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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

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A special thank you is due you to all my informants who so conscientiously kept the consumption diaries. Your commitment to the process was and is very much appreciated. Thank you.

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

[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

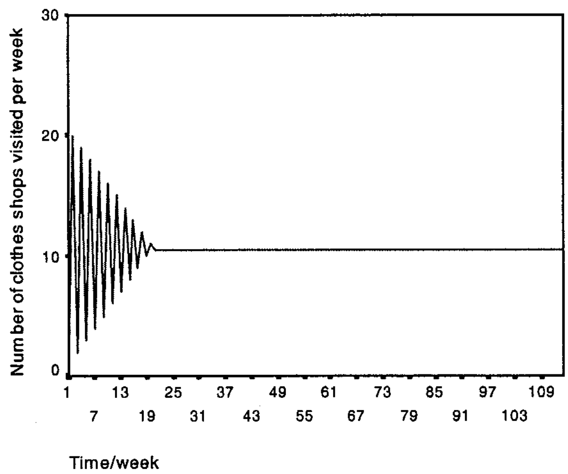
'Traditional' statistics sees processes which are unpredictable as stochastic processes e.g. the so-called random walk (Granander & Rosenblatt, 1957). Chaos theory allows this category of processes to de described as deterministic, hence the term deterministic chaos (Williams, 1997). Chaos is 'qualitative' 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



[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)

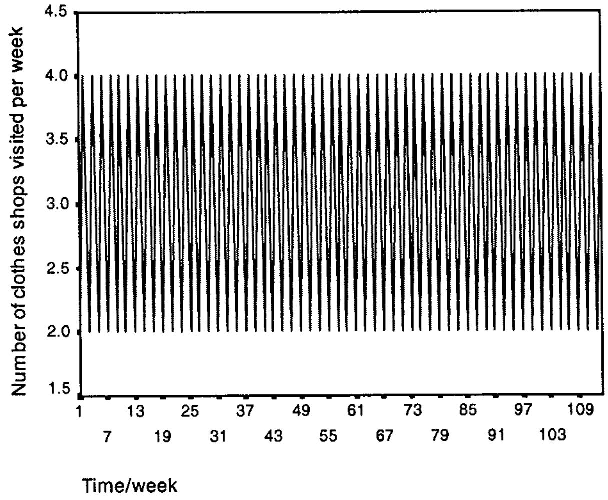
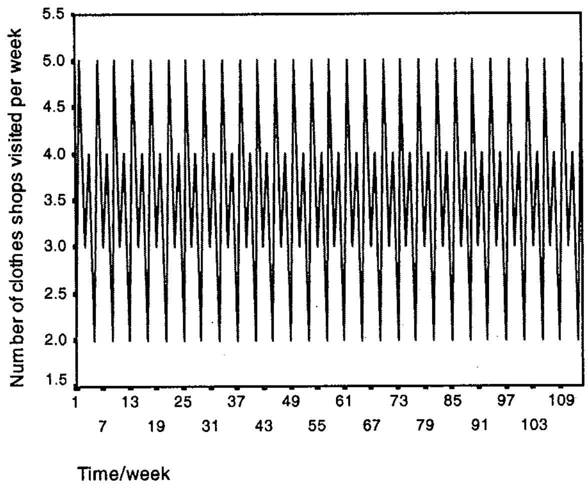
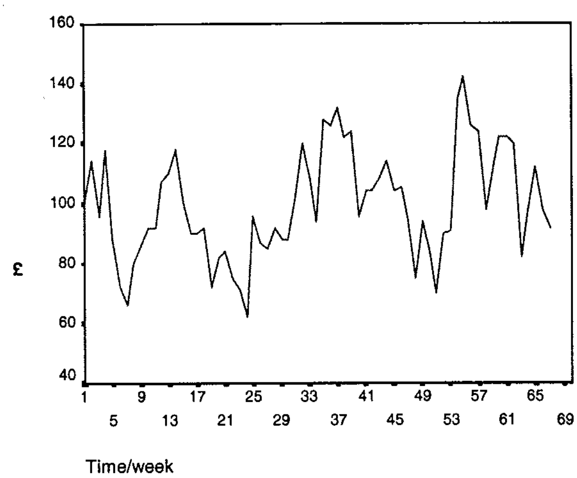


Figure 2.2.3.3: Four period behaviour series (two cycles)



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)



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)'

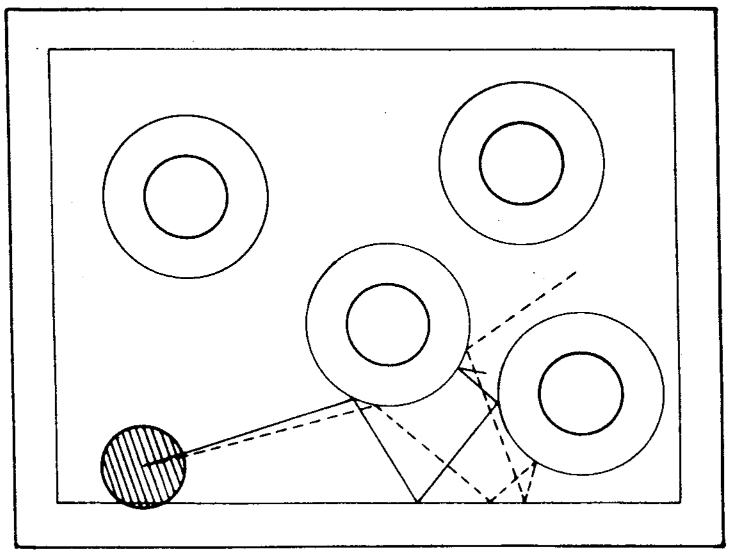
One key concept in chaos terminology is the 'butterfly effect' (attributed to Edward Lorenz). This describes a situation or system where small apparently irrelevant or insignificant events cause chain reactions which emerge as large or even cataclysmic changes at the measurable level; this is often referred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

[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

[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.