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INFORMATIONAL CASCADES AND SOCIAL CONVENTIONS

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Informational Cascades and Social Conventions

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1 Introduction

A striking regularity of human society is *localized conformity.* At one school teenagers abuse drugs and sex while at another they ``just say no". Time variation is striking as well, as with swings across decades among college-aged youths between pacifism and enthusiastic enlistment for war. Social popularity and acceptance of different religious practices, crime, vices and musical styles have fluctuated rapidly.

Localization in time or place may seem to cast doubt upon the rationality of decisionmakers, since variations in behaviors and social conventions often are not associated with obvious variations in costs and benefits. In such cases, how can both old and new behaviors be optimal? Examples include the shift in acceptance of cohabitation of unmarried couples in the U.S. from the 1950's to the present, the shift from the antibusiness college counterculture of the 60's to pre-MBA go-getting of the 80's, the unexpected collapse of communism in the Eastern Bloc, and various religious movements and revivals.

The main theme of this essay is that *learning by observing the actions of others* can explain the conformity, idiosyncrasy, and fragility of social behavior. When people within a group observe one another's behavior, they very often end up making the same choices. Thus, localized conformity. The decisions of an informed individual are a valuable resource to those who decide later. Self-interested individuals will not try to act in a way that makes their actions as informative as possible to followers. Thus, if early-movers err, followers are likely to imitate the mistake, leading to idiosyncrasy. If later on a few people start behaving differently for whatever reason, then the old convention may be swept away by rational imitation of the new behavior; hence fragility. Such imitation can explain either transient fads or permanent choices among alternative products, sexual and marital options, scientific theories, and religious beliefs.

Imitation can be based upon rational weighing of pros and cons. Individuals arriving in sequence to buy film tickets, for example, can gain useful information about the quality of the show by observing queues earlier arrivers. An individual may imitate the choices of predecessors even if his own limited information is opposing. Welch (1992) and Bikhchandani, Hirshleifer and Welch (1992) call such ignoring of own-information an *informational cascade* (see also Banerjee (1992)).

This self-reinforcing tendency gives sellers a strong incentive to induce early-movers to buy, as when new restaurants and performers hire people to attend and display enthusiasm conspicuously. The common phenomenon of low introductory prices for new products is thus a natural response by sellers to buyer cascades.

Bikhchandani, Hirshleifer, and Welch (1992) (BHW) show that informational cascades often spontaneously develop on the basis of very little information. People converge upon one action quite rapidly, and their decisions are *idiosyncratic* and *fragile*. In the BHW model, a sequence of individuals make successive choices (e.g., between two films) based on both private information received by each individual and on the observed decisions of earlier movers. With many individuals, with virtual certainty a point is reached where an individual rationally ignores his private information and bases his decision solely upon what he sees predecessors do. The accumulated evidence from predecessors outweighs his private information. The decision of this individual n is uninformative to later choosers. Thus, individual $n+1$ is no better informed than individual n, so she also joins the cascade. This reasoning extends to all later individuals. (Of course, this conclusion does not *always* follow: later movers may have different costs and benefits from adopting, or different accuracy of their private information signals.) For example, consider the stigma placed upon gaps in a personal resume. A rational employer can reasonably infer that other employers have probably detected something negative about the applicant. After enough rejection, even a good worker may become virtually unemployable.

In the cascades model, actions fluctuate randomly until the system lands at a *precariously stable* resting point, like a car teetering at the edge of a precipice. As decisions are made, evidence (in the form of past decisions) gradually accumulates in favor of one action or another. An action is fixed upon when the weight of the decision history grows just strong enough to overcome *one individual*'s opposing information. At that point, if the next individual is similar, he also is *barely* willing to ignore his own information signal, i.e., he is in a cascade. Since all further identical individuals do the same thing, a very small preponderance of evidence causes a landslide in favor of one alternative. Thus, a very small shock such as new public information can alter the behavior of many. So the restaurant, clothing style or political election campaign that is ``in" this week may be ``out" the next for no apparent reason.

Precarious stability is unlikely to last forever. An initially mistaken cascade can be corrected quite quickly as new information arrives. Of course, if the cascade is for a non-repeated activity (such as seeing a given movie or buying shares of a given initial public offering) or an infrequent activity (such as buying a car), this corrective force is less powerful.

In contrast with cascades model, most theories of conformity imply rigid behavior in the face of changing circumstances. For example, the threat of *sanctions upon deviants* (e.g., Akerlof (1976, 1980), Kuran (1989, 1991), Coleman (1987), and Hirshleifer and Rasmusen [1989]), can lock a dysfunctional social convention in place. Only seldom can a small shock affect the behavior of many individuals.

