Mathematical Social Science Monographs

Herd Behaviour
in
Markets, Polities, Cultures and Technologies

EARLY DRAFT

Gordon Burt

Note on 27th October 2020: this is a relic from 21 years ago!

Open and Distance Education Statistics

Herd Behaviour in Markets, Polities, Cultures and Technologies

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An additional aim is to foster a mathematical interdisciplinary approach to the social sciences. To this end a series of Mathematical Social Science Monographs is planned, the present book being the first of the series.

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PREFACE

The material in this book is derived from a series of papers presented at seminars and conferences:

The dynamics of party policy: an analogy with speculative markets.
Presented to the Rational Choice Group of the UK Political Studies Association, London, Autumn 1996.

A synergetics model of party policy dynamics: an analogy with speculative markets.
Presented to the Mathematical Sociology Section of the American Sociological Association, Annual Meeting, Toronto, 11 August 1997.

Herd behaviour in markets, polities and cultures – mathematical and political economy approaches.
Presented to the Scottish Economic Society Centennial Conference, Stirling, 9 April 1997.

Herd behaviour in speculative markets and political parties.
Presented to the Society for Economic Dynamics, Oxford, July 1997.

The worst Conservative defeat since the Duke of Wellington in 1832.
Presented to colleagues at the Open University, and to Open University Social Science students at Summer School, July 1997.

INTRODUCTION

> 'Even as a general assumption of economics, maximization of income by individuals with independent preferences is too simple. Adam Smith gave that theory a big send-off in *The Wealth of Nations*, but in the earlier *Theory of Moral Sentiments*, he asserted forcefully that emulation is the most pervasive of human drives.'
> (Kindleberger, 1989, p. 244)

What is the basis for human action - the emulation of others or the exercise of individual judgment? In a modern society much attention is given to the place of reason in the organisation of people's lives. Yet some of the most dramatic events of the modern world have involved the collective behaviour of the herd. In the economic sphere it is the emulation involved in herd behaviour which Kindleberger invokes to explain the manias and panics which repeatedly seize the global financial markets. In the political sphere the twentieth century has seen extensive mobilisations of political opinion in favour of major political systems. At the same time in the wider society there has been a long process of the emulation of modern culture and the waning of traditional cultures, while at a more specific level cultural fashions rise and fall and there are outbreaks of ‘social panics’. Even in technology herd behaviour is present: new and future technologies are widely and successfully 'hyped'. The literature refers to technology traps and the tendency to become 'locked in' to inferior technologies.

Not only is herd behaviour important in reality, it is also important in theory. As implied by Kindelberger's quotation it presents a fundamental challenge to rational choice explanations of human action. The starting point for most rational choice theories is the individual. Each individual is assumed to have a set of preferences and these preferences are taken as given. Preferences are exogenous. In this respect rational choice theories do not have a social basis. In contrast herd behaviour suggests that individual behaviour and the individual opinions underlying behaviour are socially formed. In particular an individual's opinions and behaviour are imitations of other people's opinions and behaviour.

Viewed more broadly the study of herd behaviour can provide a platform for a more multidisciplinary approach to the study of social systems, in particular injecting some aspects of politics and sociology into the study of economics. This book shows how the same abstract model can be applied to markets, polities, cultures and technologies.

From a mathematician's point of view the welcome increase in conceptual richness provided by these other disciplines is marred by the scarcity of mathematical models in these disciplines. This is in contrast to the case in economics where there is some criticism of over-mathematisation. The criticism of over-mathematisation in economics is in part due to the limited type of mathematical model used. Commonly it is deterministic equilibrium models which are used whereas our understanding of social reality may be more appropriately modeled by probabilistic non-equilibrium models. It is the latter type of models which I shall be investigating in this book A second criticism of mathematical models is their lack of relevance to historical reality. The book ends by considering how mathematics can model history.

2 HERD BEHAVIOUR IN MARKETS

Introduction

Studying the dynamics of herd behaviour prompts fundamental questions about economic theory. Firstly as Kindleberger points out the mere phenomenon of herd behaviour provides evidence that human action can at times be motivated by emulation of others rather than by calculation of individual self-interest. Secondly the observed dynamics of herd behaviour provides evidence that economic dynamics can be a non-equilibrium dynamics rather than the equilibrium dynamics which has long preoccupied economic theory. Thirdly it raises the methodological question as to 'whether ... mathematics adds to our understanding of the economic phenomena under analysis' (Kindleberger, 1989, p. 246). Finally a study of herd behaviour brings us closer to a sociological understanding of economies and polities as entities embedded in cultural systems.

In short the study of herd behaviour takes us to the centre of the debate about the direction which the discipline of economics should take. For a long time now there has been widespread concern that orthodox economics is in crisis. The centenary edition of the Economic Journal gave expressions of doubt from a variety of scholars (for example Hahn, 1991, pp. 47-48; Stiglitz, 1991; Wiseman 1991, p. 150). Wiseman observes that 'the growing dissatisfaction with the dominant neoclassical orthodoxy manifests itself in several ways' while Stiglitz heads one of his sections, 'The demise of early twentieth-century neoclassical economics'. A more extended critique of orthodox economics has recently been given by Hodgson (1993), while scholars in the Scottish Political Economy tradition have long argued that theirs - and not the neo-classical economics tradition - is the true tradition of the economics of which Adam Smith was such a celebrated exemplar (Cairncross 1954, Macfie 1955, Dow 1987, Winch 1997).

These criticisms attack neoclassical economics on the grounds of methodology, fundamental concepts and disciplinary basis. It is argued that there is an overemphasis on abstract and mathematical methods. It is also argued that the central ideas of rationality and optimization, and of static equilibrium and equilibrium dynamics, are inadequate representations of the real world. It is suggested that a new approach is needed. Models should be stochastic rather than deterministic and should represent dynamic non-equilibrium systems rather than a static equilibrium. The dynamics should recognise a variety of 'evolutionary' characteristics. Rather than focusing on individuals as atoms, there is a need to recognise the social, institutional level. The assumption that individuals are rational needs to be replaced by models which incorporate findings from psychology and behavioural studies. Also, it is said that the disciplinary basis of economics is too narrow and needs to adopt a multidisciplinary approach and incorporate insights from a number of other disciplines (Throsby, 1995; Atkinson, 1997). See Table 1 below.

Table 1 A schematic contrast between the concepts of neo-classical economics and the concepts of alternative approaches

neo-classical	alternative approaches
deterministic	stochastic
equilibrium	non-equilibrium
static	dynamic
'non-evolutionary'	evolutionary
individual	social/institutional
rational	psychological/behavioural
economics	multidisciplinary
mathematical	exclude maths; include maths

The rational actor model

A central feature of the herd behaviour model is the undermining of the rational actor model. 'The deficiencies in the rational actor model have long been recognised' declares Stiglitz (1991, p. 137). To remedy these deficiencies it has been suggested that individuals have bounded rationality and 'satisfice' (Simon, 1947; McCain, 1995; Conlisk, 1996). A useful formulation of bounded rationality is provided by Flam (1996, p. 1509):

'Ideally the agent in question should entertain a global vision of his problem, and see right away to maximise [his profit function over the set of plans], using some algorithm of mathematical programming. It seems more likely though that some of the following hurdles prevail:
(i) He is slightly inexperienced, not having identified his profit function Π fully;
(ii) He contends with a local approximation of Π near the current point;
(iii) He does not know the distribution of [the random vector];
(iv) He lacks experience in optimization;
(v) He is not well trained in probability.
If so, the following weak assumption on behaviour seems natural: wherever possible, the agent will exploit conceived opportunities for improvement. Such behaviour typically yields a stepwise process. As usual, two things determine the dynamics then: (a) the direction of strategy change chosen at any stage and (b) the step size taken in that direction. Regarding (a), we suppose that as long as the agent experiences a nonzero marginal payoff, he will change his plan in a direction of perceived payoff ascent [...] Concerning (b), to account for accumulation of experience, we posit, grosso modo, that step sizes tend to zero, but not too fast.'

Thus what characterises the operationalisation of an individual's bounded rationality at any one time is the direction and magnitude of the step they take - in mathematical terms, a vector. Flam (1996, p. 1513) refers to the above as single agent stochastic programming. Moving on to consider multi-agent stochastic programming Flam adopts a similar approach, in particular noting that the agent: '... may be prevented from knowing the actions and characteristics of his rivals, or ... might find it too costly to gather strategic information and interpret it'. This rejection of the rational choice non-cooperative games approach is also followed by some researchers in the developing field of evolutionary economics.

In the following section we discuss recent debates about the foundations of market theory. The new theorising about speculative markets is then expressed in terms of a general formulation of social dynamics and Lux's model of opinion dynamics in speculative markets is identified as a particular case of this formulation and is extensively discussed. Extensions to the Lux model are then considered and ideas from evolutionary economics are incorprated into the opinion dynamics. A cameo of the 1987 crash and the 1848/9 financial crisis is used to prompt questions about the role of herd behaviour in the historical evolution of the global financial system.

Market and general equilibrium theory

> '[Walras'] system of economic equilibrium ... is the only work by an economist that will stand comparison with the achievements of theoretical physics.'
> (Schumpeter, 1954, p. 827, cited in Hodgson, 1993, p. 140)

General equilibrium theory stands as a landmark achievement of the economics discipline. However the theory has problems. Firstly there is the question of its interpretation. Hicks described two basic interpretations of the general equilibrium model, referring to them as the spot economy and the futures economy. In the futures economy, actors have full information about the future and make a once-and-for-all choice of a complete schedule for future action. Hicks rejected this as unrealistic and instead work focused on the analysis of the paths followed by the spot economy through a succession of temporary equilibria, where individuals make choices at each point in time on the basis of their current expectations about the future (McKenzie 1989, Grandmont, 1989). This is the basis for the efficient market hypothesis which we shall discuss shortly.

A second key issue is what happens if the economy is out of equilibrium. Walras proposed that in such a circumstance the economy would converge to the equilibrium position through a process of tatonnement or groping:

> 'Such is the continuous market, which is perpetually tending towards equlibrium without ever actually attaining it, because the market has no other way of approaching equilibrium except by groping.'
> (Walras, 1954, pp. 380-381, cited by Hodgson, 1993, p. 141)

But does the tatonnement process in fact lead to equilibrium? Recent research emphasises that it does not necessarily do so.

> 'Most of the important mathematical economists at mid twentieth century contributed to this theory but none seems to have guessed that tatonnement could generate chaotic price sequences. [...] These difficulties in the theory of competitive markets stand after two centuries and remain to be given an adequate mathematical treatment'.
> (Day and Pianigianni, 1991, p. 65).

Speculative markets and the efficient market hypothesis

Given that this is the current state of market theory, what are we to say about speculative markets? For a long time the dominant theory of speculative markets was the efficient market hypothesis. According to this theory, rational traders use all

relevant information to form expectations about future prices and buy and sell accordingly. This brings current prices into line with future expectations. So the only price change possible is one that is random. However commentators, particularly in the wake of the 1987 crash, have found it difficult to reconcile the theoretical assumption of rationality with the behaviour of real stockmarkets:

'I have considerable belief in microefficiency of liquid organized markets. I am doubtful about any great macroefficiency. [...] When Franco Modigliani sees a mispricing of GM common and preferred, he and others can make profits doing what corrects that discrepancy ... [but] when, in the late 1970s Professor Modigliani opined that the Dow was below 1000 "irrationally" ... all he could do was write about it. Arguing with the tape by selling the general index short could be costly, and in any case ineffective, while animal spirits were what they were and analysts' shortcomings were what they were.'
(Samuelson, 1994, p. 23)

Influential in establishing this view that irrational 'animal spirits' affected prices was Shiller (1984) as well as Kindleberger (1989) himself. The rationality postulated in the efficient market hypothesis has been challenged by a variety of empirical findings: excess aggregate volatility in the stockmarket, excess dispersion, the equity premium puzzle, the concentration of portfolios and the overpricing of initial public offerings. Benartzi and Thaler (1995) suggest that the equity premium puzzle arises because investors have loss aversion, and so fail to maximise their expected earnings, their frequent 'myopic' evaluation increasing the experience of loss. Morris (1996) suggests that the overpricing of initial public offerings is a consequence of the variety of information-free priors which investors use to evaluate the initial offering. Bulkley and Harris (1997) suggest that excess dispersion is due to forecasters using an incorrect model. Excess aggregate volatility has been explained in terms of the interaction between heterogeneous traders - for example between sophisticated traders and naive traders - or noise traders (references to this literature are contained in Lux, 1995, and Lux, 1996). Shiller (1984) and Kindleberger (1989) in particular have been influential in establishing the view that irrational 'animal spirits' affect stockmarket prices.

The herd behaviour literature suggests a rather different view of the stock market to that envisaged by the efficient market hypothesis. According to this new view, traders are heterogeneous - in particular with respect to their opinions and powers - and so may be grouped on the basis of these differences. Traders' actions take place within a market exchange network. These actions are governed by opinions and rules - rather than utility maximisation. The opinions and rules are formed by a process of contagion of opinion in a social communication network (see particularly Shiller and Pound, 1989). Market power and communication power are important in their respective networks. The collectivity of market actions generates the price (which is why we refer below to the price as a 'collective construct'). The whole process is also affected by a variety of individual and collective parameters, such as individuals' susceptibility to contagion of opinion and the speed of adjustment of the market.

A general model of social dynamics

We can also set up a formalism which encapsulates these features. A market is in state S(t) at time t. The market is characterised by a set of actors A, a set of groups G (and corresponding group sizes X), a set of actions B, a set of networks N, a set of

opinions O, a set of powers Π, a set of collective constructs C and a set of parameters Q.

$S(t) = \{ A(t), G(t), X(t), B(t), N(t), O(t), \Pi(t), C(t), Q \}$

We can proceed to formalise the dynamics of the system. The dynamics of the system is a function of the state of the system.

$dS(t)/dt = f(S(t))$

This dynamics resolves into the dynamics of the various components of the state. Given the complexities of studying the complete dynamics, we shall focus particularly on the dynamics of opinion, power and action. Opinion is formed under the influence of communication actions of varying power. Power is formed under the influence of market and political actions of varying power. Actions are guided by opinion and constrained by power. The collective construct plays an important role - in the case of markets the collective construct is price.

$dO(t)/dt = f(\Pi(t), B(t), C(t); O(t))$
$d\Pi(t)/dt = f(O(t), B(t), C(t); \Pi(t))$
$dB(t)/dt = f(O(t), \Pi(t), C(t); B(t))$
$dC(t)/dt = f(O(t), \Pi(t), B(t); C(t))$

These equations can be formulated at the micro level to refer to the dynamic behaviour of individuals. Looking at the collection of individual dynamics we can then formulate the dynamic behaviour of the *distribution* of individuals. From the dynamics of the distribution we can then obtain macro level equations which describe the dynamics of the collective in terms of aggregate parameters. The equations may be given either a deterministic formulation - or a probabilistic one. Exemplifying the latter is the synergetics approach described by Weidlich (1994, p. 269) as follows:

'The main objective of synergetics is to explain mathematically under very general conditions the remarkable fact, that complex multicomponent systems can on the macrolevel be characterized by only a few order parameters, which obey a self-contained autonomous dynamics among themselves, whereas the dynamics of the vast majority of microvariables in such systems is dominated ("slaved") by these few order parameters.'

The Lux model of herd behaviour

Given the complexities of studying the complete dynamics, Lux (1995) focuses particularly on the dynamics of price p and the dynamics of group size X. Our interest in group size follows from our interest in the contagion of opinion: the groups here

are defined in terms of their opinions about the market and so the effect of contagion of opinion is to produce changes in group membership and group size.

$dp(t)/dt = f(S(t))$
$dX(t)/dt = f(S(t))$

One attraction of the Lux paper is that it aims to model the insights of the Kindleberger model (which Kindleberger himself refers to as the Minsky model or the Fisher-Minsky model). Other attractions are that it explicitly models the contagion of opinion process, and that it embeds this in a complete dynamic specification. In particular the Lux model provides a clear account of the notion of a dynamics which runs between a central equilibrium and several extremal equilibria. Finally Lux's application of synergetics theory is an exemplar of several studies which apply this approach across the full range of social science disciplines (Reiner et al. 1988, Weidlich 1994, Helbing 1994 and 1995), thus supporting my aim to establish an analogy between, and explore the linkage between, markets, polities and cultures (Burt 1994).

The situation discussed by Lux is that of three groups of traders each with their characteristic opinions about price levels: sophisticated traders who know the fundamental value, optimistic naive traders who have the opinion that the market is rising and pessimistic naive traders who have the opinion that the market is falling. The traders buy and sell according to their opinions. The demand and supply functions for naive traders are constant while the demand and supply functions for sophisticated traders are linear. (Because supply and demand functions have this simple form, the price dynamics are not the immediate source of disequilibrium which they are in Day and Pianigianni (1991) and Gu (1993), in their discussion of chaotic tatonnement processes). The equation for the price dynamics is given below.

$dp/dt = bD = b[nx\hat{} + s(m-p)]$

Notes:
(i) This corresponds to equations (5), (7) and (8) in Lux (1995, pp. 886-887); and equation (5) in Burt (1996);
(ii) p denotes price and t denotes time; b is the speed of adjustment of the market, and D denotes net demand; n is the proportion of naive traders and s is the proportion of sophisticated traders; m is the mean opinion amongst the sophisticated traders about the fundamental value; and x^ is an index of the mean optimism or pessimism of the naive traders, running from +1 when all naive traders are optimistic to -1 when all traders are pessimistic about the direction of price.

In the model, the sophisticated traders do not change their opinion (see however Lux, 1996), whereas the opinions of individual naive traders can change from optimism to pessimism and vice versa. This creates fluctuations in the mean optimism/pessimism (x^). The dynamics of x^ are derived by Lux from the transition probabilities between the opinion states. These probabilities are a function of the criterion which a trader uses as the basis for a shift in their opinion. Using the probabilities Lux applies the theory of synergetics to obtain an equation of the following form.

$dx\hat{}/dt = 2v[\tanh(z)-x\hat{}]\cosh(z)$

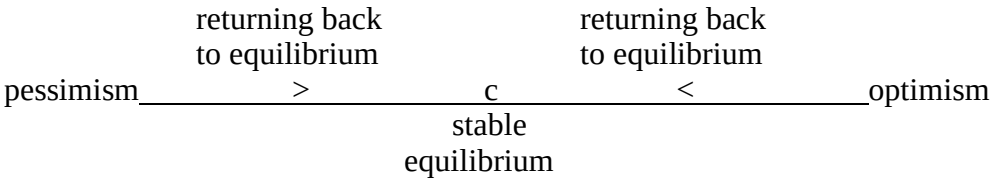
Notes:

(i) v is the speed of opinion change, and z is the criterion parameter; Tanh and Cosh are mathematical functions.
(ii) In deriving the above equation we have moved from a stochastic model involving transition probabilities, to a deterministic model. The deterministic model is an approximate mean value equation for the original stochastic system.

