

# Herding, social influence and economic decision-making: socio-psychological and neuroscientific analyses

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Typically, modern economics has steered away from the analysis of sociological and psychological factors and has focused on narrow behavioural assumptions in which expectations are formed on the basis of mathematical algorithms. Blending together ideas from the social and behavioural sciences, this paper argues that the behavioural approach adopted in most economic analysis, in its neglect of sociological and psychological forces and its simplistically dichotomous categorization of behaviour as either rational or not rational, is too narrow and stark. Behaviour may reflect an interaction of cognitive and emotional factors and this can be captured more effectively using an approach that focuses on the interplay of different decision-making systems. In understanding the mechanisms affecting economic and financial decision-making, an interdisciplinary approach is needed which incorporates ideas from a range of disciplines including sociology, economic psychology, evolutionary biology and neuroeconomics.

Keywords: herding; behavioural economics; Bayesian learning; neuroeconomics

#### 1. INTRODUCTION

Until the advent of rational expectations theory—which asserts that independent, atomistic and self-interested agents are rational in the sense that they do not make systematic mistakes and use all available information efficiently-ideas about psychology, emotion and social influence formed the basis of many influential economic analyses. Keynes, for example, explained financial instability, particularly in stock markets, as the outcome of the sociological and psychological forces that dominate in uncertain times. Keynes's psychological forces include not only the propensity to consume from income and the desire to hold money but also the waves of optimism and pessimism that affect stock markets, and the animal spirits that propel entrepreneurship (Keynes 1936, 1937). Keynes also identified sociological forces affecting investors, for example the socially propelled conventions that, in times of uncertainty, encourage speculators to believe what others believe and to do what others do (Keynes 1930, 1936, 1937). Following this approach, other economists, including Minsky (1975) and Kindleberger & Aliber (2005), have analysed the socio-psychological impacts of emotional contagion identifying the speculative euphoria which spreads through groups of investors during manic phases as a crucial catalyst in economic and financial booms; in turn, excessive pessimism and extreme risk aversion precipitate bust phases.

In general, however, the impact of sociopsychological forces has been neglected by modern economists. There have been attempts to extend the economic conceptions of rationality—for example, Simon (1955) replaced the global rationality of economic man with a model of bounded rationality. Some economists have incorporated social and emotional factors into a game-theoretic analysis via an extension of utility functions to include elements such as inequity aversion, social capital and social esteem; see Fehr & Schmidt (1999), Becker & Murphy (2003) and Bernheim (1994). In these models, phenomena such as altruistic punishment reflect emotional responses to social events (Fehr & Schmidt 1999; Bolton & Ockenfels 2000; Fehr & Gächter 2000). But social and emotional factors are still captured within a conventional maximizing approach and these attempts to incorporate psychology are a limited extension of the standard maximizing framework.

In the analyses of herding and social influence specifically, economists have also neglected sociological and psychological factors. They have focused on explaining herding as the outcome of calculations based on mathematical algorithms, for example, Bayesian updating using Bayes's rule. This neglect of socio-psychological factors has led to a simplistically dichotomous conception of herding as either rational or not rational reflecting the fact that economics incorporates a binary, dichotomous criterion for rationality determined according to whether behaviour does or does not satisfy economists' rationality axioms. The omission of sociology and psychology has also distracted economists from the possibility that herding reflects interactions between different cognitive and emotional decision-making systems. In understanding how and why these systems might operate, an interdisciplinary approach is needed to incorporate ideas from a range of disciplines including sociology, behavioural economics, evolutionary biology and neuroscience.

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## 2. ECONOMIC MODELS OF HERDING INCORPORATE NARROW BEHAVIOURAL ASSUMPTIONS

Herding can be defined as the phenomenon of individuals deciding to follow others and imitating group behaviours rather than deciding independently and atomistically on the basis of their own, private information. Herding theory has its roots in Keynes, who focused on the motivations to imitate and follow the crowd in a world of uncertainty (Keynes 1930). Keynes conceived herding as a response to uncertainty and individuals' perceptions of their own ignorance: people may follow the crowd because they think that the rest of the crowd is better informed. This can generate instability and in financial markets herding is a key factor generating speculative episodes. Since Keynes, socio-psychological influences have been neglected in economists' explanations of herding. Herding cannot be easily explained as the outcome of rational expectations theory so economists have tended to retain rationality assumptions but in a weakened form.

