light on the relationship between individual processes and aggregate processes. However it was not possible to emulate the WTS style of series at the aggregate level. The time axis would have to be based on time intervals and not stylised as in Chapter 5. Nonetheless the appendices IX and X demonstrate aggregate processes at the national and local level (although purchase not consumption).

The relationship between national or group data and the patterns observed in this study is an important question and possibly one that store based individual and store/national data is capable of addressing from a purchase perspective. However the problem with individual scanner data remains the store based nature of the figures, what is that individual purchasing and consuming outside of the store?

6.4 The managerial implications

Clearly many of the issues discussed above might be of interest from a managerial perspective, however there are some implications and questions which arise from this work which have more direct relevance to management philosophy and practice in fast moving consumer markets and more generally.

6.3.1 Management views of brand usage

Managerial characterisations of the consumer might be based on any potential prejudices and possible myths about consumers' use of brands and more generally. The practitioner literature as much as the academic literature talks a great deal about customer loyalty for example. This inherently ambiguous concept is often used in a manner in which the definition is taken as given (as discussed in Chapter 3) This evidence suggests that for fast moving goods for personal consumption loyalty is perhaps not the most appropriate term. The re-conceptualisation of the consumer outlined above might also have important implications for managers.

6.3.2 Use of chaos and complexity analysis

Knowledge of brand usage in the practitioner field is partially based on the modes of quantitative market research. Certainly there is a growing body of anecdotal evidence that suggests that more and more non-linear and complex science related techniques are being used by the multiple grocery retailers in the UK and further afield. The data resources provided by loyalty cards and the use of POS scanners provides retailers and other practitioners with ample opportunities to employ techniques such as genetic algorithms, neural network modelling and other techniques associated with chaos and complexity science.

Contact with the data analysis departments of the multiple grocery retailers and companies such as IRI Infoscan and Brann Software during the course of this research has demonstrated that many practitioners believe that chaos and complexity based forms of analysis are the future for the analysis of consumer based data. If this is the case then surely more investigations of its conceptual and empirical significance in terms of academic consumer research need to be undertaken.

6.5 Extension and further research

A number of possible applications and avenues of investigation have already been alluded to and discussed. However there are some more immediate and arguably less problematic possibilities for an extension of this method of research.

The methods employed here could be extended to aggregate/group data (e.g. national regional etc) and to other products. Moreover scanner data could be used either at the individual level or aggregate data. Although it can only provide insights into purchase as opposed to consumption. Nonetheless its potential to investigate purchase in its own right and as a proxy measure for consumption has to be acknowledged (Baron & Lock 1995; Gupta *et al* 1996).

Theoretically anything which has a temporal dimension and which can be quantified could be subject to chaos theory's methods. Here product choice is the focus, though series recording advertising spend or footfall are examples of other potential applications. Within the realms of consumer research behavioural outcomes and other observables are likely to be the most fruitful applications. Concentrating on the behaviour or 'output' variables is one way of making this work more accessible to academics and practitioners alike. This category of variables require less or sometimes nor debate about dimensions, meaning or conceptualisation, usually the issue is definition.

There is a general neglect of the significance of time series research in marketing, perhaps because it is perceived to be the domain of the economist or statistician. Further research could certainly develop dimension analysis with appropriate data. Series that were long enough could be subjected to correlation dimension tests, Lyapunov analysis and three (or more) dimensional phase space analysis (see Appendix VI).

The concepts of chaos theory and complexity science are increasingly evident in fields like organisational studies. Consumer research cannot expect to remain aloof of the other business disciplines and social sciences. As stated before the adoption of concepts cannot be sustained without some empirical use, nonetheless the concepts of

chaos have explanatory power in their own right. To eschew their use would mean that an emergent and rich area of thought is being neglected with no good reason. The irresistible process of osmosis will mean that whether chaos theory is adopted fully or not its language will permeate consumer research and marketing from sister disciplines. The belated use of postmodern modes of thought in consumer research should not become the norm or model for the treatment of new approaches and paradigms.

6.6 In conclusion

As already stated this thesis was never intended to be the last word on chaos theory and consumer behaviour. Indeed the core finding that consumption can apparently be chaotic (as described by chaos theory) opens the door to other similar and perhaps quite different studies. Even if this had not been the conclusion of the analysis then it is possible that the techniques of chaos research might have provided insights. Indeed it is likely that descriptive time series (weighted or otherwise), spectral analysis and phase space would illuminate a number of areas of marketing and consumer research even if the conceptual baggage of chaos is not taken with them; they are forms of analysis in their own right.

The significance of the core finding of this thesis is for others to judge as well as the author to assess. The true significance of this finding cannot really be judged until more research into various aspects of chaos and complexity have been undertaken, and/or more descriptive analysis of consumption and purchase time series have been undertaken.

Whilst this thesis suggests that consumers can behave chaotically it does not imply that consumers can never be ordered or predictable; of course they can as much previous work shows and as respondent CC53 demonstrates. What this work does is to suggest that chaos theory provides conceptual and empirical resources to investigate the 'disordered'.

Inevitably questions are raised as well as answered by this thesis. Consumption is complex and consumers are complex, however the acknowledgement of complexity or the inference of chaos should not be used as an excuse *not* to investigate or invalidate alternative forms of investigation. On the contrary it implies tolerance of other approaches. Consumer research is a disparate 'discipline' and sometimes the various fragmentations can be frustrating. However this thesis contends that these fragmentations are justifiable or even essential bearing in mind the chaotic and complex nature of the focus; the consumer and consumption. Complex processes require eclectic research methods and as this thesis demonstrates are amenable to techniques from chaos and complexity science.

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Appendix I - Sample characteristics

Respondent	Gender	Age
SOFT DRINK		
SD01	M	23
SD02	F	24
SD03	M	32
SD04	F	24
SD05	F	19
SD06	F	32
SD07	F	52
SD08	F	41
SD09	F	30
SD11	M	27
SAVOURY SNACKS		
SS12	M	30
SS13	F	25
SS14	F	42
SS15	F	25
SS16	F	37
SS17	F	25
SS18	F	50
SS19	F	23
SS20	F	27
SS21	M	34
BEER & ALCOHOL		
BA22	M	55
BA23	F	33
BA24	M	35
BA25	M	37
BA26	M	30
BA27	M	42
BA28*	M	30
BA29	M	25
BA30	M	43
BA31	M	29
YOGHURT		
YD32	M	24
YD34	F	63
YD35	F	56
YD36	F	61
YD37	F	23
YD38	F	52
YD39	F	41
YD40	F	52
YD41	F	55
CHOCOLATE		
CC42	M	24
CC43	M	31
CC44	F	27
CC45	F	43
CC46	F	24
CC47	F	37
CC49	F	41
CC50	M	29
CC51	M	51
CC52	M	27
CC53	M	40

Appendix II- Diary design

Page 1

Thank you very much for agreeing to take part in this study of consumption patterns for my PhD research at Stirling University, the success of my research depends on you. Therefore I cannot over-emphasise the need for you to keep as full and accurate a record as possible. To this end the diary has been designed to be readily portable so that you can record your consumption as it happens or soon afterwards. The example over the page illustrates how to fill in the diary, I also need you to fill in the respondent details as well. These and all other data will be treated **confidentially** and are essential to ensure the validity of this research. Any queries or problems then contact me on the numbers below. I will try to contact you every month until the end of May/beginning of June 1997, then I will collect the diaries from the original point of contact, home, work, club etc. All diaries with a record of the full 12 weeks will be entered into a prize draw at the end of the research period and will have a 1/25 or better chance of winning the appropriate prize for that category!! **Please write clearly.**

Thanks Again

Andrew Smith
Department of Marketing
University of Stirling
STIRLING
FK9 4LA

Tel: 01786 467380
Fax: 01786 464745
E-mail: a.p.smith@stirling.ac.uk
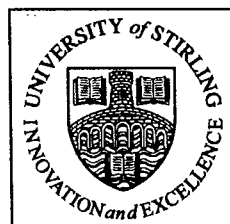
RETURN TO ANDREW SMITH AT THE ABOVE ADDRESS IF LOST & FOUND

Page 2 – Questions

Details (Please Print) Circle where options are given.

Name:

Age:

Gender: M   F

Marital Status: Married   Partner   Single

No. of children: 0   1   2   3   4   5 or more

Postcode: FK

How often do you watch TV between 5:30pm and 11:00pm at night?

most nights   2 or 3 nights a week   once a week   rarely   never

Employment status and/or Job description:

Which Stirling superstore do you most often use?

Tesco   Safeway   Other (specify)

197

Canned and bottled and cartoned soft drinks

Please record all your consumption of canned bottled and cartoned 'ready to drink' soft drinks (except those you might have as mixers in alcoholic drinks) in the manner illustrated on the following page. Thanks.

Savoury Snacks

Please record your consumption of all packaged savoury snacks such as packets of crisps, nuts, packaged meat snacks etc in sequence in the manner illustrated on the following page. Thanks.

Beer & other alcohol

Please record drinks in order of consumption. If you have two pints of Guinness followed by a pint of Tennents lager followed by another two pints of Guinness in the one night I need to know the exact order of consumption, so record them as separate items not as 'Guinness x4'. Don't worry too much about the time, morning, afternoon or evening will do. Record them as you buy/are bought/consume them or soon after Happy drinking. Thanks Again.

Individual packaged desserts - Yoghurts, trifles, mousses, ice creams etc.

Please record all your consumption of individually packaged branded desserts in sequence in the manner illustrated on the following page. Don't include desserts as part of a meal out. Thanks.

Chocolate Bars

Please record your consumption of individually wrapped chocolate bars and chocolate snacks in sequence in the manner illustrated on the following page. Please include chocolate covered wafer bars or any other snack where chocolate is a main ingredient. Thanks.

Page 4 – Example pages

Example

Date and Time consumed	Brand and Description	Where consumed
15.3.97 Morning	Diet coke can	Work
17.5 97 Lunch	Irn Bru 33cl bottle	Home
21.3.97 Evening	Tesco cherryade can	Home
22.3.97 Afternoon	Tango orange can	Shopping

Example

Date and Time consumed	Brand and Description	Where consumed
12/3/97 Morning	Pepperami gobbler	home
13/3/97 Lunch	Walkers salt & vinegar crisps	work
13/3/97 Evening	KP dry roasted peanuts	pub

Example

Date and Time consumed	Brand and Description	Where consumed
12.3.97 Evening	Guinness, pint	pub
12.3.97 Evening	Holsten pils Bottle	pub
12.3.97 Evening	Guinness, pint	pub
13.3.97 Afternoon	Tennents Lager can	Home

Example

Date and Time consumed	Brand and Description	Where consumed
14/3/97 Morning	Muller fruit comer- strawberry	Home
15/3/97 Lunch	M&S caramel cream dessert	Work
15/3/97 Evening	Tesco own brand orange yoghurt	While Shopping

Example

Date and Time consumed	Brand and Description	Where consumed
15. 3. 97 Morning	Cadbury's Wispa Gold	Home
17 .3. 97 Afternoon	Galaxy- small	Work
20. 3. 97 Evening	Cadbury's Creme egg	Shopping
21.3.97 Morning	Kit-Kat	Sports centre

