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Abstract:

We review theory and evidence relating to herd behavior, payoff and reputational interactions, social learning, and informational cascades in capital markets. We offer a simple taxonomy of effects, and evaluate how alternative theories may help explain evidence on the behavior of investors, firms, and analysts. We consider both incentives for parties to engage in herding or cascading, and the incentives for parties to protect against or take advantage of herding or cascading by others.

Key Words: herd behavior, informational cascades, social learning, analyst herding, capital markets, financial reporting, behavioral finance, investor psychology, market efficiency

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> Men nearly always follow the tracks made by others and proceed in their affairs by imitation...

— Niccolo Machiavelli, *The Prince*, Ch. 6, 1514

1 Introduction

We are influenced by others in almost every activity, and this includes investment and financial transactions. For example, it is reported as news when Warren Buffett buys a stock or commodity, and this news affects its price (see Section 6). Such influence may be entirely rational, but investors and managers are often accused of irrationally converging in their actions and beliefs, perhaps because of a 'herd instinct,' or from a contagious emotional response to stressful events.[1]

There are certainly some phenomena that are suggestive of irrational herding by markets, such as anecdotes of market price movements without obvious justifying news; examples that (with the benefit of hindsight) look like mistakes, such as the overpricing of U.S. technology stocks in the late 1990s; the fact that corporate actions such as new issues and takeovers move in waves; and the tendency of analysts to be enamored with certain sectors at different times. Practioners and the media discussions are much too ready to jump from such patterns to the conclusion that irrational herding is proved. A fully rational market may react to information that the researcher has failed to perceive; market efficiency does not mean perfect foresight, so we expect analyst forecasts and market prices to be wrong ex post; and corporate actions may move in waves in rational response to changing fundamental conditions.

There has, of course, been a great deal of serious theoretical and empirical exploration of the proposition that irrational investor errors cause market misvaluation of assets. This includes some exploration of whether there is contagion in biases across different investor groups, or from analysts to investors; and exploration of whether firms take actions to exploit market misvaluation (for recent reviews, see Hirshleifer (2001) and Daniel, Hirshleifer, and Teoh (2002)).

However, academic research has also contributed in a different way to our understanding of these issues. Recent theoretical work on social learning and behavioral convergence indicates that some phenomena that seem irrational can actually arise very

[1]See, e.g., Business Week (1998) on "Why Investors Stampede: ... And why the potential for damage is greater than ever," or the advertisement by Scudder Investments in Forbes (10/29/01) with the heading, "MILLIONS of very fast, slightly MISINFORMED sheep. Now that's opportunity."

naturally in fully rational settings. Such phenomena include: (1) frequent convergence by individuals or firms upon mistaken actions based upon little investigation and little justifying information; (2) the tendency for social outcomes to be fragile with respect to seemingly small shocks; and (3) the tendency for individuals or firms to delay decision for extended periods of time and then, without obvious external trigger, suddenly rush to act simultaneously. There has also been theoretical work on reputation-building incentives by managers, which has focused primarily on issue (1), but which has also offered explanations for why some managers may deviate from the herd as well.

In this paper we review both fully rational and imperfectly rational theories of behavioral convergence; their implications for investor trading, managerial investment and financing choices, analyst following and forecasts, market prices, market regulation, and welfare; and associated empirical evidence. Learning from prices is by now familiar in capital markets research, but we will argue here that more personal learning from quantities (individual actions), from outcomes, and from conversation is also important for markets.

We examine here behavioral convergence and fluctuations in the behavior of investors, security analysts, and firms in their respective decisions. Investors may 'herd' (converge in behavior) or 'cascade' (ignore their private information signals) in deciding whether to participate in the market, what securities to trade, and whether to buy or sell. Both analysts and investors may herd in deciding what securities to discuss and study. Analysts may also herd in the forecasts they offer. We will consider how herding or cascading may affect market prices. Furthermore, firms can herd in their investment decisions, in their financing decisions, and in their reporting decisions. For example, firms may herd in the timing of new issues, in the adoption of fashionable investment projects, or in their decisions of how to report earnings. Also, firms can take actions to protect against or exploit herding and cascading by investors and analysts.

In summary, our main goals are:

1. To provide a simple taxonomy of herding, payoff and reputation interactions, social learning and cascading.

2. Review critically the strengths and limitations of the basic analytical frameworks for understanding social learning based on observing others, and for understanding reputation-building incentives to converge or diverge behaviorally.

3. Review the evidence from capital markets regarding herd behavior or cascades, and evaluate how alternative theories may help explain evidence on the behavior

of investors, firms, and analysts. This includes consideration of both incentives for parties to engage in herding or cascading, and the incentives for parties to protect against or take advantage of herding or cascading by others.

Some issues omitted issues here are social learning and imitation in games (see, e.g. Fudenberg and Kreps (1995), Gale and Rosenthal (2001)), and the vast general literatures on social learning through prices (e.g., Grossman and Stiglitz (1976)), and on the clearing mechanisms by which trades are converted to prices (e.g., Glosten and Milgrom (1985), Kyle (1985)).

The remainder of this paper is structured as follows. Section 2 classifies mechanisms of learning and behavioral convergence. Section 3 describes basic principles and alternative economic scenarios in rational learning models Section 4 describes agency and reputation-based herding models. Section 5 describes theory and evidence on herding and cascades in security analysis. Section 6 describes herd behavior and cascades in security trading. Section 7 describes the price implications of herding and cascading and their relation to bubbles. Section 8 describes herd behavior and cascades in firms' investment, financing, and reporting decisions. Section 9 concludes.

2 Taxonomy and mechanisms of social learning and behavioral convergence

An individual's thoughts, feelings and actions can be influenced by other individuals by several means: by words, by observation of actions (e.g., observation of quantities such as supplies and demands), and by observation of the consequences of actions (such as individual payoffs, or market prices). This influence may involve fully rational learning, a quasi-rational process, or even in ways that do not improve the observer's decisions at all.

The process of social influence can promote convergence or divergence in behavior; Figure 1 provides a taxonomy of different sources of convergence or divergence. We do not regard as convergence mere random formations with illusory appearance of systematic groupings. Our focus also excludes mere clustering, wherein people act in a similar way owing to the parallel independent influence of a common external factor. Our focus is on convergence or divergence brought about by actual *interactions between individuals.*

Herding/dispersing is defined to include any behavior similarity/dissimilarity brought about by the interaction of individuals. (Originally herding referred to physical clumping, but this has been extended by economists to convergence in the action space.) Possible sources include:

1. Payoff externalities (often called network externalities or strategic complementarities); for example, it pays for one person to use email if everyone else does too;

2. Sanctions upon deviants (as when dissidents in a dictatorship are jailed or tortured)

3. Preference interactions (some individuals may prefer to wear Versace this season, just because everyone else is; others may prefer to deviate the color that is 'in' this season);

4. Direct communication (someone may simply state which of two alternatives are better- but it is not so simple, since there is an issue of credibility),

5. Observational influence (an individual may observe the actions of others or consequences of those actions).

Figure 1 describes a double hierarchy of means of convergence. At the top of the hierarchy is the most inclusive category, *herding/dispersing*. Rectangles depict the *observational hierarchy* (A, B, C, D), which describes the informational sources of herding or dispersing. These include:

- A. *herding/dispersing*: Observation of others can lead to dispersing instead of herding. For example, if preferences are opposing.

- B. *Observational Influence*: Dependence of behavior upon the observed behavior of others, or the results of their behavior; may be imperfectly rational.

- C. *Rational Observational Learning*: Observational influence resulting from rational Bayesian inference from information reflected in the behavior of others, or the results of their behavior.

- D. *Informational Cascades*: (Observational learning in which the observation of others (their actions, payoffs, or even conversation) is so informative that an individual's action does not depend on his own private signal).

The last category, informational cascades, describes a condition in which imitation will occur with certainty. Even as simple a form of social interaction as imitation offers a crucial benefit: it allows an individual to exploit information possessed by others about the environment. When a friend is fleeing rapidly, it may be good to run even before seeing the saber tooth tiger chasing around the bend. The benefit from imitating others, and of taking into account the payoff outcomes of others, is fundamental, as evidenced by the observation of such behavior in many kinds of animals. Even when imitation probably does not occur through a 'rational' process of analysis, the proclivity to imitate may be well attuned to costs and benefits through the guidance of natural selection. We will use the word imitation broadly to include sub-rational mechanisms that induce an individual to be influenced by the behavior of another individual to behave the same way.

There is an extensive literature in both psychology and zoology on imitation in many animal species, both in the wild and experimentally (see, e.g., Gibson and Hoglund (1992), (Giraldeau (1997), and Dugatkin (1992)). Imitation has been documented among birds, fish, and mammals in foraging and diet choices, selection of mates, selection of territories, and in means of avoiding predators. Indeed, Blackmore (1999) (e.g., pp. 74-81) suggests that in early hominids there was strong selection for ability to imitate innovative, complex behaviors, so that the evolution of large brain size was linked to the rise of the propensity to imitate. Starting within an hour of birth, humans also engage in imitation. There is also contagion in the emotions of individuals interacting as groups (see, e.g., Barsade (2001)).

An individual is said to be in an *informational cascade* if, based upon his observation of others (e.g., their actions, outcomes, or words), his selected action does not depend on his private information signal (see Bikhchandani, Hirshleifer, and Welch (1992), Welch (1992) and Banerjee (1992) [Banerjee uses the term 'herd' for what we refer to here as a cascade]). In such a situation, his action choice is uninformative to later observers. Thus, cascades tend to be associated with *information blockages*. Such blockages are an aspect of an informational externality: an individual making a choice may do so for private purposes with little regard to the potential information benefit to others.

Gale (1996) reviews models of social learning and herding in general..For an exposition and description of applications of informational cascades, see Bikhchandani, Hirshleifer, and Welch (1998); Bikhchandani, Hirshleifer, and Welch (2001) provides an annotated bibliography of research relating to cascades.

Returning to Figure 1, rectangles depict the *payoff interaction hierarchy* (I, II, III), which provides a different (though not mutually exclusive) perspective on herding or dispersing. These include:

- I. *Herding/Dispersing* (as in the information hierarchy)

- II. *Payoff and Network Externalities* This involves convergence or divergence of behavior arising from the fact that an individual's action affects the payoffs to others of taking that action. The classic model of herding as a direct payoff interaction is Hamilton's ((1971)) analysis of the geometry of the 'selfish herd,' wherein the clumping of prey animals is an indirect outcome of the selfish attempt by each one to put others between itself and predators. In financial economics, the Diamond and Dybvig (1983) bank run model involves a direct payoff externality, and the Admati and Pfleiderer (1988) theory of volume clumping involves payoff interactions induced by the incentive for uninformed investors to try to trade with each other instead of with the informed.

- III. *Reputational Herding and Dispersion*

  This is convergence or divergence of behavior based on the attempt of an individual to maintain a good reputation with another observer. Such a desire for good reputation can cause payoff interactions, making III a subset of II (see Scharfstein and Stein (1990), Rajan (1994), Trueman (1994), Brandenburger and Polak (1996), and Zwiebel (1995).) Ottaviani and Sorenson (2000) explore the relation between reputational herding and informational cascades.