This is possible because herding phenomena are consistent with a range of different statistical hypotheses-for example, Kirman (1993), using a Markov chain approach, presented his 'ants' model in which ants 'convert' by copying another ant; for example, ants faced with two symmetric food sources will tend to concentrate on one or the other source (rather than distributing themselves evenly across both). This behaviour pattern may be interpreted as recruitment activity by ants—when there are positive externalities from foraging behaviour the joint exploitation of one source will give more benefit to the group than an even distribution of effort over two different sources (Kirman 1993). Similar models of herding can be founded on Bayesian hypotheses: others' actions constitute information which is used when adjusting probabilities and expectations. In updating their probabilities, individuals will use Bayes's rule, systematically revising their probabilistic judgements using information about others' actions, and this generates herding and 'information cascades' (Scharfstein & Stein 1990; Banerjee 1992; Bikhchandani et al. 1992; Avery & Zemsky 1998; Chamley 2004). In these Bayesian updating models, agents use sophisticated logic in the context of sequential decision-making but, in contrast to rational expectations models, the outcome can be good or bad depending on whether the decision-makers are sent down a correct or incorrect track by the actions of their predecessors. Empirically, herding as a Bayesian learning process is consistent with the evidence from a large number of economic experiments (e.g. Anderson & Holt 1996, 1997 and many others), but this evidence does not establish that a Bayesian explanation is superior to other explanations including those drawing upon ideas from other social sciences. Nonetheless, even in the Bayesian models, the basic premise is that economic decisions are in essence the outcome of a cognitive process employing a mathematical algorithm to process information and form expectations. In addition, the focus tends to be on a dichotomous division of behaviour into rational or irrational; a person is assumed to be rational if their

behaviour is consistent with Bayesian updating. Sociological influences are confined to learning from others' actions and psychological and emotional factors are accorded very little role at all.

Learning themes emerge in the macro-economic literature too. Topol (1991) analysed herding as the outcome of rational trades in which traders weight information about the prices paid by other traders against their own private judgements of fundamental value. Acemoglu (1992) analysed rational learning about others' decisions via signal extraction from aggregate data. Ideas about imitative learning are also developed in the analyses from Austrian economics which explore Hayek's insights about the knowledge as a path-dependent process (Hayek 1952; Rizzello 2004). Paralleling the sequential herding theories of Bayesian theorists, social learning in Austrian economics differs from ordinary problem solving in that serial processing of information is important, generating path dependency and propelling the acquisition of knowledge along a path determined by past beliefs.

Many economic models have concentrated on herding as the outcome of learning but other models have been developed to include other motivations for imitating others, following Keynes categorization of the three main motivators of herding behaviour: learning, reputation and/or 'beauty contests'. Keynes observed that it is better to be conventionally wrong than unconventionally right and this is because following others may help individuals to maintain good reputations; it makes sense to follow the crowd because there is safety in numbers. Scharfstein & Stein (1990) incorporated this insight about social influence into their analysis of herding in fund managers' decisions. Fund managers have to convince people that they are investing wisely and, as short-term performance is not a good indicator of skill, they rely for their reputations on comparisons with peers. This will provide incentives to follow others and disregard private information.

Payoff externalities are also important: buying into a market can help that market to rise and expectations about the beliefs of others can also generate herding behaviour. These effects are captured in models of beauty contests and iterative thinking. The beauty contest is Keynes's metaphor for the iterated reasoning that characterizes financial speculation: competitors in a newspaper contest are asked to choose from a series of photos not who they think is the most beautiful but who they think others think is most beautiful. Keynes argues that a similar process describes financial speculation—people will purchase a tulip bulb, house or a dotcom share at a seemingly exorbitant price not because they independently believe that the object is worth the cost but because they believe that other people think that it is. In this way, herding can propagate instability. These ideas about beauty contests and iterative thinking as a basis for imitative behaviour are developed in Camerer & Weigelt (1991), Ho et al. (1998), Bhatt & Camerer (2005) and Camerer (1997, 2003). Irrational imitative behaviour may also be explained by the expectations of others' irrationality (Porter & Smith 1995). Again, these ideas draw upon insights from Keynes: the long-term value of an asset is

unimportant if you intend to sell the asset quickly (Keynes 1936, p. 156). This insight is important because it suggests that if time horizons are short and discount rates are high for speculators in highly liquid financial markets, then the speculative bubbles that emerge from herding behaviour will reflect short termism, in which case the social costs of liquid financial markets may be disproportionately high.