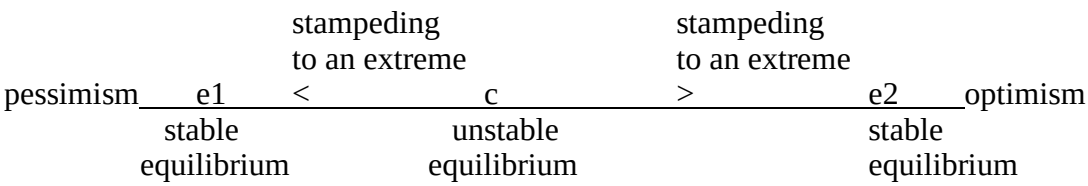
Lux's paper develops three different models, each corresponding to a different criterion parameter z. In model 1, naive traders change their opinions purely on the basis of other traders' opinions. There are basically two forces at work here: a balancing force which tends to even out opinion, and a herding force which reinforces any imbalance which happens to occur. What happens to mean opinion depends on the relative strengths of these two forces. If the balancing force is strong enough relative to the herding force, then there is a single stable central equilibrium with naive traders split equally between optimism and pessimism. If the herding force dominates the balancing force, then the central equilibrium becomes unstable and there is motion towards one or other of two stable extremal equilibria: either optimism or pessimism is predominant. (These are the most likely situations. Due to the stochastic nature of the model there can be variations from these, in particular a jump from one extreme equilibrium to the opposite extreme).

Figure 1 Equilibria for mean opinion

(a) The case of weak herd behaviour: a stable central equilibrium c



(b) The case of strong herd behaviour: an unstable central equilibrium c,
and two stable extreme equilibria; optimisim or pessimism dominates



In model 2, naive traders change their opinions not only on the basis of other traders' opinions but also on the basis of price movements. This provides a linkage between opinion dynamics and price dynamics. The result is a two-dimensional analogue of model 1: either a single central equilibrium of opinion and price or two extremal equilibria, pessimism and undervaluation of price or optimism and overvaluation of price. An additional possibility is periodic orbiting of the central equilibrium. In model 3, naive traders now change their opinions partly on the basis of real returns in addition to the aforementioned criteria. Here real returns are taken to be a function of price and of price change. Note that it is model 3 which provides the most developed formalisation of Kindleberger's model.

Table 2 below summarises the most likely possibilities. It is important to note that due to the stochastic nature of the model there are many other possible dynamic patterns. Writing about related issues in mathematical biology Renshaw (1991, pp. 2, 5) emphasises the importance of realising that 'both deterministic and stochastic models have important roles to play in the analysis of any particular system'. One problem which can occur is that deterministic and stochastic models can generate different conclusions. For example, he comments on (deterministic) chaos theory: 'where fantasy takes over is in the belief that the mathematically exquisite and delicate fine structure might be observed in biology. Any superimposed environmental noise, almost no matter how small, destroys it. So for practical ecological purposes the chaotic regime relates to apparently random dynamics'. Lux (1995, p. 889) acknowledges such problems and supplements his work with simulation runs, at one point concluding 'taking the randomness that has been suppressed in our derivations into account, the system may ... undergo transitions between cyclic behaviour and stable steady states leading to an erratic appearance of the overall evolution of prices.'

Table 2 Equilibria for different models and different parameter values

Model	Herd strength	Equilibrium Location & Stability		
1	weak		central stable	
	strong	pessimism stable	central unstable	optimism stable
2*	weak		central stable if ** periodic orbit if **	
	strong	pessimism stable	central unstable	optimism stable
3*			central stable if *** bubbles and crashes if ***	

Notes:* In Models 2 and 3, an equilibrium is actually a pair of equilibria - of opinion and of policy.
** Instability occurs if naive party members are more powerful and sophisticated party members are less powerful; if naive party members are highly sensitive to policy changes; and if the speed of change of opinion is high. *** See Lux (1995) p. 891 for details of the conditions.

Extensions to the Lux model

The contagion of opinion discussed in the previous section concerns contagion between just two possible opinions about a single price. What if there are more than two possible opinions? One example of this would be contagion of opinion between sophisticated traders, naive optimists and naive pessimists (Lux, 1996, considers movements between these three groups but not on the basis of contagion of opinion). In general there are a multiplicity of opinions - concerning a multiplicity of prices. For example people's local allegiances encourage them to focus investment in their own company or industrial sector or country, or selected investment strategy or

investment instrument (Shiller and Pound 1989). A rather different point is that there may a continuum of opinions. For example sophisticated traders may all buy and sell according to the fundamental price, but they may have differing opinions amongst themselves as to what this fundamental price is. Another example would be differing opinions about the correct portfolio balance between two investment instruments. This is the issue addressed by Samuelson (1989; 1994) who contrasts his conclusion 'if I am a rational maximizer I shall do best if I myopically put the same fraction of my portfolio into equities during every period' with the investment behaviour of real investors. Thaler and Williamson (1994) discuss the extreme case of 100% equities. In situations where more than two components are involved, the representation of differing opinions about the correct portfolio balance requires a multidimensional continuous space. Deviations from optimal strategy in these situations are discussed by Kelly (1995). The aim of the present section is to consider contagion of opinion in these more complex opinion spaces.

In extending the Lux models our main concern is to preserve the following features. Firstly there are basically two forces exerting an influence on opinion shifts, a balancing force which tends to even out opinion, and a herding force which reinforces any imbalance which happens to occur. The balancing force pulls the distribution back to some central equilibrium, and a herding force pushes the distribution to one or more extremal equilibria. Before setting out on the main programme of extensions let us first note a very simple extension. This is to suggest that the 'central' equilibrium may not involve exactly equal proportions between the two groups - what is characteristic about the central position is that it is between the two extremal equilibria. This broader notion of the central equilibrium can be thought of as reflecting whatever is the 'natural' distribution between the two groups. Notice that, in focusing on equilibria, we are not implying that the dynamics always settles down to one or other of the equilibria - rather that the equilibria form useful reference points from which to view the dynamics whether it is equilibrium dynamics or not.

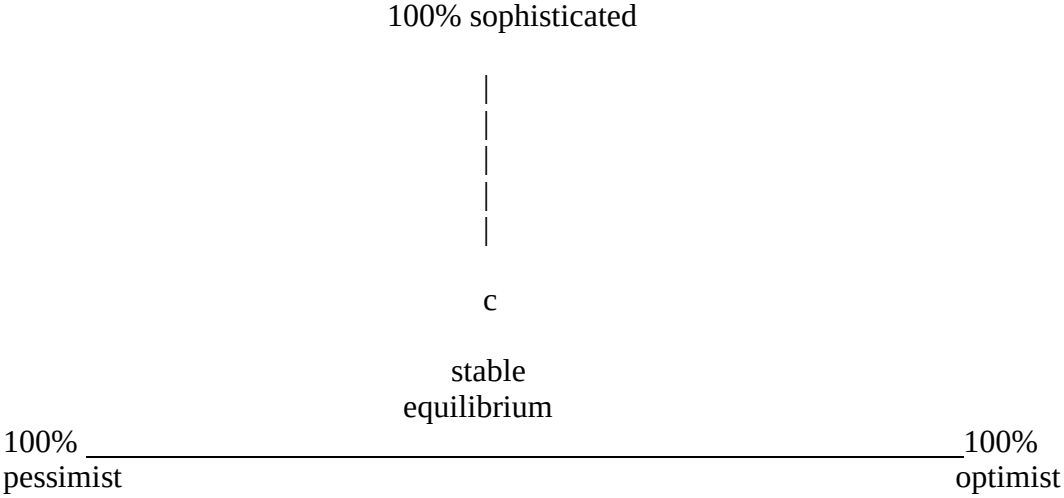
Three opinion groups

In our first extension of the model we consider contagion between three groups of traders: sophisticated traders, naive optimists and naive pessimists. Let x(i) be the proportion of traders in group i. So x(1)+x(2)+x(3)=1. The proportions x(i) can be represented as a point in a triangle. (This is analogous to Figure 1 representing the proportion x^ of pessimists and optimists as a point on a line in the two-group case). As the proportions change the point moves around the triangle.

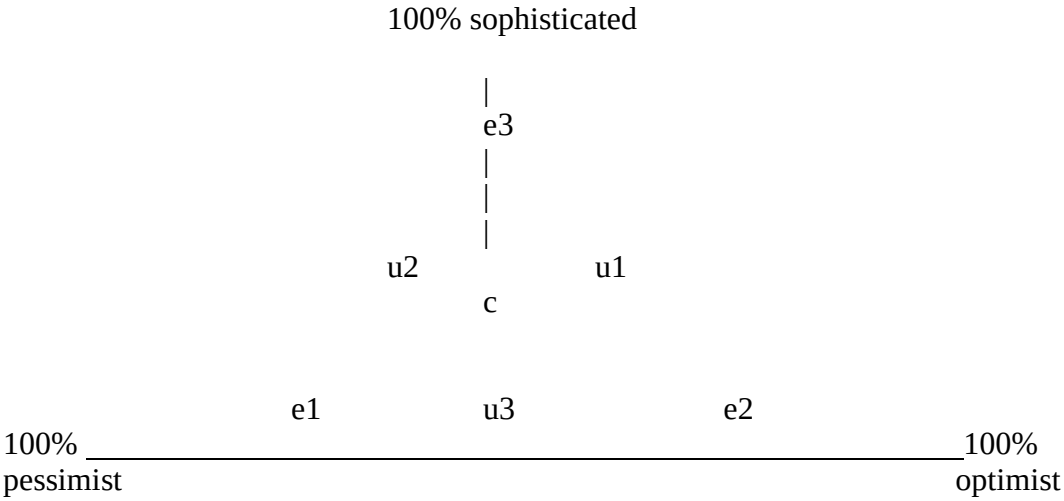
We now assume that it is valid to make a simple analogy with the two-group situation. We assume that the dynamics again resolves into two cases. If the balancing force is strong enough relative to the herding force then there is a single stable central equilibrium with traders evenly balanced between the three groups. This equilibrium is represented as the central point c of the triangle in Figure 2a. Here each group contains a third of the population. If the herding force dominates the balancing force then the central equilibrium becomes unstable and there is motion towards one or other of three stable extremal equilibria, points e1, e2 and e3 in Figure 2b. These three stable equilibria form an inner triangle. The midpoints of each side of the triangle (u1, u2 and u3) are unstable equilibria. The model suggests the possibility of three types of market: a market dominated either by optimists, or by pessimists or by fundamentalists, with the possibility of switches between these three possibilities.

Figure 2 Equilibria for mean opinion

(a) The case of weak herd behaviour: a stable central equilibrium c



(b) The case of strong herd behaviour: an unstable central equilibrium c, and three stable extreme equilibria; and three other unstable equilibria



One can regard the figure above as a partial specification of the equation for the opinion dynamics. The geometric representation also makes it easier to entertain alternative possibilities. One such is that it may be the three mid-points (u1, u2 and u3) that are the stable equilibria and the three vertices that are the unstable equilibria. For example one alternative offers the possibility of a stable equilibrium at u3 involving a balance between optimists and pessimists, together with a small minority of sophisticated traders.

Many opinion groups

Suppose now that we have many groups of traders. Again let x(i) be the proportion of traders in group i. The proportions x(i) can be represented as a point in a higher

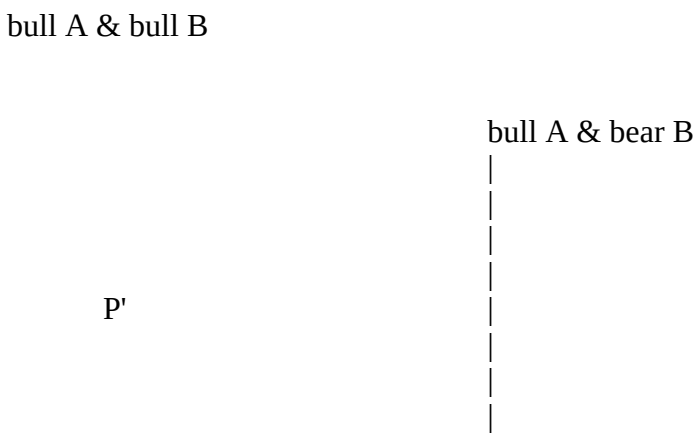
dimensional 'triangle' (in the case of four groups, a tetrahedron). As the proportions change the point moves around the 'triangle'.

Again we assume that it is valid to make a simple analogy with the two- and three-group situations. The dynamics resolves into two cases. If the balancing force is strong enough relative to the herding force then there is a single stable central equilibrium with naive traders evenly balanced between the n groups. If the herding force dominates the balancing force then the central equilibrium becomes unstable and there is motion towards one or other of n stable extremal equilibria. The n stable equilibria form a 'triangle'. The midpoints of each side of the 'triangle' are unstable equilibria (as are the centres of the faces).

A possible application is where there are n investment sectors and there are n groups with each group biased somewhat towards that particular sector. For example we may have people investing in their own company or industrial sector or country, or investment strategy or investment instrument. This provides the natural distribution represented by some central position. In the presence of strong herding behaviour there may be a rush into investment in a particular company or sector or country, thus boosting the size of the corresponding group.

Taking this a step further we may imagine that for each investment sector, there are bears and bulls. Any individual is then either a bear or a bull on each of the n sectors. Thus there are 2-to-the-power-n possible groups. If herd behaviour is sector-specific then path P is traversed. If herd behaviour is not sector-specific then path P' is traversed. Kindleberger provides various examples of non-sector-specific herd behaviour: even though the bull market starts in one sector it is transmitted to other sectors (Kindleberger, 1987, p. 141, Table 7.1, illustrates the international propagation of the 1847-1848 crisis).

Figure 3 Sector-specific and non-sector-specific paths



bear A & bull B P bear A & bearB

A one-dimensional opinion continuum

We now consider the case where there is a continuum of opinions - for example opinions about what the fundamental price is or opinions about the correct percentage of equities in a portfolio. We start by postulating that there is some natural probability distribution of people along the continuum. This is indicated by the continuous curve in Figure 4a. What happens if there is some slight shift in the probability distribution - indicated by the dotted curve in Figure 4a? By analogy with the two-group situation the dynamics again resolves into two cases. If the balancing force is strong enough relative to the herding force then there is a return to the original natural distribution, and so this central equilibrium is the only stable equilibrium. However if the herding force dominates the balancing force then the slight shift becomes accentuated and there is motion towards some stable extremal distribution. In this case the extremal distribution is stable and the central equilibrium is unstable. Figure 4 b illustrates a left extremal distribution and a right extremal distribution.

Figure 4 Equilibria for mean opinion

(a) The case of weak herd behaviour: a stable central distribution

returning back to equilibrium — stable, central distribution

. .

pessimism optimism

(b) The case of strong herd behaviour: an unstable central distribution c, and two stable extreme distributions; optimisim or pessimism

stampeding to an extreme distribution — unstable, central distribution — stampeding to an extreme distribution

. e2 . c . e1

pessimism optimism

The above figures illustrate what is happening to the distribution of people. We might wish to summarise the situation by simply describing what happens to the mean of the

distribution. A look at the figures shows that if herding is low then the mean of the equilibrium distribution has some central value, but if herding is high then the mean adopts one of two extremal values. Thus the behaviour of the mean of the distribution can be illustrated in a figure exactly the same as Figure 1. In other words the geometry of Figure 1 can be used either to illustrate the equilibria of the proportion in a two-opinion situation, or to illustrate the equilibria of the mean in an opinion continuum situation.

A continuous multidimensional opinion space

Suppose now that traders have an opinion not just about one price or one portfolio proportion - but about many. Each trader's opinion now needs to be represented in a multidimensional continuous opinion space. We treat this in an analogous way to the one dimensional continuum. We start by postulating that there is some natural probability distribution of people in continuous opinion space. By analogy the dynamics again resolves into two cases. If the balancing force is strong enough relative to the herding force then there is a return to the original natural distribution, that is the natural distribution is the single stable central equilibrium. However if the herding force dominates the balancing force then the slight shift becomes accentuated and there is motion towards some stable extremal distribution. In this case the extremal distribution is stable and the central equilibrium is unstable.

Again we might wish to summarise the situation by simply describing what happens to the mean of the distribution. If herding is low then the mean of the equilibrium distribution has some central value, but if herding is high then the mean adopts one of a number of extremal values. Thus, if we take the case of two dimensional opinion space, the behaviour of the mean of the distribution can be illustrated in a figure exactly the same as Figure 2. In other words the geometry of Figure 2 can be used either to illustrate the equilibria of the proportion in a three-opinion situation, or to illustrate the equilibria of the mean in a continuous two-dimensional opinion space situation.

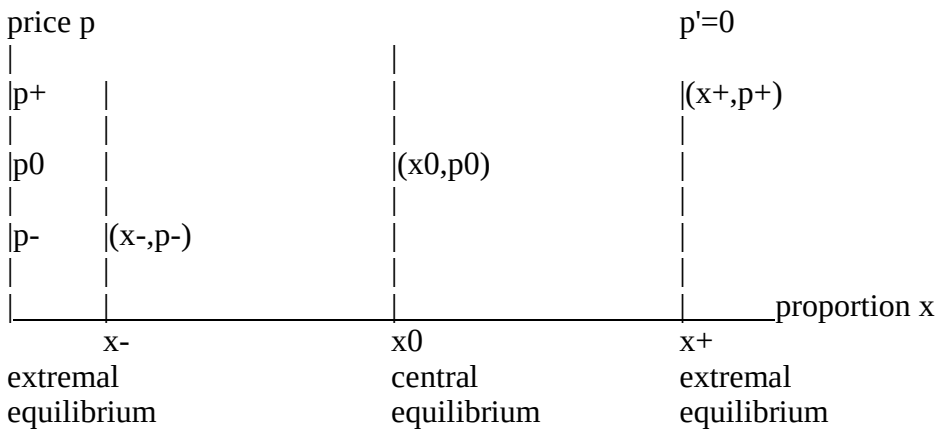
Contagion and price dynamics

We now return to the situation where there are discrete opinion groups and consider adding price dynamics to the opinion dynamics. As in the original Lux model 2, the linkage between opinion dynamics and price dynamics is provided by the fact that traders change their opinions partly on the basis of other traders' opinions and partly on the basis of price movements - and by the fact that price changes are determined by the proportions of traders in the various groups.