3 Basic Principles and Alternative Economic Scenarios in Rational Learning Models

3.1 Some Basic Principles

We begin by describing further some features of the basic informational cascades model, which provides a simple way to illustrate some principles common to models of rational observational learning (item C) as well as those unique to the cascades setting. The occurrence of an informational cascade can even lead to a complete information blockage. Consider a sequence of ex ante identical individuals who face similar choices, observe conditionally independent and identically distributed private information signals, and who observe the actions but not the payoffs of predecessors. Suppose that individual i is in a cascade, and that later individuals understand this. Then individual $i+1$, having gained no information by observing the choice of i, is, informationally, in a position identical to that of i. So $i+1$ will also make the same choice regardless of his private signal. By induction, this reasoning extends to all later individuals- the accumulation of information comes to a screeching halt once a cascade begins.

The conclusion that information is blocked forever is of course too extreme, for several reasons. First, a publicly observable shock can dislodge a cascade. Second, if individuals are not ex ante identical, then the arrival of an individual with deviant information or preferences can dislodge a cascade. Third, the occurrence of a cascade requires that individual do not receive an arbitrarily precise signal- likelihood ratios must be finitely bounded (on all these items, see, e.g., Bikhchandani, Hirshleifer, and Welch (1992)). Fourth, whatever choice is fixed upon in the cascades, if payoff outcomes from that choice eventually work their way into the public information pool, cascades can be dislodged.[2] Thus, the more plausible implication to be drawn from the basic cascades model is just that information aggregation can be unduly slow relative to what could in principle be attained; and that blockages can occur which may last for significant periods of time (see, e.g., the discussion of Gale (1996)).

A generalization of the cascades concept is what can be called a *behavioral coarsening*. This is any situation in which an individual takes the same action for multiple signal values. In such a situation his information is not fully conveyed by his actions to observers. Behavioral coarsening leads to partial information blockage. A cascade is the extreme case in which the coarsening covers all possible signal values, so that blockage is complete.

The poor aggregation of information in informational cascades of course means that decisions will also be poor, even if the signals possessed by numerous individuals could in principle be aggregated to determine the right decision with virtual certainty. Since the model is fully rational, individuals understand perfectly well that the precision of the public pool of information implicit in predecessors' actions is quite modest. As a result, even a rather small public shock can cause a longstanding and popular action to switch.

Although the arrival of enough public information will improve decisions, the arrival of a signal public disclosure may, paradoxically, make decisions worse. Additional information can encourage individuals to fall into a cascade sooner, aggregating the information of fewer individuals, so there is no presumption that the signal will improve decisions in the cascade (Bikhchandani, Hirshleifer, and Welch (1992)). For similar reasons, the ability of individuals to observe past actions with low noise instead of high noise, or the ability to observe payoff outcomes in addition to past actions, can make

[2] However, bad cascades need not be dislodged with certainty; see Cao and Hirshleifer (2000).

decisions worse on average (Cao and Hirshleifer (1997, 2000))- "a little knowledge is a dangerous thing."[3]

In a real investment context, the assumption of the basic cascades model that the timing and order of moves is exogenously given is unrealistic. When individuals have a choice of whether to delay, there can be long periods with no investment, followed by sudden spasms in which the adoption of the project by one firm triggers the exercise of the investment option by many other firms (Chamley and Gale (1994)).[4]

Most of the ideas described above can be generalized to models of social learning in which cascades do not occur. Even when information blockage is not complete, information aggregation is limited by the fact that individuals privately optimize rather than taking into account their effects upon the public information pool. In particular, there is a general tendency for information aggregation to be self-limiting. At first, when the public pool of information is very uninformative, actions are highly sensitive to private signals, so actions add a lot of information to the public pool. (The addition can be directly through observation of past actions, or indirectly through observation of consequences of past actions, as in public payoff information that results from new experimentation on different choice alternatives.) As the public pool of information grows, individuals' actions become less sensitive to private signals.

The loss of sensitivity of actions to private signals can occur suddenly, with a switch from full usage of private signals to no usage of private signals (as in Banerjee (1992), and the binary example of Bikhchandani, Hirshleifer, and Welch (1992)). It can occur gradually (as in the more general cascades model with multiple signal values), yet still reach a point of complete blockage (as in Bikhchandani, Hirshleifer, and Welch (1992)). Or, it can occur gradually but never reach a point of complete blockage. For example, it can occur that there is always a probability that individuals use their own signals, but where that probability asymptotes toward zero; this leads to 'limit cascades' (Smith and Sorenson (2000)). Alternatively, there can be cascades proper, but owing to observability of project payoffs, there can be a probability less than one that the cascade evenetually breaks (see Cao and Hirshleifer (2000)). Or, if there is some sort of observation noise, the public pool of information can grow steadily but more and more slowly (Vives (1993).

In sum, whether information channels become quickly or only gradually clogged,

[3]Also, the ability to learn by observing predecessors can make the decisions of followers noisier by reducing their incentives to collect (perhaps more accurate) information themselves (Cao and Hirshleifer (1997)).

[4]See also Hendricks and Kovenock (1989), Bhattacharya, Chatterjee, and Samuelson (1986), Zhang (1997) and Grenadier (1999).

and whether the blockage is complete or partial, is dependent on the economic setting; but the general conclusion that there can be long periods in which individuals herd upon poor decisions is robust. Also in general there tends to be too much copying or behavioral convergence; someone who uses his own private information heavily provides a positive externality to followers, who can draw inferences from his action..

The cascade outcome described by Banerjee (1992) or Bikhchandani, Hirshleifer, and Welch (1992) is based on the public pool of information dominating the individual's private signal. Obviously, this cannot occur with certainty if the private signal likelihood ratios are unbounded. However, the growth of the public information pool may be excruciatingly slow, so even in settings where people occasionally observe extremely informative signals a cascades model can be a good approximation. In particular, as the public pool of information grows more informative, the likelihood that an individual will depart from it substantially based on an extreme signal becomes very small.

Thus, the cascades and some other rational learning theories have several general implications:

- *idiosyncrasy* (poor information aggregation). Behavior resulting from signals of just first few individuals drastically affects behavior of numerous followers.

- *fragility* (fads). When cascades form, there is complete blockage of information aggregation, sensitivity to small shocks. As in Hollywood adventure movies, it is inevitable that the car will end up teetering precariously at the very edge of the precipice.

- *Simultaneity* (delay followed by sudden joint action). Endogenous order of moves, heterogeneous preferences and precisions can exacerbate these problems so that sudden 'chain reactions,' 'stampedes' or 'avalanches' occur.

- *Paradoxicality* (greater public information, or greater observability of the actions or payoffs of others does not necessarily improve welfare or even the accuracy of decisions).

- *Path dependence* (outcomes depend on the order of moves and information arrival). This implication is shared with models with payoff interdependence (e.g., Arthur (1989)).

3.2 Alternative Economic Settings

We now describe in somewhat more detail alternative sets of assumptions in observational influence models and the implications of these differences.[5]

3.2.1 Observation of Past Actions Only

Here we retain the assumption of the basic cascade model that only past actions are observable, but consider the a variety of model variations.

1. *Discrete, Bounded, or gapped actions vs. continuous unbounded actions*

If the action space is continuous, unbounded, and without gaps, then an individual's action is always at least slightly sensitive to his private signal. Thus, actions always remain informative, and informational cascade never form. Thus, informational cascade require some discreteness, boundedness or gaps (Lee (1993); see also Vives (1993) and Gul and Lundholm (1995)). The earliest cascade models were based upon discreteness (as in Bikhchandani, Hirshleifer, and Welch (1992), Welch (1992)) or on the equivalent of a binary action space (Banerjee (1992)).

The assumption of discreteness is in many settings highly plausible. We vote for one candidate or another, not for a weighted average of the two. Often alternative investment projects are mutually exclusive. Although the amount invested is often continuous, if there is a fixed cost the option of not investing at all is discretely different from positive investment.

More broadly, one way in which the action set can be bounded is if there is a minimum and maximum feasible project scale. If so, then when the public information pool is sufficiently favorable a cascades at the maximum scale will form, and when the public information pool is sufficiently adverse individuals will cascades upon the minimum scale. Since there is always an option to reject a new project, investment has a natural extreme action of zero. Chari and Kehoe (2000) provide a model where a lower bound of zero on a continuous investment choice creates cascade.[6]

Similarly, gaps can create cascades. For example, it may be that significant new investment or significant disinvestment is feasible, but owing to fixed costs a very small change is clearly unprofitable. If so, then cascades upon no action is feasible if private

[5] We do not review the growing literature on how rates of learning vary during macroeconomic fluctuations and how this can contribute to booms and crashes in levels of investment (see, e.g., Gonzalez (1997), Chalkley and Lee (1998), Chamley (1999), Veldkamp (2000)).

[6] Asymmetry between adoption and rejection of projects is often realistic and has been incorporated in several social learning models of investment to generate interesting effects.

signals are not too informative.

Even if the true action space is continuous, ungapped and unbounded, to the extent that observers are unable to perceive or recall small fractional differences, the actions of their predecessors effectively become either noisy or discrete. Discretizing can potentially cause cascades and information blockage; noise similarly slows down learning. There must be at least some effective discreteness or noise because real observers have finite perceptual and cognitive powers. At some point, it is literally physically impossible for an observer to perceive arbitrarily small differences in actions. Even if perception were perfect, it would also be impossible, in the absence of infinite time and calculating capacity, to make use of arbitrarily small observed differences in actions. Thus, for fundamental reasons there must be either noise, perceptual/analytic discretizing, or both.[7]

If perceptual discretizing is very fine-graded, the outcome will still be very close to full revelation. However, it is doubtful that perception and analysis is consistently fine-graded; consider, for example, the tendency for people to round off numbers in memory and conversation. Kahn, Pennacchi, and Sopranzetti (2002) find clustering for retail deposit interest rates around integers, and provide evidence that is supportive of their model in which this is caused by limited recall of investors.

2. Costless versus costly private information acquisition

Individuals may observe private signals costlessly in the ordinary course of life, or may expend resources to obtain signals. Most social learning models take the costless route. Costs of obtaining signals can lead to little accumulation of information in the social pool for essentially the same reason as in other cascades or herding models. Individuals have less incentive to investigate or observe private signals if the primary benefit of using such signals is the information that such use will confer upon later individuals. (Burguet and Vives (2000) analyze social learning with investigation costs). Indeed, if an individual reaches a situation where he optimally would not make use of a signal, then clearly it does not pay for him to expend resources to obtain it. The outcome is similar to that of the basic cascades model: information blockage.

This suggests an extended definition of cascades that can apply to situations where private signals are costly to obtain. An *investigative cascade* is a situation where either:

[7] In the absence of discretizing, repeated copying will gradually accumulate noise until the information contained in a distant past action is overwhelmed. This overwhelming of analog signals by noise when there is sequential replication is the reason that information must be digitized in the genetic code of DNA, and in information that is sent (with repeated reamplification of signals) over the internet.

1. An individual acts without regard to his private signal; or,
2. The individual chooses not to acquire a costly signal, but he would have acted without regard to that signal if he were forced to acquire the same level of signal precision that he would have acquired voluntarily if he were unable to observe the actions or payoffs of others.

Calvo and Mendoza (2001) study the decisions by individuals to investigate and invest in different countries. If investigation of each country requires a fixed cost, they find that the optimal amount of investigation of a country diminishes rapidly with the number of countries, leading to greater herding.