In assessing these models, different economic conceptions of behaviour can be categorized according to Simon's (1979) distinctions of 'substantive rationality' and 'procedural rationality' (Baddeley 2006). If herding is the outcome of a rational algorithmic process, e.g. as used in the Bayesian updating theories described above, then this fits with Simon's concept of substantive rationality. On the other hand Keynes's analyses of financial markets are more consistent with a view of procedural rationality, i.e. behaviour which is sensible and reasonable reflecting the judicious balancing of the pieces of information in a process of 'appropriate deliberation' (e.g. using intuition, heuristics and rules of thumb). Either way, however, the focus is on a cognitive process and on a black and white partitioning of behaviour according to whether it is or is not rational. Psychology, emotions and sociological factors play only a limited role. A richer, more interdisciplinary analysis of herding would escape economists' usual preoccupation with a stark dichotomy between the rational and the irrational; it would also capture the complexities of herding if it is the outcome of interactions between different decision-making systems.

### 3. PSYCHOLOGY BROADENS BEHAVIOURAL ASSUMPTIONS AND CAPTURES PERSONALITY. **EMOTION AND MOOD**

In the context of herding analysis, psychological analyses can explain the impacts of personality traits, moods and emotions on herding behaviour. From the perspective of cognitive psychology, the Bayesian theories outlined above focus on the cognitive processes of social learning as a way to acquire information and knowledge but the underlying dependence on an assumption of rationality limits these analyses. This is addressed in part in the large literature on cognitive bias: cognitive biases may lead to herding because, for many reasons including cognitive constraints, environmental cues and/or framing effects, individuals may be following the ill-judged decisions of a group (Tversky & Kahneman 1974; Baddeley et al. 2005).

Cognitive factors are moderated by personality and psychological traits (Borghans et al. 2008). There is evidence suggesting that individuals of lower cognitive ability are more risk averse and if herding is a response to risk then cognitive factors may play a role (see Dohmen et al. 2007), though identifying the causal factor in this is difficult. Baddeley et al. (2007) also found that quick thinking is associated with contrarian behaviour, i.e. disagreeing rather than agreeing with the herd. Psychological factors such as personality traits may also predispose people to susceptibility to particular moods, and experimental evidence shows that there is a link between psychological traits

associated with sociability (e.g. conformity, extraversion and risk aversion) and the propensity to herd (Baddeley et al. 2007). Counterfactual evidence shows that overconfidence is associated with a propensity to lead herds rather than follow them (Bernardo & Welch 2001).

Lo et al. (2005) separated the impact of mood and personality on financial decision-making, finding that extreme moods impair trading performance but that good trading performance is not significantly associated with particular personality traits. They conclude that any individual can be a good trader if they have the appropriate training and experience. How can this be explained in psychological terms? Mood is to an extent affected by exogenous factors rather than individual differences—for example, there is some evidence that financial trading patterns are affected by weather-induced changes in mood (Hirshleifer & Shumway 2003; Kamstra et al. 2003). These factors may affect everyone and so common behaviour patterns, interpreted as herding, may in fact just be a common response to an environmental situation determined by exogenous variables rather than endogenous

In general, cognitive accounts tend to neglect the role of affect and emotion and a broader psychological approach does have the potential to fill in some of the gaps by introducing an analysis of affect and emotion. Bringing emotions, affect and visceral factors into economic analysis is complicated and it is important to explain what they are in order properly to analyse the specific role that they play in economic and financial decision-making. Affect is the experience of *feeling* an emotion; emotions are biological, innate and instinctive responses to stimuli and involve the recall and cognitive processing of affect. Elster (1996, 1998) also distinguished emotions and visceral factors with the former being triggered by beliefs, the latter reflecting the basic drives. Elster (1996, 1998) explained that while there is no one distinguishing feature of emotions most emotions do have the following features: they are formed on the basis of cognitive antecedents and beliefs, they involve intentional objects and are associated with physiological arousal and expression, they have valence, i.e. may have positive or negative strength.

In analysing the emotions psychologists have tended to focus on 'action tendencies', i.e. tendencies to act, and on identifying the cause of emotions rather than the impact of emotions on behaviour (Elster 1998). Generally, positive emotions are passively undergone and not chosen though negative emotions can be blocked or the situations which cause them can be avoided. This reflects a distinction between 'occurrent emotions' (i.e. emotions which occur in a particular situation) and 'emotional dispositions': for example, a predisposition to be irascible makes the occurent emotion of anger more probable but the occurent emotion can be avoided if situations precipitating anger are avoided. Some of these features are difficult to establish empirically but physiological responses can be measured during economic experiments, for example Smith & Dickhaut (2005) used heart rate data to infer emotional states in auction experiments.