Payoff interactions can cause one individual's action to directly increase the benefit to another of doing the same thing (see Schelling [1978], Farrell and Saloner [1985], Arthur [1989], Katz and Shapiro (1994); for a skeptical viewpoint, see Liebowitz and Margolis [1994]). Thus, conventions such as driving on the right hand side of the road are self-enforcing. Relatedly, individuals with *conformity preference* directly prefer to do the same things that others are doing. The stable action may not be the best one (see Jones [1984]). As Becker (1991) shows, a seller may price close to the edge of demand instability.

With *parallel reasoning*, everyone independently figures out the best alternative. With *direct communication*, those who figure out the best choice pass their information on to others.

Neither theory explains why mass behavior is error-prone.

2 The Basic Model

Consider a setting where each individual observes only the *actions* of predecessors, not their information signals. (`Actions speak louder than words.') Each individual in a sequence observes the decisions (smoking or not) of all predecessors. Everyone has the same costs and benefits from adopting the behavior. If smoking is healthful its net value is +$1, and if harmful, -$1, with equal probability. Each individual then privately observes a private signal: *H* (favorable to smoking) versus *L* (unfavorable), which is informative, but inconclusive.

If adoption is the optimal action, each individual has a 3/4 chance of observing *H*, and a 1/4 chance of observing *L*. These probabilities are reversed if rejection is optimal. Given the optimal action, signals are independent, so Berenice may see *L* even if Ahmet sees *H*.

Each individual decides after observing his own information signal and the actions of predecessors. (If indifferent, he flips a fair coin.) In Diagram 1, Ahmet, the first individual, adopts if he observes signal *H* and rejects if he sees *L*. So Berenice can infer that Ahmet adopted if and only if his signal was *H*. If Ahmet adopted, Berenice should also adopt if her signal was *H*. If Berenice's signal is *L*, it is offset by Ahmet's *H* signal, so she tosses a coin to decide. Similarly, if Ahmet rejected, Berenice rejects if she sees *L*, and tosses a coin if she sees *H*.

For Charles, if (1) both Ahmet and Berenice adopted, Charles adopts too, because he knows that Ahmet observed *H*, and that Berenice probably did too (though she may have seen *L* and flipped a coin). So Charles adopts *even if he sees an L signal*; he is in an *UP cascade*. Similarly, if (2) both predecessors rejected, Charles is in a *DOWN cascade*. If (3), Ahmet adopted and Berenice rejected (or vice versa), Charles knows that Ahmet observed *H* and Berenice observed *L* (or vice versa). Since these signals cancel, Charles follows his own signal.

In the cascades case wherein both predecessors adopted, since Charles adopts regardless of his signal, his action *provides no information to successors* about the desirability of smoking. So even if both Charles and Desi have L signals, Desi continues the UP cascade. This reasoning extends to Eric, Fiona, ... Linda, ... Zorro... and so on. Since opposing information remains hidden, an early preponderance toward either adoption or rejection, however mistaken, is self-reinforcing.

The overall outcome is therefore idiosyncratic and history-dependent, even though individuals' information would, if combined, yield very accurate decisions. The discreteness of actions reduces their informativeness and, owing to cascades, increases the likelihood of error. There is indeed evidence that individuals' choices influence observers, as when farmers observed neighbors' adoption of hybrid corn (Ryan and Gross [1943]). Going beyond the numerical example, cascades can form even if individuals observe only a few `neighbors', or observe only a summary statistic of past actions.

The fallibility of cascades makes them *fragile*. If some individuals have more precise signals than others, or if public news is revealed at a later date, or if the relative desirability of adopting versus rejecting changes, then cascades are easily reversed. Thus, cascades help explain fads in which the actions of large groups of individuals suddenly change in response to a very small stimulus.

In this setting, *cascades must arise eventually* (see Bikhchandani, Hirshleifer and Welch (1992); Banerjee (1992)). Intuitively, information keeps accumulating until a fairly mild preponderance of evidence favors one or the other action. Once this happens, a cascade starts, so the public information pool is not very conclusive. Typically, cascades begin surprisingly soon. Even when information signals are very noisy (so that *H* is only weakly associated adoption being optimal), the probability of a cascade forming after ten individuals is greater than 99%!

The probabilities of a DOWN cascade after two individuals *given that in fact adopting is superior* can be remarkably high. With a signal accuracy is 60%, so that when adopting is preferable, 60% of the time an H signal is observed, about 1/3 of the time the wrong cascade occurs. Owing to cascades, long-term outcomes depend heavily on chance circumstances and early choices.

2.1 Fashion Leaders

When information precisions differ, the idiosyncrasy of cascades can become more extreme. In the binary signal example, the action of a single initial expert may cause millions to follow. If everyone knows that Ahmet, a doctor, has slightly better information about whether or not to eat oat bran, and if Ahmet acts first, a cascade starts *immediately.* Berenice should imitate her better-informed predecessor, making her action is uninformative. If Charles is like Berenice he also imitates, and the cascade continues indefinitely. Ahmet sways a long train of followers even though his information is far less accurate than the *combined* information of a thousand individuals like Berenice.