Appendix III – Analysis: Weighted Time Series & Phase Space Portraits

SD01
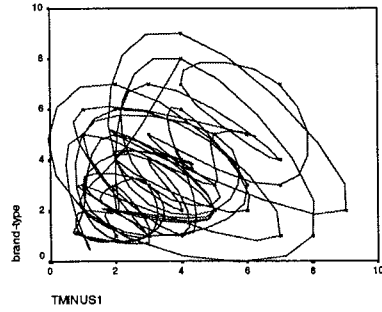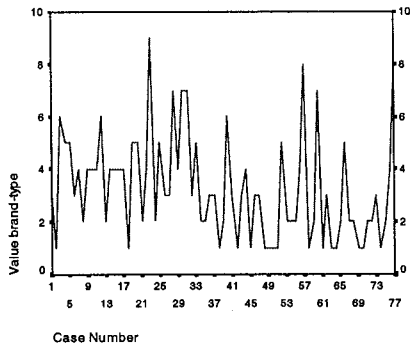
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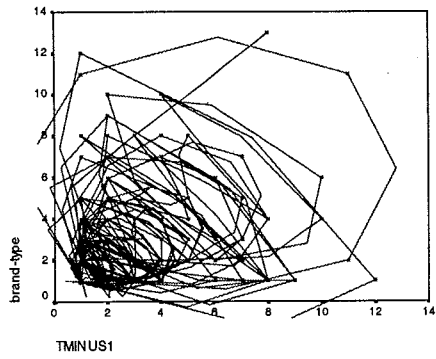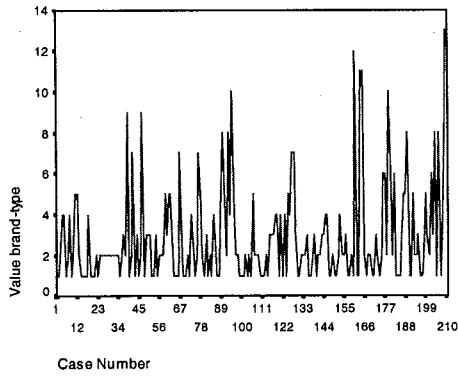
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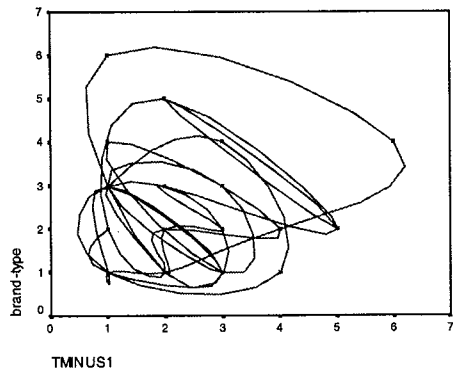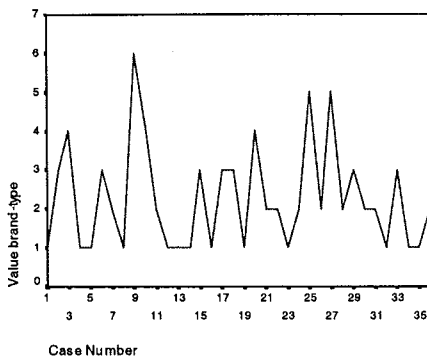
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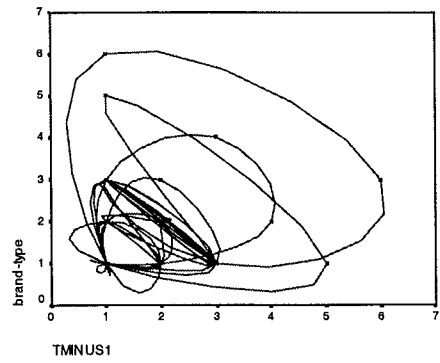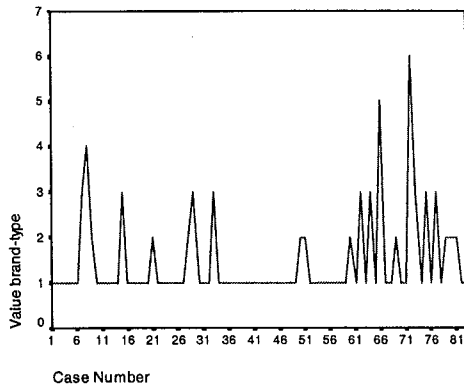
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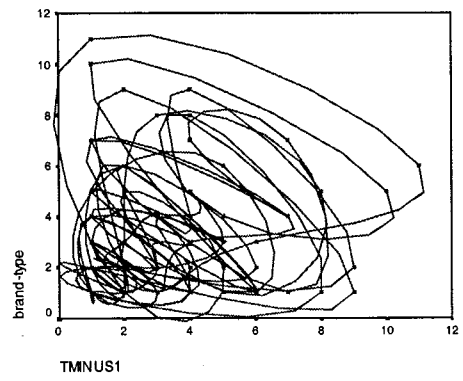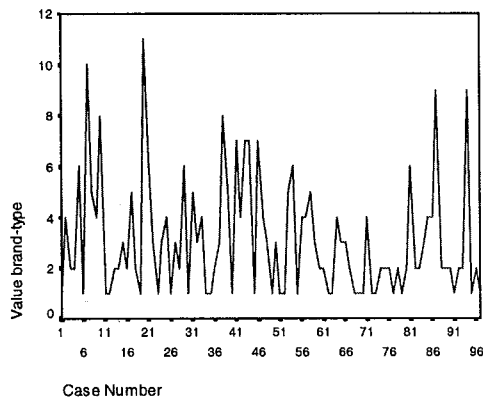
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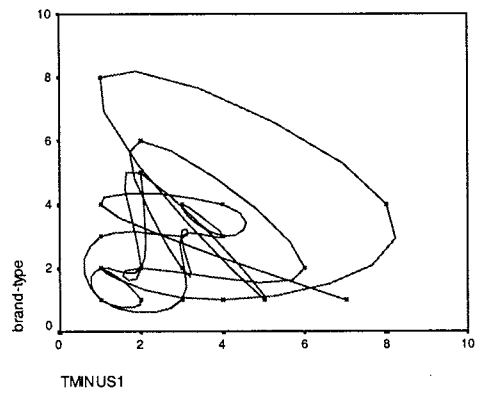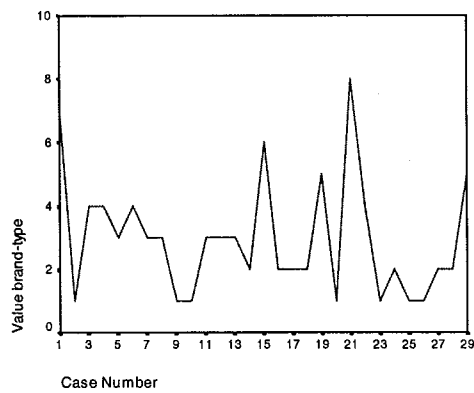
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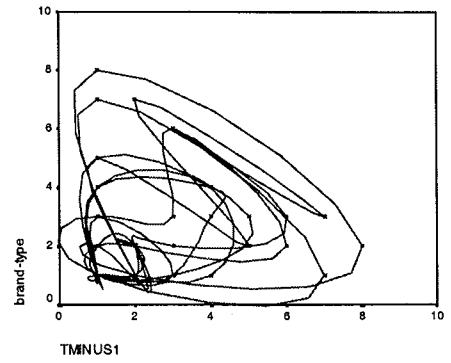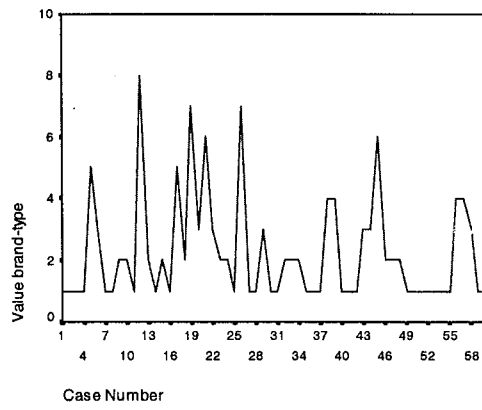
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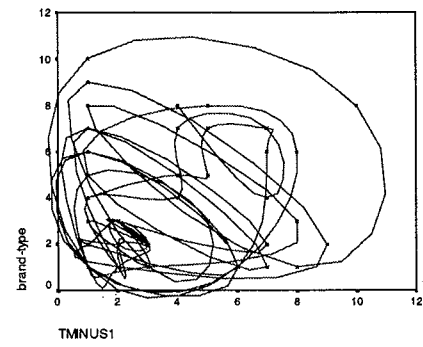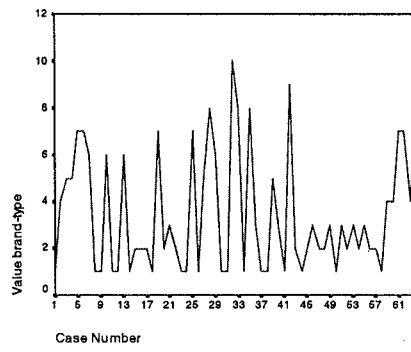
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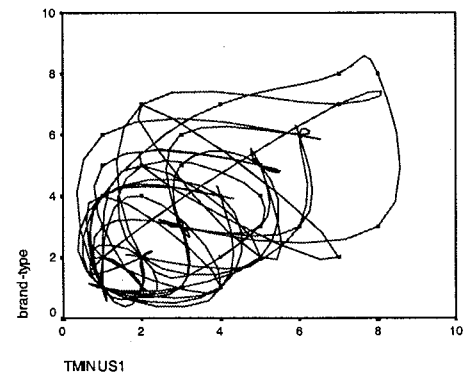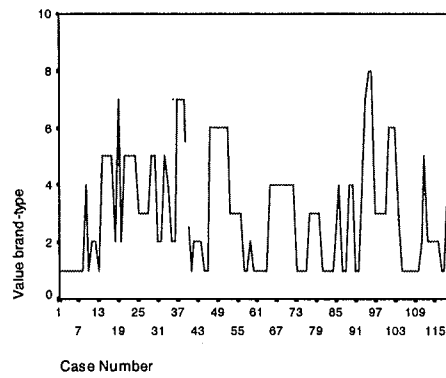
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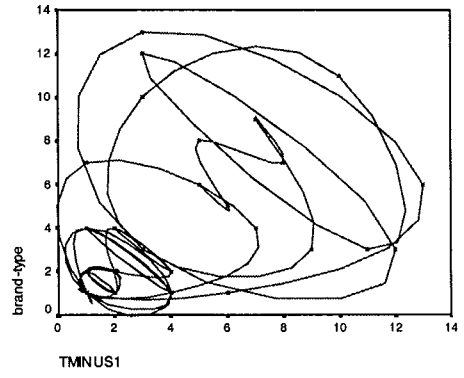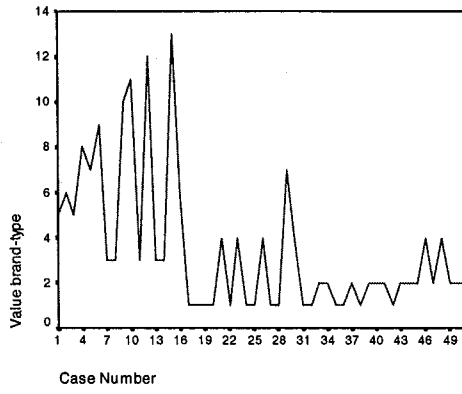
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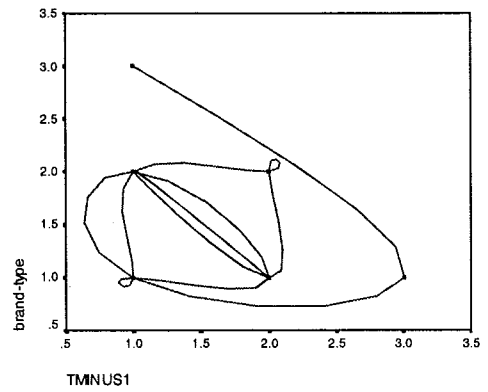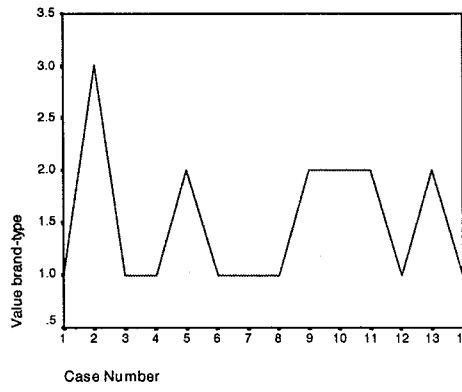
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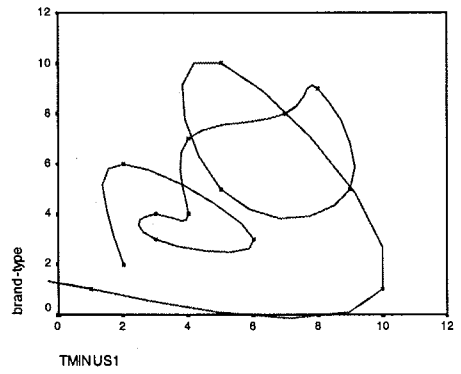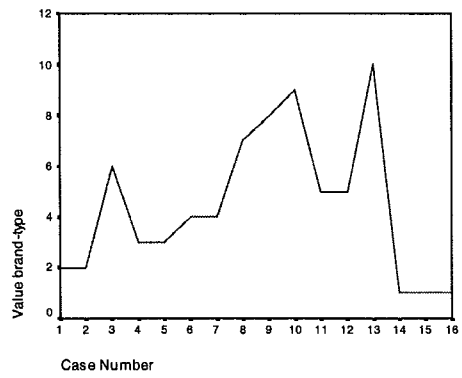
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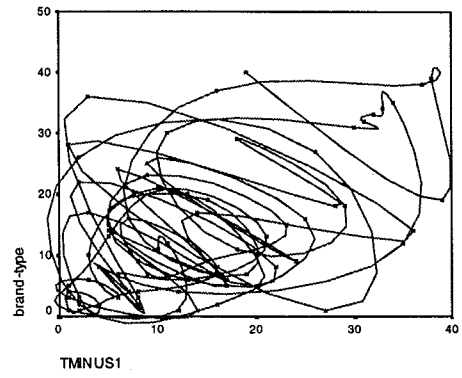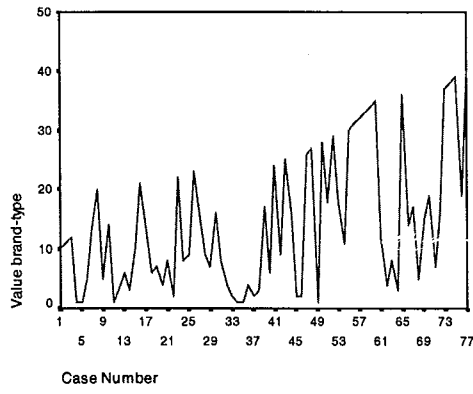
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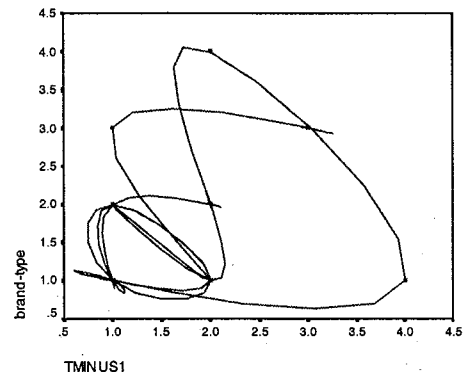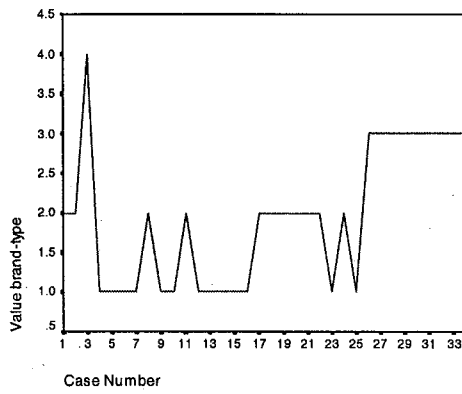
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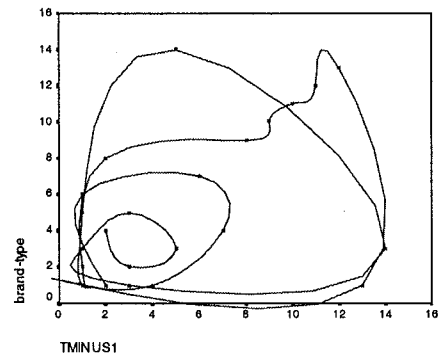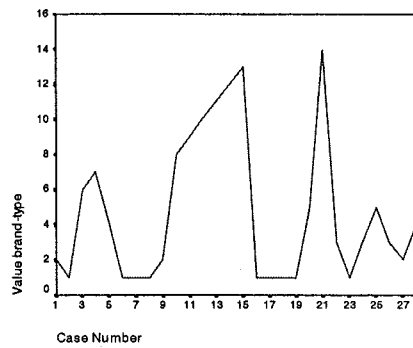
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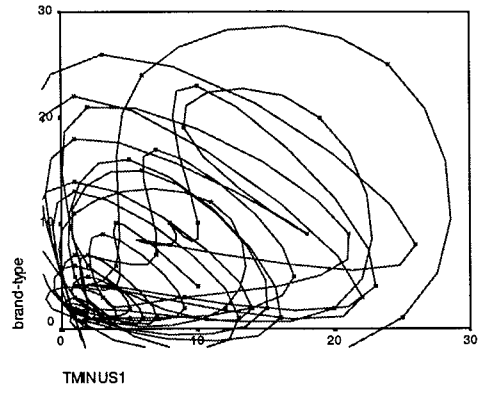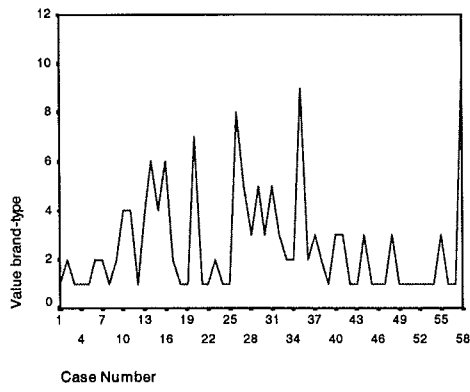