Visceral factors can propel individuals towards acting in contrary to their own self-interest but Elster (1996) emphasized that emotions and visceral factors are neither rational nor irrational because they cannot be chosen: emotions do not necessarily interfere with rationality. Emotions may be important 'tie-breakers' e.g. when the outcomes are indeterminate in rational choice models. Emotions are crucial when reason is an insufficient guide to decisionmaking (de Sousa 1987) so emotion 'serves as a functional equivalent for the rational faculties it suspends' (Elster 1998, p. 60). While visceral factors and emotion can be very effective because they operate with minimal cognitive intervention, people may nonetheless underestimate their influence (Le Doux 1996; Loewenstein 1996, 2000).

Emotion, affect and decision-making are intertwined in the economic and financial world but until recently, economic analysis has neglected the role of emotions in economic decision-making (Elster 1996, 1998). Rational choice theories in economics tend to assume homogeneous, self-interested individuals employing universally rational methods of decisionmaking. Introducing emotion allows us to escape this dichotomous approach. Risk, for example, can be characterized as a feeling and feedback effects can intensify fear responses to evaluations of risk, precipitating panics. Emotional factors such as nervousness or euphoria can induce shifts in aggregate demand in a way that cannot be explained just using economic analysis (Katona 1951). Greed, hope and fear are likely to be the emotions most relevant to financial decision-making, in portfolio selection (Shefrin 2002). Other emotions will affect economic decisions more broadly, for example the irrational exuberance seen in bullish markets reflects an interaction of hope and greed. When individual panics precipitate 'social panics' this may reflect the interplay between risk, anxiety and fear (Loewenstein et al. 2007).

The influence of visceral factors varies in intensity, exerting overwhelming influences when in a 'hot state' but with cognitive factors exerting more influence during 'cold' states. So, while these visceral factors are essential to human survival and basic daily functioning, they often conflict with higher level cognitive processes; for example, misjudgements can occur when individuals underestimate the impact of visceral factors when in a cold state (Loewenstein 2000). This may be the reason why visceral factors have often been neglected in economics because economics tends to focus on the rational motivators of behaviour. More recently, there has been an increasing focus on visceral factors in economic theory, for example in models of addiction and in the analyses of emotional factors such as fear in situations of risk and uncertainty (e.g. Laibson 1999; Loewenstein 2000; Bernheim & Rangel 2004). Visceral factors and emotions will also affect the trade-offs people make in pursuing different goals. Economics has traditionally been grounded in the assumptions of stable preferences but visceral factors will compromise the stability of preferences; these will be affected in the short term by internal bodily states and external events, both of which can change rapidly. The only

way to capture the impact of visceral versus cognitive influences is to develop a model in which decisions reflect interactions between different decision-making systems.

Emotions will play a role in the formation of cognitive biases: in describing the impact of fear and greed in financial decision-making. Shefrin (2002) argued that frame dependence, i.e. when decisions are affected by the context in which they are taken, reflects an interaction of cognitive and emotional factors. Emotion and cognition also interact in responses to ambiguity aversion, described by Shefrin as fear of the unknown. Emotion will affect the use of the 'availability heuristic'. This heuristic involves using information that is most readily accessible, i.e. most easily remembered: emotions affect memories and so will determine what is remembered and what is forgotten.

Some of these emotional factors are starting to gain prominence in the recent economic analyses. Akerlof & Shiller (2009), for example, developed Keynes's insights about 'animal spirits'. Originally, Keynes analysed animal spirits just in the context of entrepreneurship, arguing that uncertainty about the future prevents entrepreneurs from properly calculating the future benefits of their business decisions. In the absence of a basis for rational calculation, entrepreneurs' decisions will be propelled by animal spirits, i.e. 'a spontaneous urge to action' (Keynes 1936, 1937). Akerlof and Shiller extend Keynes's animal spirits to cover a range of socio-psychological, noneconomic motivations affecting macro-economic phenomena, including herding and speculation. They define five animal spirits: confidence, fairness, corruption, money illusion and storytelling (the latter referring to narratives that shape our sense of who we and others are). In the context of herding behaviour, confidence and storytelling will be the most crucial of Akerlof and Shiller's animal spirits: following Keynes (1936), if the state of confidence is strong and people are optimistic, then the macro-economy will be vulnerable to waves of euphoria, optimism and overconfidence, precipitating herding and speculative bubbles; but when the state of confidence is weak and people are pessimistic, then the macro-economy will be prone to slumps and financial crises. These forces will spread via storytelling, word of mouth and false intuitions (e.g. intuitions that prices cannot fall) feeding herding and contagion, all perturbed by anything from dramatic news stories to sporting events. Asset prices will be susceptible to feedback loops instability will be further magnified by leverage with knock-on effects for the real economy as herding and speculative bubbles exacerbate instability and affect wealth, investment and the availability of finance. In this way, Akerlof and Shiller's animal spirits can explain market trends.