3. Observation of all past actions versus a subset or statistical summary of actions

Instead of observing all past actions, it may be that people can observe only the most recent actions, a random sample, or can only observe the behavior of their neighbors. Some models with these features are discussed elsewhere; we note here that in such settings mistaken cascades can still form. Alternatively, individuals may only be able to observe a statistical summary of past actions. Information blockage and cascades are possible in such a setting as well (Bikhchandani, Hirshleifer, and Welch (1992)). (With continuous actions, as discussed above, the outcome may be slow information aggregation rather than cascade; Vives (1993).) A possible application is to the purchase of consumer products. Aggregate sales figures for a product matter to future buyers because it reveals how previous buyers viewed desirability of alternative products (Bikhchandani, Hirshleifer, and Welch (1992), Caminal and Vives (1999)).[8]

3. Observation of past actions accurately or with noise

In most social learning models any actions that are observed at all are observed accurately, but in some there is noise (see Vives (1993), Cao and Hirshleifer (1997)). Under special circumstances a model in which individuals learn from price is in effect a basic social leaerning model with indirect observation of a noisy statistical summary of the past trades of others. But in general a market price scenario is more complex; the consequence for an individual of taking an action is not just an exogenous payoff function, but the result of an equilibrating process.

4. Choice of timing of moves versus exogenous moves

[8] A SmithKline Beecham advertisement states, "Doctors have already endorsed Tagamet in the strongest possible way. With their prescription pads." The add shows a bar graph in three-dimensional perspective in which 237 million prescriptions tower above a modest 36 million for Pepcid. A miniscule footnote reveals that the Tagamet figure was since 1977, Pepcid only since 1986!

Chamley and Gale (1994) offer a model of irreversible investment in which individuals with private signals about project quality have a choice as to whether to invest or delay. This is therefore a model of optimal option exercise. They find that in equilibrium there is delay. The advantage of delay is that an individual can gain information by observing the actions of others. But if everyone were to wait, there would be no advantage to delay. Thus, in equilibrium investors follow randomized strategies in deciding how long to delay before being the first to invest. Investment by an individual can trigger immediate further investment by others. Indeed, in the limit a period of little investment is followed by either a sudden surge in investment or a collapse. Thus, the model illustrates simultaneity). In equilibrium cascades occur and information is aggregated inefficiently.

Zhang (1997) offers a setting in which investors have private information not only about project quality, but about the precision of their signals. In the unique symmetric equilibrium, among investors with favorable signals, those whose signals are less precise delay longer than those with more precise signals (because imprecise investors have greater need for corroborating information before investing). In equilibrium there is delay until the critical investment date of the individual who drew the highest precision is reached. Once he invests, other investors all immediately follow, though investment may be inefficient. This sudden onset of investment illustrates simultaneity in an extreme form.

Chamley (2001) finds that when individuals have different prior beliefs, there are multiple equilibria that generate different amounts of public information. Chari and Kehoe (2000) show that when there is a binary decision of whether or not to invest, but an endogenous choice of timing, consistent with Chamley and Gale (1994) and Zhang (1997), inefficient cascades still occur. They find that even when there is a continuous level of investment bounded below by zero, an inefficient cascade on zero investment can occur (for reasons discussed earlier). They also find that cascades remain even when individuals have the opportunity to share information, because individuals do not have an incentive to communicate truthfully.[9]

A number of other models describe how information blockages, delays in investment and periods of sudden investment changes, and overshooting can occur, either with (Caplin and Leahy (1994), Grenadier (1999)) or without (Caplin and Leahy (1993), Persons and Warther (1997)) informational cascades. Caplin and Leahy (1994) analyze informational cascades in the cancellation of investment projects in a setting with en-

[9]Gul and Lundholm (1995) examine a model that allows for delay in which a continuous action space leads to full revelation and therefore no cascades.

dogenous timing. They find that that there can be sudden crashes in the investments of many firms triggered by individual cancellations. These models share the broad intuitions that informational externalities cause choices about whether and when to invest to be taken in a way that is undesirable from a social point of view.

Persons and Warther (1997) offer a model of boom and bust in the adoption of financial innovations based upon observation of the payoffs resulting from the repeated actions of other firms. They find a tendency for innovations to 'end in disappointment' even though all participants are fully rational; a natural consequence of learning is that the boom continues to grow until disappointing news appears. Zeira (1999) develops related notions of informational overshooting to real estate and stock markets.

5. Presence of an evolving publicly observable state variable

Grenadier (1999) examines informational cascades in options exercise, in which an exogenously evolving publicly observable state variable influences the incentives to exercise the option. A small recent move in the state variable can be the 'straw that broke the camel's back' in triggering informational cascades of option exercise. Grenadier suggests several applications, such as "the building of an office building, the drilling of an exploratory oil well, and the commitment of a pharmaceutical company toward the research of a new drug."

6. Stable versus stochastic hidden environmental variable

Bikhchandani, Hirshleifer, and Welch (1992) provide an example where the underlying state of the world is stochastic but unobservable. This can lead to fads wherein the probability that action changes is much higher than the probability of a change in the state of the world.

Perktold (1996) assumes a Markov process on the value of the choice alternatives, and individuals make repeated decisions over time. He finds that cascades occur and break recurrently. Moscarini et al (1998) examine how long cascades can last as the environment shifts. Nelson (2001) explores the relation between high correlation of individual actions and cascades. She offers a model of IPOs in which the decision to go public is more likely to be associated with informational cascades than the decision to hold off.[10] Hirshleifer and Welch (2002) consider an individual or firms subject to

[10] Nelson also points out that care is needed in the testing of herding and cascades models if the proxy used is correlation of behavior. She shows that there is often a lower correlation of behavior in a setting with cascades than in a setting where all the information is made public. This is because public information induces high correlation in actions: people converge to the right action. On the other hand, if the benchmark for comparison is one where each individual's information remains private, herding and cascades will be associated with higher correlation of action. So it is still reasonable in testing

memory loss about past signals but not actions. They describe the determinants (such as environmental volatility) of whether memory loss causes inertia (a higher probability of continuing past actions than if memory were perfect) or impulsiveness (a lower probability).

7. Homogeneous versus heterogeneous payoffs

Individuals have different preferences, though this is probably more important in non-financial settings. Suppose that different individuals value adoption differently. A rather extreme case is opposing preferences or payoffs, so that under full information two individuals would prefer opposite behaviors. If each individual's type is observable, different types may cascades upon opposite actions.

However, if the type of each individual is only privately known, and if preferences are negatively correlated, then learning may be confounded— individuals do not know what to infer from the mix of preceding actions they observe, so they simply follow their own signals (Smith and Sorenson (2000)).

8. Endogenous cost of action: market models with price

This is a large topic that we cover separately below.

9. Single or repeated actions and private information arrival

Most models with private information involve a single irreversible action, and a single arrival of private information. In Chari and Kehoe (2000), in each period one investor receives a private signal, and investors have a timing choice as to when to commit to an irreversible investment. In equilibrium there are inefficient cascade. If individuals take repeated, similar, actions and continue to receive non-negligible additional information, actions will of course become very accurate. However, there can still be short-run inefficiencies (e.g., Hirshleifer and Welch (2002).

10. Discrete signal values versus continuous signal values

Depending on probability distributions, possible to get limit cascades (Smith and Sorenson (2000)) instead of cascades. As commented by Gale (1996), the empirical significance is much the same—information aggregation can be poor large periods of time.

11. Exogenous rules versus endogenous contracts and institutional structure

Some papers that examine how the design of institutional rules and of compensation contracts affects herding and informational cascades in project choice include Prendergast (1993), Khanna (1997), and Khanna and Slezak (2000) (discussed below); see also

such models to examine behavioral convergence. But a fuller test of such models would look examine whether high convergence in behavior is achieved without high accuracy of decisions.

Ottaviani and Sorenson (2001).

3.2.2 Observation of Consequences of Past Actions

Vicarious learning is so powerful that one might expect that observing past payoffs would eliminate information blockages and lead to convergence upon correct actions. Indeed, in an imperfectly rational setting, Banerjee and Fudenberg (1999) find convergence to efficient outcomes if people sample at least two predecessors. On the other hand, as emphasized by Shiller (2000a), in practice imperfect rationality makes conversation a very imperfect aggregator of information. This suggests that biases induced by conversation may be important for stock market behavior.

Even under full rationality, it should be noted that the Banerjee/Fudenberg setting always leaves a rich inventory of information to draw from. In each period a continuum of individuals try all choice alternatives, so there is always a pocket of information available about the payoff outcome of either project. Cao and Hirshleifer (2000) examine a setting that is closer to the basic cascades model. There are two alternative project choices, each of which has an unknown value-state. Payoffs are in general stochastic each period conditional on the value-state. Individuals receive private signals and act in sequence, and individuals can observe all past actions and project payoffs. Nevertheless, idiosyncratic cascades still form. For example, a sequence of early individuals may cascade upon project A, and its payoffs may become visible to all, perhaps revealing the value-state perfectly. But since the payoffs of alternative B are still hidden, B may be the superior project. Indeed, the ability to observe past payoffs can sometimes trigger cascades even more quickly-an indication of parodoxicality.

Caplin and Leahy (1993) examine a setting where potential industry entrants learn indirectly from the actions of previous entrants by observing industry market prices. Entrants do not possess any private information prior to entry. Imperfect information slows the adjustment of investment to sectoral economic shocks. (On the informational and action consequences of firms observing past payoffs, see also Persons and Warther (1997) discussed earlier.)

3.3 Imperfectly Rational Individuals

So far we have focused primarily on fully rational models. Some models that assume either mechanistic or imperfectly rational decisionmakers include Ellison and Fudenberg (1993, 1995) (rules of thumb), Hirshleifer, Subrahmanyam, and Titman (1994) ('hubris' about the ability to obtain information quickly), Bernardo and Welch (2001) (overconfidence), Hirshleifer and Noah (1999) (misfits of several sorts), Hirshleifer and Welch (2002) (memory loss about past signals),

In the rules of thumb approach the behavior of agents is specified based on analytical convenience, or on the researcher's judgment that the rule of thumb or heuristic would be a reasonable one for agents with limited cognitive powers to follow. The other approach is to draw on experimental psychology to suggest assumptions about imperfect rationality of agents in the model. Both approaches have merit, but for both, verification of the behavioral assumptions is desirable. In particular, even behavioral assumptions that are based broadly upon psychological evidence are usually not based upon experiments that are very close to the particular economic setting being modeled.

In Smallwood and Conlisk (1979), choices are based on payoffs received, and on market share of the choice alternatives. Ellison and Fudenberg (1995) specify that an individual takes an action if all individuals in the sample are using it, or if they obtained a higher average payoff using the action than the alternative. In Ellison and Fudenberg (1993), decisions are based upon past payoffs from a sample of observations from past adoptions, and based upon the market shares of choice alternatives.

If individuals use a diversity of decision rules (whether rational, quasi-rational, or simple rules of thumb), then there will be greater diversity of action after a cascade among rational individuals starts. This action diversity can be informative, and can break cascades (Bernardo and Welch (2001), Hirshleifer and Noah (1999)). This improves the efficiency of the choices of rational individuals in the long run.

There are many other possible directions to take imperfect rationality and social learning. Evidence of emotional contagion within groups suggests that there may be merit to the popular views about contagious manias or fads (see also Shiller (2000b),Lynch (2000), and Lux (1995)). On the other hand, some historically famous bubbles, such as that if the Dutch Tulip Bulbs, may have reflected information rationally and fully (see, e.g., Garber (2000)). Furthermore, there are rational models of bubbles and crashes that do not involve herding (see, e.g., the agency/intermediation model of Allen and Gale (2000a), and the review of Brunnermeier (2001)).