Equilibrium occurs when both price and proportions of traders stay the same, that is $p'=0$ and $X'=0$, where p' is the rate of change of price and X' is the vector of rates of change of proportions. Because p' is a linear function of the proportions, the condition $p'=0$ corresponds to some hyperplane in multidimensional price-proportion space. In Figure 5 below, this is indicated by the straight line $p'=0$ in the price-proportion plane. However when $p'=0$, the p' term in the rates of change X' vanish, and so the X' equations revert to the form they had in model 1. So the equilibria for the proportions X are the same as those for model 1. These are indicated by the three vertical lines in the figure. The equilibria in the price-proportions space are thus the projection of these equilibria onto the the $p'=0$ hyperplane. This is illustrated by

points ABC in the figure. So there is either a central stable equilibrium of proportions *and price* (x0, p0), or several extremal stable equilibria of proportions *and price*, (x-, p-) and (x+, p+).

Figure 5 Equilibria in price-proportion space



This completes our work on extensions to the Lux model. It should be emphasised that the dynamics of these situations is likely to be every bit as various as the dynamics discussed in the original Lux model. Although we have only suggested the possible equilibria which may exist, the proposal is that the dynamics would relate to these equilibria. The technical details of how it might do so are still to be worked out. Some justification for the extensions proposed here are to be found in the historical accounts provided by Kindleberger (see the earlier discussion preceding Figure 3).

Inserting the ideas of evolutionary economics into opinion dynamics

The basic intuition underlying the Lux model is quite simple. Action is determined by opinion, and opinions are formed by communication in a social network. Of prime interest then is the dynamics of people in opinion space. In what follows we shall consider how the model might be extended, considering in turn the nature of opinion space, the distribution of individuals in opinion space, the dynamics of opinion space, path-dependent dynamics, landscape dynamics and the notion of globalization as a regime change. The linkage between opinion dynamics and price dynamics is discussed and followed by a consideration of the concepts of bounded rationality and search.

Opinions

Because the herd behaviour model postulates that communicated opinions drive actions, it is important to consider carefully what opinions are communicated and in what way they are translated into actions. The most direct 'opinion' which can be communicated is the action of others. Here it might be thought that herd behaviour is the imitation of behaviour rather than the imitation of opinion. People sell if they see others selling. However others' behaviour may not be precisely communicated and

may not be precisely imitated. For this reason it is justifiable to focus on opinion as mediating communication and action. Lux (1995) envisages the simplest form of opinion and action. If a trader has the opinion that the market is undervalued then the trader buys some fixed amount. However opinions may concern either the level of 'desirable' value or the 'desirable' change to the current value - where change might be in absolute or percentage terms.

Opinion space

The simplest opinion space is that where there is just one opinion! The representative agent approach which dominates the literature exemplifies this approach. All other approaches envisage the possibility of heterogeneous agents, the simplest case here being where there are just two opinions. For example the literature refers to sophisticated traders and naive (or noise or feedback) traders. Kirman (1993) and Lux (1995) considers two naive opinions concerning the stock market, optimists who think the price will move up and pessimists who think the price will go down. Subsequently Lux includes sophisticated traders in his model, thus envisaging three opinion groups. Finally many of the synergetics models envisage an opinion space of n distinct groups (Reiner et al 1988, Weidlich 1994). Helbing (1995) moves beyond discrete opinion space and considers continuous opinion space - of multiple dimensions.

Here I wish to consider multidimensional opinion space. Each point in this space corresponds to a possible portfolio of investments. So the dimensionality of the space is the number of possible investments. Opinions concern both the 'desirable' portfolio and also, given a particular current portfolio, the 'desirable' change to the current portfolio. Such opinions concern both the investment amounts and also investment proportions (that is proportions of total investment).

Distribution of traders in opinion space

Because of its role in driving the price dynamics, what is of interest is the distribution of traders in opinion space. The representative agent approach envisages all individuals concentrated at one particular point of opinion space. In discrete opinion space we have simply the frequency distribution across the groups, and interest attaches to what is (are) the most frequent group(s). For example in Lux's model a bull or a bear market is distinguished according as naive traders are optimistic or pessimistic.

In continuous opinion space the distribution of opinions may be unimodal or multimodal. The distribution around each modes may be concentrated or spread out. The evidence presented by Shiller and Pound (1989) of local concentrated investment behaviour suggests a complex multimodal distribution, a topography of modes of varying heights and concentrations, the modes constituted by multidimensional bundles of attributes of varying dimensions. The opinion space may contain sparse and unoccupied regions.

Opinion dynamics

Having formulated a concept of the opinion distribution we are now ready to consider how the opinion distribution changes over time. Here we would like to bring together the synergetics model with a number of ideas in evolutionary economics as discussed

by Hodgson (1995). The concept of a population distributed in opinion space leads us naturally to consider population processes such as birth, death and migration (Hodgson, 1993, pp. 202-203). Lux (1996/7) extends his original model by postulating a birth process whereby new investors are more likely to start off as naive and a death process in which investors leaving the system are more likely to be sophisticated, with migration between naive and sophisticated traders and between naive pessimists and naive optimists.

Following mathematical models of biological populations, the issue of frequency-dependence (density-dependence) is considered. Hodgson (1993, pp. 207-209) contrasts the neo-classical notion of decreasing returns to scale with more recent ideas about increasing returns to scale (Arthur, 19xx). A related notion is that of critical mass (Hodgson, 1993, pp. 210-212). As we have seen, frequency-dependent models have been used by Lux (1995) to model herd behaviour in speculative markets. Earlier Kirman (19xx) used a rather different frequency-dependent model, a generalized urn scheme. What these models demonstrate is that frequency-dependence is associated with path-dependence. Where the system ends up at depends on the path it takes - the end result depends on initial conditions and on random shocks. Different initial conditions or shocks may change the trajectory substantially, sometimes moving it into and confining it to some restricted region in opinion space. This is referred to as lock-in, an idea Hodgson (1993, pp. 205-207) relates to the notion of 'chreodic development' and to the presence of 'multiple peaks' in the probability distribution (Hodgson, 1993, pp. 209-210). Applying these ideas to herd behaviour in speculative markets, we are led to ask whether herd behaviour leads the market along a particular path, perhaps locking the market in to some persistent over-valuation of certain stocks and under-valuation of others. Thus there is a spatial aspect to the way in which the dynamics exhibits various forms such as convergence, divergence, cycles and chaos. For the space may be partitioned with different regions exhibiting their own distinctive dynamics.

Finally the multimodal distribution in opinion space is likely to be maintained by an appropriate pattern of network influences. This allows for the occurrence of local herd behaviour as well as global herd behaviour.

Landscape dynamics - regime changes

Complex as the topography of opinion space may be, further complexity is added when we consider 'landscape dynamics', that is the way in which the topography changes. Hodgson (1993, pp. 209-210) refers to shifting peaks and the role of context (Hodgson, 1993, pp. 207-209). The landscape may evolve smoothly (gradualism) or dramatically (punctuated equlibria).
Particular landscapes can be institutionalized as regimes, corresponding to changes in system parameters.

Globalization as a regime change?

Two of the parameters in the original Lux (1995) model are the speed of change and the strength of herd behaviour. Somewhat analogous in Helbing's (1995) more general formulation are the diffusion coefficients. One (simplified) view of globalization might be that it involves a regime change characterized by a change in these basic parameters. The globalization of society and in particular of the stock market, is reflected in the strengthening of the migration coefficients and an increase

in the speed of change - due to the introduction of the new communication technology. Also it may be that herding is more prevalent: if globalization involves greater information demands and greater uncertainty then this will force greater reliance on the opinions of others.

Search: new opinions from old

'Our concept of search obviously is the counterpart of that of mutation in biological evolutionary theory' (Nelson and Winter, 1982, p. 472)

In our argument so far opinions are formed by contagion of opinion. It might be argued that this has two defects: firstly it provides no source for change in the set of opinions available to individuals, and secondly it provides no feedback from real events on opinions. Witt in particular emphasises the importance of endogenous change and the emergence of novelty in economic evolution. This suggests enlarging our opinion space to embrace novelty.

These omissions are a consequence of us moving so radically away from the extreme concept of perfect rationality. Are there less extreme concepts which allow feedback from real events to influence opinion? One approach is bounded rationality which recognizes the computational limitations of individuals. A formulation of bounded rationality which is particularly relevant to this paper is that by Flam (1996):

'Ideally the agent in question should entertain a global vision of his problem, and see right away to maximise $\Pi(x)$ over X, using some algorithm of mathematical programming. It seems more likely though that some of the following hurdles prevail:
(i) He is slightly inexperienced, not having identified his profit function Π fully;
(ii) He contends with a local approximation of Π near the current point;
(iii) He does not know the distribution of r;
(iv) He lacks experience in optimization;
(v) He is not well trained in probability.
If so, the following weak assumption on behaviour seems natural: wherever possible, the agent will exploit conceived opportunities for improvement. Such behaviour typically yields a stepwise process. As usual, two things determine the dynamics then: (a) the direction of strategy change chosen at any stage and (b) the step size taken in that direction. Regarding (a), we suppose that as long as the agent experiences a nonzero marginal payoff, he will change his plan in a direction of perceived payoff ascent [...] Concerning (b), to account for accumulation of experience, we posit, grosso modo, that step sizes tend to zero, but not too fast'

A helpful discussion here is Goldberg's (1989, pp. 2-6) discussion of the robustness of traditional optimization and search methods which he contrasts with the robustness of genetic algorithms. He considers calculus-based, enumerative and random methods. Flam's approach is a variant of hill-climbing which Godlberg identifies as a calculus-based method. All these methods Goldberg rejects as either too specialized or as having poor efficiency. At which point Goldberg presents his case for genetic algorithms. From his discussion it is clear that there are a host of competing methods in the technical field of optimization. A similar impression is gained reading accounts of how traders operate: a whole variety of methods are in play. The literature refers to rules of thumb being used. Indeed it is argued that environments of greater complexity may be associated with simpler decision rules. (Although some of the 'rules of thumb' seem to involve rather complex beliefs!).

Although we have suggested that these methods are subject to feedback from real events rather than just opinion, the effectiveness of the feedback is poor. No doubt different rules have differential effectiveness. However due the the noise in the system there is only weak selection of better methods.

The role of opinion dynamics in the evolution of the global financial system

Although the formulation of opinion dynamics in Part 1 works well, I am uneasy about what the opinion dynamics 'rests on'. What are the opinions about? What is the nature of the actions which follow from the opinions? What is the nature of the powers which an individual applies in their actions? In short how do opinion dynamics relate to broader economic realities? To give a picture of what might be involved in addressing these questions, consider the following cameo.

A cameo

The stockmarket crash of October 1987 was characterised by herd behaviour in the international financial system. The case that herd behaviour was involved has been well argued by Kindleberger (1989) and Shiller (1989) amongst others. Herd behaviour occurs as the result of communication of opinion within some communication network, and the international communication network involved in the 1987 crash has been carefully studied by Malliaris and Urratin (1992). New York, London, Hong Kong, Tokyo, Sydney and Singapore were all interconnected (except that New York did not have significant connections with Singapore or Sydney). However power and influence in the communication network is not always symmetric. Malliaris and Urratin suggest that London influenced Hong Kong; Hong Kong and New York influenced Tokyo; Hong Kong, Tokyo and Sydney influenced Singapore. (Note however that the authors' overall conclusion was to reject the notion that New York had played a leading role, and to conclude that the crisis had been a truly international one). Nor were reactions during the crash uniform across all exchanges and all industrial sectors. Rather what was observed was a configuration of locally modulated herd behaviour.

Modern communication technology ensured that herd behaviour was communicated very rapidly throughout the system - it is interesting to compare the speed of the transmission of this crisis with the speed of transmission of the 1848-9 financial crisis as portrayed in Table 7.1 in Kindleberger (1989, p. 141) which appeared to develop over a period of months or even years! 'The crisis itself came late in the summer. It was Anglo-French ... but had echoes in British-Indian trade, in Amsterdam and the Low Countries, and to a certain extent in Germany and even New York'. Notice too that the countries involved in the 1848-9 crisis do not exactly map onto the cities examined in the study of the 1987 crash. The contrast illustrates how the importance of the European imperial powers has diminished with their loss of empire, and how new financial centres in the Far East have risen to take their place. As the structure of power in the world system has changed so have the centres of financial power, the epicentres of stock market crashes. Travelling further back in world history the South Sea Bubble of 1720 involved the collapse of the stock of the South Seas Company involved in trade with Spanish America. So not only do the centres of financial power change but so does the structure of dominant investment opportunities.

Key features of the cameo

What this cameo adds is a more concrete notion of powers and of space. Economic activity is structured by geography, by company, by industry and by technology. Financial control of this economic activity is structured in a similar fashion. Of interest is how the first structure maps onto the second structure. At one extreme would be a world where economic activity in a particular location is financially controlled from that location. At the other extreme would be a world where the location in which an economic activity had no financial control over the activity in that location. What we find in reality is a world where there is a bit of both, the first illustrated by Shiller and Pound's (1989) identification of local control, and the second illustrated by the notion that a world city specialises in financial control (Kennedy, 1991).

We can sketch a one-dimensional model for a one dimensional space as follows. Investors are distributed along this space f(x). Activities are distributed along the same space. Each investor has an investment portfolio in these activities distributed over this space. Activities fluctuate in profits and in price. Individuals adjust their portfolios partly in response to this and partly in response to opinion. Opinion is also a distribution over the same space - a distribution which may represent the ideal portfolio or a distribution which may represent a desirable change in a portfolio. This model involves adding an opinion dynamics to Hotelling's model of locational strategy.

Conclusion: mathematical and political economy approaches

This paper provides a useful vantage point for viewing the debate between mathematical and political economy approaches. The two central references for the paper are Kindleberger and Lux, both of whom are studying herd behaviour in speculative markets and yet Kindleberger follows a political economy approach while Lux follows a mathematical approach. In the introduction I noted Kindleberger's challenge to certain substantive aspects of economic theory. Kindleberger (1987, pp. xii-xiii, 243, 246-247) also challenges the dominant methodology. He believes 'economics needs history, even more than history needs economics' and comments 'it is time that economics accept reality'. He agrees with McCloskey's view of economics as a series of stories, and also refers to economics as a toolbox of models. His claim for his own model of financial crises is not that it is 'valid in all times and places, but simply that there may be occasions when it helps economists to understand what is taking place'.

Turning to the dominant methodology in economics Kindleberger criticises the insistence on expressing everything in mathematical terms, doubting whether the mathematics *in all cases* adds to our understanding. He notes Tinbergen's advocacy of the econometric method: identification of variables, postulation of relationships, data collection, statistical testing, identification of best-fit formulae and policy application. He also notes that Tinbergen 'claimed that "literary economists" stop at the first stage of gathering variables'. Kindleberger discusses the criticism of his own work that it is anecdotal and argues that the important issue is 'whether the evidence is representative or not.'

Although Lux adopts a mathematical approach, his model explicitly maps on to many of the features identified by Kindleberger. (Lux, 1995, pp. 881-882, comments 'Throughout his penetrating book [Kindleberger] highlights the importance of psychological factors and irrational factors in explaining historical financial crises'.) The Lux paper thus demonstrates that mathematics is not restricted to rational actor models and can model alternative assumptions about economic reality. It also demonstrates that mathematics can be respectful of the insights generated by historical approaches. This still leaves open the question as to whether the mathematics adds anything. Writing earlier Kindleberger (1987, p. 246) had admitted such a possibility: 'in many complex questions, I am reasonably certain that it does.' In the case of Lux (1995) what the mathematics adds is a precision of articulation. Lux's three main propositions articulate the main varieties of dynamics possible and the conditions under which these dynamics occur.

Methodology is a question of trade-offs! Given a set of resources there is a trade-off between a variety of desirables - between the number of variables considered and their articulation, the number of and articulation of relationships, the completeness of the data set, the precision of inference and so on. Historical, mathematical and statistical approaches each make a different trade-off. Turning to my own paper, I have concentrated on exploring extensions to the model and setting out analogous applications in politics and cultures - at the cost of losing the precision of inference to be found in Lux and at the cost of losing the richness of account to be found in Kindleberger!

Towards the end of the chapter I have had two further aims:

(i) to put the ideas of evolutionary economics into opinion dynamics models of speculative markets;

(ii) to identify the role of herd behaviour in the historical evolution of the global financial system.

The section specifically devoted to the first of these aims has I feel been successful in developing a coherent and systematic account of the concepts involved - sufficient for a mathematical formulation to be fairly easily developed. What requires more work is the articulation of how the model finds expression in speculative markets. Regarding my second aim the cameo of the 1987 crash and the 1848/9 financial crisis has I feel been successful in giving a picture of the historical process at the same time as indicating how this history illustrates certain fundamental concepts in the models introduced earlier in the paper. What is less clear to me at this stage is how to bridge the gap in a more integrated way between the richness of historical accounts and the precision of formulation present in mathematical models (cf. Kindleberger, 1989, pp.).

Appendix 1 Reflections on rationality

We have noted that much discussion centres around the question as to whether or not traders are rational and the market efficient. The literature on the efficient market already distinguishes between weak and strong market efficiency depending on the knowledge possessed by the traders. The table below offers a more extended typology.

Firstly we note that individual actions on the stock market are not coordinated. This raises issues of collective rationality: could coordinated action yield better social outcomes? Our main interest in the present paper is in the concept of individual rationality. The most extreme assumptions hypothesise perfect knowledge of consequences, or, in stochastic settings, perfect stochastic knowledge. In the table I have also noted 'post hoc rationality' because this sometimes occurs in discussion but is of course not available to the decision maker in real time! In many cases stochastic knowledge is limited and the decision maker is forced to adopt intrinsic limitation rationality. Operating at this level, I have suggested that 'God doesn't know any better'. However at any one time, society is characterised by a certain state of knowledge and of inference techniques. Operating at the limits of that state of knowledge and inference techniques, I refer to as social limitation rationality. Of course any one individual in society lacks access to the total array of current knowledge and inference techniques. Relying on their own knowledge and inference techniques, an individual practises individual limitation rationality - they do the best they can and don't know any better. These limitations include those limitations identified in the literature on the psychology of decision making as well as decision-making resource limitations. It is a model of bounded rationality. Can an individual do anything other than act rationally within the constraints of individual limitation rationality? One can imagine possibilities such as willful irrationality and ambivalent irrationality. Perhaps of more significance is habit and custom. Finally it might be argued that search is driven by an exploration rationale rather than an optimising one.

Table Concepts of rationality

collectively rational	
individually rational:	
perfect rationality	
[post hoc rationality]	
perfect probabilistic rationality	
intrinsic limitation rationality	God doesn't know any better.
social limitation rationality (now/ for ever)	They don't know any better. [they variously defined]
individual limitation (bounded) rationality	I don't know any better.
wilful irrationality	X is better but I choose to do Y.
ambivalent irrationality	I know I should do Y but alas …
habit, custom	This is what I do; this is what is done.
search rationality	I'll give it a whirl.