## 4. SOCIOLOGICAL FORCES CREATE INTERDEPENDENCE AND ENCOURAGE HERDING

Sociological forces interact with psychological forces and will affect individual behaviour if groups act in

concert without any clear coordinating mechanism explained by Jung as the outcome of a collective unconscious and by le Bon (1896) as a mob psychology. The impact of sociological forces specifically on individual economic decision-making was addressed in Katona's early work on economic psychology (Katona 1951, 1975). Katona (1975, p. 47) used ideas from cognitive psychology to analyse how individuals learn from groups; he distinguished between the different forms of learning—for example, between the mechanical forms of learning such as the 'stamping-in' of simple rules of thumb and heuristics versus the learning that occurs via problem solving and understanding. In these terms, herding is likely to be more of a stamping-in/heuristical type; it is not about understanding deeper processes and direct experience of problems but instead is about relying on simple observation of others to acquire information. On the interactions between individuals and groups in a social learning context, group forces and group motives are important, reflecting not only imitation and conscious identification with group but also group-centred goals and behaviour. Imitation and suggestion reinforce group situations and group coherence but are not the necessary conditions for being part of a group (Katona 1975, pp. 50-51). Reference groups give standards for behaviour, and group-centred belonging and motivation are more likely to be important in small groups (Katona 1975, p. 51).

Katona (1975) argued that social learning is simpler and more selective than individual learning. With social learning, people prefer short cuts and follow simplifying rules of thumb and routines. Imitation qualifies as a 'fast and frugal heuristic' in social situations (Gigerenzer & Goldstein 1996). Akerlof & Kranton (2000) argued that sociological factors mould people's identities and this can have an impact on preferences. This has implications for herding because when a person identifies strongly with a group, then their perceptions of social pressure from that group can lead them to lose faith in their own judgements and copy the actions of others in their group. It might be rational to submit to group pressure, to empathize and to obey rules of etiquette in a world where social context is important and when social factors enhancing status and reputation are important.

Given the strong urges to overcome cognitive dissonance, i.e. to establish non-contradictory belief systems (Festinger 1957, pp. 200-201), group influence is also important in reconciling dissonance; we can persuade ourselves to buy a tulip bulb at an excessively high price if we see others doing the same. In this way, individual differences of opinion are ignored and similarities in small parts of information are transmitted to large numbers of people. Socio-cultural norms, attitudes, habits, membership of groups will influence decisions. Discussion of beliefs with friends and associates will mean that information selected is determined by the groups to which the listener belongs. Social learning will continue until the majority has a uniform belief system (Katona 1975).

Herding and social influence may also reflect the impact of 'social emotions': social norms will act as external sanctions inducing negative emotional states

when individuals do not conform (Elster 1998). For imitative behaviour in a wider socio-economic context, social norms will regulate and sustain certain emotions, e.g. in encouraging conformity to particular social and economic norms. Emotional factors may precipitate herding in financial markets when acting with a group moderates a fear response but has the unintended consequence of generating speculative bubbles. Prechter & Parker (2007) argued that sociological factors will have an impact on the macro-economy and presented a 'socionomic' analysis which focuses on the importance of social context to decision-making. Responses in uncertain social situations will differ from responses in isolated situations and/or when outcomes are more certain. Specifically, uncertainty in financial markets generates unconscious, non-rational herding as an instinctive response to endogenous fluctuations. Markets will fluctuate erratically, reflecting social mood, and this generates financial instability.

Shiller (1995) also brought ideas in from sociology to explain the impact of social influence on herding in the economic sphere by developing insights from the sociologist Solomon Asch. Asch's (1956) experiments demonstrated that experimental subjects have a tendency, even with very unambiguous tasks, to make the wrong choice when they see a group making a wrong choice. This finding has been replicated in a large number of sociological studies (Bond & Smith 1996). Shiller argues that this evidence about the impact of social influence is not necessarily inconsistent with the Bayesian hypotheses outlined above—it is just rational social learning taken to its extremes: he argues that the experimental subjects were making rational judgements about the probabilities of different scenarios concluding that a large group were all very unlikely to be wrong about a simple decision. This led to a tendency to discount personal perceptions in favour of the information communicated by group (Shiller 1995, p. 182).