We argue elsewhere that limits to investor attention are important for financial reporting and capital markets (see the review of Daniel, Hirshleifer, and Teoh (2002), and the model of Hirshleifer, Lim, and Teoh (2001)). Such limits to attention may pressure individuals to herd or cascade despite the availability of a rich set of public and private information signals (beyond past actions of other individuals). A related issue is whether the tendency to herd or cascade greater when the private information that individuals receive is hard to process (cognitive constraints and the use of heuristics for hard decision problems were emphasized by Simon (1955); in the context of social influence, see Conlisk (1996)). In this regard, Kim and Pantzalis (2000) provide evidence that apparent herd behavior by analysts is greater for diversified firms, for which the task that analysts face is more difficult.[11]

Difficulty in analyzing opaque accounting reports has been widely raised in the press as a source of the recent Enron debacle. In testimony to the House of Representatives on December 12, 2001, the Director of Thompson/First Call indicated that when analysts can not disentangle a firm's accounting there, tends to be greater herding in analyst forecasts (i.e., smaller dispersion in forecasts) than is the case for the average S&P 500 firm.

3.4 Market Prices, Herding, and Informational Cascades

If markets are perfect and investors are rational, then risk-adjusted security returns are unpredictable. We will refer to this combination of conditions- full rationality and perfect markets- as 'classical.' By perfect markets we mean that each investors trades as if he can buy or sell any amount at a given market price. Thus, even though a rational expectations model such as that of Grossman and Stiglitz (1976) has information asymmetry, since individuals perceive that they can trade at a given price, we view this as a perfect market. Furthermore, in a classical market there is neither an excess nor a shortfall in price volatility relative to public news arrival about fundamental value (where we include as 'public' even information that was originally private but which can be rationally inferred by observing market prices or trading) . It follows immediately that fully rational models of cascades or herding cannot explain anomalous evidence regarding return predictability or excess volatility (for recent reviews of theory and evidence relating to investor psychology in capital markets, see, e.g., Hirshleifer (2001), Daniel, Hirshleifer, and Teoh (2002)).

This is not to deny that information blockages and herding may affect prices. What this does show is that to explain return patterns that are anomalous from the classical viewpoint, it is necessary to introduce either market imperfections or failures of human

[11] Some physicists and mathematicians have offered heavily-engineered models of mechanistic agents to examine the relation of herd behavior to price distributions (see, e.g., Cont and Bouchaud (1999)). An early analysis of direct preference for conformity was provided by Kuran (1989), but the informational implications have not been fully explored.

rationality.

Even within a fully rational setting, cascades or herding can have the serious effect of blocking information aggregation. The properties of return unpredictability, and of correct volatility in a classical market are relative to the information that can be inferred from publicly observable variables including market prices and volumes. However, the existence of cascades can affect how much information goes into that information set in two ways. First, it can cause some information to remain private which otherwise would be reflected in and inferable from prices and trades. Second, it can cause individuals to change their investigation behavior, potentially reducing the amount of private and public information that is generated in the first place.

Vives (1995) analyzes the rate of learning in competitive securities markets. The intuition is similar to the intuition in herding models with exogenous action costs. An informed trader does not internalize the benefit that other traders have from learning his private information as revealed through trading. Thus, the rate of convergence of price to efficiency is slow.

In Glosten and Milgrom (1985), even though the action space is discrete, there are no informational cascades. This fact has stimulated some analysis of how endogeneity of prices can act to prevent cascades. In simple trading settings, cascades cannot occur (see Avery and Zemsky (1998)). Intuitively, cascade would contradict market clearing. Securities prices should aggregate private information through trading. If there were a cascade where informed traders were buying regardless of their signals, then *a fortiori* so would uninformed traders. If the optimal response to even an adverse signal is to buy, then so is the reponse to having no signal. But if, foreseeably, both informed and uninformed are trying to buy, the marketmaker ought to have set prices differently.

However, if there are multiple dimensions of uncertainty, then something akin to a cascades can occur. It is standard to assume that informed investors know more than the market maker about the expected payoff of the security. Avery and Zemsky introduce a second informational advantage to informed investors over the market maker–uncertainty over *whether* informative signals were sent. In consequence, a price rise can encourage an investor with an adverse signal to buy when there is a transaction cost or bid-ask spread. The price rise persuades the investor that others possess favorable information, whereas the market maker adjusts prices sluggishly in response to this good news. This relative sluggishness of the marketmaker arises from his ignorance over whether an informative signal was sent. Informed traders-even those with adverse signals-at least know that information signals were sent, so that the previous order probably came from a favorably informed trader. In contrast, the market maker places greater weight on the possibility of a liquidity trade.

The behavior described by Avery and Zemsky is very cascade-like, in that the individual is acting in opposition to his private signal- a rather extreme behavioral coarsening. However, it is in fact not a true informational cascade. When no information signal is received, the investor takes a different action from when information is received. So there are really three possible signal realizations-favorable, unfavorable, and no signal. Action is in fact dependent on this appropriately redefined signal. In any case, this pseudo-cascading phenomenon leads to partial information blockage.

It is worth noting that in a different setting, true cascades may indeed occur. Suppose that A is sometimes informed, when A is informed B is aware that A is informed, but C is not informed and does not know when others are informed. As usual there is also non-information-based ('liquidity') trading. Then there would seem to be a benefit to B of imitating A's trade, and for C to take up the slack.

Gervais (1996) finds information blockage owing to bid-ask spreads. In his model, there is uncertainty about investors' information precision. Trading occurs over many periods yet trader private information is not incorporated into price. Informed investors receive a signal and know the precision of the signal, but the market-maker does not. Initially a high bid-ask spread acts as a filter by deterring trade by informed investors unless they have high precision. However, as the market-maker observes whether trade occurs, he is able to update about signal precision and about the value of the asset. Owing to his increased knowledge over time the market-maker narrows the spread. This narrowing causes even investors with imprecise signals to trade, so eventually the market-maker stops learning about investors' information precision. This independence of the decision to trade from the private information about precision is a behavioral coarsening, and causes this type of information to remain forever private.

Cipriani and Guarino (2001a) extend Glosten/Milgrom to a multiple security setting. They allow for traders that have non-speculative motives for trading. In Cipriani and Guarino, the trading of informed investors causes information to be partly reflected in price. As prices become more informative, at some point one more of the conditionally independent private signals causes a rather small update in expected fundamental value. As a result, an investor who has a non-speculative reason to purchase the security finds it profitable to purchase the security even if his private information signal is adverse. In other words, he is in a cascade. Similarly, investors who have a non-speculative motive to sell do so regardless of their signal. With all informed investors in a cascade, further aggregation of information is completely blocked. Thus, in contrast to Avery and Zemsky, informational cascades proper form. Furthermore, cascades lead to contagion across markets.

In Lee (1998) there are quasi-cascades that result in temporary information blockage, then avalanches. This arises from transactions costs and discreteness in trades, which lead to behavioral coarsening. In sequential trading, hidden information becomes accumulated as the market reaches a point at which, owing to transactions costs, trading temporarily ceases. Eventually a large amount of private information can be revealed by a small triggering event. The triggering event is a rare, low probability adverse signal realization. An individual who draws this signal value sells. Other individuals who observe this sale are drawn into the market, causing a market crash or 'avalanche.'

These papers apply a sequential trading approach. Beaudry and Gonzalez (2000) apply a rational expectations (simultaneous trading) modeling approach to show that cascading occurs when information is costly to acquire, leading to price and investment fluctuations. Like these other papers, investment is a discrete decision.[12]

A key issue regarding the occurrence of information blockage in these models is the significance of the assumption of discrete actions. Any model that attempts to explain empirical phenomena such as market crashes as (quasi-)cascades must calibrate with respect to the size of minimum trade size or price movements. Such constraints are most likely to be significant for illiquid markets.[13]

Perhaps the more important role of cascades is likely to be in the decision of whether or not to participate at all, rather than in the decision of whether to buy or sell. If there is a fixed cost (perhaps psychic) of participating, then there can be a substantial discreteness to individual decisions that does not rely in any way upon limiting the size of trades to a single unit. Or, if people are imperfectly rational, so that there is some sort of barrier to their participating, again there can be cascades of participation versus non-participation.

In the context of risk regulation, Kuran and Sunstein (1999) develop the notion of *availability cascades*; their ideas are applicable to security market activity. If high publicity about a firm or market theory makes the firm more salient and 'available'

[12]Chakrabarti and Roll (1997) offer a simulation analysis of the effects of investors learning by observing the trades of others. They report that under some market conditions learning by observing others reduces market volatility and in others increases volatility.

[13]In a short run level, the expectation that NYSE specialists will maintain an 'orderly market' by keeping prices continuous can potentially force temporary deviations of prices from market values, block information flow. This suggests a relevance of cascade only in extreme circumstances.

to investors. This may encourage cascades of investment (Huberman (1999) provides evidence and insightful discussion about the effect of familiarity on investment). Local biases in investment (see, e.g., Coval and Moskowitz (2001)), and the home bias puzzle of international finance (see, e.g., Tesar and Werner (1995), Lewis (1999)) may be examples of availability cascades. In any case cascades in market participation offer a rich avenue for further analytical exploration.

There is starting to be some exploration of the formation and clearing of information blockages associated with the choice of individuals over time as to whether or not to participate in trading (Romer (1993), Lee (1998), Cao, Coval, and Hirshleifer (2001), and Hong and Stein (2001)). In settings with limited participation, large crashes can be triggered by minimal information, and the sidelining and entry of investors can cause skewness and volatility to vary conditional upon past price moves. (Bulow and Klemperer (1994) consider a different setting with asymmetric revelatory effects of trading.)

4 Agency/Reputation-Based Herding Models

In the seminal paper on reputation and herd behavior, Scharfstein and Stein (1990) consider two managers face identical binary investment choices. Managers may have high or low ability, but neither they nor outside observers know which. Observers infer the ability of managers from whether their investment choices are identical or opposite, and then update based upon observing investment payoffs. Managers are paid according to observers' assessment of their abilities. It is assumed that high ability managers will observe identical signals about the investment project, whereas low ability managers observe independent noise.

There is a herding equilibrium in which the first manager makes the choice that his signal indicates, whereas the second manager always imitates this action regardless of his own signal. If the second manager were to follow his own signal, observers would correctly infer that his signal differed from the first manager, and as a result they would infer that both managers are probably of low quality. In contrast, if he takes the same choice as the first manager, even if the outcome is poor, observers conclude that there is a fairly good chance that both managers are high quality and that the bad outcome occurred by chance. Thus, their model captures the insight of John Maynard Keynes that "it is better to fail conventionally than to succeed unconventionally."

Rajan (1994) considers the incentive for banks with private information about borrowers to manage earnings upward by relaxing their credit standards for loans, and by refraining from setting aside loan-loss reserves. When there is a bad aggregate state of the world, even the loans of high ability managers do poorly. Thus, observers do not 'punish' a banker reputationally as much for setting aside loan-loss reserves if other banks are doing so as well. Thus, the set-aside of reserves by one bank triggers set-asides by other banks. This simultaneity in the actions of banks is somewhat analogous to the delay and sudden onset of informational cascades in the models Zhang (1997) and Chamley and Gale (1994). Furthermore, Rajan shows that banks tighten credit in response to declines in the quality of the borrower pool. Thus banks amplify shocks to fundamentals. Rajan provides evidence from New England banks in the 1990s of such delay in increasing loan loss reserves, followed by sudden simultaneous action.