Appendix 2: Notes still to be incorporated

Whereas herd behaviour provides a social alternative to individual rational choice explanations of behaviour, an individual alternative is habit (Campbell and Cochrane, 1997; Chapman, 1998).

Lux explains bubbles by herd behaviour. Other explanations include the use of the concept of rational bubbles. However Santos and Woodford (1997, p. 49) suggest that under certain specified circumstances bubbles do not occur but proceed to note that 'our results excluding the possibility of rational pricing bubbles do not imply that there should be no role for an effect of self-fulfilling expectations upon asset prices and equilibrium allocations'.

Grandmont (1998) writes on expectations formation and stability of large socioeconomic systems.

'You regard men as infinitely selfish and infinitely far-sighted. The first hypothesis may perhaps be admitted in a first approximation, the second may call for some reservations.' Henri Poincare to Leon Walras (letter of October 1, 1901).

3 HERD BEHAVIOUR IN POLITICAL SYSTEMS

We now turn to politics. The study of herd behaviour has important implications here too. In part this follows from what I have already said about the implications for economic theory. An important modern strand of political theory has explicitly imported rational choice concepts from economics, and so the limitations of the rational choice model in economics are likewise limitations when the model is used in politics. Indeed it may be possible to widen the argument. Much political theory, although it does not make explicit use of rational choice terminology, nevertheless is essentially rational choice in its conceptual nature. Whenever reference is made to political actors having interests and using power to pursue these interests, a rational choice model is implicitly being invoked.

The chapter starts by noting how the early perfect rationality models of the political system have given way to models incorporating uncertainty, irrationality and ideology. The analogy between herd behaviour in markets and herd behaviour in politics is then made explicit and examples of herd behaviour in political parties are given. Following a brief review of the development of formal methods in political science, we shall indicate how an analogous model to the Lux model can be used to represent changes in the policy of a single party, and also changes in a policy consensus between parties. In both cases, the role of policy leadership is emphasised. The relationship between party policy and public opinion is discussed. Leadership crises are seen as periods where contagion of opinion leads to flight from one extremal equilibrium to another. The voting record in UK general elections is then examined in an attempt to identify herd behaviour amongst voters.

From rational choice to uncertainty and ideology/opinion

The recent history of the application of formal methods to the study of politics has parallels with the recent history of the development of models of speculative markets. The assumption of complete rationality has given way to the acknowledgement of uncertainty and of the importance of opinion or ideology. The early work of Hotelling (1929), Black (1949) and Downs (1957) considered the case of a one-dimensional opinion space (variously referred to as issue space, policy space or ideological space). It was assumed that politicians and voters possessed perfect rationality and it was deduced that, under certain circumstances, policies would converge to the policy preference of the median voter. This is known as 'the median voter theorem'. In a more general context Arrow (1951) established the general impossibility theorem which alerted scholars to the possibility that, if there were more than two alternative candidates, successive voting between pairs of candidates could lead to an endless cycling of victorious alternatives. Tullock (1967, p. 37) however argued that in practice this finding was irrelevant because voters usually clustered around some middle position. Later McKelvey (1979) demonstrated that if the opinion space was of two or more dimensions the median voter theorem did not hold because of the possibility of cycling. (However this too is subject to the criticism made by Tullock).

The median voter theorem has also been criticised on the grounds that the assumption of rationality is unrealistic. Empirical studies have found considerable ignorance

amongst voters about parties' policies, and parties themselves are uncertain about the electoral consequences of adopting particular policies. Much work has been done incorporating uncertainty into the early models (Calvert 1986; Coughlin 1992). However some have argued that even these approaches do not go far enough. Hinich and Munger (1994) suggest that voters are ignorant of the real issue space and so make simplifying assumptions and operate with an ideological space of just one or two dimensions. Morris and Rabinovitz (1997) offer an alternative suggestion as to how voters simplify reality, with some voting for candidates on the basis of the candidates' policy *positions* (as prescribed by the median voter theorem) but others voting on the basis of whether or not the candidates are in the correct policy *direction*. (There is a quite precise correspondence here with the model for sophisticated and naive traders in Lux).

Party opinion and party policy

Budge (1994) makes similar arguments. He feels that most models make too strong assumptions about the knowledge possessed by political parties. Instead he argues that parties operate within a fixed range of policy positions, changing their policy positions according to certain fixed rules. Reviewing the evidence reported by Budge, Burt (1997) suggests that the results are consistent with the hypothesis that parties shift their policies at random. Recalling that random behaviour of prices is the feature which suggests the efficient market hypothesis, we investigate first whether there is an analogous 'efficiency' in the political process, before proceeding to develop the political analogue to Lux's model of herd behaviour in speculative markets. We develop a precise analogy between policy determination by parties and Lux's contagion model of speculative markets as follows:

(i) the policy of a party in one-dimensional space corresponds to price;
(ii) naive party members have an opinion that the policy should move to the left or that it should move to the right, just as naive traders think the market price will go down or up;
(iii) naive party members form their opinions on the basis of others' opinions - just as naive traders do;
(iv) sophisticated party members have a definite preferred policy, just as sophisticated traders know the fundamental market price;
(v) political demands are based on policy opinions, just as market demands are based on price opinions;
(vi) policy is determined by the political demands of naive and sophisticated traders, just as price is determined by the market demands of naive and sophisticated traders;
(vii) three models can be developed exhibiting either a stable central policy equilibrium or stable extremal policy equilibria or some kind of dynamic motion around these equilibria, just as in the three Lux models.

The efficient market and the efficient political process

Brealey and Myers (1991, p. 290-291) give an account of the origins of the concept of efficient markets. In 1953 Kendall reported on his attempts to identify cycles in stock and commodity prices: he had been unable to find any! Instead prices followed a random walk (more accurately, a submartingale), with successive price changes being independent of one another. The efficient market hypothesis is one attempt to explain this random behaviour. Suppose today's price is lower than our expectation of what

the price will be tomorrow. We can therefore make money by buying today. This increased demand then increases the price today. In this way today's price adjusts to the price which we expect for tomorrow. Therefore the only change that can happen tomorrow is a random one, one that we could not have predicted. This argument requires that today's price fully adjusts to tomorrow's expected price. For this to happen there needs to be an efficient market, that is competition between rational agents who have access to all the relevant available information. This information includes past prices, other publicly available information and also 'all the information that can be acquired by painstaking fundamental analysis of the company and the economy' (Brealey and Myers, 1991, p. 295). An extra twist can be added to this argument. If academic researchers were able to demonstrate market inefficiency, then they would be recruited by market institutions and the inefficiency eliminated. However '... many of the researchers have become famous. None has become rich' (Brealey and Myers, 1991, p. 293)!

To what extent might a similar argument apply to party policy? For here too we have the empirical finding of random behaviour. Is this the result of an 'efficient' political process within the party? Suppose today's policy is to the left of our expectation of what the policy will be tomorrow. We can therefore obtain political advantage within the party by moving to that policy today. In this way today's policy adjusts to the policy which we expect for tomorrow. Therefore the only change that can happen tomorrow is a random one, one that we could not have predicted. This argument depends on there being political competition between party members to be in early occupation of future party policy positions. It is consistent with one type of party conflict, one which 'represents a personal struggle for power between different leaders and their respective followers...'(Graham, 1993, p. 149). However the argument would appear to ignore a second type of party conflict arising from 'genuine disagreements over strategy, policy or ideology' (Graham, 1993, p. 149). Because this second type of conflict seems such a crucial feature of party policy formation we now leave the efficient market hypothesis behind us and focus on the dynamics of conflicting opinion within parties.

The dynamics of conflicting opinions

The presence of policy conflict within parties is discussed by Graham (1993, p. 154):

'... An intra-party sect may believe that the party should redefine its basic objectives ... [it] must be able ... to win other members to its cause. ... the sect assumes that its membership is potentially coterminous with the membership of the party and that all within its fold are susceptible to its appeals'.

What this account usefully emphasises is the contagion of opinion: shifts which take place in people's opinions under the influence of other people's opinions. The literature also makes a distinction between levels of sophistication within a party. Sophisticated politicians may change their policy in the light of fundamental shifts whereas naive political actors may simply follow the herd. Graham (1993, pp. 61-62) describes a party thus:

'Thousands of individuals seek to control the party's decisions ... [A party has] an informal structure ... of a small leadership group, a relatively generalized bureaucracy, a reserve army of activists, and an unstable and constantly changing

cohort of ordinary members ... inexperience and fluidity of a party's membership result in its affairs being run by a relatively small circle of leaders ...'

The preceding account of contagion of opinion in a political party bears a close resemblance to the account by Lux (1995) of the contagion of opinion amongst traders on the stockmarket. He makes a distinction between two types of trader: 'noise traders' who lack information about fundamental values, and fundamentalists who do possess such information. Because they lack fundamental information, noise traders are forced to base their opinions simply on other traders' opinions. When others are optimistic about prices they too are inclined to be optimistic about prices, and vice versa. In the absence of fundamentalist traders this herd behaviour tends to sustain either an over-priced or an under-priced market, situations referred to as speculative bubbles. The presence of fundamentalist traders alters the conclusions somewhat. Again speculative bubbles can form but there may also be cycles of opinion and of price levels. To explain the bursting of the bubbles Lux (1995, p. 893) introduces the final element of his model, the effect which actual returns have on traders' behaviour:

'Overvaluation (or underevaluation) of assets occurs because of fierce self-amplifying reactions of speculators on small deviations from the equilibrium. On the other hand, an endogenous breakdown of bubbles is brought about because excess profits vanish as the bubble decelerates. Hence, both excess volatility and mean-reversion can be explained with this type of noise trader/infection model'.

Having identified some of the qualitative features which are observed in the dynamics of conflicting opinions about party policy and their analogy with conflicting opinions about stockmarket prices we are now ready to construct the formal model.

Party policy: a power-weighted average of opinions

In this section we shall consider the direct determination of party policy, assuming that party members' opinions are fixed. Many individuals participate and they each have their own individually preferred policy. They each try to push the party towards their preferred policy. In this process some individuals have more power than others. The aggregation of these individual actions exerts a pressure on party policy. The speed of policy adjustment in the face of this pressure depends on the party's organizational responsiveness.

It may be that there is no net pressure for policy change, in which case current policy is at an equilibrium. If this is not the case - if there is net pressure for change - then it may happen that the speed of adjustment is instantaneous: policy moves immediately to its equilibrium position. In analogy with the concept of market clearing in economics we might refer to this as 'political demand clearing'. Here however we assume that policy takes a finite time to adjust to net pressure for change. An appropriate model is therefore a differential equation.

change in party policy =	speed of adjustment	x	individuals' powers	x	individuals' policies

$$dp/dt = b\,[\,\Sigma\,\pi(i)\,f(i)(p(i)-p)] = b\,D \qquad [1]$$

The term on the left hand side denotes the rate of change of party policy. The symbol p denotes party policy, that is some point along the ideological continuum from left to right. The symbol t denotes time. The right hand side contains the factors which determine the rate of change in party policy: b is the speed with which the party policy adjusts to pressure; $\pi(i)$ is the power used by individual i to change party policy, and p(i) is the policy which is preferred by individual i. Taking power to mean relative power, we have that the powers sum to unity: $\Sigma\pi(i)=1$. What is important about an individual's preferred policy may not be its absolute position but rather where it lies in relation to the current policy of the party - this is expressed by the function f(i), what we shall refer to as the judgment function. The force exerted by each individual is the combination of their power and their policy preference. Finally the individual forces are aggregated, denoted by the summation sign Σ.

[FN. To facilitate comparison with Lux (1995), D can be thought of as net demand. In Lux the relevant equations are (5), (7) and (8), pp. 886-887. The above equation can then be interpreted as expressing change in price p as a function of net demand D.]

An equilibrium is a state of affairs at which the rate of change of policy is zero (that is dp/dt=0). We now consider the equilibria for different distributions of power and different forms of the judgment function. First we suppose that party members base their action on the *magnitude* of the difference between current policy and their own individual policy preference. If all individuals have equal power then the equilibrium policy is the mean of the individual policy preferences. If all individuals do not have equal power then the equilibrium policy is the weighted mean of the individual policy preferences - each individual's preference being weighted by their power. An alternative basis for action might be that party members act only on whether their preference is to the left or right of current policy. In this case what matters is the *sign*

of the difference between individuals' policy preferences and the current policy: each individual is counted as -1 or +1 depending as they are to the left or right of the current policy. If all individuals have equal power then the equilibrium policy is the median of the individual policy preferences. If all individuals do not have equal power then the equilibrium policy is the weighted median of the individual policy preferences - again each individual's preference is weighted by their power. (In passing note how the Downsian median policy is a policy equilibrium under the special conditions of two party majority voting: equal power and the sign function of policy preferences).

[FN In Lux, 1995, pp. 886-887, equation (5) considers the *sign* of naive traders' preferences, whereas, for fundamentalist traders, equation (7) considers the *magnitude* of the difference between the market price and the fundamental value]

Table 1 Equilibria for special cases of equation [1]

the judgment function, f(i)=	individuals' powers, $\pi(i)$	equilibrium
magnitude	all equal	mean of the p(i)
magnitude	unequal	power-weighted mean of the p(i)
sign	all equal	median of the p(i)
sign	unequal	power-weighted median of the p(i)

If current policy is not at an equilibrium then we may use the differential equation [1] to obtain another equation which specifies how party policy changes over time. For example consider the case where party members are sophisticated and react to the magnitude of their differences from party policy. So the equilibrium is the power-weighted mean. Equation [1] becomes:

$$dp/dt = b [\Sigma \pi(i)(p(i)-p)] = b [\Sigma \pi(i)p(i) - \Sigma \pi(i) p] = b [m - p] \quad [2]$$

Recall that $\Sigma\pi(i)=1$. Here m is the power-weighted mean. We can integrate this equation to obtain the equation below which indicates that the policy p approaches the power-weighted mean m from the left or right at an exponentially decreasing rate.

$$p=m+-(1/b)\exp(-bt+c) \quad [3]$$

Now consider the case where party members are naive and react simply to the sign of their differences from party policy. So the equilibrium is the power-weighted median. Equation [1] becomes:

$$dp/dt = b [\Sigma \pi(i)\text{sign}(p(i)-p)] = b [\Sigma' \pi(i) - \Sigma'' \pi(i)] = b [x\hat{}] \quad [4]$$

Where Σ' denotes summation over those to the left of the policy and Σ'' denotes summation over those to the right of the policy, and x^ denotes the power-weighted

differential between left and right. Although this cannot be solved explicitly the behaviour of the solution is similar to that of the power-weighted mean case.

We now suppose that the party has two groups of members, a group of naive party members and a group of sophisticated party members. The naive group act only on whether their preference is to the left or the right of current policy while the sophisticated group act on the magnitude of the difference between current policy and their own preference. Equation [1] then becomes a combination of equations [2] and [4], with weightings n and s to reflect the relative sizes of the two groups, x^ denoting the power-weighted differential for the naive members and m denoting the power-weighted mean for the sophisticated members.

$dp/dt = b[nx^ + s(m-p)]$ [5]

[FN This corresponds to Lux, 1995, p. 887, equation (8), where the power-weighted mean m is the consensus amongst fundamentalist traders about the fundamental value.]

Again although this cannot be solved explicitly the behaviour of the solution is similar to that of the power-weighted mean case. Thus the behaviour of our model so far is quite straightforward: a gradual convergence to the equilibrium policy, in this case at some point between the median preference of the naive party members and the mean preference of the sophisticated party members.

The shifting of opinions

In the preceding section we assumed that individual policy preferences remain fixed. We now consider what happens when these preferences are allowed to change. This brief section sets up a basic model for shifting opinions.

The literature on party conflict pays attention to the formation of groups or sects, and so it is reasonable to identify opinions as discrete, corresponding to the opinion of the group of which one is a member. Here we shall consider two groups: the group whose policy preference is for a policy to the left of current policy, and the group whose policy preference is for a policy to the right of current policy. Following Lux (1995, pp. 883-885) we can give a score of x=-1 to the left opinion and x=+1 to the right opinion. The mean of such opinions is denoted x^. We now need to consider the probability of an individual changing their opinion. We postulate that this probability depends on some criterion which can be represented by the parameter z. We can also think of z also as an indicator of whether there is a rightward or a leftward tendency. If z is positive there is a rightward tendency and if z is negative there is a leftward tendency. With a rightward tendency the probability of moving to the right is greater than the probability of moving to the left; and with a leftward tendency the opposite is the case. Lux adopts a linear response model, which leads him to a 'functional form commonly chosen in the related literature'. There are two possible old opinions and two possible new opinions, and so four response probabilities.

probability of staying left	p(L/L)=1-vexp(z)	[6]
probability of moving from left to right	p(R/L)=vexp(z)	[7]
probability of staying right	p(R/R)=1-vexp(-z)	[8]
probability of moving from right to left	p(L/R)=vexp(-z)	[9]

[FN The corresponding equation in Lux is equation (3), p. 885.]

Here exp denotes the exponential function and v denotes the speed of change of opinion.

We now use these response probabilities for *individuals* in order to derive an equation for change in the *group* opinion. In his derivation Lux (1995, pp. 883, 894-895) appeals to the concept of synergetics which 'basically consists of a probabilistic, macroscopic approach to the analysis of the dynamics of multi-component systems with interactions among the units constituting the system.' There are four stages in the derivation:

(i) derive an expression for the probability of a change in the size of the groups, expressed in terms of response probabilities [(A1) and (A2) in Lux];
(ii) derive the Master equation for the change in the probability distribution of the size of the groups [(A3) in Lux];
(iii) derive the equation for the change in the expected value (mean) of the size of the groups [(A4) and (A5) in Lux];
(iv) derive the equation for the change in the mean opinion (over the groups) [(A6) and (A7) and (2) in Lux].

Using the particular response probabilities postulated above Lux (1995, p. 885, equation (4)) derives his equation for a shift in mean opinion.

$$dx^/dt = 2v[Tanh(z)-x^]Cosh(z) \qquad [10]$$

The term on the left hand side denotes the rate of change of opinion. The symbol x^ denotes the mean opinion. The symbol t denotes time. The right hand side contains the factors which determine the rate of change in opinion: v is the speed of change in opinion; and z is the criterion parameter. The terms Tanh and Cosh are particular mathematical functions. The most important point about equation [10] is that it explains change of opinion in terms of the criterion parameter, the nature of which we shall now consider.