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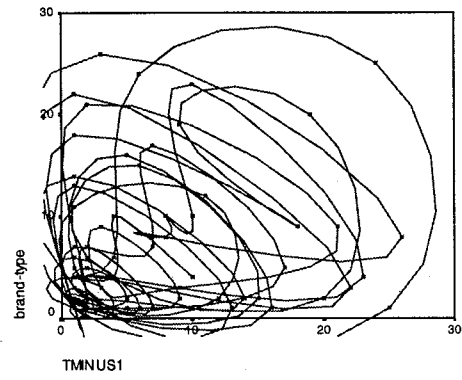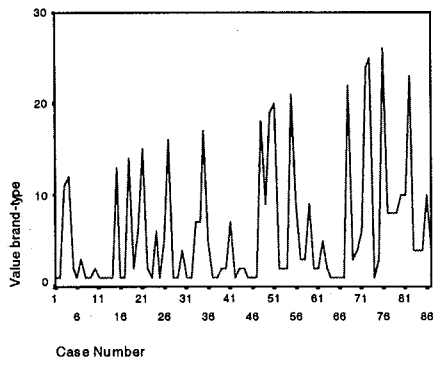
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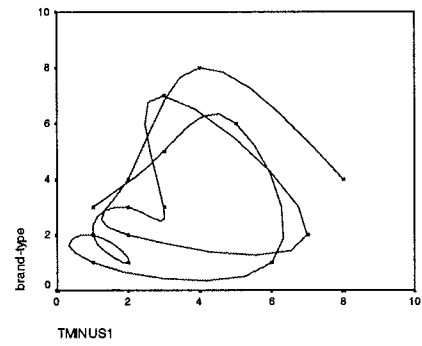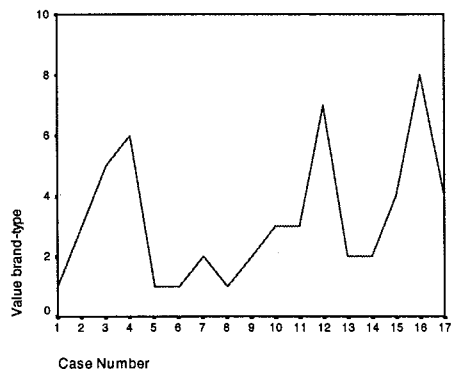
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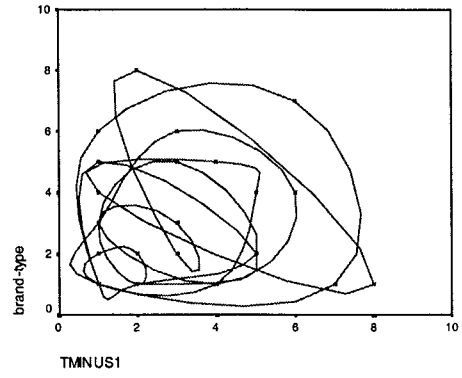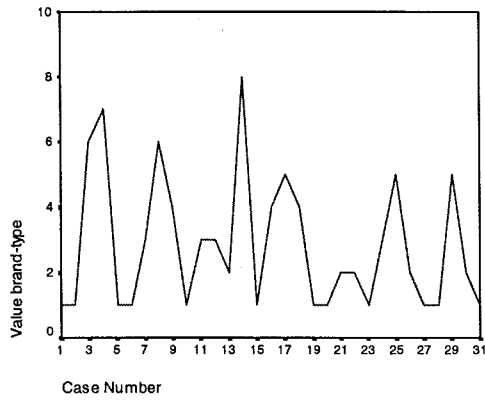
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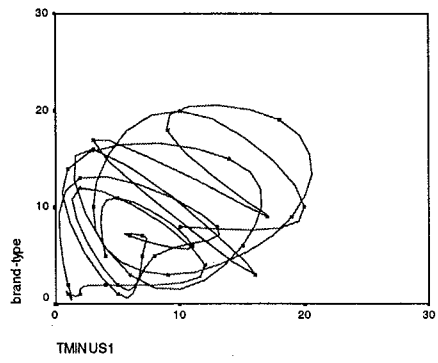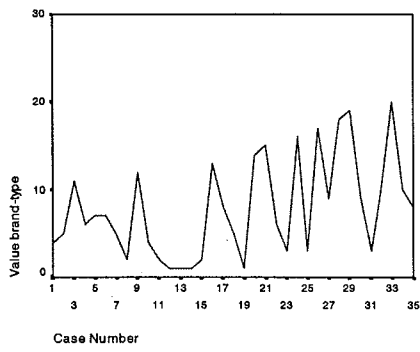
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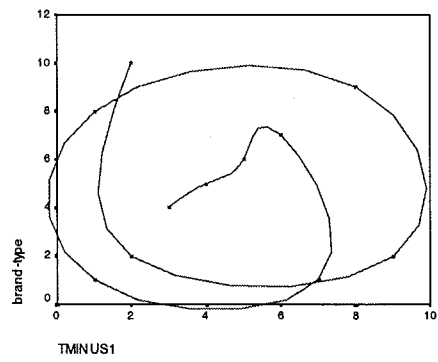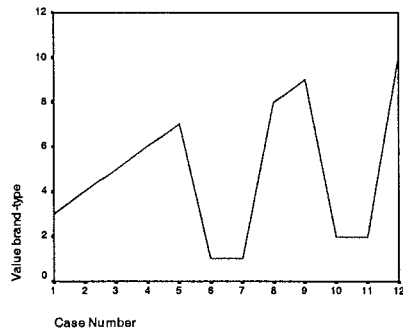
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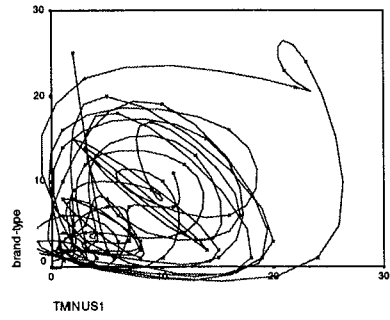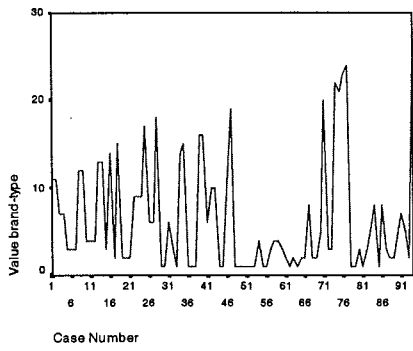
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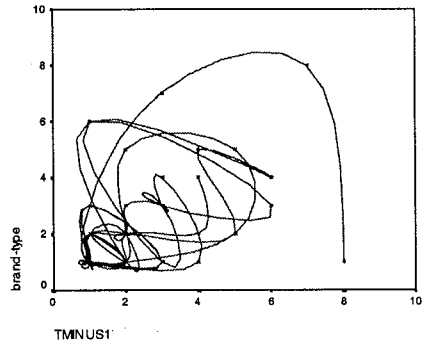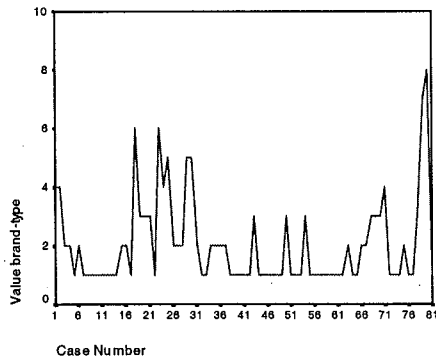
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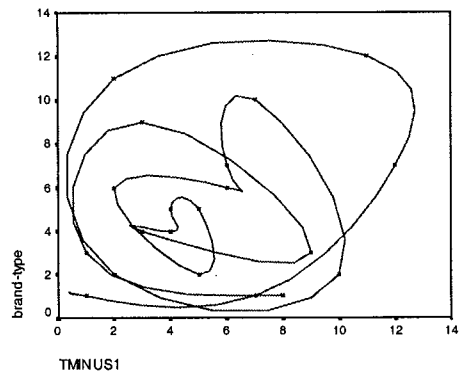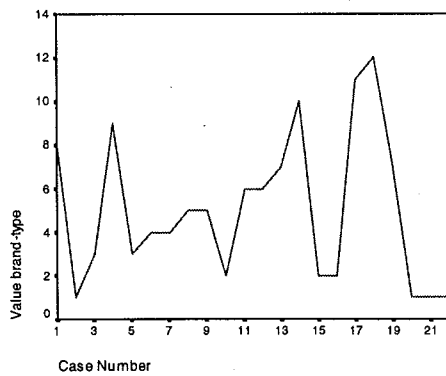
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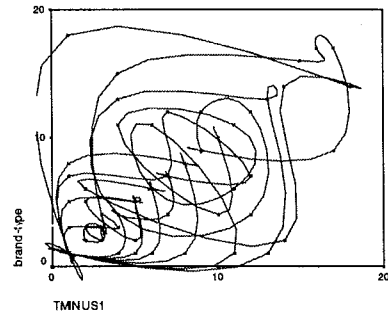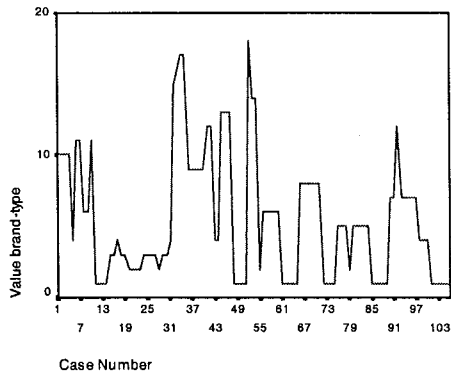
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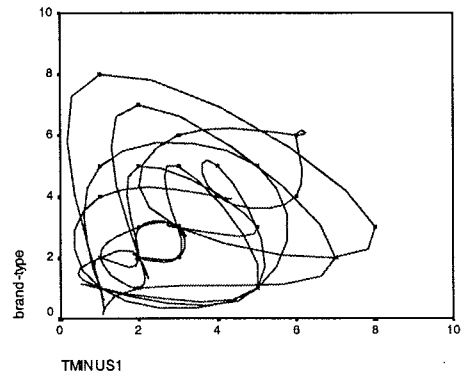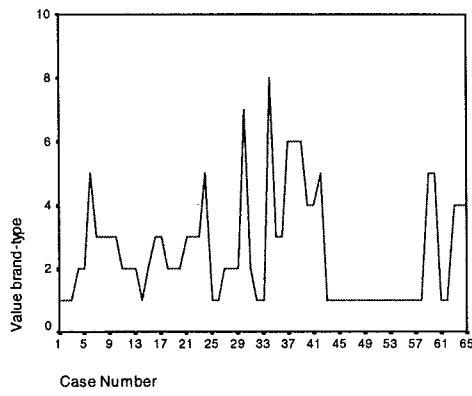
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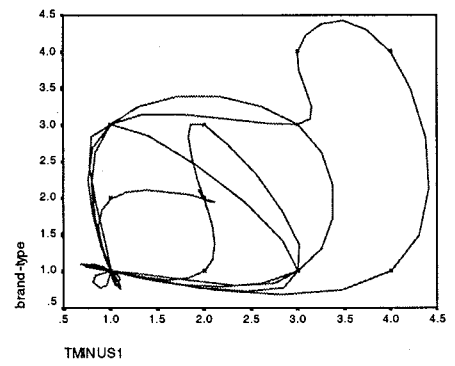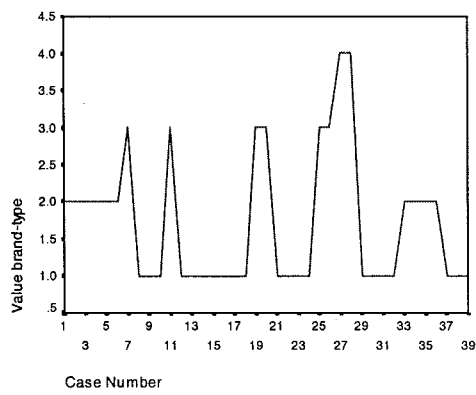
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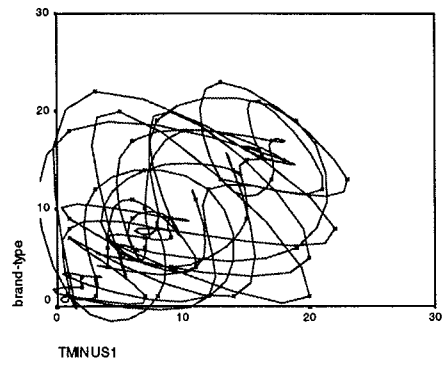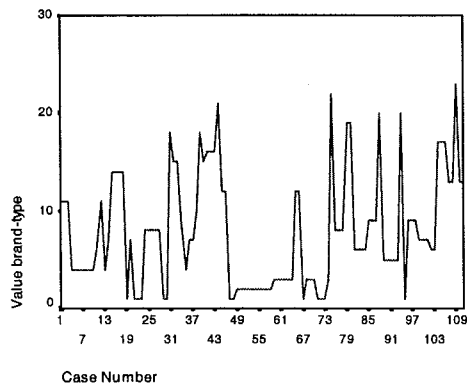
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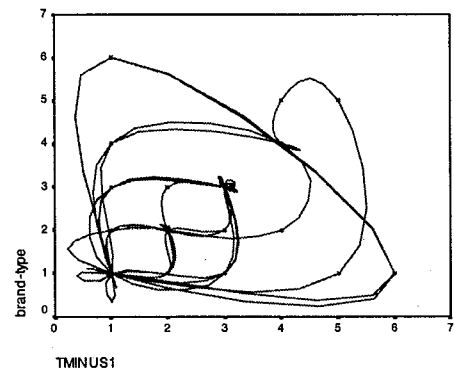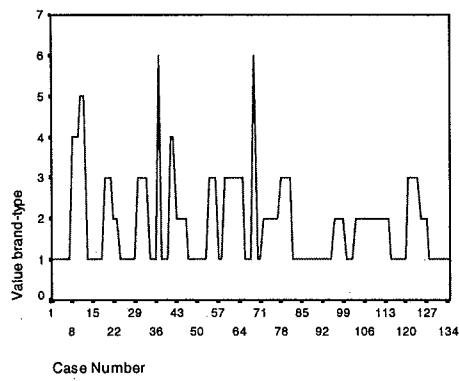
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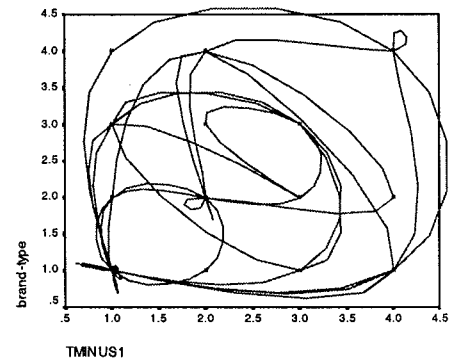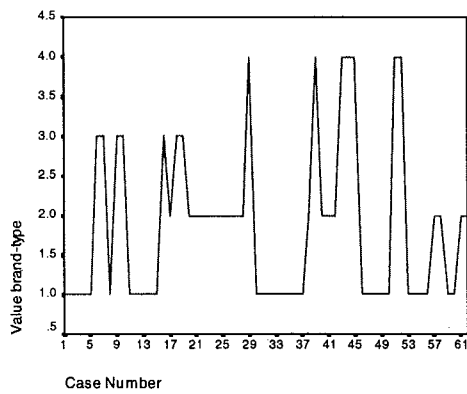
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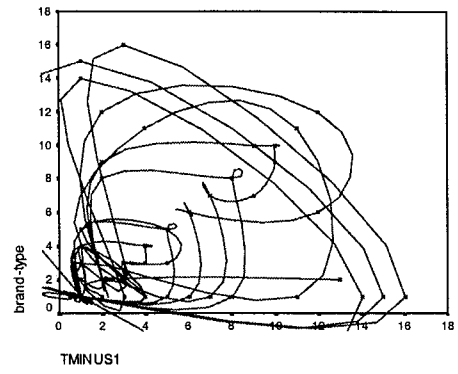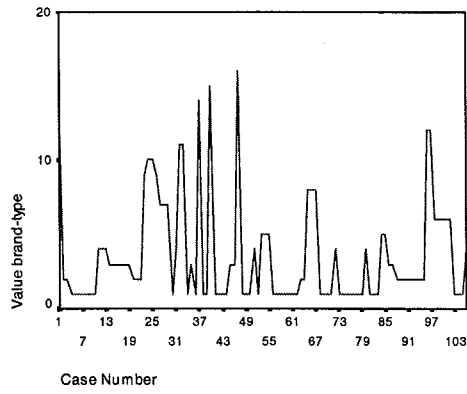
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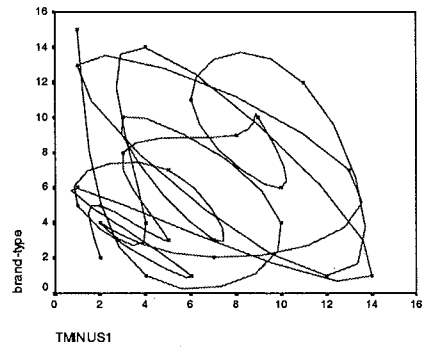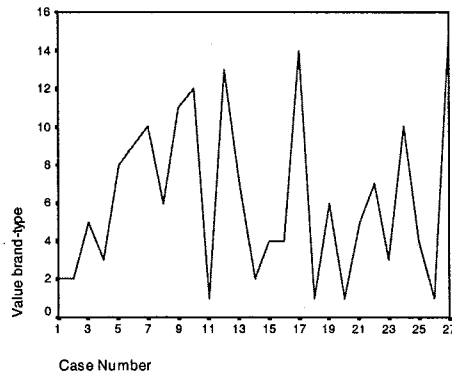
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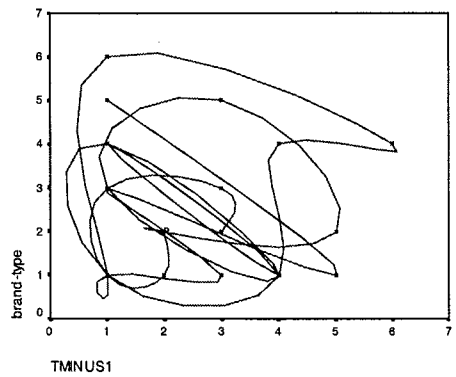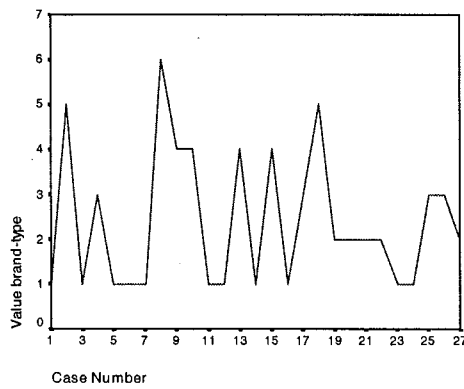