Trueman (1994) considers the reputational incentives for stock market analysts to herd in their forecasts of future earnings. We cover this paper in the next section. One of his findings is that analysts have an incentive to make forecasts biased toward the market's prior expectation. In a similar spirit, Brandenburger and Polak (1996) show that a firm with superior information can have a reputational incentive to make investment decisions consistent with the prior belief that observers have about which project choice is more profitable. Intuitively, even if the prior-disfavored project choice is the more profitable of the two alternatives and even if observers assume that the manager will make the profit-maximizing choice, the market may still be disappointed that the prior-favored choice was not the more profitable of the alternatives. This can occur, for example, if the likely driver of selection of the prior-disfavored choice is disappointing information about the prior-favored alternative. Where these papers focus on pleasing investors, Prendergast (1993) examines the incentives for subordinate managers to make recommendations consistent with the prior beliefs of their superiors.

Where in Scharfstein and Stein it is better to fail as part of the herd than to succeed as a deviant, Zwiebel (1995) describes a scenario in which it is always best to succeed, but where the fact that a manager's success is measured relative to others sometimes causes herding. The first premise of the model is that there are common components of uncertainty about managerial ability. As a result, observers exploit relative performance of managers to draw inferences about differences in ability. The second premise is that managers are averse to the risk of being exposed as having low ability (perhaps because the risk of firing is nonlinear). For a manager who follows the standard behavior, the industry benchmark can quite accurately filter out the common uncertainty. This makes following the industry benchmark more attractive for a fairly good manager than a poor one, even if the innovative project stochastically dominates the standard project. The alternative of choosing a deviant or innovative project is highly risky in the sense that it creates a possibility that the manager will do very poorly relative to the benchmark. Thus, the model offers an alternative explanation for corporate conservatism to the herd-free reputational models of Hirshleifer and Thakor (1992) and Prendergast and Stole (1996), and the memory-loss approach of Hirshleifer and Welch (2002).

However, in Zwiebel's model a very good manager can be highly confident of beating the industry benchmark even if he chooses a risky, innovative project. If this project is superior, it pays for him to deviate. Thus, intermediate quality managers herd, whereas very good or very poor managers deviate. Zwiebel's approach is suggestive that under some circumstances portfolio managers may herd by reducing the risk of their portfolios relative to a stock market or other index benchmark, but under others may intentionally deviate from the benchmark. Several papers pursue these and related issues such as optimal contracting in detail (see, e.g., Maug and Naik (1996), Gumbel (1998), Huddart (1999), and Hvide (2001)). Sciubba (2001) provides a model of herding by portfolio managers in relation to past performance. Brennan (1993) analyzes the asset pricing implications of such index-herding behavior.

In some models a principal designs institutions and/or compensation schemes in the face of managerial incentives to engage in informational cascades or making choices to match an observer's priors (Prendergast (1993) [discussed above], Khanna (1997), Khanna and Slezak (2000)). Khanna (1997) examines the optimal compensation scheme when managers have incentives to cascade in their investment decisions. He examines a setting in which the managers of competitor firms can investigate to generate private signals. A manager may delay investigation in the expectation of gleaning information more cheaply by observing the behavior of the competitor. A manager may also observe a signal but cascade upon the action of an earlier manager. Khanna describes optimal contracts that address the incentives to investigate and to cascade, and develops implications for compensation and investments across different industries.[14]

Khanna and Slezak (2000) provide an intra-firm model in which the tendency for cascades to start among managers reduces the quality of project recommendations and choices. This is a disadvantage of 'team decisions,' in which managers make decisions sequentially and observe each others' recommendations. Incentive contracts that eliminate cascades may be too costly to be desirable for the shareholders. A hub-and-spokes hierarchical structure where managers independently report recommendations to a su-

[14]See also Grant, King, and Polak (1996) for a review of informational externalities in a corporate context when there are share price incentives.

perior eliminates cascades, but requires superiors to incur costs of monitor subordinates to ensure that subordinates do not communicate. Thus, under different conditions the optimal organizational form can be either teams or hierarchy.

5 Herd Behavior and Cascades in the Analysis of Securities

5.1 Herd Behavior in Investigation and Trading

In an informational cascades setting where individuals have to pay a cost to obtain their private signals, once a cascades starts individuals have no reason to investigate. In security market settings, the assumption that the aggregate variance of noise trading is large enough to influence prices non-negligibly (as in the seminal paper of DeLong, Shleifer, Summers, and Waldmann (1990) and subsequent models of exogenous noise) implicitly reflects an assumption that individuals are irrationally correlated in their trades. This could be a result of herding (which involves interaction between the individuals), or merely a common irrational influence of some noisy variable on individuals' trades.[15]

The analysis of Brennan (1990) was seminal in illustrating the possibility of herd behavior in the analysis of securities. He provided an overlapping generations model in which private information about a security is not necessarily reflected in market price the next period. This occurs in a given period only if a pre-specified number of individuals had acquired the signal. Thus, the benefit to an investor of acquiring information about an asset can be low if no other investor acquires the information. However, if a group of investors coordinate to acquire information than the investors who obtain information first do well. Since the setting is special it has stimulated further work to see if herding can occur in settings with greater resemblance to standard models of security trading and price determination.

Froot, Scharfstein, and Stein (1992) offer a model that endogenizes price determination more fully. In their setting, investors with exogenous short horizons find it profitable to herd by investigating the same stock. In so doing they are, indirectly able to effect what amounts to a tacit manipulation strategy. When they buy together the price is driven up, and then they sell together at the high price. Thus, herding even on 'noise' (a spurious uninformative signal) is profitable.

[15] Golec (1997) provides a possible example of such a common irrational influence. He calls this 'herding on noise,' one of our two possible interpretations.

However, even in the absence of opportunities for herding there is a potential incentive for individuals, acting on their own, to effect such manipulation strategies. If individuals are allowed to trade to 'arbitrage' such manipulation opportunities, it is not clear that such opportunities can in equilibrium persist. This raises the question of whether there are incentives for herding per se rather than for herding as an indirect means of manipulation.[16]

Hirshleifer, Subrahmanyam, and Titman (1994) examine the security analysis and trading decisions of risk averse individuals, where investigation of a security leads some individuals to receive information before others. They find a tendency toward herding. The presence of investigators who receive information late confers an obvious benefit upon those who receive information early- the late informed drive the price in a direction favorable to the early-informed. But by the same token, the early-informed push the price in a direction unfavorable to the late-informed. The key to the model's herding result is that the presence of the late-informed allows the early-informed to unwind their positions sooner. This allows the early-informed to reduce the extraneous risk they would have to bear if, in order to profit on their information, they had to hold their positions for longer. This risk-reduction that the late-informed confer upon the early informed is a genuine ex ante net benefit- it is not purely at the expense of the late informed. Overconfidence about the ability to become informed early further encourages herding in this model; each investor expects to come out the winner in the competition to study the 'hot' stocks.

Holden and Subrahmanyam (1996) show that there can also be herding in the choice of whether to study short-term or long-term information about the stock. Intuitively, exploiting long-term information again involves the bearing of more extraneous risk, which can be costly.

5.2 Herd Behavior by Stock Analysts and other Forecasters

Several studies of forecasters have reported herding or herding-like findings. Ashiya and Doi (2001) report that Japanese macro-economic forecasters herd in their forecasts, regardless of their age. Ehrbeck and Waldmann (1996) find, consistent with psychological bias rather than rational reputational-oriented bias, that economic forecasters bias their forecasts in directions characteristic of high mean-squared-error forecasters. However,

[16] Another interesting question is whether short horizons can be derived endogenously. Dow and Gorton (1994) find that owing to the risk of trading on long-term information, prices will not fully reflect private information.

the analytical literature on stock market analysts has focused on rational reputational reasons for bias.

Analyst earnings forecasts are biased, as documented by Givoly and Lakonishok (1984), Brown, Foster, and Noreen (1985), and many more recent authors. Forecasts are generally optimistic in the U.S. and other countries, especially at horizons longer than one year (see e.g. Capstaff, Paudyal, and Rees (1998) and Brown (2001)). More recent evidence indicates that analysts' forecasts have become pessimistic at horizons of 3 months or less before the earnings announcement (Brown (2001), Matsumoto (2001) and Richardson, Teoh, and Wysocki (2001)).

Stickel (1992) finds that the compensation received by analysts is related to its ranking in a poll by *Institutional Investor* about the best analysts. Furthermore, forecasts by members of *Institutional Investor*'s of 'All-American Research Team' were more accurate than those of non- members. These findings suggests that analysts may have an incentive to adjust their forecasts to maintain good reputations for high accuracy.

Mikhail, Walther, and Willis (1999) find that analysts whose forecasts are less accurate than peers are more likely to turn over. This importance of relative evaluation supports the premise of reputational models of herding. However, they find no relation between either absolute or relative profitability of an analyst's *recommendations* and probability of turnover. Hong, Kubik, and Solomon (2000) find evidence suggesting that there are reputational incentives for analyst herding. Less experienced analysts are more likely to be terminated for 'bold' forecasts that deviate from the consensus forecast than are experienced ones, suggesting that the pressure to build reputation is strongest for analysts for which uncertainty about ability is greatest.

Trueman (1994) provide a model in which analysts tend to issue forecasts that are biased toward prior earnings expectations, and also herd in the sense that forecasts are biased toward those announced by previous analysts. In his analysis, an analyst has a greater tendency to herd if he is less skillful at predicting earnings-it is less costly to sacrifice a poor signal than a good one.

Stickel (1990) finds that changes in consensus analyst forecasts are positively related to subsequent revisions in analyst's forecasts, apparently consistent with herd behavior. This relationship is weaker for the high-precision analysts who are members of the 'team' than for analysts who are not. Thus, it appears that members of the 'team' are less prone to herding than non-members. This is consistent with the prediction of the Trueman model.

Experimental evidence involving experienced professional stock analysts has also supported the model (Cote and Sanders (1997)). Cote and Sanders report that these forecasters exhibited herding behavior. Furthermore, the amount of herding was related to the forecasters' perception of their own abilities and their motivation to preserve or create their reputations.

In contrast, Zitzewitz (2001) provides a methodology for estimating the degree of herding versus exaggeration of differences (the opposite of herding) by analysts. He reports that in fact analysts on average *exaggerate* their differences. He also finds that analysts under-update their forecasts in response to public information, indicating an overweighting of prior private information. This evidence opposes the conclusion that analysts on the whole herd. It is potentially supportive of reputational models in which some individuals intentionally diverge (e.g., Prendergast and Stole (1996)), or with over-confidence on the part of analysts in their private signals.

It is also often alleged that analysts herd in their choice of what stocks to follow. There is very high variation in analyst coverage of different firms Bhushan (1989). In his sample, the average number of analysts following a firm was approximately 14, but a number of firms were followed by only 1 analyst; the maximum number of analysts was 77. This is not inconsistent with herding by analysts in their coverage decisions, and indirectly by the investors that listen to them. But in the absence of any first-best benchmark for the dispersion of analyst following across firms, it is hard to draw any conclusion on this issue

There are also allegations that analysts herd in their stock recommendations. This issue is studied by Welch (2000), who finds that revisions in the buy and sell stock recommendations of a security analyst are positively related to revisions in the buy and sell recommendations of the next two analysts. He traces this influence to short-term information, identified by examination of the ability of the revision to predict subsequent returns.[17]

Welch also finds that analysts' choices are correlated with the prevailing consensus forecast. Welch further finds that the 'influence' of the consensus on later analysts is not stronger when it is a better predictor of subsequent stock returns. In other words, the evidence is consistent with analysts herding even upon consensus forecasts that aggregate information poorly. This is consistent with agency effects such as reputational herding, or could reflect imperfect rationality on the part of analysts. Finally, Welch finds an asymmetry, that the tendency to herd is stronger when recent returns have been positive

[17]This could reflect cascading, or could be a clustering effect wherein the analysts commonly respond to a common, independently observed signal.