The criterion for a shift in opinion

In general the criterion for changing one's opinion will include objective features of the situation and also the subjective opinions of others. Objective features include the current position of party policy and the 'returns' or political benefits accruing to the party. The subjective opinions of others include the opinions of naive party members and also the opinions of sophisticated party members. These various factors can be given different weights and combined to form a particular criterion. Each of sections I to III of Lux's paper deals with a different criterion parameter, and the following three sections of this paper will parallel that development. The three criterion parameters are:

(i) the criterion parameter which consists solely of the mean opinion of naive party members,
$$z=ax^ \qquad [11]$$
(ii) the criterion parameter which consists of the mean opinion of naive party members together with the current change in the policy position of the party,

$z=(a(1)/v)dp/dt+a(2)x^$ [12]

(iii) the criterion parameter which consists of the mean opinion of naive party members together with the current change in the policy position of the party and the mean opinion of sophisticated party members,
$z=a(0)+(a(1)/v)dp/dt+a(2)x^$ [13]
The cofficients a, a(0), a(1) and a(2) represent the strength of the factors involved. In the next section we shall refer to a in equation [11] as the strength of herd behaviour.

Naive party members: the contagion of opinions

[FN This corresponds to section I of Lux]

The preceding section noted that one type of criterion for a shift in opinion was the opinions of others. In particular the first criterion (equation [11]) concerned a situation where the sole criterion was the mean opinion of naive party members, while the third criterion (equation [13]) included also the mean opinion of sophisticated party members. In both cases what matters is the opinion of others, what Lux refers to as mutual mimetic contagion. The central ideas here are communication, aggregation and response: communication within the party leads each individual to form a view about the aggregate opinion and to respond by shifting their own opinion. In the following equation these three processes are denoted by C, A and R, and individuals' opinions at time t are denoted by x(t).

new opinions = response x aggregation x communication x old opinions

$x(t+1) = R\ A\ C\ x(t)$ [14]

In this section we consider the first criterion, the simple case represented by equation [11], corresponding to contagion of opinion amongst naive party members. The three processes take the following specific forms, the first two stages of communication and aggregation being deterministic while the third stage is probabilistic:

(i) each individual communicates their opinion to every other individual;

(ii) each individual on receiving these communications gives equal weight to them and aggregates them to derive the mean opinion;

(iii) each individual adopts a probabilistic response using the first criterion parameter, that is the probability depends on the mean opinion; if mean opinion is to the right then the individual is more likely to move to or stay on the right; equation [11] is substituted into equations [6]-[9].

[FN Here the aggregation process gives equal influence to all individuals. Just as Lux ignores the exceptional influence of financial gurus, so we ignore the exceptional influence of the party leaders. Such exceptional influences could be modelled by a different aggregate such as the power-weighted mean.]

Substituting the criterion parameter of equation [11] in equation [10] yields the following:

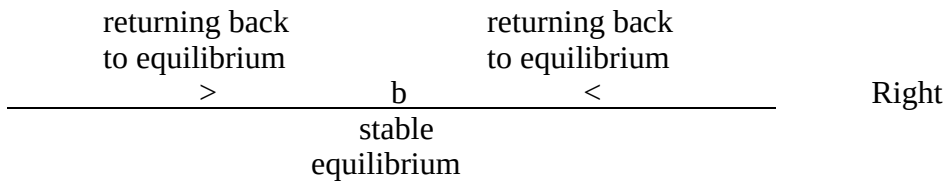
$$dx^/dt = 2v[\tanh(ax^)-x^]\cosh(ax^) \quad [15]$$

[FN Lux (1995, p. 885) equation (4). Lux proceeds to discuss the dynamics of this equation and the text here parallels his account.]

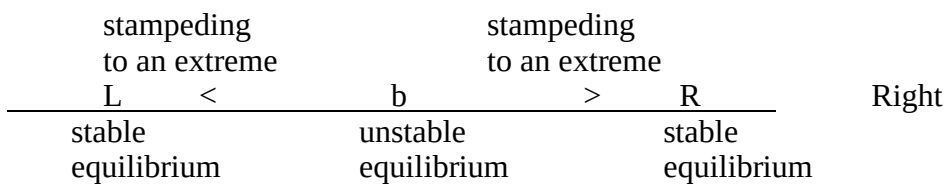
What is the equilibrium mean opinion? This depends on the strength, a, of herd behaviour in the party. If herd behaviour is weak then the equilibrium is the most 'obvious' one: an even balance exists between those who think the party should move to the left and those who think the party should move to the right. Even if the mean opinion deviates somewhat from this balanced position, the deviation will be only temporary and will quickly subside, returning back to equilibrium. We refer to the equilibrium as being stable. However if herd behaviour is strong, we obtain a result which is rather surprising. An even balance is still an equilibrium but now it is unstable: any slight deviation to the left [right] of an even balance will quickly lead to a stampede to the left [right]. The stampede eventually comes to a halt at some extreme point on the left [right]. This point is a stable equilibrium. So the mean opinion remains with a majority being of the opinion that the party should move to the left [right]. Thus there are two stable equilibria, one on the left and one on the right. At any one time the party will be near one of them and usually will continue to stay there. However due to the probabilistic nature of the model, it can happen that there is a switch from one stable equilibrium to the other. A possible example of this might be that the mean opinion in the UK Labour party was at a left equilibrium in the eighties and then switched to a right equilibrium in the nineties.

Figure 1 Equilibria for mean opinion

(a) The case of weak herd behaviour: a stable balanced equilibrium b



(b) The case of strong herd behaviour: an unstable balanced equilibrium b, and two stable extreme equilibria



Contagion of opinion and policy shifts

[FN This corresponds to section II of Lux]

We now consider the second criterion parameter expressed in equation [12]. The opinions of naive party members are still influenced by mean opinion but now there is an additional influence, namely the current movement in party policy. Moreover party policy is determined by the joint action of both naive and sophisticated party members. The influence of policy on naive opinion operates in the following manner. If party *policy* is moving to the right [left] then this increases the probability of a shift in *opinions* from left to right [from right to left], and decreases the probability of a shift in *opinions* from right to left [from left to right]. These considerations lead to the following two equations. The first equation is simply equation [5] from an earlier section, representing how party policy changes under the political pressures of both naive and sophisticated party members. The second equation is the generalisation of equation [15], indicating how the mean opinion of naive party members changes under the two influences described above.

$dp/dt = b[nx^ + s(m-p)]$ [16]
$dx^/dt = 2v[Tanh(z)-x^]Cosh(z)$ where $z=(a(1)/v)dp/dt+a(2)x^$

[FN Lux (1995, p. 888) equations (10).]

What is the equilibrium here? In this context, an equilibrium means not only an equilibrium of mean opinion but also an equilibrium of party policy. In this case too the answer depends on the strength, a, of herd behaviour in the party.

If herd behaviour is weak then the equilibrium is again the most 'obvious' one. In terms of *opinion* an even balance exists amongst naive party members between those who think the party should move to the left and those who think the party should move to the right; and in terms of party *policy*, the equilibrium policy is situated at the mean policy preference of the sophisticated party members. This equilibrium may be stable or unstable. Instability occurs if naive party members are more powerful and sophisticated party members less powerful, if naive party members are highly sensitive to policy changes and if the speed of change of opinion is high. This condition of instability is characterised by 'convergence to a periodic orbit', that is there will be periodic swings from left to right and back again, in terms of both naive opinion and party policy. Something akin to this phenomenon has been identified in *public* opinion. Scholars have identified cycles of 'domestic policy mood' in the period 1956-1993. Charted on a liberalism-conservatism scale, American public opinion 'reaches a liberal high point in the early 1960s, meanders mainly in the liberal end of its range through the middle 1970s, moves quite dramatically toward conservatism approaching 1980, and then begins a gradual return to liberalism over the 1980s' (Stimson, MacKuen and Erikson, 1995, p. 548).

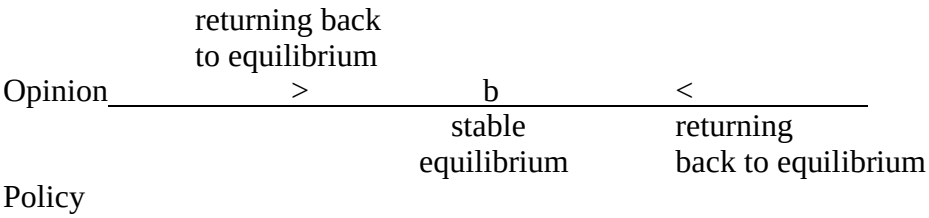
However if herd behaviour is strong, the 'obvious' equilibrium is still an equilibrium but now it is unstable. In addition there are two additional equilibria, a left equilibrium and a right equilibrium, both of which are stable. The left equilibrium L is characterised by a mean *opinion* amongst naive party members that party policy should move to the left, and by a party *policy* which is to the left of the mean policy preference of sophisticated party members. Similarly the right equilibrium R is characterised by a mean *opinion* amongst naive party members that party policy should move to the right, and by a party *policy* which is to the right of the mean policy preference of sophisticated party members.

The above observations do not completely characterize the global behaviour of the system of equations [16]. Lux (1995, p. 889) observes:

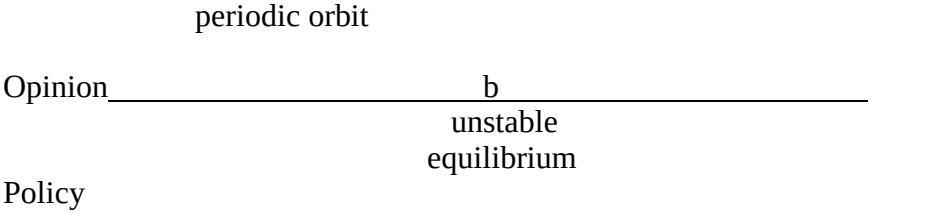
'Numerical experiments suggest that the bubble equilibria [that is, L and R] will be stable for a broad range of parameter values but not for all. Simulation runs also indicate that stable equilibria [L and R] can coexist together with a limit cycle enclosing all three steady states which is also stable. Taking the randomness that has been suppressed in our derivations explicitly into account, the system may then undergo transitions between cyclic behaviour and stable steady states leading to an erratic appearance of the overall evolution of prices.'

Figure 2 Equilibria for mean opinion and party policy

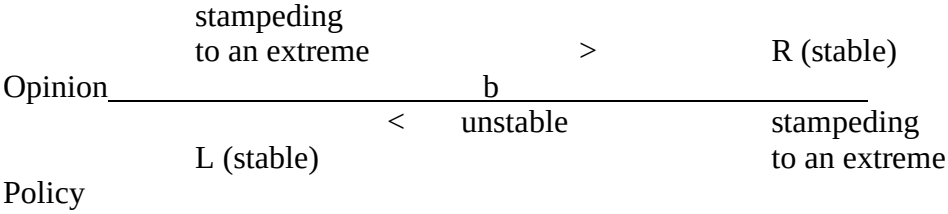
(a) The case of weak herd behaviour: a stable balanced equilibrium b



(b) The case of weak herd behaviour: periodic swings left and right



(c) The case of strong herd behaviour: an unstable balanced equilibrium b, and two stable extreme equilibria



Switching between left and right

[FN This corresponds to section III of Lux]

At this point in his argument Lux is still not satisfied that he has a model which will fit events like the October 1987 crash. He wants to ensure that the extreme equilibria do not remain stable - that they eventually crash. Using Kindleberger's (1989) account

of financial crises, Lux (1995, p. 890) notes that 'there have often been prolonged periods of time where financial experts have judged that stocks are overvalued or priced too low ... a period of distress precedes the ultimate crash ... there are pessimistic and warning voices ... [the crash is] foreshadowed by a gradual erosion of confidence in the market'.

We can identify analogies to this process in party politics. In the UK politics of the eighties and nineties, there was a prolonged period of time when political experts judged that the Labour party had shifted too far to the left to be electable and over this period there was an erosion of confidence in left-wing strategies. Another example is that through the eighties political experts judged that the Conservative party had shifted too far to the right and then finally with the introduction of the poll tax and the development of confrontational approaches to the European Community there was an erosion of confidence and Prime Minister Thatcher was forced to relinquish office. Somewhat similarly, scholars of American politics have identified 'critical realignments', that is abrupt, large and enduring forms of change in prevailing electoral patterns: the Whig critical realignment 1836-1840; the Antebellum Republican critical realignment 1856-1860; the Jim Crow critical realignment 1876-1904; the Republican Industrial critical realignment 1896-1904; the New Deal Democratic critical realignment 1928-1936; and the Post-World War II Republican critical realignment 1948-1952 (Nardulli, 1995).

The key features of these events is the establishment of an extreme equilibrium which finally collapses. (Interestingly the American data offers us a history of successive 'extreme' equilibria). In order to model this, we revise the criterion parameter of the previous section to include a factor, a(0), representing a general prevailing mood of the party, as having an influence on naive individuals' opinions. This is the third criterion as expressed earlier in equation [8].

$$z=a(0)+(a(1)/v)dp/dt+a(2)x \qquad [8]$$

There are two different ways of interpreting a(0). The first approach starts by noting that naive individuals' opinions are already influenced by the mean naive opinion. This suggests that we might think of 'the general prevailing mood' as representing the mean opinion of the sophisticated individuals. If sophisticated opinion is to the left [right] of party policy then this increases the likelihood of a shift to the left [right]. This effect is captured by expressing a(0) as (m-p) or some function of (m-p). This leads to a system of equations in x^ and p, similar to [16] except for the change in the z factor. The behaviour of this system remains to be investigated.

The second approach is to relate a(0) to the the political returns of adopting a particular policy! Only at this late stage are we taking account of the factor which Downs felt was central to party positioning! The political return with which Downs was primarily concerned was the winning of electoral power. However, before considering this external return, it is worth noting in passing that there are returns for individual party members irrespective of returns to the party as a whole. To the extent that these internal returns arise from following the herd either in terms of naive opinion, sophisticated opinion or policy change, the effect of these returns have already been taken care of in our earlier equations. To handle the effect of external returns requires us to study the dynamics of inter-party competition. This takes us beyond the aims of the present paper, and of course the work of Budge (1994) as well

as Burt's (1996) commentary raise questions as to how powerful an influence these external returns are.

The approach adopted by Lux (1995, pp. 890-893) is the second one. He relates the prevailing mood factor a(0) to the difference between the actual returns and the average expected returns. This leads to a much more complicated system of three equations involving x^, p and a(0). Making certain simplifications Lux establishes an interesting dynamic behaviour. The balanced equilibrium is the unique equilibrium. Under certain parametric conditions there is a periodic orbit characterised by slow movement away from the balanced position and rapid collapse followed by slow movement in the opposite direction. This type of behaviour meets Lux's requirements of finding a system which models the stockmarket with its bubbles and crashes.

Conclusion

As a result of our application of Lux's model to the formation of policy within political parties, we have established that contagion of opinion can drive the dynamic movement of policy in a variety of ways, depending on the strength of herd behaviour, the balance between naive and sophisticated voters, the sensitivity of naive party members to policy changes and the speed of opinion change. Also different variants of the criterion parameters give rise to different versions of the model and different kinds of dynamics.

Herd behaviour in UK party politics

The model's prediction that a political party adopts a policy corresponding to some central equilibrium is somewhat similar to the prediction obtained if we imagine that party members are allowed to vote on policy and if we then apply the median voter theorem. What is distinctive about the Lux-type model is that it also predicts the possibility of a party adopting extremal policies and it predicts that this can occur in quite a dramatic way. The studies reported in Klingemann et al. (1994) and Budge (1994) which chart policy shifts in political party manifestos give some evidence that this kind of dramatic shift in policy does take place. For example in the UK, the Conservatives under Edward Heath as leader were centre-left, but under Margaret Thatcher moved sharply right, with a small shift back under John Major. The Labour Party under James Callaghan were in the centre (for certain of its policies foreshadowed measures applied more wholeheartedly by Thatcher), but during the early 1980s moved sharply left, to be followed by a slow drift back to the centre or even centre-right, a movement which has accelerated under the leadership of Tony Blair.

Inter-party opinion and inter-party policy

Just as the post-war consensus was at least partly brought about by a movement of the Conservative party towards the centre and left-of-centre, with the Conservative governments of 1951 to 1964 maintaining many of the previous Labour government's measures, so the post-1997 consensus appears to be characterised by the Labour party moving towards the centre and right-of-centre, with Tony Blair promising that he will not reverse the fundamental changes introduced by Margaret Thatcher. Thus *inter*-party opinion has moved from the post-war left to the post-1997 right. In part this is a herd phenomenon: people had to 'move with the times'.

Policy and leadership crises within a party

Shifts in party policy do on occasion appear to take place with the same drama as characterise stockmarket booms and crashes. The model proposed by Kindleberger seems to work well. For example, through the 1980s Mrs Thatcher and the policies of the New Right attracted growing 'political investment'. Euphoria developed with successive election victories. As the 1980s ended, conflict within the Conservative party on Europe and on the poll tax, ushered in a period of distress. Finally revulsion set in and the party deserted Mrs Thatcher for a new leader and at least some diminution of her policies. Her successor John Major had a somewhat similar experience - surviving a challenge from John Redwood for the party leadership, but continuing to encounter dissent from within the party, particularly over Europe, right up to the general election on 1st May 1997.

We can explain this process in terms of the role of the leader in establishing a particular regime over the party. When the regime is flourishing there is strong positive support for the leader, little dissent and little support for alternative potential leaders. Party members have invested in the leader. Due to their position of power the leader is able to provide returns to their supporters. However some point is reached when the leader is no longer able to provide returns to 'investors'. This may happen in a variety of ways: political appointments may be limited, public opinion may decline, the leader may no longer be able to guarantee election victory and finally the leader's future may be in doubt and so members anticipate that the leader may in the future

not be in a position to provide returns. At this point the communication of opinions is of strategic importance. Contagion of opinion is now very likely since communication intensifies, and there is much uncertainty and much at stake. Others' opinions need to be checked out both in order to inform one's own opinion and in order to persuade them of one's own opinion. A stalking horse may be put forward, that is a challenger who has no real chance of winning against the leader but whose candidature allows the registration of dissident opinion so that contagion can work its course. A further complication is that there may be strategic communication of opinions, that is the opinion which a party member communicates may not actually conform to their real private opinion - because their future political returns may depend on them expressing the 'correct' opinion (cf. Weidlich, 1994). In this murky process of opinion contagion, the opinion may strengthen that the current leader is no longer a good political investment. Party members panic and rush to withdraw their support.