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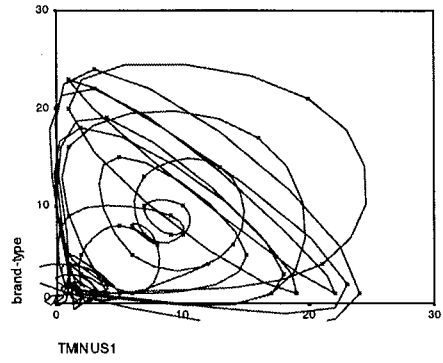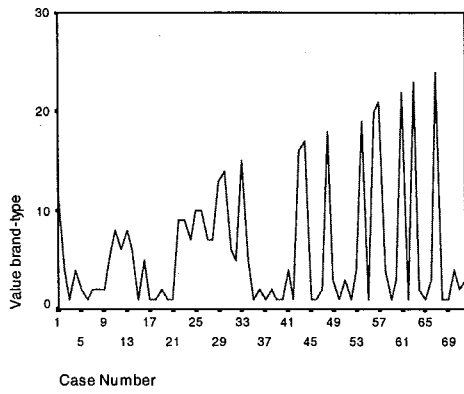
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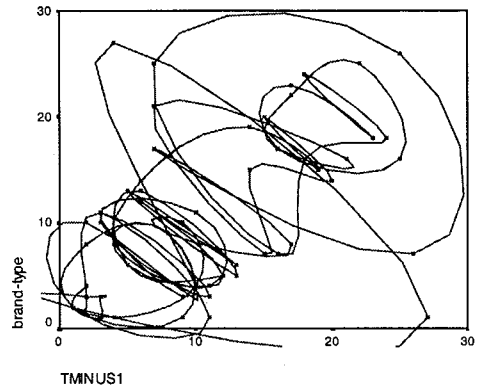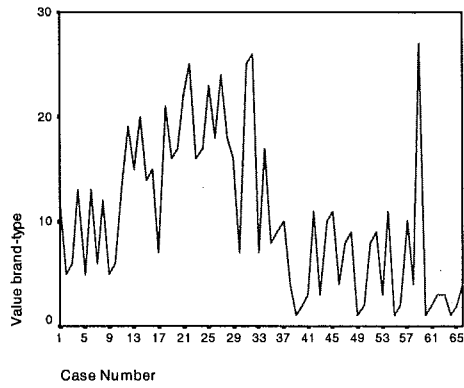
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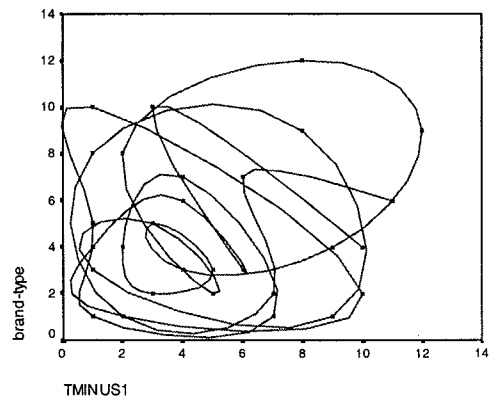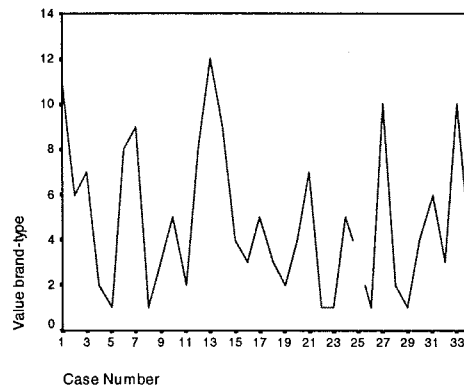
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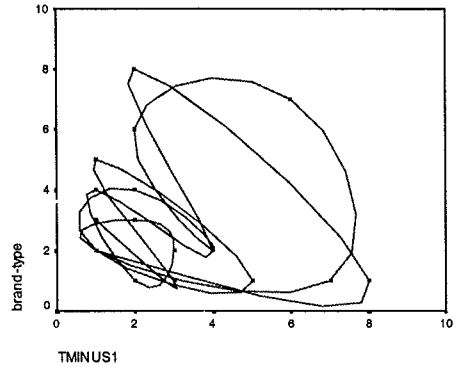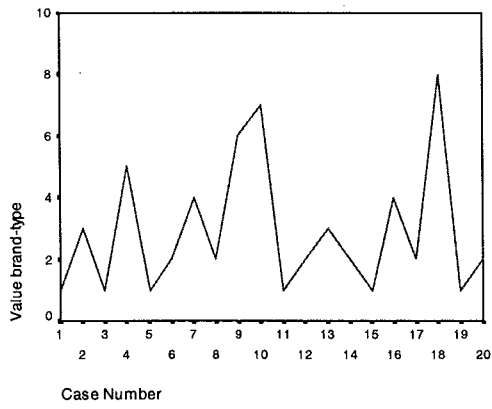
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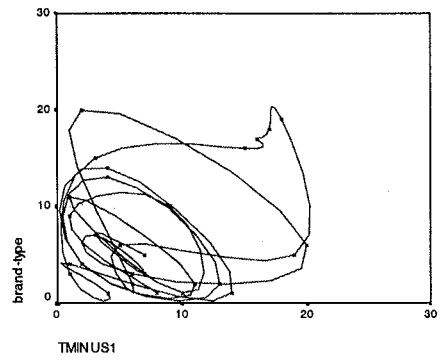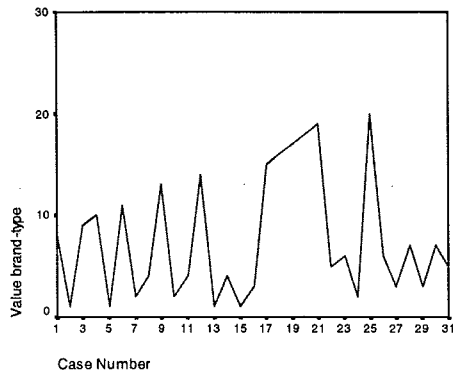
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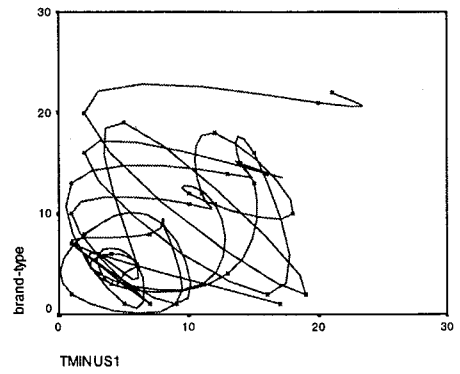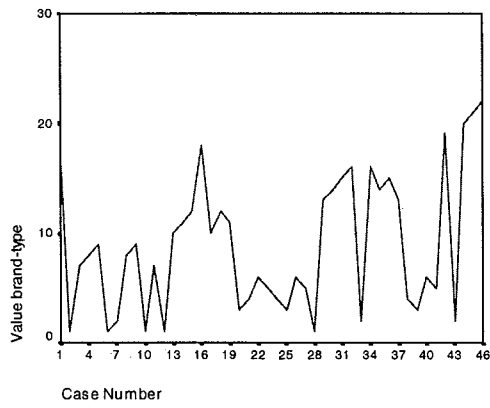
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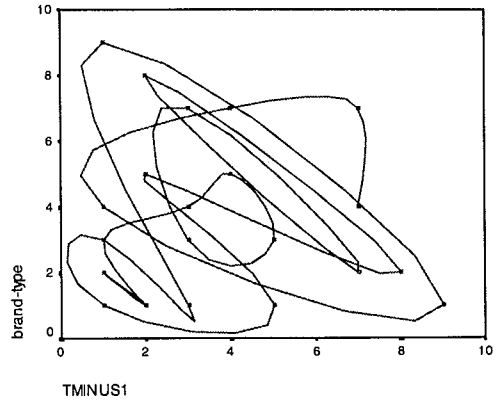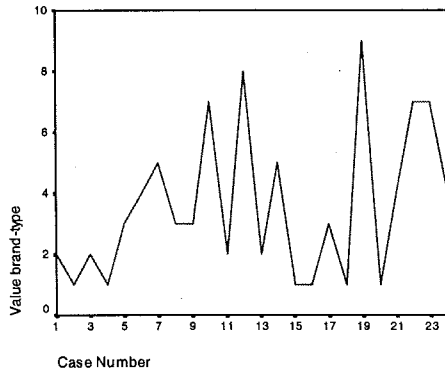
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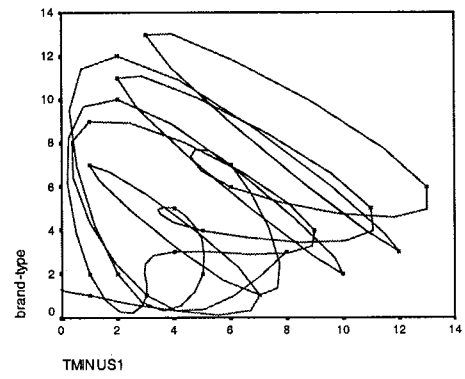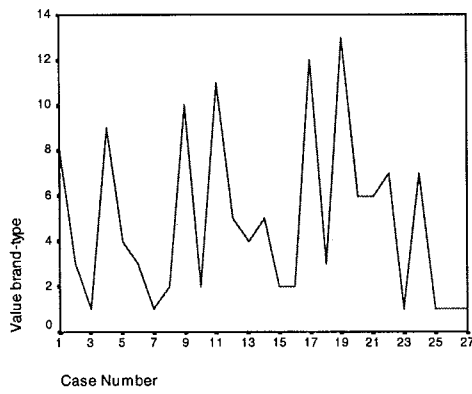
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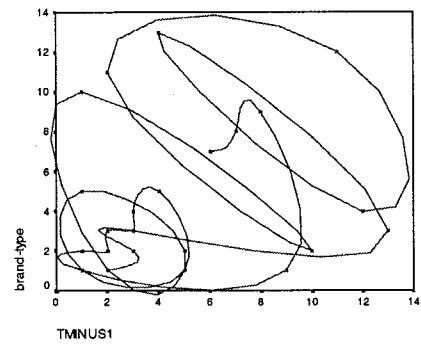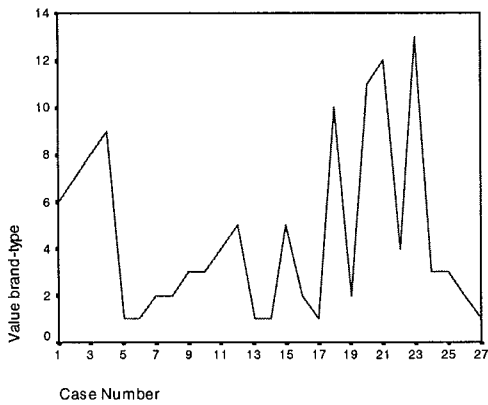
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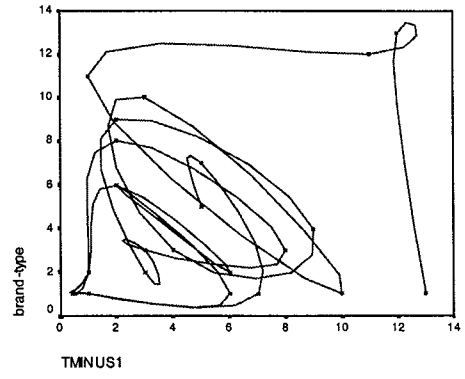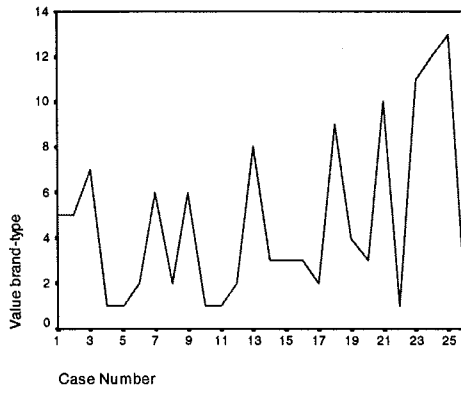
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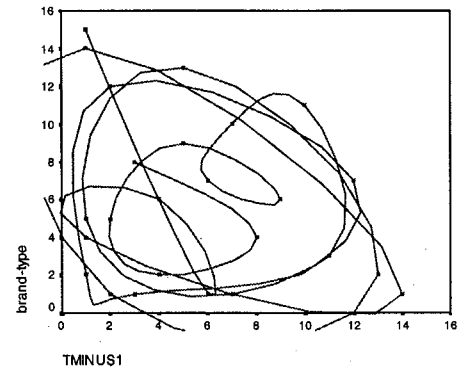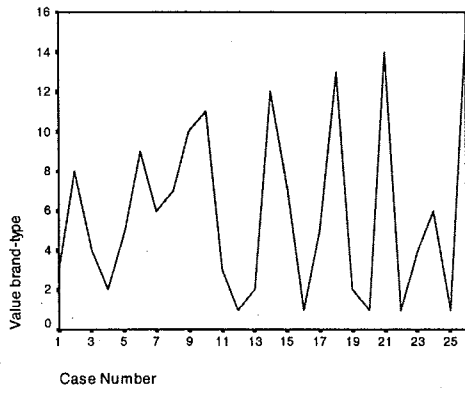
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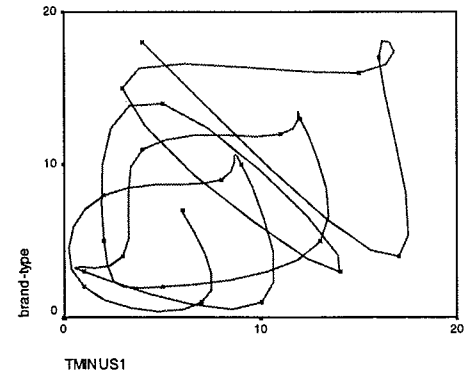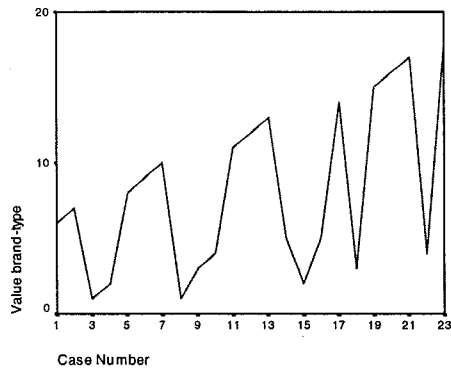
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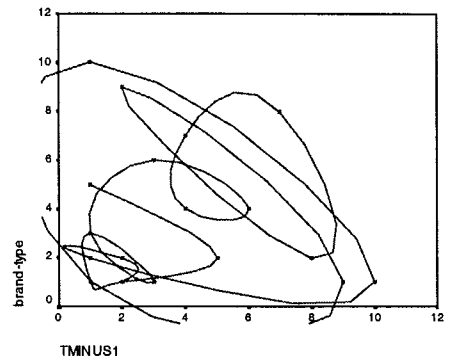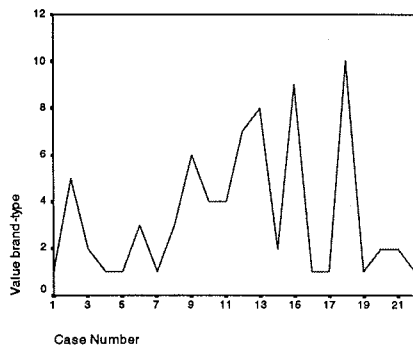
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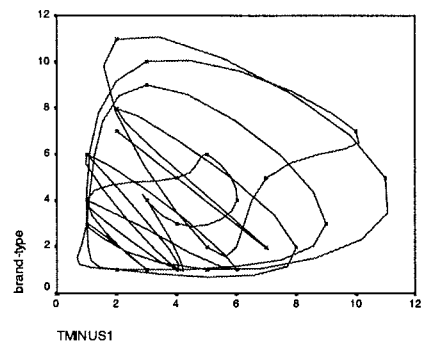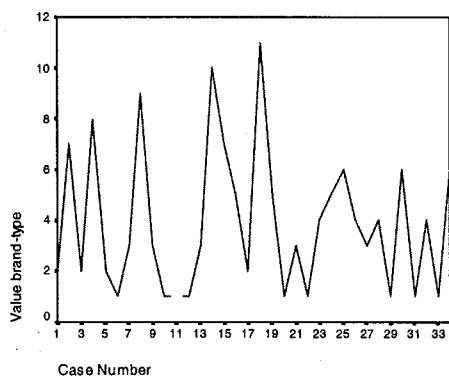
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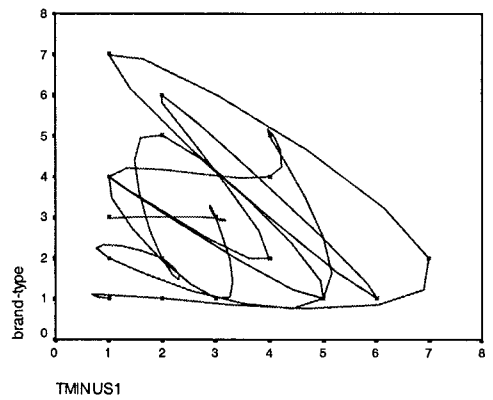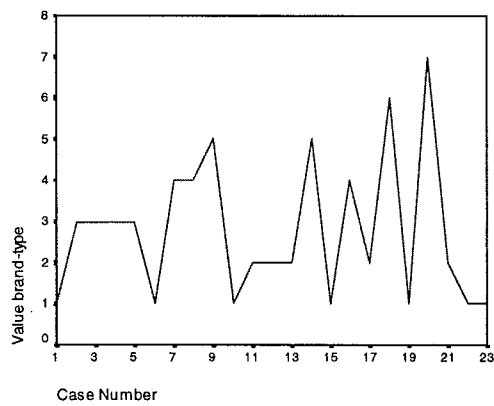
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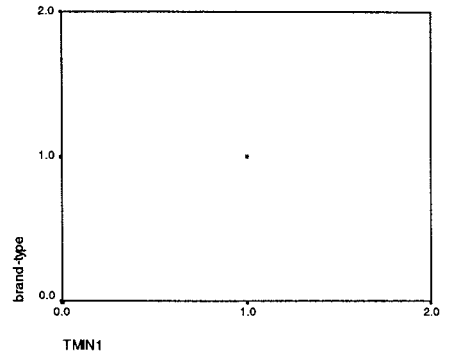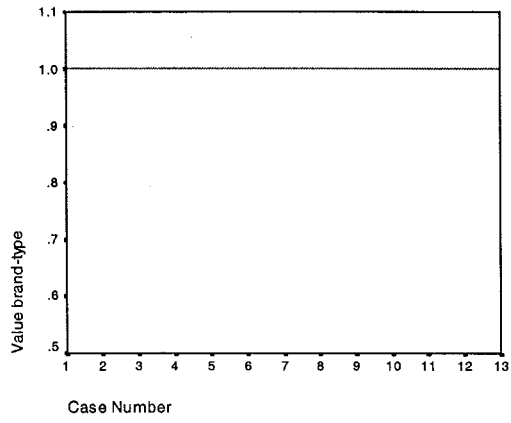
Appendix IV - Codes for the five key example plots