('good times') and when the consensus is optimistic. He speculates that this could lead to greater fragility during stock market booms, and the occurrence of crashes.

The evidence on the recommendations of investment newsletters on herding is mixed. Jaffe and Mahoney (1999) report only weak evidence of herding by newsletters in their recommendations over 1980-96. However, Graham (1999) develops and tests an explicit reputation-based model of the recommendations of investment news letters, in the spirit of Scharfstein and Stein (1990). He finds that analysts with better private information are less likely to herd on the market leader, Value Line investment survey. This finding is consistent with the models of Scharfstein and Stein (1990) and Bikhchandani, Hirshleifer, and Welch (1992).

6 Herd Behavior and Cascades in Security Trading

Some sociologists have emphasized that the 'weak ties' of liaison individuals, who connect partly-separated social networks, are important for spreading behaviors across networks (Granovetter (1973). A recent literature in economics has examined the strength of peer-group effects in a number of different contexts (see, e.g., Weinberg, Reagan, and Yankow (2000), and the survey of Glaeser and Scheinkman (2000)). In a capital markets context, Shiller and Pound (1989) find based on questionnaire/survey evidence that word-of-mouth communications are reported to be important for the trading decisions of both individual and institutional investors. Two recent studies report that employees are influenced by the choices of coworkers in their decisions of whether to participate in different employer-sponsored retirement plans ((Duflo and Saez 2000), Madrian and Shea (2000)). Kelly and O'Grada (2000) and Hong, Kubik, and Stein (2001) provide further evidence that social interactions between individuals affects decisions about equity participation and other financial decisions. A theoretical analysis of learning from neighbors is provided by Bala and Goyal (1998).

6.1 The Endorsement Effect

According to informational cascades theory, endorsements can be extremely influential if the endorser has a reputation for accuracy, and if the endorsement involves an actual informative action by the expert. This could take the form of knowing that the expert took a similar action (buying a stock), but could also involve the expert investing his reputation in the stock by recommending it.

The choice by a big-five auditor, top-rank investment bank, or venture capital to invest its reputation in certifying a firm influences investor favorably toward the firm.[18] Furthermore, just as shopping mall developers use 'anchor' stores to attract other stores, according to McGee (1997) some IPO underwriters have been using the names of well-known investors as 'anchors' to attract other investors.[19]

There are many examples of influential investors, some more benign than others. In a story entitled "Pied Piper of Biotech Keeps Followers Happy with Cut-Rate Stock," the *Wall Street Journal, 5/7/92* says "Wherever David Belch invests his money , a crowd of stockbrokers and money managers is sure to follow. 'David Blech is the single most important force in the biotech industry,' says Richard Bock, a stockbroker... I follow whatever stock he goes into, knowing it will be a success.' "

Some investors are influenced in cold-calls by brokers by statements that famous investors are holding a stock (see Lohse (1998) on "Tricks of the Trade: 'Buffett is Buying This' and other Sayings of the Cold-Call Crew"). (Since Buffett is typically a passive investor, his influence reflects perceptions that he is well informed rather than that he will reorganize the firm.) One investment digest explicitly gave as its key reasoning for spotlighting a stock the fact that Buffett was involved in it (Davis (1991)).

When news came out that Warren Buffett had bought approximately 20% of the 1997 world silver output, according to The Economist (1998) silver prices were sent "soaring." When Warren Buffett's filings reporting his increased shareholding in American Express and in PNC Bank became public, these shares rose by 4.3% and 3.6% respectively (Obrien and Murray (1995)).

According to Sandler and Raghavan (1996), "Whether Warren Buffett has been right or wrong about a stock, investors don't like to see him get out if they're still in. Some investors in Saloman are focusing almost entirely on the famed Omaha, Neb.,

[18] See the models of Titman and Trueman (1986), and Datar, Feltham, and Hughes (1991), and the evidence of Beatty and Ritter (1986), Booth and Smith (1986), Johnson and Miller (1988), Beatty (1989), Carter and Manaster (1990), Feltham, Hughes, and Simunic (1991), Simunic (1991), Megginson and Weiss (1991), Michaely and Shaw (1995), and Carter, Dark, and Singh (1998). A salient recent example of this certification effect is the drop of 36% in the shares of Emex when First Boston denied Emex's claim that it was their investment banker (Remond and Hennessey (2001)).

[19] "As any fashion house knows, stitching a designer label on a pair of jeans allows it to charge two or three times the going rate for pants. Now, battling to set themselves apart from the crowd, and entice more investors to their initial public offerings of stock, fledgling technology companies with unproven products and no earnings are bragging of their ties to stock-market winners like Microsoft Corp., Cisco Systems Inc. or American Online Inc. Never mind that some of these anchor investors don't appear to be picky; they invest in bunches of smaller companies because they know that not every investment will pan out. The fact is, the hype works..." The article gives several examples in which tech stock analysts and investors may have been influenced by the cachet of anchor investors.

multibillionaire's decision, announced Sept. 12, ..." to convert Salomon preferred shares into common shares instead of taking cash.

Investing human capital is also form of endorsement; for example, when it was announced that John Scully was signing on as chairman and CEO of the little known firm Spectrum Information Technologies Inc., its stock jumped by close to 46%.[20] The influence of stock market 'gurus' is a sort of endorsement, but in some cases investors seem irrationally influenced by well-known but incompetent analysts. This may involve a limited attention/availability effect wherein investors use an analyst's visibility fame as an indicator of ability. A would-be guru can exploit the flaws of this heuristic by using even outlandish publicity stunts to gain notoriety; see, e.g., the description of Joseph Granville's career in Shiller (2000b).

Stock prices react to the news of the trades of insiders; see, e.g., Givoly and Palmaon (1985). It seems clear that these trades provide information to market participants, who adjust their own trading (as a function of price) accordingly. Such influence on the part of insiders potentially gives them the power to manipulate prices, as reflected in the analysis of Fishman and Hagerty (1995); see Fried (1998) for a discussion of the 'copycat theory' that insiders exploit imitators by trading in the absence of private information.

Investors are also influenced by private conversations with peers. For example, Fung and Hsieh (1999) state that "a great deal of hedge fund investment decisions are still based on "recommendations from a reliable source.' " There is also evidence that investors are influenced by implicit endorsements, as with default settings for contributions in 401(k) plans; see Madrian and Shea (2000).

6.2 A Challenge in Measuring Herding

An important challenge to empirical work on herding is to rule out clustering. Some external factor could be independently influencing different investors' trades in parallel, even if there were no interaction between the trades of the different investors in the alleged herd. In general it is hard to rule out clustering conclusively, though a few studies are able to do so in specific contexts. One method of addressing this is to include proxies for possible variables that may jointly affect the behavior of different individuals (for a general analysis of econometric issues in measuring social interaction, see, e.g., Brock and Durlauf (2000)). Of course, no matter how thorough the study, it

[20] *Wall Street Journal*, 10/14/93, "Sculley Becomes Chief of Spectrum, Placing Bet on Wireless Technology", John J. Keller)." A later *Business Week* investigation suggested that the CEO of Spectrum was "a manipulator who duped John Sculley and milked the company" (Schroeder (1994)).

is always conceivable that some joint causal factor has been omitted.

Some studies go further to examine natural or artificial experiments which rule out the possibility of an omitted influence. Sacerdote (2001) provides evidence of peer effects in a study of roommate choices with random assignments, so avoids this. Also, a growing literature starting with Anderson and Holt (1996) has confirmed learning by observing actions, and the existence of informational cascades in the experimental laboratory (see also Hung and Plott (2001), Anderson (2001), Sgroi (2000) and Celen and Kariv (2001)). Consistent with cascades, Dugatkin and Godin (1992) find experimentally that female guppies tend to *reverse* their mate choices when they observe other females choosing different males.

The simultaneous causation issue is present in most herding tests, but becomes more tricky in financial market tests because of the influence of price. It is possible for individuals to herd in a conditional fashion, dependent upon past price movements. However, even if we rule out all non-price joint causal effects, correlation in trades conditional upon price movements is not necessarily herding. For example, suppose that certain mutual funds have correlated trades that are associated with past price movements. This could indicate herding. On the other hand, it could be that some other group of investors such as individual investors is herding, and that the mutual funds are not. The mutual funds may merely be adjusting their trades in response to price movements. In the extreme, if there are only two groups of traders, then by market clearing, herding by one group of traders automatically implies correlation in the trades of the other group, even though there may be no interaction whatsoever between members of this other group.

Alternatively, it could be that some group of investors is jointly influenced by some unobserved influence, and again that the mutual funds are jointly responding to price. Once again, the correlation in the trades of the mutual funds does not imply herding. Thus, to verify that a group is truly herding, it is crucial either to control for price, or if not, to verify whether the causality of the behavioral convergence is really coming from the group in question or from other traders.

6.3 Evidence Regarding Herding in Trades

Several papers on institutional investors trading have developed alternative measures of trading; see, e.g., Lakonishok, Shleifer, and Vishny (1992), Grinblatt, Titman, and Wermers (1995), Wermers (1999). Bikhchandani and Sharma (2001) critically review alternative empirical measures of herding.

Griffiths et al (1998) find increased similarity of behavior in successive trades for securities that are traded in an open outcry market rather than a system trading market) on the Toronto stock exchange, consistent with the possibility of imitation-trading raised by the evidence of Biais, Hillion, and Spatt (1995). Grinblatt and Keloharju (2000)) provide evidence consistent with herding by individuals and institutions.

Institutional investors constitute a large fraction of all investors. By market-clearing it is impossible for all investors to be buyers or sellers. Although testing for herding by such a large group is not unreasonable, it certainly makes sense in addition to examine finer subdivisions of investors. In older studies, Friend, Blume, and Crockett (1970) found, during a quarter in 1968, a tendency for mutual funds to follow the investment decisions made in the previous quarter by successful funds. Kraus and Stoll (1972) found that in a sample of mutual funds and bank trusts from 1968-9 attribute the large trade imbalances they find in stocks to chance rather than correlated trading. Klemkosky (1977) found that in 1963-72 that stocks bought by investment companies (mainly mutual funds) subsequently do well.

Using quarterly data on the portfolios of pension funds from 1985-89, Lakonishok, Shleifer, and Vishny (1992) find relatively weak evidence that pension funds engage in either positive feedback trading or herding, with a stronger effect in smaller stocks. Grinblatt, Titman, and Wermers (1995) find that most stock mutual funds purchased past winners during 1974-84. They find a tendency for funds to buy and sell stocks at the same time in stocks in which a large number of funds are active. Herding was strongest among aggressive growth, growth and income funds. Wermers (1999) finds that during 1975-94 there was little herding by mutual funds in the average stock, but that there was herding in small stocks and in stocks that experienced high returns. Growth-oriented mutual funds tended to herd in their trades. He also found superior performance among the stocks that herds buy relative to those they sell during the six months subsequent to trades, especially among small stocks. Nofsinger and Sias (1999) report that changes in institutional ownership are associated with high contemporaneous stock and returns, that institutions tend to buy after positive momentum, and that the stocks institutions buy outperform those that they sell. On a shorter time scale, Kodres and Pritsker (1997) report herding in daily trading by large futures market institutional traders such as broker-dealers, banks, and hedge funds, although measurement issues create significant challenges

Brown, Harlow, and Starks (1996) and Chevalier and Ellison (1997) find that fund managers that are doing well lock in their gains toward end of the year by indexing the market, whereas funds that are doing poorly deviate from the benchmark in order to try to overtake it. Chevalier and Ellison (1999) indentify possible compensation incentives for younger managers to herd by investing in popular sectors, and find empirically that younger managers choose portfolios that are more 'conventional' and which have lower non-systematic risk.