### 5. EVOLUTIONARY BIOLOGY CAN EXPLAIN THE **EVOLUTION OF HERDING INSTINCTS**

Evidence of herding in other animals, especially our close relatives, suggests that herding may have (had) an evolutionary value in a social context; it is not just about individuals maximizing their own outcomes. For example, animals will monitor the actions of other individuals as this gives social information about resource availability and mating potential (Danchin et al. 2004). Imitation has been selected for amongst monkeys as a successful strategy enabling the rapid transmission of good ideas throughout a species (Surowiecki 2004). Emotional contagion is observed in children, for example, when they cry. Emotional contagion is imitative and is, initially, a state of vicarious distress which precedes mind-reading abilities but may contribute to the development of empathetic capacities (Prinz 2005).

Herding may have evolutionary advantages for humans not just because of informational influences as highlighted in the theories above. Baddeley et al. (2007) presented evidence that more conformist individuals are more susceptible to intragroup social pressure, suggesting a normative influence. Normative influences, such as receptivity to social influence, may be particularly important in understanding herding. Simon (1990) argued that, among social animals, the evolutionary fitness of altruists may exceed that of the selfish: 'docility' i.e. receptivity to social influence, is an evolved instinct that has survived and permeated the human population to serve important evolutionary purposes. Docile people have the intelligence and motivation to learn quickly from social information and do not screen social information for its contribution to personal fitness. Docility allows people to believe large numbers of propositions without any direct proof. Docile individuals are also more adept at social learning, making them more able to acquire knowledge, skills and 'proper behaviors' i.e. the values, goals and attitudes that are useful in overcoming environmental obstacles, thus contributing to the evolutionary fitness of human populations. So, according to Simon, a genetic predisposition to imitate others has evolved which serves a social purpose in encouraging socially constructive empathy and altruism, helpful in overcoming dissent and conflict, though Simon's analysis is problematic because it does not allow that such conformism might also precipitate tyranny and oppression, illustrating the fact that the trait of docility may not necessarily suit a complex modern world.

Evolutionary theories have the potential to explain how instincts such as herding have evolved in a social context, if not in an individual context. The way that humans make choices in risky situations (e.g. the overweighting of low probabilities, the dependence of probability judgements on context) are seen in animals too-for example in monkeys and honey beessuggesting that human neural circuitry is 'old', and adapted to basic survival instincts (Camerer et al. 2004). On the other hand, in evolutionary terms, instinctive tendencies may be appropriate only in primitive settings: sociability and aversion to aggression may have evolved to allow the development of the stable social structures essential to the competitive success of small communities. But these instincts will be counterproductive if the survival purpose of evolved instincts has been perverted by situational factors in modern 'artificial' contexts. For example, an instinct to follow others may have been important to survival in a primitive setting but this does not mean that it is an effective strategy in the heavily interconnected globalized, computerized world in which assets, information and expectations can move very quickly. If large-scale herding, e.g. in financial markets, reflects the overriding influence of normative influence and/or emotional factors, then maybe herding is an inappropriate proximate mechanism and is not well suited to the modern context because it can generate instability on a very large scale. This raises the question of whether the basic instincts manifested in proximate mechanisms such as herding are suitable to a modern, technological age.

An evolutionary approach is not inconsistent with ideas about Bayesian reasoning, if Bayesian reasoning is a skill that has evolved to serve social purposes.

For example, with heterogeneity in personality types, rule-based decision-making (such as Bayesian updating) helps ensure consensus among divergent personalities, fostering effective societal decisionmaking processes despite natural heterogeneity. However, human instincts are hard-wired processes that have not evolved recently enough to be specifically associated with modern behaviours (unlike the neurological origins of the abilities to read and write); there is no reason that an ingrained instinct to herd should be useful in modern financial markets. Cohen (2005) argued that the human brain is a confederation of mechanisms that usually cooperate but sometimes compete. Proximate mechanisms such as herding, when motivated by emotional responses that appear irrational and motivated by emotions, in fact are engaging evolutionarily old but highly conserved brain mechanisms which may be locally optimal but are not necessarily universally optimal. Also, instincts that have evolved to increase the chances of survival may be just that-instinctual and therefore not manifested as a deliberative Bayesian-style thought process.