'Climber'
SS13

Value Label	Value	Frequency
Quavers c	1.00	6
Hula Hoops rs	2.00	5
Discos s&v	3.00	4
Hula Hoops s&v	4.00	4
GW Chicken	5.00	3
Mini Cheddars	6.00	3
Pringles s&v	7.00	3
Hula Hoops c&o	8.00	4
Walkers po	9.00	3
Walkers s&v	10.00	2
Walkers sb	11.00	2
Nik Naks	12.00	2
GW sb	13.00	2
GW rs	14.00	2
Braningans rb&m	15.00	2
M&S s&v	16.00	3
GW c&o	17.00	2
KP dry roasted nuts	18.00	2
Discos c&o	19.00	2
GW s&v	20.00	1
Walkers rs	21.00	1
Highlander c&o	22.00	1
Frazels	23.00	1
Chipsticks s&v	24.00	1
Skips	25.00	1
Pringles c&c	26.00	1
M&S bacon rashers	27.00	1
Tesco rs	28.00	1
M&S cheese puffs	29.00	1
M&S burger bites	30.00	1
Monster munch s&v	31.00	1
Walkers bbq	32.00	1
Frisps s&v	33.00	1
Frisps rs	34.00	1
Bacon Crunchies	35.00	1
Discos rs	36.00	1
KP salted nuts	37.00	1
Tesco sb	38.00	1
Braningans sh&p	39.00	1
Red Mill s&v Twirls	40.00	1

'Oscillator'
SD02

Value Label	Value	Frequency
Diet Irn Bru	1.00	71
Diet Coke	2.00	61
Barr Diet Lemonade	3.00	24
Diet Pepsi	4.00	18
Diet Virgin Cola	5.00	12
Diet Fanta	6.00	5
Diet Lilt	7.00	5
St.Ivel Mr Juicy	8.00	6
Rio Light	9.00	2
7 up Light	10.00	2
Schweppes Lemonade	11.00	2
Barr Cola	12.00	1
Barr Red Cola	13.00	1

'Stager'
BA22

Value Label	Value	Frequency
Somerfield German Pi	1.00	22
Tesco Royal Dutch La	2.00	13
Tennents 80/-	3.00	12
Adnams	4.00	6
Staropramen	5.00	4
London Pride	6.00	4
Shepherd Neame	7.00	3
Guiness Enigma Lager	8.00	3
Calders 80/-	9.00	3
King & Barnes IPA	10.00	3
Jennings Cumberland	11.00	2
Guiness	12.00	2
Tennents 70/-	13.00	2
Dortmunder Dab Pils	14.00	2
Alloa Export 80/-	15.00	2
Coniston Bluebird	16.00	2
Devon Pride	17.00	1
Young's Double Choco	18.00	1
Boddingtons	19.00	1
Budweiser Budvar	20.00	1
Deuchars IPA	21.00	1
Lefee	22.00	1
Burtonwood Bitter	23.00	1
Belhaven Best	24.00	1
Fraoch heather beer	25.00	1

'Flat-topped oscillator – sessioner'
BA25

Value Label	Value	Frequency
John Smiths Bitter	1.00	28
Becks	2.00	7
Caffreys	3.00	10
Guinness	4.00	8
Boddingtons	5.00	8
Biere D'Alsace	6.00	7
McEwans Lager	7.00	7
McEwans Export	8.00	6
Double Maxim	9.00	5
Caledonian Blond	10.00	4
Beamish Red	11.00	3
Theakstons Best	12.00	3
Old Speckled Hen	13.00	3
Newcastle Brown Ale	14.00	2
Belhaven 80/-	15.00	1
Caledonian 80/-	16.00	1
Carlsberg	17.00	2
Martsons Pedigree	18.00	1