6.4 Creditor Runs, Bank Runs, and Financial Contagion

An older literature argued that bank runs are due to 'mob psychology' or 'mass hysteria' (see the references discussed in Gorton (1988)). At some point economists may revisit the role of emotions in causing bank runs or 'panics,' and more generally causing multiple creditors to refuse to finance distressed firms. Such an analysis will require attending to evidence from psychology about how emotions affect judgments and behavior

At this point the main models of bank runs and of financial distress are based upon full rationality (for reviews of models and evidence about bank runs, see, e.g., Calomiris and Gorton (1991) and Bhattacharya and Thakor (1993) section 5.2) . There is a negative payoff externality in which withdrawal by one depositor, or the refusal of a creditor to renegotiate a loan, reduces the expected payoffs of others. This can lead to multiple equilibria involving runs on the bank or firm, or to bank runs triggered by random shocks to withdrawals (see, e.g., Diamond and Dybvig (1983)). This of course does not preclude the possibility that there is also an informational externality.

The informational hypothesis (e.g., Gorton (1985)) holds that bank runs result from information that depositors receive about the condition of banks' assets. When a distressed firm seeks to renegotiate its debt, the refusal of one creditor may make others more skeptical. Similarly, if some bank depositors withdraw their funds from a troubled bank, others may infer that those who withdrew had adverse information about the value of the bank's illiquid assets, leading to a bank run (see, e.g., Chari and Jagannathan (1988), Jacklin and Bhattacharya (1988)).

Bank runs can be modeled as informational cascades, since the decision to withdraw is bounded (the individual cannot withdraw more than 100% of his deposit). There is a payoff as well as an informational interaction: early withdrawals hurt loyal depositors, and more generally refusal of a creditor to renegotiate hurts other creditors. However, at the very start of the run, when only a few creditors have withdrawn, the main effect may be the informational conveyed by the withdrawals rather than the reduction in the bank's liquidity.

If assets are imperfectly correlated, cascades can pass contagiously between banks and cause mistaken runs even in banks that could have remained sound; (on information and contagion, see Gorton (1988), Chen (1999), and Allen and Gale (2000b)). This suggests that the arrival of adverse public information can trigger runs (see, e.g., Calomiris and Gorton (1991))

There is evidence of geographical contagion between bank failures or loan-loss reserve announcements and the returns on other banks (see Aharony and Swary (1996) and Docking, Hirschey, and Jones (1997)). This suggests that bank runs are triggered by information rather than being a purely non-informational (multiple equilibria, or effects of random withdrawal) phenomenon.[21] Saunders and Wilson (1996) provide evidence of contagion effects in a sample of U.S. bank failures during the period 1930-32. On the other hand Calomiris and Mason (1997) find that the failure of banks during the Chicago panic of June 1932 was due to common shocks, and Calomiris and Mason (2001) find that banking problems during the great depression can be explained based upon either bank-specific variables or publicly observable national and regional variables rather than contagion.

6.5 Exploiting Herding and Cascades

Firms often market experience goods by offering low introductory prices. In cascades theory, the low price induces early adoptions, which helps start a positive cascade. Welch (1992) developed this idea to explain why initial public offerings of equity are on average severely underpriced by issuing firms.[22] Neeman and Orosel (1999) provide a model of auctions in a winner's curse setting in which a seller (such as a firm selling assets) can gain from approaching potential buyers sequentially, inducing informational cascades, rather than conducting an English auction.

[21] There is also evidence of contagion in speculative attacks on national currencies (Eichengreen, Rose, and Wyplosz (1996)).

[22] An example is provided by the description of the Microsoft IPO in Fortune (1986) (p. 32): "Eric Dobkin, 43, the partner in charge of common stock offerings at Goldman Sachs, felt queasy about Microsoft's counterproposal. For an hour he tussled with Gaudette, using every argument he could muster. Coming out $1 too high would drive off some high-quality investors. Just a few significant defections could lead other investors to think the offering was losing its luster." This illustrates the use of price to induce cascades, and the result of the cascades model that individuals with high information precision are particularly effective at triggering early cascades.

7 Herding, Bubbles, and Crashes: The Price Implications of Herding and Cascading

Popular allegations of securities market irrationality often emphasize the contagiousness of emotions such as panic or frenzy. Critics often go on to argue that this causes excess volatility, destabilizes markets, and makes financial system fragile (see, e.g., the critical review of Bikhchandani and Sharma (2001) and references therein). There is indeed evidence that emotions are contagious and that this contagion affects perceptions and behavior (see, e.g., Hatfield, Cacioppo, and Rapson (1993), Barsade (2001)). In the classic fully rational models of securities market price formation, information is conveyed through prices or pricing functions that are observable to all, so there is no room for localization in the contagion process (Grossman and Stiglitz (1980), Kyle (1985)). Even recent models of herding and of informational cascades in securities markets involve contagion based upon observation of either market prices or trades, again leaving little room for localization.

On the other hand, the evidence discussed in Section 6 suggests that social interactions between individuals affects financial decisions. This suggests that the social or geographical localization of information may be an important part of the process by which trading behaviors spread. Furthermore, some sociologists and economists argue that there are threshold effects in social processes, where the adoption of a belief or behavior by a critical number of individuals leads to a tipping in favor of one behavior versus another (Granovetter (1978), Schelling (1978), Kuran (1989, 1998)).

Thus, an important direction for further empirical research is to examine how whether a localized process of contagion of beliefs and attitudes affects stock markets (see, e.g., Shiller (2000a)), and whether securities market price patterns are consistent with rational models of contagion. An important theoretical direction is to examine the implications for securities market trading and prices of conversation between individuals; see the analysis of DeMarzo, Vayanos, and Zwiebel (2000), and the concluding discussion of Cao, Coval, and Hirshleifer (2001).

If herding is driven by agency considerations, one would expect any price effects of herding to be driven by institutional investors. Sias and Starks (1997) provide evidence that institutional investors are a source of positive portfolio return serial correlations (both own-and cross correlations of the securities held by institutions). Aitken (1998) finds that the autocorrelation of the returns of emerging stock markets increased sharply at the time that institutional investors were expanding their positions in emerging markets. He argues that this indicates that this reflected the effect of fluctuating sentiment by institutional investors.[23]

There is a large and growing literature on contagion between the debt or equity markets of different nations (see, e.g., Bikhchandani and Sharma (2001)). Borensztein and Gelos (2001) report moderate herding in the trades of emerging market mutual funds during 1996-9, but was not stronger during crises than normal times. With regard to price effects of herding, there are some large correlations in returns, but it is hard to measure whether this is an effect of herding, and there is only mixed evidence as to whether correlations are higher during financial crises. Choe, Kho, and Stulz (1999) provide strong evidence of herding by foreign investors before the 1996-7 period of economic crisis for Korea, but herding was actually lower during the crisis period. Furthermore, they do not find any indication that trades by foreign investors had a destabilizing effect on Korea's stock market. Many studies have examined how the occurrence of a crisis in one country affects the probability of crisis in another country; see, e.g., Berg and Pattillo (1999) for a review of this research.

Experimental asset markets have been found to be capable of aggregating a great deal of the private information of participants; however, in complex environments the literature has shown that blockages form so that imperfect information aggregation is imperfect (see, e.g., Noeth et al (2002), Bloomfield (1996), and the surveys of Libby, Bloomfield, and Nelson (2001), Sunder (1995)). Experimental laboratory research provides a very promising direction for exploring the relationship of herding to market crashes (see, e.g., Cipriani and Guarino (2001b)). These should provide the raw material for new theorizing on this topic.

Gompers and Lerner (2000) provide evidence of 'money chasing deals' in venture capital. Inflows into venture capital funds are associated with higher valuations of the new investments made by these funds, but not with the ultimate success of the firms. Thus, it seems that correlated enthusiasm of investors for certain kinds of investors moves prices for non-fundamental reasons. However, Froot, O'Connell, and Seasholes (2001) find that portfolio flows in and out of 44 countries during 1994-98 were *positive*

[23] Christie and Huang (1995) are unable to detect 'herd behavior,' in the sense of high cross-sectional standard deviations of security returns at the time of large price movements. Rather than measuring herd behavior (social influence) per se, this is an indirect measure of the tendency for some group of investors to react in a common way more at the time of extreme shocks than at other times. However, it is not obvious what the fundamental benchmark should be for the association between large shocks and idiosyncratic variability; see also Chang, Cheng, and Khorana (2000), who report that in the U.S. and several asian markets, there is relatively little evidence of herding except for the two emerging markets in the sample; and Richards (1999).

forecasters of future equity returns, with statistical significance in emerging markets.

8 Herd Behavior and Cascades in Firms' Investment, Financing, and Reporting Decisions

It is often alleged in the popular press that managers are foolishly prone to fads in management methods (for examples and formal analysis see Strang and Macy (2001)) investment choices, and reporting methods.

Managers learn by observing the actions and performance of other managers, both within and across firms. This suggests that firms will engage in herding and be subject to informational cascades, leading to management fads in accounting, financing and investment decisions. The popularity of different investment valuation methods, securities to issue, and so on have certainly waxed and waned. There are booms and quiet periods in new issues of equity that are related to past stock market returns and to the past average initial returns from buying an IPO (see, e.g., Ibbotson, Ritter, and Sindelar (1994), Eckbo and Masulis (1995) and Lowry and Schwert (2002)). However, it is not easy to prove that fluctuations in investments and strategies result from irrationality, rational but imperfect aggregation of private information signals, or direct responses to fluctuations in public observables.

Takeover markets have been subject to seemingly idiosyncratic booms and crashes, such as the wave of conglomerate mergers in the 1960's and 70's, in which firms diversified across different industries, the subsequent refocusing of firms through restructuring and bustup takeovers in the 1980's, followed by the merger boom of the 1990s. Purchase of another firm: targets of a takeover bid are 'put into play,' and often quickly receive competing offers, despite the negative cost externality of having a competitor. Haunschild (1993) provides interesting evidence about apparent informational contagion of the decision to engage in a takeover. In her 1981-90 sample, a firm was more likely to merge if one of its top managers was a director of another firm that had engaged in a merger during the preceding three years.

Several papers have attempted to measure herd behavior in investment decisions. Jain and Gupta (1987) report only weak evidence of herding in loans to LDC's by US banks. D'Arcy and Oh (1997) study cascades in the decisions of insurers to underwrite risks and the pricing of insurances. Foresi, Hamo, and Mei (1998) provide evidence consistent with imitation in the investment decisions of Japanese firms.

Is there a more general tendency toward strategic imitation? Gilbert and Lieberman

(1987) examined the relation amongst the investments of 24 chemical products over two decades. They found that larger firms in an industry tend to invest when their rivals do not. In contrast, smaller firms tend to be followers in investment. This behavior is consistent with a 'fashion leader' version of the cascades model in which the small free-ride informationally on the large (where large firms may have greater absolute benefit from acquiring precise information, or scale cost economies in information acquisition). Survey evidence on Japanese firms indicates that a factor that encourages firms to engage in direct investment in an emerging economy in Asia is whether other firms are investing in that country. This is consistent with possible cascading based upon a manager's perception that rival firms possess useful private information about the desirability of such investment (Kinoshita and Mody (2001)). Greve (1998) provide evidence of firm imitation in the choice of new radio formats in the U.S.