### 6. INTERACTING BRAIN SYSTEMS EXPLAIN HERDING IN NEUROECONOMIC ANALYSES

Neuroscientific evidence can help us to understanding the roles played by socio-psychological factors in economic decision-making and—developing ideas from psychology, evolutionary biology and neuroscienceneuroeconomists argue that understanding brain organisation and function can help us to understand economic and financial behaviour. Damasio (1994) pioneered the neuroscientific analysis of the role of emotion in economic and financial decision-making, arguing that the impact of emotional factors does not necessarily preclude rational thought; mood and emotion do not necessarily work against reason, instead they may work in concert with it. Lesion patient studies established that brain lesions associated with damage to emotional processing led to constraints on rational behaviour. On the basis of this sort of evidence, Damasio developed his 'somatic marker hypothesis' arguing that emotions provide important physiological cues that can help decision-making. The role of affect in financial decision-making is confirmed in a functional magnetic resonance imaging (fMRI) study showing that risk-seeking and risk-aversion mistakes in financial decision-making are associated with the activation of neural circuits associated with affect and emotion (Kuhnen & Knutson 2005). The role of emotions in economic decision-making has been confirmed by other neuroscientific evidence which shows that emotional circuits in the brain operate in response to ambiguity and during learning/information processing (Glimcher & Rustichini 2004; Houser et al. 2005; Shiv et al. 2005; Naqvi et al. 2006).

These insights inspired the growth of a literature which applied neuroscientific insights about the 'dual processing' of reason and emotion to economic and financial problems. A neuroeconomic approach escapes the simplistic categorization of economic behaviour into rational versus irrational because

behaviour is analysed as the outcome of interactions between different decision-making systems and thought processes (e.g. Schneider & Shiffrin 1977). Kahneman (2003) mapped the brain into two different brain systems: system 1 (automatic, quick, intuitive) and system 2 (cognitive, deliberative, controlled). There are different systems for emotion and deliberation and these are associated with automatic versus controlled processing. Emotions are the low-level physiological processes that rapidly elicit stereotyped, valenced behavioural responses and engage different neural structures from those engaged during cognitive processing (Sanfey et al. 2006). The operation of these different systems is not a manifestation of irrationality: emotional and cognitive systems can operate together and emotional systems may have evolved as effective adaptations to past environments and circumstances. Neuroeconomic models are being developed which analyse economic decisions as the outcome of interactions between these deliberative/cognitive and automatic/affective systems (e.g. Camerer et al. 2004, 2005; Loewenstein & O'Donoghue 2004; Rustichini 2005; Camerer 2007). Also, Glimcher & Rustichini (2004) focused on the dual roles of emotion and reason as manifested in the consilience of economic and neuroscientific approaches to decision-making. Frith & Singer (2008) developed ideas about the interaction of reason and emotion in a socio-economic context: when social motivations and emotions compete, they propel our sense of fairness, altruistic punishment, trust and framing effects. Sanfey et al. (2006) also argued that economic behaviour can be understood in terms of 'dual process models' which make a distinction between emotion and deliberation.

Different areas of the brain perform different functions. Higher level, recently evolved cognitive functions are more general and flexible and are used for reasoning and planning, and may be a 'critical substrate for 'homo economicus' (Cohen 2005). Cohen also postulated that the increased capacity for reason and control was associated with the development of particular areas of the brain, e.g. the pre-frontal cortex, and this reflected adaptations to profound changes in the social as well as the physical characteristics of human environments. Ironically, this may have generated social and evolutionary instability because ancient emotional responses were less well adapted to modern conditions than ancient environments: the development of technologies may have accelerated the mal-adaptation of old emotional processes. For example, limbic structures in the brain are often associated with impulsive emotional responses and these may have been appropriate in a world in which immediate rewards were important. In primitive environments, basic resources were scarce and perishable and so quick, instinctive action was essential to avoid starvation; but in a modern context, these instincts may not serve a useful purpose and may in fact generate perverse behaviours such as addiction. Cohen argues that the more recently evolved areas of the brain, including the pre-frontal cortex, have developed to interact effectively with older structures in circumstances in which our emotional mechanisms are not well suited. In this way, we can override inappropriate emotional responses using control and reasoning. Evolution has 'vulcanized' the brain, i.e. increased its strength and resilience. Reason and control have balanced primitive emotional responses, for example, by allowing humans to develop precommitment devices, e.g. saving plans and nicotine gum, to moderate the influence of impulsive, self-destructive emotional decision-making (Cohen 2005).