'Steady stater'
YD36

Value Label	Value	Frequency
Safeway apri	1.00	5
Safeway mango	2.00	5
Safeway peach	3.00	5
Safeway orange	4.00	4
Ski extra b/cherry	5.00	3
Ski ex peach	6.00	3
Tesco apri	7.00	3
Safeway pine	8.00	3
Safeway pass frui	9.00	3
Safeway nec	10.00	3
Safeway rasp	11.00	3
Ski extra strawb	12.00	2
Ski ex rasp	13.00	2
Tesco goose	14.00	2
Tesco vanilla	15.00	2
Tesco rasp	16.00	3
Tesco summer frui	17.00	3
Vifit strawb	18.00	2
Tesco Rhubarb	19.00	1
Tesco banana	20.00	1
Tesco cherry	21.00	1
Tesco summer frui li	22.00	1
Vifit peach	23.00	1
Ski Extra Orange	24.00	1
Tesco nec&peach	25.00	2
Tesco blcherry	26.00	1
Safeway strawb	27.00	1

Appendix V – Analysis: Spectral Plots

SD01

Periodogram of brand-type

SD02

Periodogram of brand-type

SD04

Periodogram of brand-type

SD05

Periodogram of brand-type

SD07

Periodogram of brand-type

SD08

Periodogram of brand-type

SD09

Periodogram of brand-type

SD10

Periodogram of brand-type

SS13

Periodogram of brand-type

SS16

Periodogram of brand-type

SS17

Periodogram of brand-type

BA22

Periodogram of brand-type

BA23

Periodogram of brand-type

BA25

Periodogram of brand-type

BA26

Periodogram of brand-type

BA28

Periodogram of brand-type

BA29

Periodogram of brand-type

BA30

Periodogram of brand-type

BA31

Periodogram of brand-type

Frequency

YD35

Periodogram of brand-type

Frequency

YD36

Periodogram of brand-type

Frequency

Appendix VI- Rotations of two embedding dimension phase space analysis (plotted in 3D).

The following are representations of the five example informants; one from each group as identified in Chapter 5. The data values are plotted against two lags; t-1 and t-2. This produces a three dimensional representation of the data. Clearly this can only be presented in two dimensions here, and the resulting complexity or intricacy and true nature of the form is diminished. Only two rotations are provided for each informant, although an infinite number could theoretically be produced. The first rotation in each case represents the plot with the origin (0) at the top of the page. The second rotation is from the base of the plot, the origin being situated in the middle of the plot.

Unlike the one embedding dimension phase space plots used in Chapter 5, these plots use straight interpolation lines. This is essentially a stylistic point but naturally gives the plot a more 'angular appearance' than those in Chapter 5 and Appendix II.

'Climber'
SS13

Rotation 1
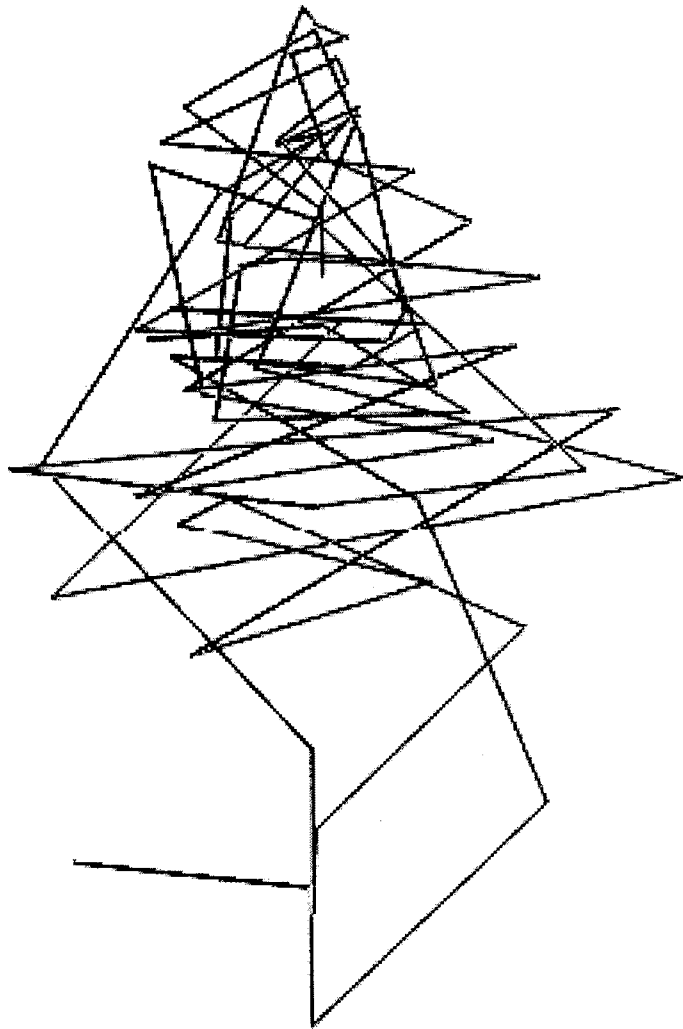
SS13

Rotation 2
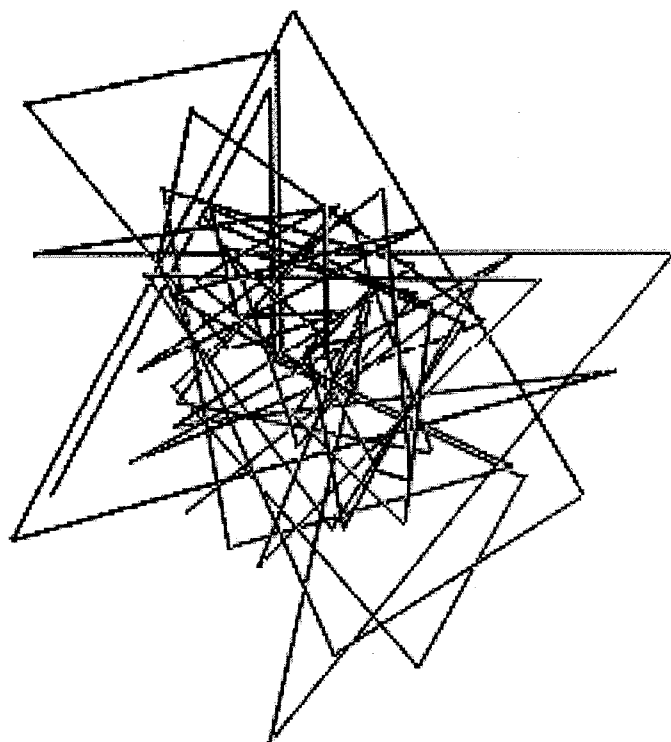
'Oscillator'
SD02
Rotation 1
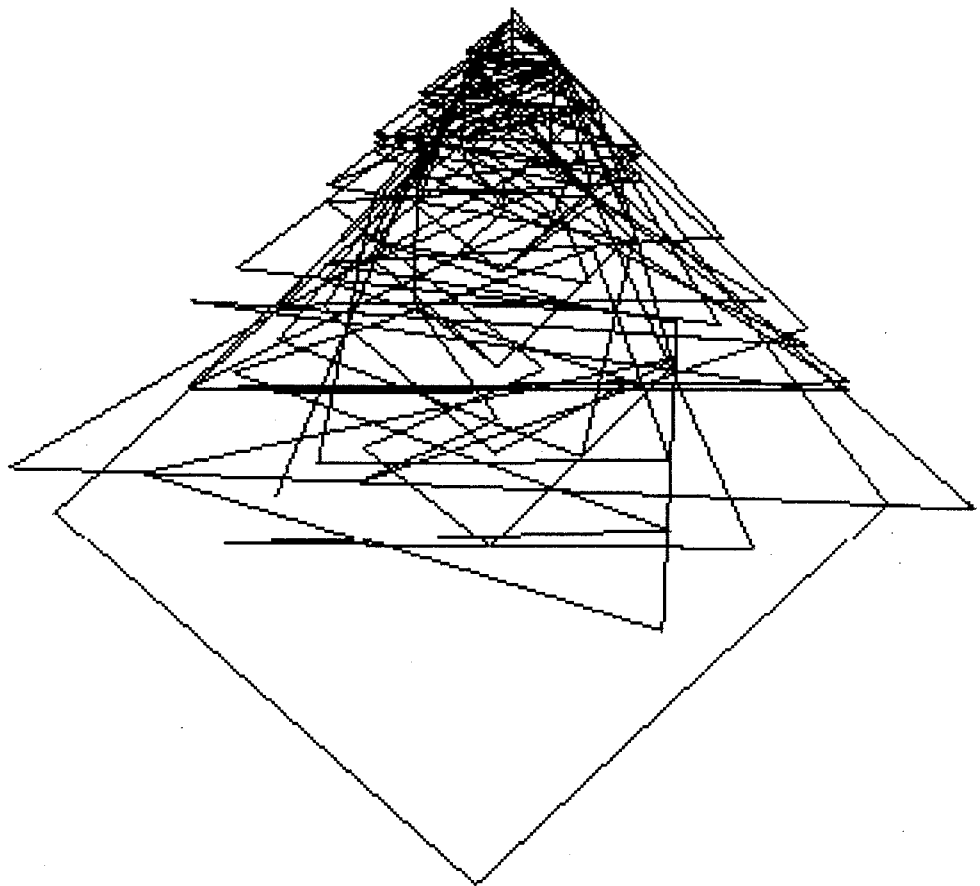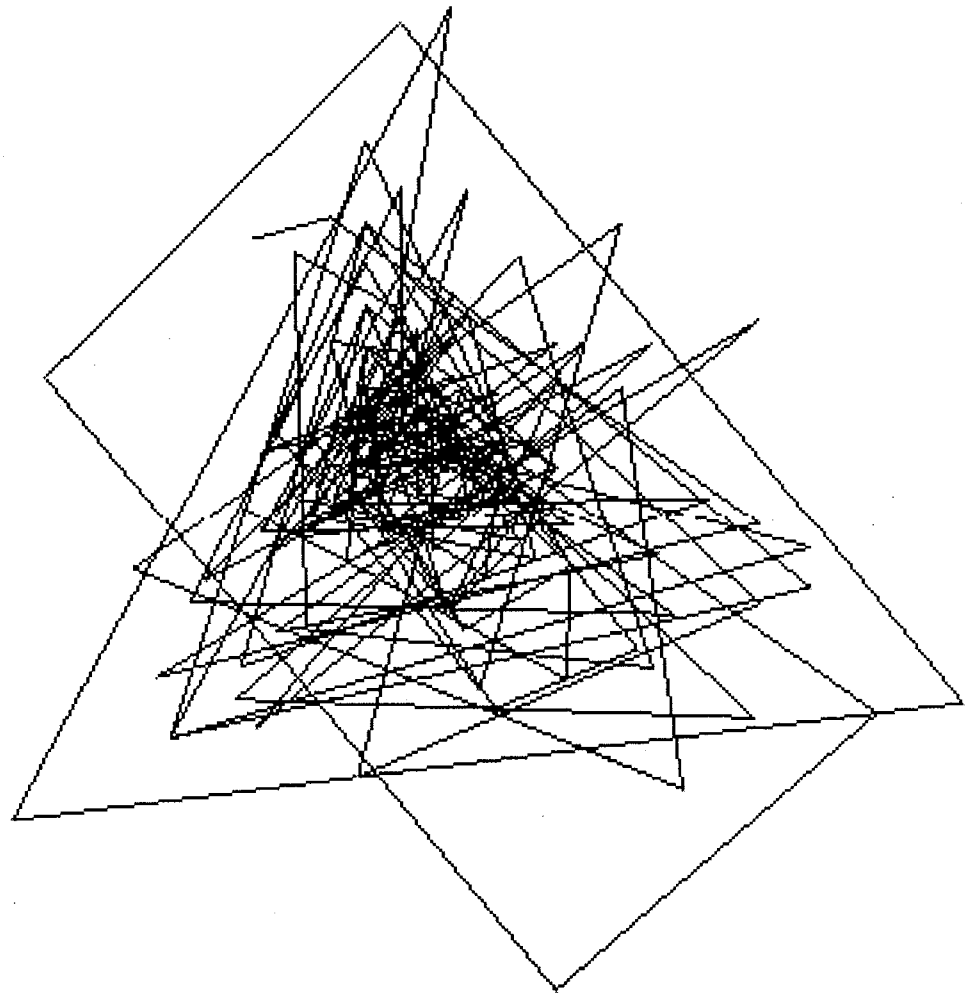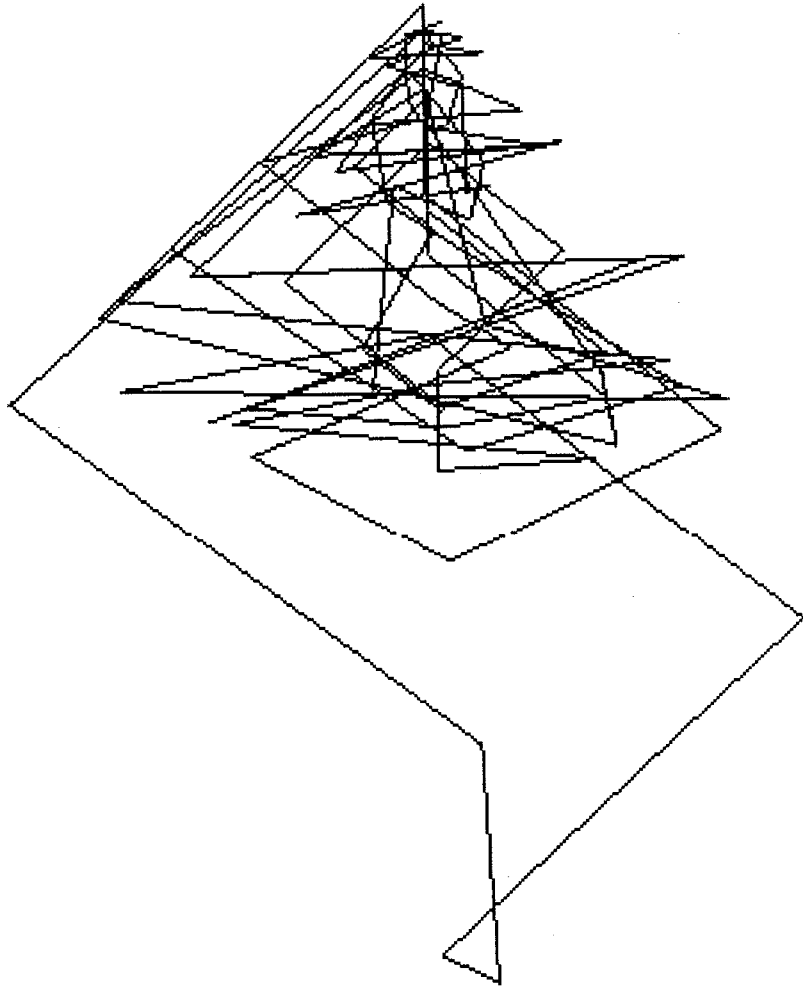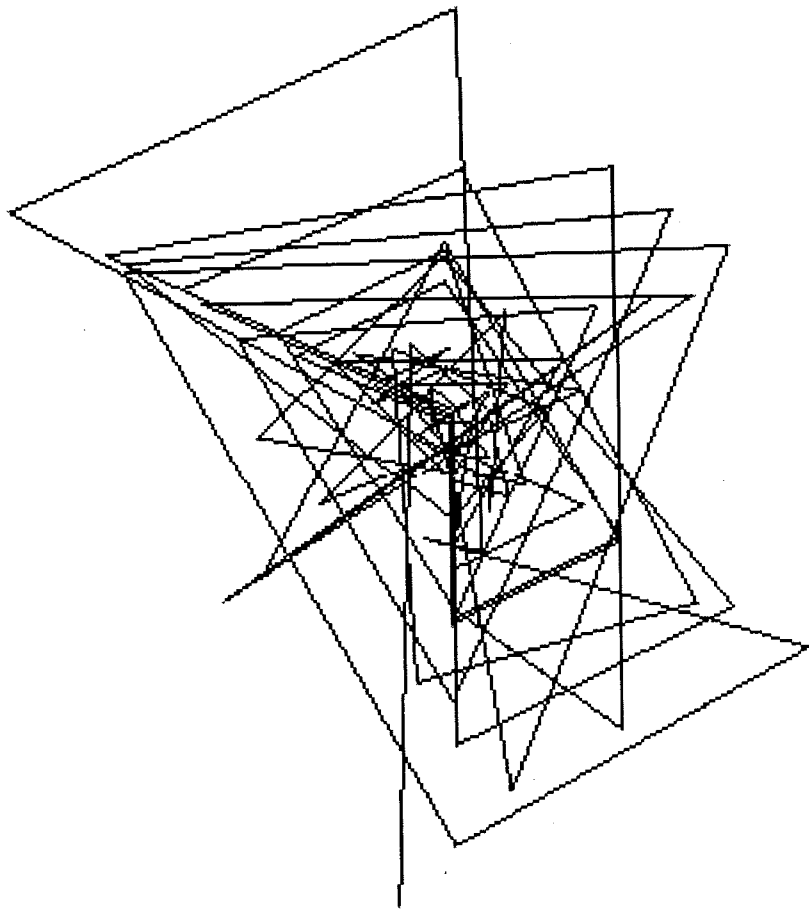
'Flat-topped oscillator – sessioner'
BA25
Rotation 1