We can apply the models developed earlier to this situation. The simplest approach is to consider two possible opinions, either for or against the current leader. In the good times there is an extremal equilibrium of high support. As a result of the crisis this collapses to become an extremal equilibrium against the leader, cf. Figure 1b. A more complex model would allow several opinions, say three, one opinion for the current leader and two opinions in favour of one or other of two challengers. With several challengers the model becomes like that of Figure 2b, the triangle. In the crisis of the Thatcher leadership, Heseltine presented the initial challenge (the Figure 1 model), and Thatcher withdrew. Major and Hogg then entered the contest against Heseltine (the Figure 2b model). A combined model would consider both stages of the contest and all four contestants (a tetrahedron model akin to Figure 3). The present contest for the leadership, following John Major's resignation in the wake of the general election defeat, has six contenders.

It is worth noting that in leadership situations it is the central equilibrium which is unstable. Even if opinion were evenly divided between the candidates the knowledge that the constitution specified just one leader forces opinion and contagion of opinion towards some extremal equilibrium. (Hence it is Figures 1b and 2b which apply, not 1a and 2a).

Inter-party policy leadership

By analogy with the preceding argument we can formulate a notion of inter-party policy leadership. It is not just that there is currently a new right consensus. The point is that this is the agenda which had been set by Mrs Thatcher's Conservatives in the 1980s. This policy leadership was established by their 1983 election victory over Michael Foot's Labour Party and David Steel and Roy Jenkins's Alliance Party. Thereafter the Alliance crumbled and the Labour party policy moved to the right, albeit slowly and reluctantly.

Party opinion and public opinion

So political parties do appear to experience dramatic opinion shifts. What of public opinion - does it too shift dramatically, and how do public opinion shifts relate to party opinion shifts? A clear and well-documented example of public opinion shift is the phenomenon of 'mid-term blues' when the public opinion poll rating of the ruling party falls sharply during the middle term of their office. These mid-term blues may themselves be a reflection of strategic behaviour by the ruling party as it presents its

more unpopular policies at the start of its term of office (Price, 1997). As a result a party may discount mid-term blues and so it may not be swayed into making major opinion shifts as a result. There are occasions however when parties do appear to take low opinion poll ratings seriously and they can be contributory factors in causing major policy change (or at least leadership change) within parties. Influence can also work in the opposite direction. A party experiencing dramatic policy or leadership crises can find this being reflected in falls in public support. In the case of the Thatcher leadership crisis this happened sufficiently far away from the next election that the Conservatives were able to recover in time and win the 1992 election.

Spring 1997 saw a leadership crisis too close to the election (Price, 1997). With just seven weeks to go before the election, the opinion polls showed support for John Major's ruling Conservative party hovering around 30%. In contrast Labour party support was above 50%. During the campaign the Labour lead fell only slightly and the Labour landslide swept the Conservatives from power.

Voting percentages and opinion dynamics

However changes in opinion polls and changes in voting percentages for parties can too often be misinterpreted as fundamental changes in public opinions. For example some commentators have interpreted the 1970s electoral advances by the Liberal Party, the Scottish Nationalist Party and Plaid Cymru as reflecting a major change in public opinion. Yet, as we shall see, the reality is somewhat different. In general the key to understanding changes in percentage votes is to note the following points:

(i) given a particular franchise and given a set of competing parties there is some central equilibrium in voters' opinions about the competing parties;

(ii) extensions of the franchise change this central equilibrium;

(iii) changes in the set of competing parties create a different central equilibrium;

(iv) given a set of competing parties the variable fielding of candidates distorts the percentage votes from the central equilibrium in a predictable manner;

(v) with fixed franchise, a fixed set of competing parties and a fixed pattern of fielding candidates, the changing social composition of the electorate changes the balance of percentage votes;

(vi) with a fixed franchise, a fixed set of competing parties, a fixed pattern of fielding candidates and a fixed electoral social composition, the dynamic movement of percentage votes can be taken as an indicator of changes in opinion and as such can exhibit a variety of patterns;

(vii) one possible pattern is a periodic cycle;

(viii) another possible pattern is a sudden displacement from equilibrium followed by a return;

(ix) sudden displacements are associated with either national crises or crises internal to one or more of the parties.

The historical voting record

These points can be illustrated by an account of UK voting patterns since the Reform Act of 1832. In 1832 Liberals had 67% of the vote and Conservatives 29%. The Liberal vote declined progressively over the next three elections falling to 47% in 1841 (Conservative 51%), rising steadily again to 66% in 1859 (Conservative 34%), falling to 45% in 1886 (Conservative 51%) and remaining in the mid-40%s up to December 1910. (Between 1900 and 1910 Labour moved from 1% to 6%). So between 1832 and 1886 there were one and a half cycles of two-party dynamics, with Liberals ranging between 47% and 67% and Conservatives ranging between 51% and 30%-odd. However much of this variation in percentage votes can be explained by variation in the number of candidates fielded. For example in 1832 there were 636 Liberal candidates and 350 Conservatives candidates, whereas in 1841 there were 388 Liberal candidates and 498 Conservative candidates. So what we observe is not a periodic cycle in opinions but in candidates fielded. Gash (1997, pp. 239, 240) comments: '... the composition of the House of Commons ... was decided almost as much by the elections which were not contested as by those that were. [...] Too many dams and obstructions existed for the tides of public opinion to flow with either freedom or power along the electoral channels.' (Further points to note about this period are (i) the franchise was further extended by the Reform Acts of 1867 and 1884; and (ii) both parties usually had over a hundred unopposed returns.)

The 1918 election saw a sudden change in fortunes. In December 1910 Liberal and Conservatives enjoyed a combined vote of 91%. In 1918 this combined vote had been reduced to 64%. There had been a major expansion of the franchise between 1910 and 1918, additional parties had entered the arena and existing parties such as Labour had fielded a greater number of candidates than they had in 1910.

From 1918 there were further extensions of the electorate culminating in the extension of the franchise to women over 21 in the general election of 1929. In the five elections in the period 1918-1929, Labour expanded its fielding of candidates and in parallel with this its share of the vote, gaining 37% in 1929 and forming the first Labour government. Meanwhile in 1924 the Liberals had sharply reduced their fielding of candidates thereby gaining just 18% of the vote, a situation they were not able to reverse in 1929 even by a major expansion in the number of Liberal candidates fielded. In 1929 the balance of votes was 38% Conservative, 37% Labour and 18% Liberal. Crisis followed and the 1931 election brought a national government with the Conservatives gaining 61% of the vote - a percentage which slipped back to 53% in 1935.

The Labour landslide of 1945 is commonly (but, as we shall see shortly, misleadingly!) seen as ushering in a thirty year period of two-party politics with public opinion giving little support to third parties. This period came to an end in 1970/1974 as public opinion suddenly became more volatile and third parties enjoyed a dramatic increase in percentage votes. In the 1966 election the two major parties together obtained 90% of the vote but in the February 1974 election, their combined vote fell to 76%.

Since 1974 there have been a number of major changes. In 1979 the third parties lost much of the ground they had gained in 1974, to the benefit of the Conservatives (and to Labour in Scotland). The 1983 election witnessed a dramatic fall in the Labour vote, and also in Scotland a fall in the Scottish Nationalist Party vote, to the benefit of

the newly formed Social Democrats and the Liberals. The subsequent elections of 1987 and 1992 saw a gradual recovery of the Labour vote and the demise of the Social Democrats and then the dramatic Labour triumph of 1997. In Scotland, the Scottish Nationalist Party made an advance in 1992 which was sustained in 1997. Voting percentages are given in Tables 2 and 3 (sources: Craig 1989; Wood and Wood 1992; The Times, May 3 1997, p. 1; The Independent, May 3 1997, p. 1; The Observer, May 4 1997, p. 24).

1945-1997: from two-party loyalties to multi-party volatility?

Our discussion of the voting record in the period 1832-1945 has already indicated that changes in the voting percentages were often associated with changes in the franchise, or in the set of competing parties or in the differential fielding of candidates. This makes it difficult to interpret changes in voting as changes in public opinion - at least without further investigation. Does the same argument apply for the period 1945-1997? We shall start by investigating the claim that 1970/1974 saw a decisive turning point in public opinion from two-party loyalties to multi-party volatility.

In fact the 1974 advance by third parties was largely caused by these parties fielding more candidates than they had hitherto! A study of the post-war history of the Liberal Party, Plaid Cymru and the Scottish Nationalist Party reveals a very similar pattern. Before 1970 none of these parties contested all the seats in their respective countries. The Liberal party fielded 306 candidates in 1945, increased this to 475 in 1950, but cut this back sharply to 109 in 1951, with much the same number fielded in 1955. Thereafter there were successive increases in the number of Liberal candidates fielded at the elections of 1959 and 1964, a slight reverse in 1966, and again increases in 1970, February 1974 and October 1974 when 619 candidates were fielded, close to the maximum. Plaid Cymru similarly progressively increased their field from 1955 reaching close to the maximum in 1970 - as did the Scottish Nationalist Party. Thus the third parties were continuously expanding their electoral activities for fifteen to twenty years before their celebrated electoral breakthroughs in 1970 (SNP and PC) and 1974 (Liberals).

The question is: what was happening to public opinion during this period? Did opinion remain stable at a low level throughout the period and then dramatically increase in 1970 or 1974? Or did opinion increase gradually as the number of candidates increased? In support of the latter answer we certainly find the voting percentages increasing linearly with the number of candidates fielded. However an alternative interpretation of the same figures would be that *public support for the third parties was consistently at the high 1970/1974 levels throughout the 1945-1970/1974 period but was 'suppressed' due to the third parties not contesting all the seats*. This conclusion may seem rather unremarkable were it not for the fact that it seems to pass unnoticed in the literature which gives the strong impression that it is voters' opinions which had changed in 1970 and 1974. (For example Sarlvik and Crewe, 1983, p. 30-31. Brand, McLean and Miller, 1983, discuss the situation in Scotland in a similar fashion).

This finding makes it difficult to interpret the third party percentage vote in the period 1945-1970, because this is based on an increasing number of candidates fielded in each election. It also affects the interpretation of the percentage votes for the two major parties. According to Sarlvik and Crewe p. 30, 'Elections [1945-70] were ...

decided by tiny fluctuations of Conservative and Labour support'. The figures in Table 2 above suggest that changes in the Liberal percentage vote were a major source of these tiny fluctuations in the 1951, 1959, 1964 and 1966 elections. Our new interpretation is that this was a direct result of Liberal candidate cutbacks in 1951 and 1966 and Liberal candidate expansion in 1959 and 1964. (Liberal candidate levels remained virtually unchanged between 1951 and 1955, and between 1966 and 1970). Similarly the substantial Scottish National Party candidate expansion in 1970 was the major source of the change in the balance between the Conservative and Labour vote in Scotland in the 1970 election.

From this analysis we conclude that it is misleading to regard the period 1945-1974 as a period of two-party loyalties. Certainly Westminster was characterisd by two-party politics in that period. However it is reasonable to suppose that public opinion was more diverse. For, where it had a chance to express itself, public opinion prior to 1970/1974 was just as diverse then as it was to be in the post-1974 era. It is to this post-1974 era that we now turn. Is it an era of multi-party volatility? We briefly investigate four claims which were made at one time or another during this period: (a) that the period marked the rise of a centrist force; (b) that it marked a resurgence of the Scottish Nationalist Party; (c) that it marked a new Conservative ascendancy; and, following the 1997 Labour landslide, (d) that it marked a New Labour ascendancy.

Writing in 1981, Sarlvik and Crewe (1983, p. 331) observe 'as this is being written, two years after the 1979 election, the possibility that a strong force in the centre has re-emerged to challenge the Conservative-Labour predominance is very real'. The reference here is to the formation of the Social Democratic Party, and indeed in 1983 the Liberal and SDP gained a combined vote of 25%. However this was only a 6% advance of its 1974 share of the vote and subsequently the (renamed) Liberal Democrat vote had fallen back somewhat to 18% in 1992 and 17% in 1997. The surge of the Social Democrats in 1983 was even more marked in Scotland but receded here too, with the Liberal Democrat vote in 1992 (and in 1997) registering only a 4% increase on the 1979 figure.

Over the same period the Scottish Nationalist Party fortunes have fluctuated dramatically: reaching a high point in October 1974, falling back dramatically in 1979 and 1983, recovering some of the ground lost in the two subsequent elections, to return in 1992 to the level they had gained in February 1974, a level which they sustained in 1997.

The claim that a new Conservative ascendancy had taken place might be illustrated by the 8% advance in 1979. However there were no advances in the subsequent elections of 1983, 1987 and 1992; and then of course there was the collapse in 1997. Indeed in Scotland the Conservative vote declined by 6% in the period 1979-1992 and fell a further 8% in 1997. The other side to the notion of Conservative ascendancy was the notion of Labour decline. The major slump in the Labour vote occurred in 1983 - and was associated with internal crisis within the party and the formation of the Social Democratic Party. In the subsequent elections of 1987 and 1992, Labour slowly recovered some of the ground it had lost and then raced ahead in 1997 with a further gain of 10% in the vote. In Scotland, Labour's vote in 1997 was greater than it had been at any time since 1966. The victory of 1997 was greeted with discussion of a New Labour era and debate as to whether the Conservative party had a future. However there is no reason to suppose that this 'new era' will prove any more long-lived than previous hypothesised new eras.

In conclusion, the period 1974-1997 has indeed been a period of volatility in voting percentages. However none of the 'new era' claims looks secure. The volatility of voting percentages appears to be more due to public reactions to major current events than due to major shifts in public opinion. The industrial relations issues which dominated the agenda in the 1970s and 1980s, the crisis in the Labour party between 1979 and 1983 and the formation of the Social Democratic Party, all had their influence on the voting percentages. Problems in handling a key issue put a party into crisis which produced a dramatic shift in voting percentages. The elections of 1983 and 1997 provide examples of this, each mirroring the other. In 1983 the returned Conservative government gained 42%, Labour gained 28% and the SDP-Liberal Alliance gained 25%. This is not too dissimilar from the 1997 result where the final voting percentages had the incoming Labour government gaining 44%, the Conservatives gaining 31% and the Liberal Democrats gaining 17%. At 10% the swing from Labour to Social Democratic and Liberal Alliance in 1983 is the same as the swing from Conservatives to Labour in 1997. Labour disarray in 1983 - Conservative disarray in 1997. Less a shift of public opinion, more a dramatic and disastrous process of contagion of crisis within a political party - and the voters judging party competence accordingly.

The situation in Scotland is different. Fifty years on from the 1947 Scottish Convention, the campaign looks set to bear fruit: the establishment of a Scottish parliament. There have been two electoral phases in this process. In the first phase, the Scottish Nationalist Party expanded its fielding of candidates and saw its support grow from 1% of the vote in 1945 to 22% of the vote in February 1974. In this phase it was Labour which lost more ground than the Conservatives (although Labour still had greater support than the Conservatives). The second phase ended with the Scottish Nationalists still at 22% in 1997, but with the Conservative share of the vote cut by 15% (from 33% in February 1974 to 18% in 1997).

Other expressions of public opinion in Scotland

Our concern in this paper has been with voting percentages in general elections and the effect of the number of candidates fielded. A more rounded account would include consideration of opinion polls (McCrone, 1996), local election results (Denver and Bochel, 1995) and non-electoral opinion processes (Harvie, 1994). The Scottish Government Yearbook, 1977-1992 and its successor, Scottish Affairs, provide a regular account of the Scottish political scene. Harvie (1994) includes an account of a vigorous Scottish Nationalist political process throughout the period 1947 to 1970 (that is, prior to the 'election breakthrough' of 1970/1974): the Scottish Convention of 1947, the Scottish Covenant of 1949, the contesting of general elections and bye-elections and the Liberal-SNP pact in the 1964 general election.

Table 2 Percentage votes and changes in percentage votes, UK 1929-97

	Con	Lab	Lib	others
1929	**38**	**37**	**24**	**1**
changes:				
1929-31	+23	-6	-17	0
1931-35	-7	+7	0	0
1935-45	-14	+10	+2	+2
1945	**40**	**48**	**9**	**3**
changes:				
1945-50	+4	-2	0	-2
1950-51	+5	+3	-7	-1
1951-55	+2	-2	0	0
1955-59	0	-3	+3	0
1959-64	-6	0	+5	+1
1964-66	-2	+4	-3	+1
1966	**42**	**48**	**9**	**1**
changes:				
1966-70	+5	-5	-1	+1
1970	**46**	**43**	**8**	**3**
changes:				
1970-74	-9	-6	+12	+3
1974 F 38	**37**	**19**	**6**	
changes:				
1974-74	-2	+2	-1	+1
1974O 36	**39**	**18**	**7**	
changes:				
1974-79	+8	-2	-5	-1
1979-83	-2	-9	+12	-1
1983-87	0	+3	-3	0
1987-92	0	+4	-4	0
1992	**42**	**34**	**18**	**6**
changes:				
1992-1997	-11	+10	-1	+2
1997	**31**	**44**	**17**	**8**

Table 3 Percentage votes and changes in percentage votes, Scotland 1929-97

	Con	Lab	Lib	SDP	SNP	others
1929	**36**	**42**	**18**		**0**	**4**
changes:						
1929-31	+14	-10	-10		+1	+4
1931-35	-8	+4	-2		0	+5
1935-45	-5	+11	-2		0	-4
1945	**37**	**48**	**5**		**1**	**9**
changes:						
1945-50	0	-1	+2		-1	0
1950-51	+3	+2	-4		0	-1
1951-55	+2	-1	-1		0	0
1955-59	-2	0	+2		0	0
1959-64	-2	+2	+4		+2	-6
1964-66	0	+1	-1		+3	-3
1966	**38**	**50**	**7**		**5**	**1**
changes:						
1966-70	0	-5	-1		+6	0
1970	**38**	**45**	**6**		**11**	**1**
changes:						
1970-74	-5	-8	+3		+11	-1
1974F	**33**	**37**	**8**		**22**	**1**
changes:						
1974-74	-8	0	0		+9	-1
1974O 25	**36**	**8**		**30**	**0**	
changes:						
1974-79	+7	+5	+1		-13	0
1979-83	-3	-7	+4	+12	-6	0
1983-87	-4	+7	-2	-3	+2	0
1987-92	+2	-3	+3	-9	+7	0
1992	**26**	**39**	**13**		**21**	**1**
changes:						
1992-1997	-8	+7	0		+1	0
1997	**18**	**46**	**13**		**22**	**1**

The Scottish Society of Economists - founded in 1897 on a central equilibrium!?

A final example of opinion dynamics in a 'political' system! In his inaugural address to the Scottish Society of Economists in 1897, Professor Nicholson displayed a keen understanding of political theory in establishing a central equilibrium between hot-blooded revolutionary opinions and more conservative opinions! It is interesting to muse on the political processes which may have preceded his adoption of this policy.

'I trust that if this Society has the good fortune to flourish for a century, our successors will never forget that it was founded in the spirit of John Locke, Adam Smith, and J. S. Mill - and, indeed, the whole array of British philosophers - the spirit, namely of perfect toleration in the expression of opinion ...