Cohen (2005) also argued that the evolution of the brain has been formed by social influences; with smaller groups, the chances of repeated interaction were greater. As sociality evolved, strong emotional responses to selfish and exploitative behaviour increased fitness; worrying about reputation was a necessary adaptation to a world in which individuals had a high chance of repeated interaction with a small group of people. Evidence for the operation of ancient emotional structures in the context of social influence includes evidence from ultimatum games, in which altruistic behaviours are associated with activations in areas associated with emotional processing such as the insula (Sanfey et al. 2003). Evidence from the neuroscientific analysis of economic games suggests that social rewards are associated with activations in areas associated with the processing of rewards, e.g. the ventral striatum, and these activations are in addition to activations from financial rewards; also, activations are particularly pronounced when cooperation is reciprocated (Rilling et al. 2002; Sanfey 2007).

fMRI and transcranial magnetic stimulation (TMS) studies have tested hypotheses about the theory of mind and empathy: empathy allows us to understand and share emotions and theory of mind allows us to understand others' beliefs and desires. When experimental subjects observe their partner receiving painful electrical shocks, their empathetic responses engage automatic, emotional processing circuits such as the insula. Furthermore, empathetic responses seem to be generated by making representations of our own internal feeling states in response to pain observed in others. Heterogeneity in brain activation across subjects was strongly correlated with heterogeneity in the responses to empathy questionnaires (Singer et al. 2004; Singer & Fehr 2005). There is also evidence that cognitive control has evolved within a social context. Research shows that human children and chimpanzees use similar cognitive skills when dealing with physical tasks but human children have more sophisticated cognitive skills when dealing with social tasks, including social learning and theory of mind (Herrmann et al. 2007).

It is possible that humans have a 'mirror system' that helps us to understand the actions of others and the analysis of mirror mechanisms parallels elements of the analysis of sympathy and empathy in Adam Smith's (1759) Theory of moral sentiments (Sugden 2005). Experiments on monkey imitation show that monkeys' socialized instincts are propelled by the activity of mirror neurons. These ideas have been extended to describe human instincts to follow others as the outcome of mirror neuron activity (Rizzolatti et al. 2002; Rizzolatti & Craighero 2004;

Iacoboni 2005), though the analysis of the role played by the mirror system in a human context is limited by the fact that the single neuron experiments required to verify mirror neuron theories cannot easily be conducted on human subjects for ethical reasons.

Applying specifically to herding, one way to separate hypotheses about herding as the outcome of affective rather than cognitive processing is by assuming the primacy of affect and following Zajonc (1984) in inferring that longer decision times are associated with more deliberation. If herding and group behaviour are the outcome of Bayesian reasoning processes, as postulated by the rational choice theorists, then they will engage the areas associated with controlled deliberation rather than an instinctive, affective response. There is some evidence from binary choice experiments that the decision to herd is associated with shorter decision times rather than longer ones, which suggests that it is either an instinctive, emotional response and/or that the propensity to herd is a well-practised automated decision-making heuristic (Baddeley et al. 2007). An alternative explanation might be that social pressure may emerge from imagined scenarios as much as real scenarios and so even without the actual face-to-face interactions, social interactions can still be imagined. This links with neuroscientific fMRI evidence about activations in Asch-type tasks (Berns et al. 2005). It also links into neuroeconomic research which shows that real and imagined events are associated with the same neurocognitive response (Rizzolatti et al. 2002; Avenanti et al. 2005).

What are the lessons for herding models? If economic behaviour, herding included, reflects the interactions of different neurological systems then a neuroeconomic approach, which blends economics, psychology and evolutionary biology with social neuroscience, will provide an explanation of herding as the product of both cognition and emotion.

### 7. CONCLUDING REMARKS

This paper has explained that an eclectic approach is essential to understanding how and why herding and social influence evolve in an economic and financial context. Ideas and evidence about social influence, imitation and herding have been surveyed using an interdisciplinary approach which brings together a range of ideas from the social and behavioural sciences including economics, sociology, psychology, evolutionary biology and neuroscience. The most powerful explanations for herding and social influence emphasize the dual roles played by reason and emotion. Herding and imitation in economic and financial decision-making may reflect a social learning process but this will be moderated by emotions and by sociopsychological traits determining receptivity to social influence. This paper also confronts the narrow and stark conceptions of rationality seen in modern economic models of herding and social influence. The economist's focus on a dichotomous, binary concept of rationality has meant that important sociopsychological factors have been neglected; and the focus just on the proximate mechanisms that propel

herding (e.g. learning, profit-making, reputation building) has led to a neglect of how and why underlying propensities to herd and imitate have evolved to serve more primitive social goals. For future research, in blending insights from economics and other social sciences with ideas and experimental evidence from neuroscience, neuroeconomics has considerable power to increase our understanding of how reason and emotion interact to generate herding in the economic and financial spheres.

Sincere thanks go to the theme editors and referees for their constructive and helpful comments on earlier drafts and also to The Leverhulme Trust for their generous sponsorship of this research.

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