'Flat-topped oscillator – sessioner'
BA25
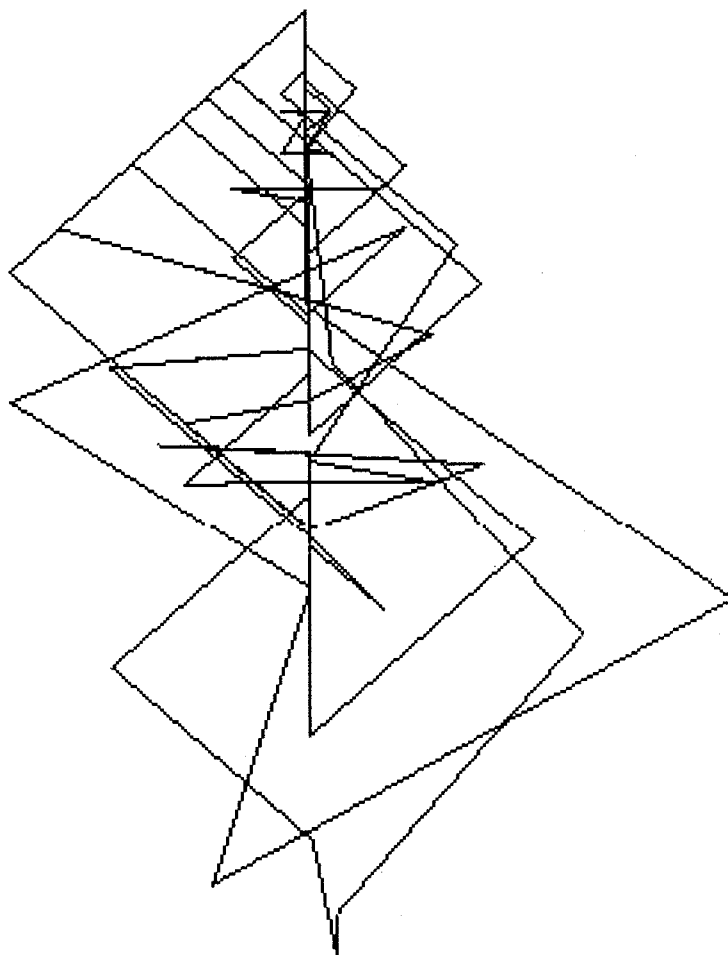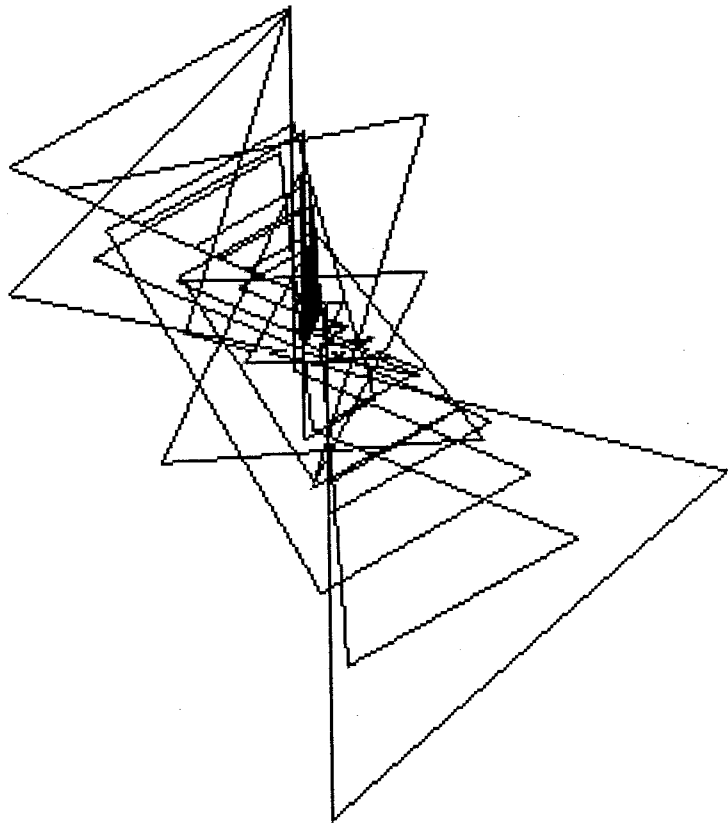
'Steady stater'
YD36
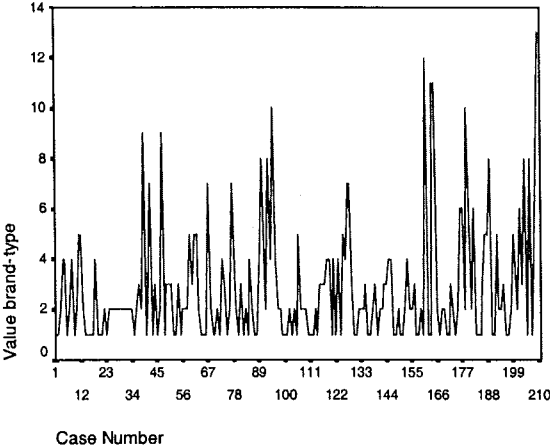**Rotation 1**
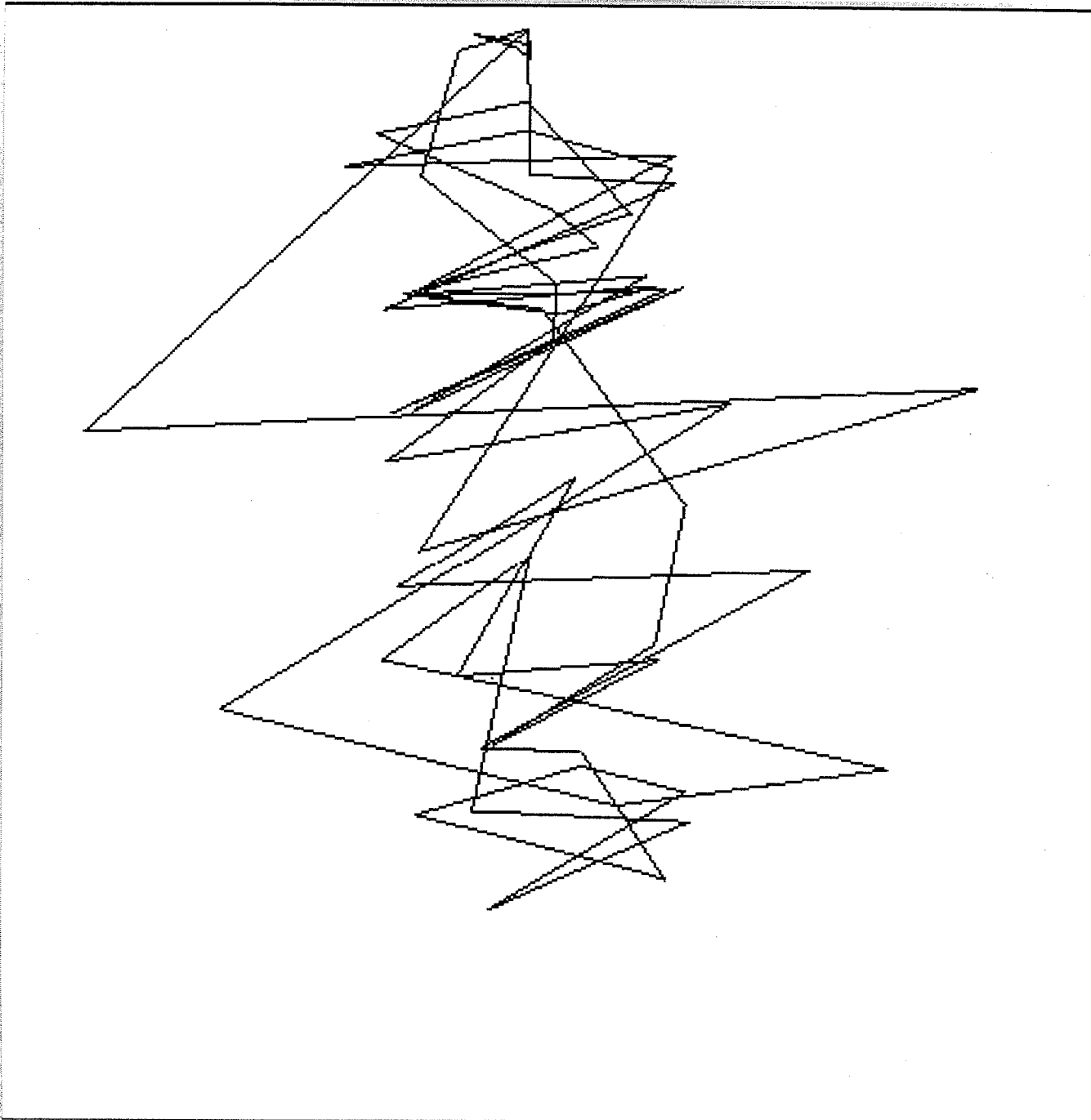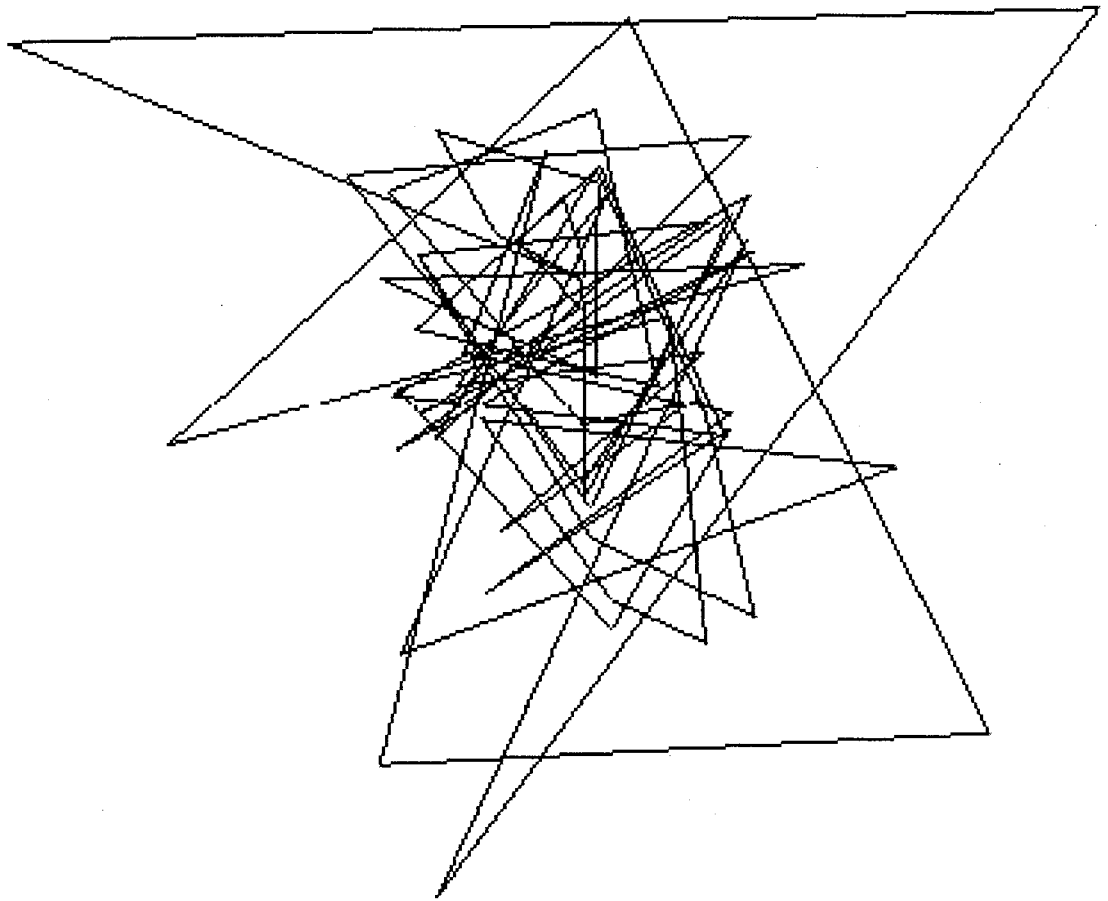
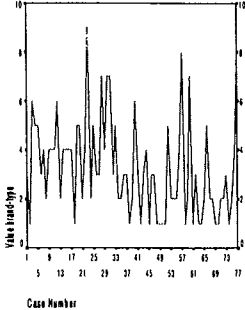# Appendix VII - Examples of WTS and PSP in relative scale