Chaudhuri, Chang, and Jayaratne (1997) examine spatial clustering of bank branches in cities. They point out that banks are likely to have imperfect information about the potential profitability of opening a branch in a particular neighborhood. They show that a bank's decision to open a new branch in a census tract of New York City during 1990-95 depended on the number of existing branches in that tract. They use tract-level crime statistics land-use data, and socioeconomic data to control for expected tract profitability. They conclude that there is a positive incremental relation between a bank's decision to open a new branch and the presence of other banks' branches, consistent with information-based imitation.

Analogous to the endorsment effect in indivdual investor trading are endorsement effects in real investments. Real estate investment is a prime area of application for cascades/endorsement effects, because the investment decisions are discrete and conspicuous (Caplin and Leahy (1998) analyze real estate herding/cascading).[24]

Economists have long studied agglomeration economies as an explanation for geographical concentration of investment and economic activity (e.g., Marshall (1920), Krugman and Venables (1995, 1996)). Such effects are surely important. However, as pointed out by DeCoster and Strange (1993), geographical concentration can occur without agglomeration economies owing to learning by observation of others: 'spurious agglomeration.' Empirically some papers use previous investment by other firms

[24]For example, consider Bianco (1996) in *Business Week* entitled: "A Star is Reborn: Investors hustle to land parts in Times Square's transformation." The article states of Disney that "Its agreement to revamp the New Amsterdam Theater, a Beaux Arts gem, was like waving a magic wand: Wait-and-see investors piled in." After long delay, the transformation of New York's Times Square was triggered by an investment by Disney, after which "wait-and-see investors piled in," an illustration of simultaneity.

in a location as a proxy for agglomeration economies in predicting investment by other firms (e.g., Head, Ries and Swenson (1995, 2000)). Barry, Gorg, and Strobl (2001) empirically test between aggregation economies and what they call the "demonstration effects," whereby a firm locates in a host country because the presence of other firms there provides information about the attractiveness of the host country. They conclude that both agglomeration economies and agglomeration effects are important.

The observation of the payoffs, not just actions of rivals is clearly important in firms' investment decisions. For example, after Sara Lee Corp. introduced the fashionable Wonderbra to the U.S. in New York in May 1995, VF Corporation observed its popularity and then "surged ahead with a nationwide rollout five months ahead of Sara Lee..." (Weber (1995)). Referring to VF's 'second-to-the-market' business strategy, *Business Week* stated that "Letting others take the lead may be outre at Paris salons, but it's a winning style at FV."

Reporting and disclosure practices are variable over time; for example, recently it has been popular for firms to disclose *pro forma* earnings in ways that differ from the GAAP-permited definitions on firms' financial reports. Firms have argued that this allows them to reflect better long-term profitability by adjusting for non-recurring items. However, it is also possible that firms are just herding, or that they are exploiting herd behavior by investors. At this point the evidence is not clear, though regulators have expressed concern about this practice.

More generally, in a meta-study of accounting choices, Pincus and Wasley (1994) report that voluntary accounting changes by firms do not appear to be clustered in time and industry, suggesting no herding behavior in accounting changes. This result further indicates, surprisingly, that firms do not switch accounting methods in response to changes in macro-economic investment conditions that are experienced at about the same time by similar firms within an industry. Rather, the voluntary accounting changes would appear to be made in response to firm-specific needs, such as a firm-specific need to manage earnings.

However, it is not obvious why firms would need to manage earnings in response to firm-specific circumstances, yet would not want to manage earnings in response to a common factor shock. One speculative possibility is that there is a concern for relative performance, as reflected in the model of Zwiebel (1995), combined with some deviation from perfect rationality that causes investors to adjust imperfectly for accounting method in evaluating firms' earnings.[25] The concern for relative performance may create a

[25]For example, Daniel, Hirshleifer, and Teoh (2002) suggest that owing to limited attention, Hirsh-

stronger incentive for managers to manage earnings upward when the firm is doing poorly relative to peers than when the entire industry is doing poorly.[26]

9 Conclusion

According to Gertrude Stein (as quoted by Charlie Chaplin), "Nature is commonplace. Imitation is more interesting." We have described here why imitation is interesting for capital markets. In our discussion of rational observational learning, we described some emergent conclusions: idiosyncrasy (mistakes), fragility (fads), simultaneity (delay followed by sudden joint action), paradoxicality (more information of various sorts can decrease welfare and decision accuracy), and path dependence. We have explored how literature on herding, social learnings, and informational cascades can be applied to a number of investment, financing, reporting and pricing contexts.

We have also argued that these conclusions are fairly robust in rational social learning models. Depending on the exact assumptions, information may be completely suppressed for a period (until a cascade is dislodged); under other assumptions, information is asymptotically revealed, but too slowly. A setting where information arrives too slowly to be helpful for most individuals' decisions is essentially the same from the point of view of both welfare and predicting behavior as one where information is completely blocked for a while. Although cascades require discrete, bounded, or gapped action space, or cognitive constraints, we have argued that discreteness and boundedness are highly plausible in some financial settings. Even when these conditions fail, owing to noise, the growth in accuracy of the public information pool tends to be self-limiting, resulting in similar effects.

There are many patterns of convergent behavior and fluctuations in capital markets that do not obviously make immediate sense in terms of traditional economic models, such as fixation on poor projects, stock market crashes, sharp shifts in investment and unemployment, bank runs. Such behavioral convergence often appears even in the face of negative payoff externalities. Although other factors (such as payoff externalities) can lock in inefficient behaviors, the rational social learning theory and especially cascades theory differ in that they imply pervasive but fragile herd behavior. This occurs be-

leifer, Lim, and Teoh (2001) analyze explicitly how informed parties can adjust their disclosure decisions to exploit the limited attention of observers.

[26]Consistent with this idea, Morck, Shleifer, and Vishny (1989) provide evidence that the likelihood of hostile takeover forcing managerial turnover was high for firms underperforming their industry, but was not high when the industry as a whole was underperforming.

cause the accumulation of public information slows down or blocks the generation and revelation of further information. This idiosyncratic feature of cascades and rational observational learning models cause the social equilibrium to be precarious with respect to seemingly modest new shocks.

Rational observational learning theory suggests that in many situations, even if payoffs are independent and people are rational, decisions tend to converge quickly but tend to be idiosyncratic and fragile. Convergence arises locally or temporally upon a behavior, and can suddenly shift into convergence on the opposite behavior. The required assumptions, primarily discreteness or boundedness of possible action choices, are mild and likely to be present in many realistic setting. This suggests that the effects of observational learning and herding mentioned in the first paragraph of this section are likely to affect behavior in and related to capital markets. This includes both herding by firms, and actions by firms such as financing, disclosure and reporting policies that can potentially be managed to exploit investors that herd. Similarly, perhaps the special skill that some hedge fund and mutual fund managers seem to have is in exploiting the herding behavior of imperfectly rational investors.

Models of reputation-based herding do not typically share the fragility feature of rational observational learning theory. However, reputation-based models have much to offer in their own right. This includes explanation of those herds that seem stable and robust. As another example, the reputation approach helps explain dispersion as well as herding, and when one or the other will occur. Reputation models also offer a rich set of implications about the extent of herding in relation to characteristics of the agency problem and the manager.

Most instances herding in capital markets are likely involve mixtures of reputational effects, informational effects, direct payoff interactions, preference effects, and imperfect rationality. For example, to explain predictability in securities markets, some imperfect rationality is likely to be needed. Integration of the different effects will lead us to better theories about capital market behavior.

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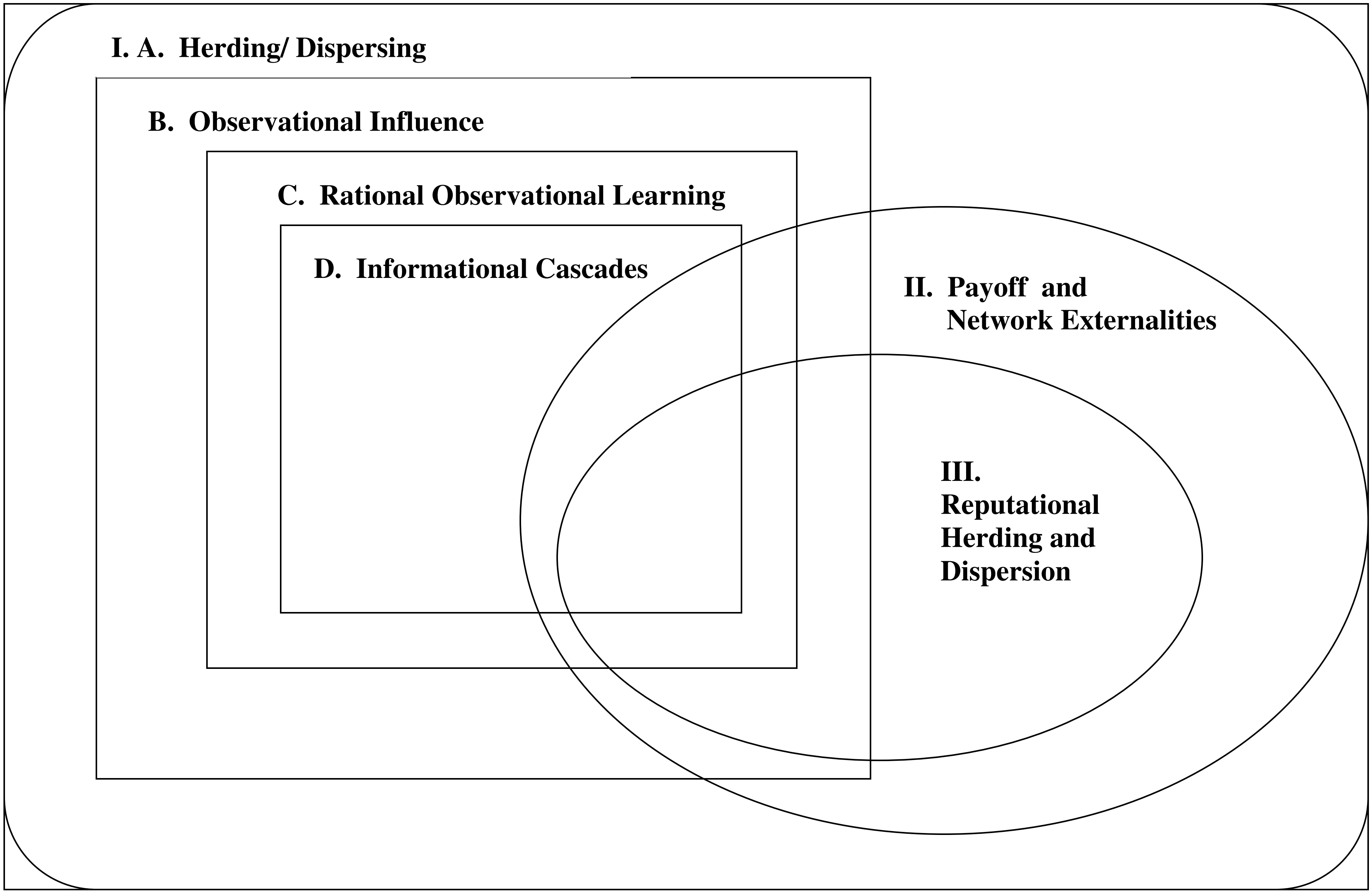

Figure 1: Topic Diagram