... some of us - let me say the older members - may be a little alarmed at this profession of absolute toleration. Some of us may be afraid that we shall become a very hot-bed of revolutionary opinions ...

But on the other side, the younger of you may be a little disappointed with this cold-blooded scientific programme. Every young man is impatient; he rushes at practical reforms as naturally as a baby kicks and squalls ...'
(Nicholson, 1897, p. 546-548)

Nicholson was particularly attracted to this central equilibrium policy for the Society. For he was clearly worried lest partisan groups be allowed to persuade the Society to adopt an official opinion on some matter which would then be regarded as authoritative by the public. We might interpret his remarks here as concern that contagion of opinion might lead to the formation of an extremal equilibrium (!?):

'Every society soon sees its badge worn by the stupid, the crack-brained and ignorant, proud in joining themselves to it to give themselves airs ... [public opinion] ought to receive laws from truth alone and not from any authority.'
(Nicholson, 1897, p. 545)

4 HERD BEHAVIOUR IN CULTURES

Not at all surprising is the application of the herd behaviour model in the study of cultures. For culture is inherently a collective phenomenon. Within sociology we find the study of cultures and ideologies, and whereas in economics and political science preferences are often assumed to be fixed, in sociology there is much discussion of the social formation of beliefs. In particular the dramatic collective formation of beliefs through contagion is explicitly addressed in the study of 'social panics'. Turning to mathematical sociology we find that, in contrast to models in economics and politics, there is an eschewal of rational choice models and instead a focus on communication models. Often however the models are fairly simple in form, being linear and deterministic - although the recent work of Helbing is an exception to this.

We now explore the mathematical sociology literature. To conclude this part of the book, a brief discussion follows of the dynamics of academic cultures, an analogy being drawn between the model developed here and Kuhn's theories. Finally these concepts are briefly applied to the Scottish political economy tradition!

Mathematical sociology

Two broad issues are evident in recent contributions to mathematical sociology. The first issue is how to construct a conceptual framework which is both mathematically sophisticated and sociologically insightful. Thus, in his review of Helbing (1995), Fararo (1996) praises the book for presenting 'an analytically elegant and conceptually coherent account of a class of stochastic processes and their linkage to a variety of social phenomena', but at the same time notes that it provides 'no explicit connections to structuralist interests in the patterns of social networks and their transformation over time' (p. 291). The second issue concerns the appropriate relation between models of social systems and the more established and more mathematically articulated models of economic systems. Thus Allen (1992) and Braun (1993) have developed Coleman's (1972) original account of systems of social exchange in quite different ways, but Braun finds himself in debate with Bruderl (1990) and Henning (1994) regarding the application of standard economic models and techniques.

The aim of the present paper is to illuminate both of these key issues by addressing a particular problem in political science, namely the modelling of policy formation within political parties. My approach uses the type of stochastic modelling advocated by Helbing and so it will be interesting to see the extent to which the model is sociologically insightful! Indeed the approach I shall use is a fairly direct translation of the synergetics model of speculative markets developed by Lux (1995). So we can also reflect on the second issue - the relationship between models of social (here political) systems and models of economic systems.

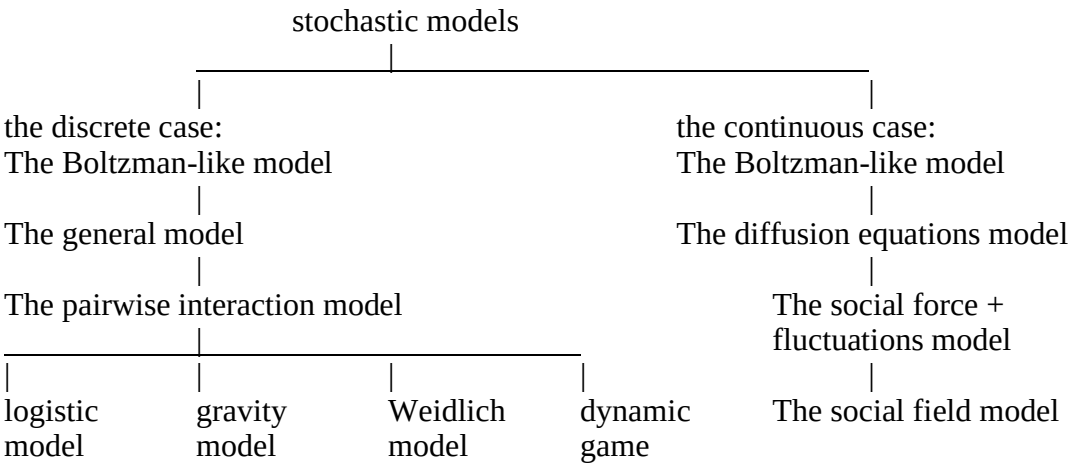
The first part of the paper briefly considers whether there is a political analogue of the efficient market hypothesis, but the main part of the paper explores the possibility of applying the contagion model of speculative markets proposed by Lux (1995). It turns out that the model I develop has close similarities with Stokman and Zeggelink's

(1996) model of policy networks. The paper ends with a review of the model in terms of the two key issues mentioned above, namely sociological insight and the relationship between social system models and economic models.

In this final section we shall discuss the links between the model in this paper and the mathematical sociology literature, particularly the links to the work of Helbing (1994) and Stokman and Zeggelink (1996). The link between Lux and Helbing is a direct one: Lux's model derives from the work of Weidlich (e.g. 1994), and Helbing identifies the behavioural model of Weidlich as a special case of Helbing's 'Boltzmann-like equations' (see Figure 3a of this paper). In the present paper it is the second part of the model, namely that which is expressed in equations (6) to (15), which relies on the synergetics approach. In particular equations (6) to (9) express the transition probabilities in terms of the speed of reaction (v) and what Helbing calls the 'readiness', namely the exponential of the criterion parameter (cf. Helbing's utility difference) - see Figure 3b. Thus the model in this paper can be regarded as following the approach advocated by Helbing and others.

Figure 3 A conceptual map of Helbing's (1994) stochastic models

(a) The different models



(b) The components of the pairwise interaction model - a rough guide

rate of change of behaviour probability vector = inflow - outflow

flow = sum of component flows

component flow = transition rate x population probability

transition rate = spontaneous rate + pairwise induced rate + 3-wise rate + ..

pairwise rate = pair interaction rate x pair readiness rate x pair probability

pair probability = imitation + avoidance

imitation (avoidance) = imitation (avoidance) frequency x source probabty.

readiness = exponential of utility difference / distance

But to what extent does the model developed here relate to the substantive concepts developed by political science scholars? To answer this we turn to Stokman and Zeggelink's (hereafter SZ) model of policy networks. Their model is discrete and involves instantaneous adjustment to policy positions - in contrast to the continuous and gradual adjustment approach of my model. Nevertheless correspondences exist between some of their equations and some of mine:

(i) In SZ, utility is expressed by a loss function, namely the deviation of current policy from the ideal policy. This corresponds to the difference terms in my equations [2] to [5].

(ii) In SZ, the policy outcome is the mean of public actors' preferred policy positions, weighted by their voting power. SZ equation [3], p. 86. This corresponds to the topic covered by my equations [2] to [5]. (SZ discuss their use of the mean as opposed to the median. On this issue, see Caplin and Nalebuff (1991) and Ma and Weiss (1995)).

(iii) Each actor's preferred policy is the mean of other actors' preferred policy, weighted by certain weights. SZ equation [5], p. 87. The weights here are the product of the others' control over a particular individual and the salience of the particular issue for the others. This corresponds to the contagion of opinion dealt with in my equations [6] to [15]. However I assume equal weight and do not distinguish between actors' control and actor's salience - so here SZ offers a conceptually richer account.

(iv) Actors' control over others is the product of their access to others and the resource they can bring to bear on that access. SZ equation [4], p. 87. This too is an area not addressed in my model.

(v) In SZ the policy space is multidimensional, whereas here it is one-dimensional.

A final distinction between SZ and my model concerns the modelling of networks, an important issue identified by Fararo in his remarks quoted at the beginning of this paper. Whereas policy networks are an explicit focus for SZ, in my model the policy network is assumed to be one where everybody communicates equally with everyone else. My neglect of political networks is paralleled by Lux's (acknowledged, p. 884) neglect of networks in the market place. The relevance of networks in this context is indicated by Shiller's (1989) report of survey evidence and Baker and Iyer's (1992) model of financial markets as networks.

Clearly then there are gaps in what my model covers. However they are not irredeemable gaps. Therefore to conclude this paper I shall draw on the literature in order to construct an agenda for areas which need to be covered in future work. The comment by Fararo indicates that for him an important requirement of a sociologically insightful model would be its explicit treatment of social networks and their dynamics. Generalising this we may say that such a model should include the basic features of a social system - and that it should also specify the dynamics of these basic features. For my purposes of reviewing relevant contributions to the literature I shall specify the basic features of social systems as power, networks, groups, opinions and 'collective constructs' such as price or policy. We may introduce a formalism which seeks to capture these essential features. A social system is in state $S(t)$ at time t. The state is characterised by a set of actors A, a set of groups G, a set of powers Π, a set of opinions O, a set of collective constructs C and a set of networks N.

$S(t) = \{ A(t), G(t), \Pi(t), O(t), C(t), N(t) \}$

The dynamics of the system is a function of the state of the system.

$dS(t)/dt = f(S(t))$

This dynamics resolves into the dynamics of the various components of the state. Given the complexities of studying the dynamics of the components all together, it is customary in the literature to find analyses of the dynamics of just one or a few of the components. Even when the focus is on the dynamics of just one component, it is usual to simplify the set of independent components (that is the components on which the dynamics depend) by considering just one or a few:

(i) Thus the dynamics of actors and groups typically focuses on the population processes of birth, death and migration. Durand and Durand (1992) propose a simple predator-prey model for the voter support for two competing political parties. Reiner, Munz and Weidlich (1988) offer a synergetics approach to migration between interacting subpopulations.

(ii) Focusing on the dynamics of power Braun (1990) and Brudel (1990) offer alternative formulations of Coleman's exchange model for the dynamics of control power. Allen (1992) studies the dynamics of a more complex power structure, involving the ceding of power to third parties. If we think of wealth as monetary power, then another relevant study here is Angle's (1992) study of the interaction between individuals with different initial endowments of wealth.

(iii) Focusing on the dynamics of opinion, Troitzsch (1987) develops a synergetics model of attitudes within a political party. Weidlich (1994) also uses a synergetics model not only of openly exhibited political opinion, but also of 'internal propensity' with respect to one's own publicly expressed opinion ('This distinction is important in situations with opinion pressure', p. 275).

(iv) Focusing on the dynamics of collective constructs, Lux (1995) discusses the dynamics of price. The determination of policy is a major focus for Stokman and Zeggelink (1996).

(v) Finally on the evolution of social networks, this is the subject matter of a recent special issue of JMS (1996).

Thus the literature contains studies of the various key aspects of a social system. As Fararo notes, it remains to be seen how the framework offered by Helbing and others can be articulated to accommodate all these aspects.

Finally, a brief note on the second issue, the relation between models of social systems and models of economic systems. The analogy developed in the present paper suggests the value of transforming economic models into socio-political models. However it is important to consider which economic models are most fruitful for transformation - and indeed which economic models are considered most fruitful in the contemporary economics literature. The debates surrounding Braun (1990, 1996), Bruderl (1990) and Henning (1996) have a tendency to follow traditional economics. However a new approach is heralded by Lux (forthcoming):

'the recent burst of interest in non-linear dynamics has led to a number of innovative approaches concerning the empirical and theoretical analysis of speculative markets ... the idea that what is going on in those markets is generated by some chaotic process ... stands in marked contrast to traditional economic theories of efficient markets which interpret financial prices as realizations of a stochastic process mirroring randomly forthcoming 'news' about the asset in question.'

In conclusion, synergetics models do already embody a number of key sociological concepts but could be developed further to incorporate greater sociological richness; and they have the potential for providing models of economic systems which are more sociologically attuned.

Opinion dynamics in cultures: the culture of academic economics

Having considered opinion dynamics in markets and in political systems, we now briefly consider opinion dynamics in cultural systems. I thought it might be interesting to consider here the culture of academic economics and the role within it of the Scottish political economy tradition! For the contemporary state of the discipline of economics is discussed using much the same language as has been used to discuss financial and political crises. Writing in 1987, Dow notes 'there has indeed been a growing awareness of the shortcomings of orthodox economics, to such an extent that it is now conventional to describe economics as being in a state of "crisis"' (Dow,1987, p. 335). Ten years later Lawson (1997) refers to 'the failings of the formalistic modelling project at the heart of all mainstream economics' and notes that despite these failings 'the project has continued largely unabated'.

In her analysis of the crisis Dow applies Kuhn's notion of paradigms. It is interesting to observe that Kuhn's theory has parallels to the discussion in the present paper. Individual adoption of a paradigm is the result of contagion of opinion, not rationality: 'it is persuasiveness which wins economic arguments, not rationality' (Dow, 1987, p. 339, 340). A new paradigm appears to offer the promise of new knowledge, leading the herd of individual scientists to invest in it. 'Normal science' is under way. A stage of distress is reached 'when the perception is generally held that enquiry within the dominant paradigm palpably fails ...' (Dow, 1987, p. 337). 'Revulsion' takes place as scientists withdraw investment from the old orthodoxy in favour of some new paradigm. The article by Lawson (1997) holds out this very prospect: 'we may find that we need to recover our status as a viable academic discipline as well ... [in view of the fact that the] possibilities for studying economic life as it occurs are increasingly being offered elsewhere'.

The Scottish tradition - leading the discipline back to its central equilibrium

Scottish political economists do not merely challenge the current 'leadership' of the economics discipline, they have a particular alternative candidate in mind! Whereas the currently dominant approach is seen as having a narrow focus on economics per se together with an over-concentration on mathematics, the Scottish political economy tradition is seen as having a more diversified portfolio of disciplines including political science, sociology, philosophy and history:

'... economics in isolation from other branches of social science tends to be emasculated ... The bent of Scottish economists is quite distinctive. They like to approach social and economic problems on a broad front, employing an empirical, matter-of-fact treatment rather than a highly abstract analysis'
(Cairncross, 1954, p. 2 , p. 5).

The Scottish tradition is currently undervalued while the narrower more mathematical approach to economics is overvalued. It is suggested that there might come a time when the narrow mathematical economics bubble might burst and academic economics might return to its fundamental value with the Scottish political economy approach being suitably valued. The contemporary extremal equilibrium in the economics discipline would then have returned to its original central equilibrium, the disciplinary and conceptual balance of political economy (Macfie, 1955).

5 HERD BEHAVIOUR IN TECHNOLOGIES

Herd behaviour is present in the diffusion of technological innovations. Moreover the literature refers to technology traps and the tendency to become 'locked in' to inferior technologies. New and future technologies are widely 'hyped'.

In this part of the book we present a case study of herd behaviour in the field of educational technology. In a study of the UK Open University, staff were invited to judge whether or not there was an analogy between the 'irrational exuberance' then being experienced in global financial markets and the enthusiasm expressed by some educators about the potential application of new technology in education.

An analogy between speculative markets and educational media markets

Introduction

Recent debates raise questions about the nature of speculative markets. Is the market rational? Or do naive traders move the markets far away from fundamental economic realities? (Burt, 1997a, 292-295). Mathematical models of herd behaviour in financial markets suggest a variety of dynamic behaviour with several equilibria being possible (Lux, 1995; Burt 1997b).

All these ideas make an appearance in a recent article 'Central banks can stave off recession' discussing the interplay of financial markets, the real economy and government policy. (The Independent, 11 September 1998). In this brief policy note I first present the arguments in Gavyn Davies' article and then translate them into arguments applying to educational media, real education and education policy.
[Note: Gavin Davies' original article is provided at the end of this paper.]

Financial markets, the real economy and government policy

In a recent article Gavyn Davies discusses the fact that the Asian meltdown, events in Russia and the threatened financial calamity in Latin America has started to leak into Western financial markets. Financial market shocks are threatening to cause a world recession.

There is an interplay between financial markets, real economies and government policy. One theory is that the real economy causes the behaviour of the financial markets and the standard procedure is to use information about the real economy to predict 'appropriate' behaviour (such as price behaviour) in the financial markets.

At the moment however the financial markets are causing the behaviour of the real economy: 'the asset market "tail" has been wagging the economic "dog"'. Large

financial movements have occurred without an obvious trigger and these financial movements have altered the economic fundamentals themselves.

'... all asset prices ... are subject to large variations when "risk premia" change. The risk premium is essentially a fudge factor, which incorporates anything which might explain a change in the degree of risk aversion by investors.'

unpredictable fluctuations in risk premia	>	wild variations in asset prices	>	economic behaviour

As a result there are several possible 'equilibria' which the real economy might be heading for. Gavyn Davies offers us a happy or an unhappy future. Up till quite recently what we have been experiencing is what US Federal Reserve Chairman had initially called 'irrational exuberance' ...

... until the exuberance went on for so long that even he was persuaded by it. The exuberance had become self-justifying. Gavyn Davies suggests that the unhappy equilibrium could also become self-justifying.

	risk premia	asset prices	real economy
equilibria:			
exuberance	fall	soaring	unsustainable growth
happy	under control	tolerably high	acceptable growth
unhappy	rise	fall	recession

The world consists of a number of connected financial markets and real economies. The network of connections is such that each part is close to some parts but farther from other parts. This affects the nature of contagion effects. The Asian melt-down had an indirect impact on Russia which in turn impacts on Latin America and eventually leaks into Western financial markets ('and this could eliminate the previous immunity of these economies to further trade shocks...').

Gavyn Davies then returns to the notion that in theory the real economy should determine behaviour in the financial markets whereas in practice financial markets sometimes have their own direction. A model developed by Neil Williams of Goldman Sachs, suggests that 'global equity risk premia are generally linked to three important variables - inflation, real bond yields and the excess of world output over its long-term trend'. Applying the model to the current situation 'equity risk premia should stay benign' [and thus avoiding the unhappy equilibrium of recession].

'But the problem is that equity risk premia are mercurial beasts, whose behaviour is not well understood. Although they are somewhat loosely linked to economic variables, they also have a life of their own, and can change by large quantities for long periods without much obvious cause. In other words, they can be driven by the vagaries and whims of financial market confidence.'

Financial confidence can collapse either due to the threat of inflation (the usual cause according to Gavyn Davies) or due to insufficient growth in demand (caused in the current situation by the financial market shocks). The collapse of financial confidence can lead to recession. This may be necessary in order to control inflation but is unnecessary if the problem is insufficient demand. The current threat is the second of these.

To avoid the unnecessary recession, 'timely intervention' is required by the central banks.