SD02   SD01

The WTSs above are in scale to each other in terms of both axes.
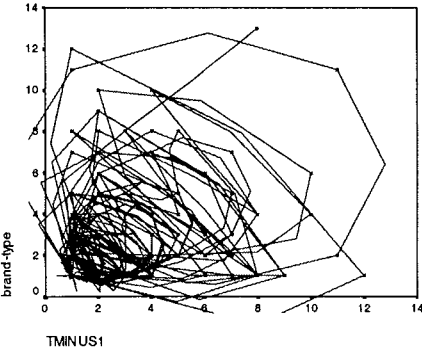
SD01   SD02
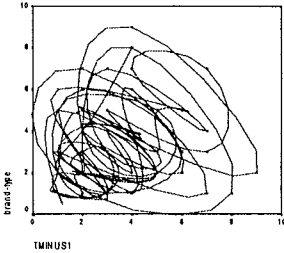
Appendix VIII - Cross correlations of product (brand/type) with situation (location) and time of day (or meal event).

Cross-correlations[1]

Respondent	Cross correlation: Situation	Cross correlation: Time of day/Meal event
SD01	0.24	0.005
SD02	0.331*	0.153
SD04	0.139	0.212
SD05	0.310*	0.112
SD07	0.341*	0.571*
SD08	0.057	0.352*
SD09	0.248*	0.169
SD10	0.429*	0.056
SS13	0.160	0.045
SS16	0.053	0.085
SS17	0.012	0.095
BA22	0.308*	0.025
BA23	0.106	-
BA25	0.215	0.319*
BA26	0.023	0.325*
BA28	0.318*	0.164
BA29	0.246*	0.180*
BA30	0.848*	0.026
BA31	0.411	-
YD35	-	0.055
YD36	0.062	0.328*
YD37	0.106	0.295
YD40	Constant variable	Constant variable
CC51	0.156	0.018

* Indicates signifcance at 95% level

Whilst there is some evidence of correlation for some informants between consumption situation and brand/variety choice and time of day and brand/variety choice the evidence is not striking. Many of the significant coefficients are still not that high. Whilst they go some way to explaining a degree of the variation in choice behaviour for a few informants they are by no means completely explain the forms shown in chapter 5. Doubts about the validity of this analysis are explored in section 5.8 (particularly the footnote to that section).

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[1] Only the longer series from each group have been included in this analysis. YD37, YD40 & CC51 are arguably below the minimum number of observations required for such analysis but are included for the sake of breadth of coverage.

Appendix IX - Aggregate purchase behaviour

Notwithstanding the emphasis on the important difference stressed between consumption and purchase (the one being the proxy of the other and *vice versa*) aggregate purchase is often relatively stable at the brand level. The following figures represent national sales data for two product groups used in the diary study. The values given are for Sterling value sales so any promotion or price effects are 'included' in the series, the series are therefore a type of 'performance index' for the brand/variety. The data is for all multiples and Co-ops with scanners (Source: IRI Infoscan). All data relates to the period beginning weekending July 1995- weekending Oct 1996. The data is in the most disaggregated form made available.
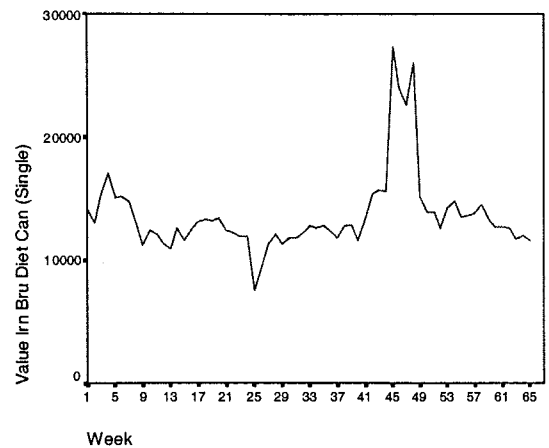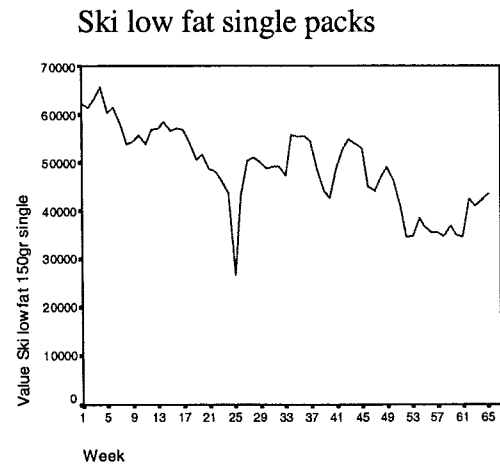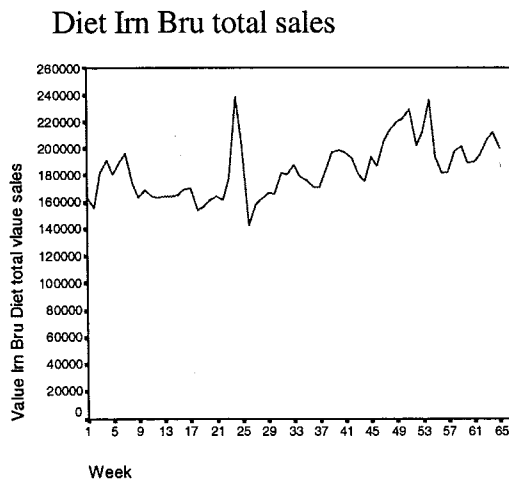
Irn Bru, sold as individual can
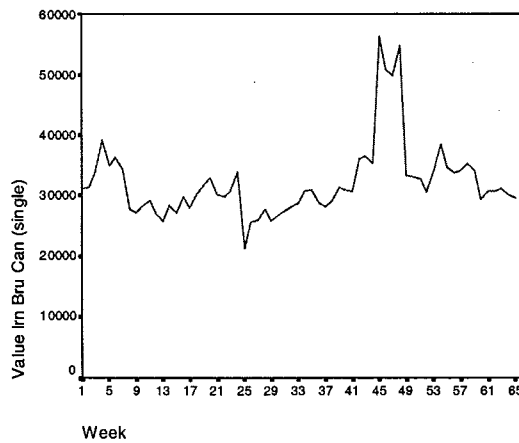
Non diet Irn Bru total sales

Diet Irn Bru single cans

240

Diet Irn Bru total sales
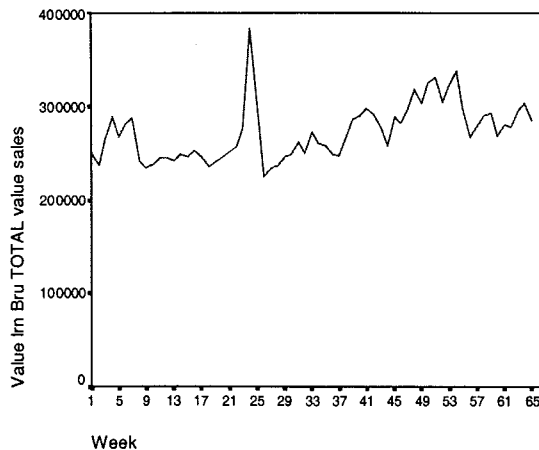
Ski low fat single packs

The series show varying degrees of stability and also show that even for the same time of year (52 weeks after an observation) that sales can be at quite a different level. However the character of the purchase series is not as volatile as those in the study for individual *behaviour*. This might be due to the fact that the observations are weekly rather than more frequent or disaggregated. On the surface of it there appears to be a situation where highly unstable individual behaviour in a variety of forms gives rise to *relatively* more stable series at the aggregated level. This has been acknowledged by other consumer researchers; to reiterate the following from Chapter 3:

> '... a great amount of brand switching is observed under conditions in which the market shares are almost constant'. (Bass et al 1976 p1051).

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Appendix X – Purchase at Stirling TESCO for study period

Selected savoury snack sales
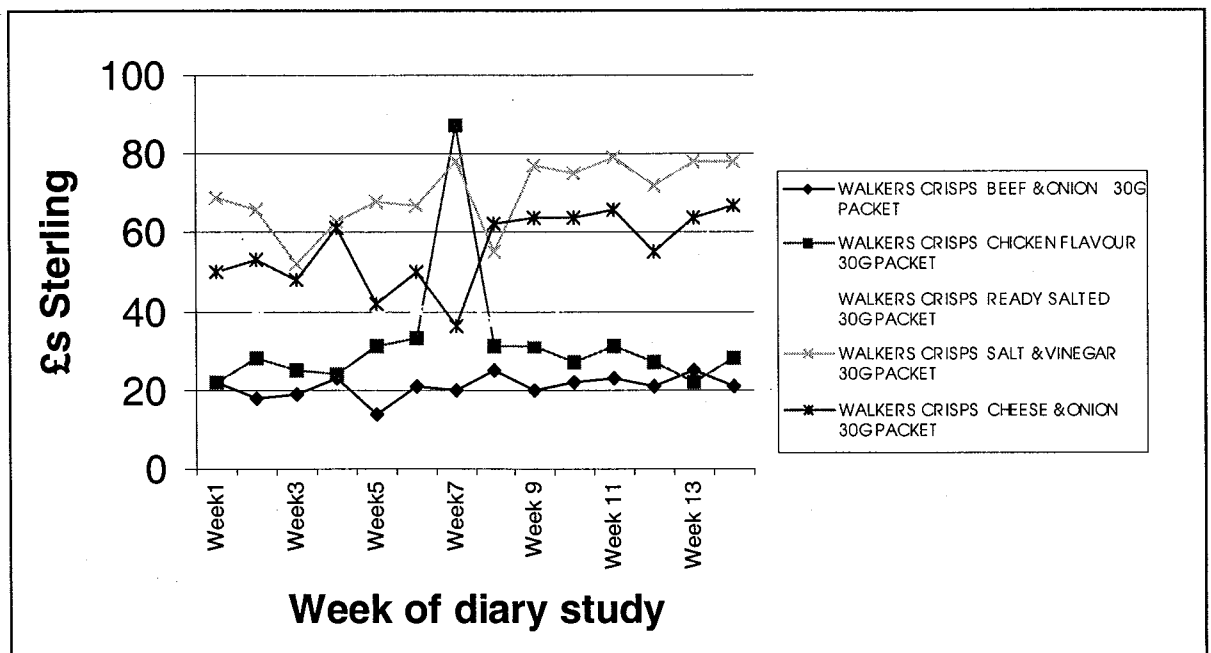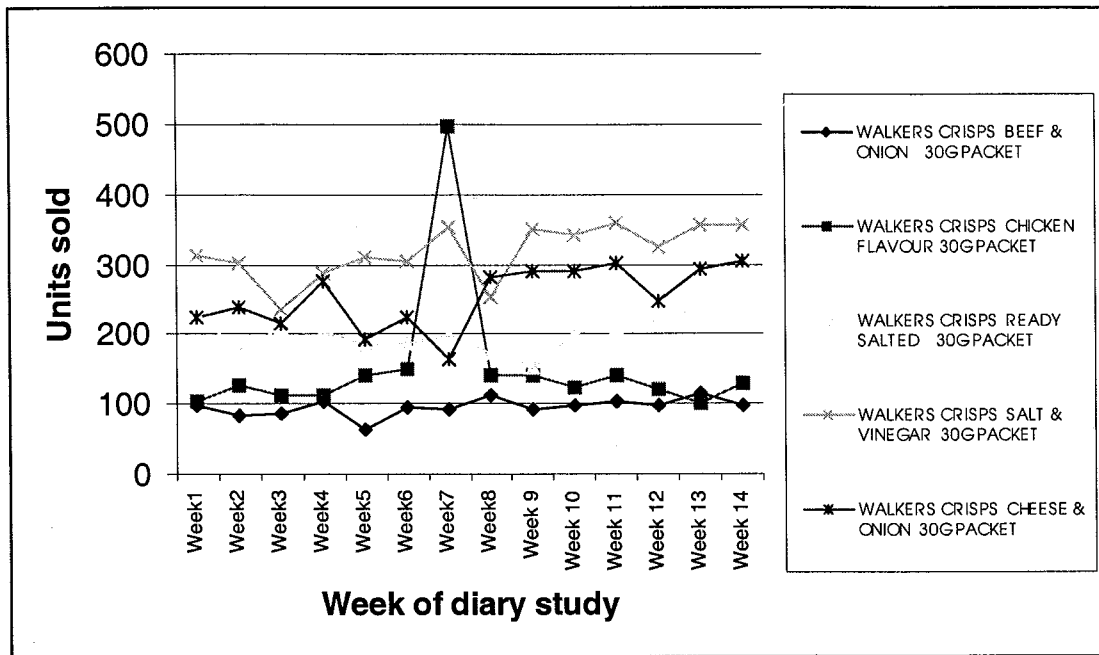
Selected yoghurt and dessert sales