The analogy with educational media: media markets, real education and education policy

We now carry out a direct paragraph-by-paragraph translation of the preceding arguments to obtain the following. Do you think the translation corresponds to media markets at the Open University and world-wide? Does the analogy work?

According to social exchange theory all social processes are characterised by social exchange not only for money but for other things like power and status. It is in this more general sense that I refer to the social processes involving (educational) media as *media markets*. There is some debate as to the relevance of media to education (see my Statistical Note 16, 'Do Media Matter'). By the phrase *real education* I refer to the teaching and learning processes which have major educational impact. By *education policy* I mean intervention in the form of rules, allocation of resources and structure of incentives affecting both media markets and real education.

There is an interplay between media markets, real education and education policy. According to the rational theory of media design, consideration is first given to educational objectives and the basic learning processes required to reach those objectives. Then the most suitable media for achieving the objectives are selected. So educational objectives are used to 'predict' (i.e. determine) appropriate media use.

At the moment however the media markets are causing the behaviour of the real education: the media market "tail" has been wagging the real education "dog". Large media movements have occurred without an obvious trigger and these media movements have altered the educational fundamentals themselves. This has been very common in my experience. Right back in the 1970s we discovered that some students were not using the TV. It was argued that we should make the assessment depend on the material in the TV, in order to boost viewing figures. On another course I was involved in, computer conferencing was planned. Fearing that students might not use it, it was decided to make one of the TMAs dependent on conferencing. Just in the last few weeks I heard of another case of much the same thing. It is not just students who face distortions in real education. My IET colleagues have their professional judgments that a certain topic X is of educational importance. Yet they are constantly exposed to the pressure that unless they research medium M, their research will not get funded. [cf. factor N for novelty in Bates 1995 ACTIONS model: ‘Novelty should be the least important of all the criteria’. (p.11)] In addition to these distortions to educational research, there are similar distortions in the main teaching units.

The values attached to educational media are subject to large variations when fashions change. Many years ago, 1976, David Hawkridge commented on this in an

article entitled 'Next Year Jerusalem!' (Keegan, 1996, cites it without noting the significance of the title). In my Research Note reviewing the distance education literature I cited Coldeway's guest editorial in the American Journal of Distance Education (1996): 'I felt that educators should have learned their lessons with the 'hype' of television, computer-assisted instruction, interactive videodisc, and other innovations over the past thirty years'.

unpredictable	>	wild	>	real
fluctuations		variations		education
in media fashion		in media value		

As a result there are several possible 'equilibria' which real education might be heading for. At the moment we are 'enjoying' what I would refer to as 'irrational exuberance' about new technologies. Let me try to talk you down to a soft landing, a balanced use of the media (provision by teacher, use by student, research by researcher, policy by policy-maker), rationally driven by real educational objectives. If exuberance goes too far there is a danger of a sudden collapse of confidence and a total rejection of these technologies [yes, it sounds incredible to me too - but isn't that what the early Hawkridge and Coldeway imply?].

Media exuberance can be self-fulfilling. The early and mythical exuberance about the OU as the university of the air helped created the real education which the OU has provided which in turn has sustained a strong broadcast activity.

	fashion wariness	media value	real education
equilibria:			
exuberance	fall	soaring	neglected
happy	under control	tolerably high	media serves education
unhappy	rise	fall	missed media opportunity

Even if we see the UKOU as being the home of good sense about educational media we may be forced by the global media market away from our happy equilibrium, swept by global media fashions - first by global media exuberance and then by global slump in the value of particular media.

'... the problem is that media fashions are mercurial beasts, whose behaviour is not well understood. Although they are somewhat loosely linked to real education, they also have a life of their own, and can change by large quantities for long periods without much obvious cause. In other words, they can be driven by the vagaries and whims of media market confidence.'

A recession in real education is an unhappy equilibrium where real education is less than it might otherwise be. One possible reason for this is that there are missed media opportunities. Educational media inflation is a situation when too much educational media money is chasing too few real educational impact goods. A real education recession may be necessary in order to control educational media inflation, that is an unhappy equilibrium may be necessary to cure irrational exuberance. A more desirable strategy is to find some way of controlling media fashions.

To avoid an unnecessary educational media recession, 'timely intervention' is required by the policy makers. Part of intervention involves 'talking the markets down' (or up). Daniel (1997) refers to 'the valuable service of pointing out regularly the discrepancies between the day-to-day reality of the product and the claims made for it'. Talking at the International Conference on Technology Supported Learning, Daniel talks down the international media market (while celebrating the OU's happy equilibrium). He emphasises that 'in using technology ... processes, approaches, rules and ways of organising things are just as important as electronic devices'. He talks about 'a reality check', about 'the chasm' in the technology adoption process and about interaction as 'a slippery term'. He expresses 'caution' about putting teaching material on the Web, and notes that what recent developments in telematics have delivered 'is not primarily greater opportunities for people to communicate with computers', etc. In his latest Open Eye article, Daniel (1998) writes: ‘Another issue is information technology. Being of its times the University for Industry sees IT as an important part of its future. Yet surveys show that people do not want to learn from computers alone, they want human contact as well.’

To quell irrational exuberance in the financial markets the chairman of the US Federal Reserve makes repeated statements stressing 'economic fundamentals'. In like fashion I am planning a series of statistical notes over the coming year which emphasise 'educational fundamentals'.

Self-Assessment Question

Develop the educational media analogy for the model developed by Neil Williams of Goldman Sachs. Possibly along the lines of or otherwise: 'global media fashion wariness are generally linked to three important variables - educational media inflation, real bond yields (???) and the excess of world output over its long-term trend (???)'.

Answer

I'm not sure. I would be most interested in your own answer.

Finally ...

... what is your judgment on the broad analogy between speculative markets and educational media markets? You may be interested in some of the comments I have already received.

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Comments by other people
Prompted by Gordon Burt's paper, 'An analogy between speculative markets and educational media markets.'

Many thanks for your comments. They are now much more informative than my original paper! Further comments welcome.

1 The analogy is worthwhile but not exact. There is an exuberance of rhetoric in educational media, and some funding activity, but little action so the effect on real education in general (not the OU) is minimal, mainly due to the opportunity cost of what IS done on new media."

2 Marc Eisenstadt has drawn my attention to the opening paragraph of his book 'The Knowledge Web' which has just come out, particularly the second 'utterance' below, which is specifically intended to pre-empt irrational exuberance:

"In the four years we have been working together, we have become fond of confounding our colleagues with the following two apparently contradictory utterances:
· Utterance one (evangelical):
'There are three important technologies that all education researchers should come to terms with as a matter of urgency: the Web, the Web, and the Web.'
· Utterance two (pragmatic):
'Let's face it, the Web even at its most ideal is a pretty awful medium for studying and undertaking course work…"
<etc etc.... full explanations provided, including reconciliation of the two utterances>

3 "Sounds like a good idea, if I understand your drift. There is far too much irrational exuberance about the supposed potential of new media which is distracting from the core purpose of university life."

4 "I'm always suspicious of new-fangled stuff. I like to know what is really tried and tested and works."

5 "a) Gavyn Davies writes a lot and is considered a leading economist; my view, for what it is worth, is that most of what he states is untestable and on the occasion that he makes predictions that can be tested they are often wrong. He was one of the reasons I stopped reading the Independent.
b) What do economists mean by the `real economy'; nothing much to do with you and I, I suspect."

6 I happily admit to irrational exuberance about the new educational media!! (or - at least - to the role editors fulfil in assuring the integration of courses with whatever media technology makes available.....)
PS I understand Gavyn Davies is now worth a few bucks? Do you reckon experts like us could take to "speculative markets" like a duck to water?!

7 It sounds just what I need to dampen the ardour of technocrats in this particular part of the world. [A message from far away.]

8 "… a shift to instrumentality – a concern with means rather than ends … an obvious example is our own institution's current obsession with IT." Stevens (1998)

Also in Society Matters is the following comment: “[In his inaugural lecture] John Clarke reminded us that the most lasting benefit of university study is to acquire an attitude of ‘systematic scepticism” (Daniel, 1998).

9 Your approach seems parallel to the perspective I'm developing on the use of national statistics. The use of statistics to help shape public debates is declining. The debates are increasingly ideological. The facts don't matter.

10 There is another analogy. In both areas (economics and education) people do experiments which resemble genuine impartial investigations. But in contrast to a scientific experiment, the results, whatever they are, tend to be used as "support" for the opinions of the experimenter. This is the way chancellors introduced and continue with Milton Friedman's monetarism and also the way Baker and Blunkett justify their "reforms" to the schools.

11 Thought: headlines can be much more gung-ho than the full text.

12 ‘… what frequently gets overlooked is that these information and communications technologies are just means to an end …’ (Kirkwood, 1998, p. 2)

13 The new technology foundation course created ‘an electronic community’. ‘Whatever problems have been thrown up appear to be more than outweighed by the advantages.’ ‘Students are using the conferencing system to a certain extent, for example to download essential course material, only a minority are choosing to use it extensively.’ ‘Course planners have to ensure that their use of new technology does not actually pose an obstacle to students.’ Need to avoid too high-spec equipment. Cost still an area of concern … a disproportionate effect on women. (Cook, 1998, p. 4, interviewing Dick Morris).

14 Good fun and the analogy is stimulating and very well carried through. But the argumentation slipped on page 3, where you seem to take is as self-evident that requiring computer conferencing use through TMAs would not be educationally justified. I beg to differ! Keep up the good work.

15 Still haven’s finished thinking – it certainly prompted thought – so cannot comment on other questions above. Worry about the extent to which you can draw the analogy in the first place, perhaps because I’m not user exactly what you mean by ‘media market’.

16 An interesting conceit, but I would also be interested in the pragmatic educational media market – is it growing? How can we (the Open University) claim the ‘high ground’ in it – and make money?

17 I found this intellectually stimulating and well argued. [What appealed to you most in the notes?] Basically two things: (i) the comparison with economic theory; (ii) the exposure of the irrational way in which educational fashions and toys are foisted upon us. {less appealing} I thought you could have gone further in your attack upon the massive claims for IT. The sum of money spent by the university upon IT is out of all proportion to the service of educational ends. It’s the old McLuhan fallacy of the medium becoming the message. You were a bit too kind … You could I think have applied irrational exuberance to the notion that there is an ever expanding market for

university education and questioned whether the OU should not have settled for excellence rather than expansion some years ago. The thesis that there are always more potential graduates out there leads to competition with the worst of the new universities and to diluting standards (less real education).

18 Caution on use of web (or any technology) for teaching (without considering its strengths and weaknesses) seems well-founded. [What appealed most] your clarification of terminology such as ;real education'; a statement of rational use of various media for education; a warning on hype over any technology in education. Do you think educational researchers should evaluate educational effectiveness of different media …. If so, how do you avoid 'distortions to educational research?

19 The Dearing report [on UK higher education] offers a vision founded in an obsessive enthusiasm for Computer and Information Technology.

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6 HERD BEHAVIOUR IN HISTORY

Does herd behaviour occur in history? In what sense can the models I have discussed be considered as representations of historical events? One possibility is that the models behave in a qualitative way that is similar to the qualitative behaviour of historical events. A rather stricter condition is that parameters of the model have the same properties as the parameters of historical data. A stricter condition still is that the model fits the historical data directly. Some extremely important general observations on the problematic nature of identifying models are made by Renshaw (1991, pp. 1-14) who argues for a balanced programme of research which includes the complexity of empirical data, deterministic models, stochastic models and simulation models.

Herd behaviour in economic history

Lux uses the history of financial markets in a number of ways. Firstly he uses Kindleberger's qualitative account of history to substantiate such features of the model as the contagion of opinion. In addition to this he shows that the features of the model correspond to statistical properties of historical time series of financial data. In his most recent joint work, Lux and Marchesi (1998, pp. 2-3) comment:

'Both foreign exchange markets and national stock markets share a number of stylised facts for which a satisfactory explanation is still lacking in standard theories of financial markets ... positive results are mostly striking uni-variate statistical features of the data ...
Fact 1: unit root property of spot exchange rates (or their logs)
Fact 2: fat tail phenomenon
Fact 3: volatility clusters: periods of quiescence and turbulence tend to cluster together'

Herd behaviour in political history: the worst Conservative defeat since the Duke of Wellington in 1832

This approach to financial time series leads us to consider similar analyses of political time series. A major problem in attempting similar analyses is the lack of such extensive time series data – the exception being public opinion data sets. For example the time series for democratic elections is necessarily a short one. Chapter 3 has already provided some historical data but this has been discussed only in a qualitative way. The aim of the present section is to analyse electoral time series in a quantitative way, taking as case study UK elections since 1832.

Before looking at the data it is worth noting fundamental problems with making historical comparisons over this period of time. The time series literature refers to ‘regime changes’. Hill [, B. (1996) The early parties and politics in Britain, 1688-1832. Basingstoke: Macmillan.] identifies numerous changes in the period 1688-1832. Putting this together with what we know of subsequent changes the following major regime changes took place.

(i) Whig and Tory replaced by Liberal and Conservative well into 19th C.
(ii) Labour proper started 1900
(iii) large numbers of MPS existed without any party ties at all
(iv) outside parliament, nationwide party organizations were not fully present.

(v) new parliamentarians' party allegiances had to be defined by their activities after entering Parliament rather than in advance
(vi) multi-member constituencies
(vii) paid posts with only nominal duties - ministerial patronage … p. 5 ‘possession of the necessary qualification for a vote was an asset in both social and monetary terms'
(viii) no modern Civil Service
(ix) function of PM and Cabinet emerged gradually
(x) appointments (and dismissal) at initiation of monarch
(xi) ministries did not often change in their entirety at election times
(xii) union of legislatures
1707 Scotland joined to England and Wales
1801 Ireland joined to EWS
192x Eire created leaving only N. Ireland
(xiii) constitution, e.g. re monarchy, Lords and Commons
'In 1688, Prince William of Orange, preparing to overthrow James II, published the Declaration just before setting out from Holland stated explicitly that 'this our expedition is intended for no other design, but it have a free and lawful parliament assembled as soon as possible'
(xiv) electorate

The first table shows the highs and lows for the Conservative Party in selected general elections over the period 1832-1997.

Table 1 Highs and lows for the Conservative Party, 1832-1997

	% vote	number of MPs
1832	29	175
1841	51	367
1857	33	264
1886	51	393
1906	43	156
1924	47	412
1931	61	522
1945	40	210
1955	50	345
1974O 36	277	
1983	42	397
1997	31	165

The following two tables show the correlations between the political parties as indicated by the percentage of MPs in the House of Commons. The period is split in two. In the period 1832-1910 there is a strong negative correlation, -0.8, between the two major parties, Conservative and Liberal. There is also a sizeable negative correlation between Liberal and Irish Nationalist parties in the same period. In the second period, Labour replaces Liberal as the main opponent of the Conservatives, with again a negative correlation of -0.8 between the two main parties. Labour and

Liberal strengths also correlate negatively at -0.6. These figures suggest that the Conservaties are the dominant party confronted by a major opposition party and a minor opposition party which compete with one another.

Table 2 Correlations between percentage of MPs of different parties, 1832-1910

	Cons	Liberal	Irish nationalist
Conservative	1	-.81*	.02
Liberal		1	-.59*
Irish nationalist			1

Notes:
(i) * denotes significance at .05 level.
(ii) n=

Table 3 Correlations between percentage of MPs of different parties, 1922-1992,

	Cons	Labour	Liberal
Conservative	1	-.83*	-.09
Labour		1	-.47*
Liberal			1

Notes:
(i) * denotes significance at .05 level.
(ii) n=19

The above tables relate to the percentage of MPs. How does the percentage of MPs relate to other factors? The equations in the Display below provide the answer. Again the period is split into the same two sub-periods. We start by considering the Conservative lead in MPs over the Liberals in the period 1832-1910. Firstly, by definition the lead in MPs is composed of a lead in elected MPs and a lead in unopposed MPs. In fact these two components correlate 0.8. (Thus the eve-of-poll pundits of the nineteenth century could fairly confidently predict the result simply by considering the lead in unopposed MPs!). The lead in elected MPs itself depends on the lead in the number of candidates fielded. The lead in unopposed MPs also depended on the lead in candidates fielded and also negatively on the number of Labour candidates fielded. Indeed the final result, the lead in MPs could be reasonably well predicted simply from the lead in candidates fielded - offering pundits an alternative way of predicting the result!

In more recent times, 1922-1992, the rise of the modern political party has meant that there are few unopposed MPs and few uncontested seats. The lead in MPs is very strongly determined by the lead in the percentage vote.

Display 1 How the Conservative lead in MPs depends on other factors

Conservative lead over Liberals in percentage of MPs, 1832-1910

lead in MPs= lead in elected MPs + lead in unopposed MPs

NB the two components are correlated 0.8

lead in elected MPs = -.06 + .54 lead in candidates
p.0008 rsq.48

lead in unopposed MPs = .06 + .41 lead in candidates -.76 Labour candidates
p.0001 rsq.74

lead in MPs = .02 + 1.03 lead in candidates -2.24 Labour candidates
p.0001, rsq.73

lead in % votes = -9.32 + .697 lead in candidates
p.0001, rsq.83

Conservative lead over Labour in percentage of MPs, 1918-1992

lead in elected MPs = -.0115 + 2.44 lead in % votes
p.0001 rsq.94

The next table below shows that it is indeed a rare event for the Conservatives to have less than 200 MPs. However it is not all that rare, having occurred in three out of forty-one general elections, that is one in fourteen or 7%.

Table 4 The number of MPs: distribution over forty-one elections

	The number of MPs							
	150-199	200-249	250-299	300-349	350-399	400-449	450-499	500-549
no. of elections	3	3	13	10	7	4	0	1

A key question which has been debated since the 1997 defeat is how likely is it that the Conservatives can bounce back? One way of putting this question is to ask: is there a correlation between one election and the next? This involves looking at the autocorrelations lagged by different numbers of time points (corresponding to elections).

The analysis identifies that the time series for Conservative candidates is a non-stationary process but is random white noise when differenced. This means that there is a trend over time for the number of Conservative candidates to increase but there is random variation about this trend. This reflects the development of the party machines in the nineteenth century and first half of the present century. The Conservative vote has a moving average model. The number of Conservative MPs moves over time in a purely random fashion. On a historical basis, it is quite likely that the Conservatives will bounce back

Table 5 Autocorrelations for Conservative candidates, % vote and MPs

Lag (elections)		0	1	2	3	4	5	6	7 8
autocorrelations									
Cons. candidates	1	.80	.67	.56	.47	.37	.31	.22	.12
Cons. % vote	1	.28	.04	-.01	-.10	-.02	.02	-.09	-.09
Cons. MPs	1	.06	-.06	-.02	-.21	.23	.03	-.07	-.08

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