When individuals decide *when* to move, BHW conjecture that higher-precision individuals will tend to act first, since they have less gain from observe others (see Zhang, forthcoming). Thus cascades should form extremely rapidly (after one individual), which may be disastrous.

In contrast, if Ahmet has slightly *lower* information precision than followers, his action does *not* start a cascade; Berenice should follow her own signal. This hurts Berenice slightly, but now her action is informative to all who follow. Charles and all successors therefore benefit substantially. Thus, modest early differences in precision can make a big difference later. If a higher-precision individual show up late, he can shatter a cascade, because he is more inclined to use his own information signal. His action conveys valuable information to followers.

This suggests that decision-makers should be ordered inversely with their precisions. Perhaps this is why, according to the Talmud, the ancient Hebrew judges of the Sanhedrin voted in inverse order of seniority, a practice also followed in US Navy court-martials. More generally, judges sitting in lower-level courts making initial judgments are normally less experienced (less precise?) than those in higher appellate courts.

There is indeed evidence that ill-informed decisionmakers imitate accurate ones (see applications below). Experiments have found that a human subject's failure in a task raises the probability that in further trials he will imitate a role-model (Thelen, Dollinger, and Kirkland [1979]). Children instinctively imitate their parents and teachers. Newborns as early as 42 minutes old imitate the facial expressions of adults. Indeed, Meltzoff (1988) suggests that imitation is such a fundamental propensity of the human infant that we should be called `*homo imitans.*' Imitation of high prestige individuals may be based on a belief that the prestigious are good decisionmakers. As Bandura (1977) says, ``in situations in which people are uncertain about the wisdom of modeled courses of action, they must rely on such cues as general appearances, speech, style, age, symbols of socioeconomic success, and signs of expertise as indicators of past successes."

3 Fragility of Cascades: Further Considerations

The conformity brought about by cascades remains brittle even after many individuals adopt. Thus, the arrival of a little information, or the mere possibility of a value change (even if the change does not actually occur) can shatter an informational cascade.

3.1 The Public Release of Information

The release of public information *prior to the start of a cascade* can make some individuals worse off (in an ex ante sense). Public information release has two effects on an individual: (i) it directly provides information, and (ii) it changes the decisions of predecessors, and the information conveyed thereby. A film review that provides very noisy information is only slightly useful to Berenice. Since Ahmet's choice may turn out to be significantly less informative to Berenice, this indirect disadvantage can outweigh the direct benefit.

Thus, it is not obvious that health authorities should quickly disseminate noisy information. Sketchy disclosures of possible advantages of oat bran, fish-oil, or Prozac, can trigger harmful fads. Of course, clear-cut information (e.g., smoking causes cancer) are likely to benefit all users.

Once a cascade starts, individuals' decisions convey no further information. An informative public disclosure at this point cannot reduce the information conveyed by individual's decisions. So identical individuals welcome public information Such a public disclosure may therefore be beneficial. How much public information is required to shatter an established cascade? Even a public signal less informative than the private signal of a single individual can do the trick. Thus, a film reviewer whose information is no better than others' can still sway thousands.

In the illustrative model given earlier, suppose that adoptions and rejections are evenly split until Eric and Fiona both adopt. Successors recognize two possibilities: (1) both received favorable (H) signals, or (2) Eric observed H and Fiona observed L, leading her to flip a coin. Consider a film review almost as informative as a typical viewer's signal. Gerard can reason that even if Eric and Fiona *both* observed H, a negative restaurant review almost cancels out one H. So if Gerard observes L, he is almost indifferent. Since Fiona may actually have observed L, Gerard should reject, breaking the cascade.

4 Examples

Cascades occur when individuals with inconclusive private information make discrete decisions sequentially. This section discusses how well the cascades model's assumptions and implications it some actual applications. Some criteria pertaining to model assumptions are: (i) Do individuals observe the actions of others?; (ii) Do individuals learn from direct discussion with others?; and (iii) Are informational effects more important than other effects?

Point (ii) is not crucial, since `actions speak louder than words.' Regarding (iii), non-informational factors (sanctions against deviants, payoff interdependence, desire to conform) may also be present. Sometimes payoff interactions are negative, which *opposes* uniformity. An early entrant in a new line of business is a potential competitor to followers. If such entrance attracts followers, this suggests that information effects are overcoming negative payoff interaction. Even when payoff interactions, sanctions, or conformity preference support uniformity, cascades may still describe the process which determines which alternative is fixed upon.

A second group of criteria pertain to implications of the theory: (i) is behavior localized and idiosyncratic (often mistaken)?; (ii) is behavior fragile?; and (iii) do individuals follow predecessors in opposition to their own private information?

4.1 Politics

The political scientist Bartels (1988) has discussed ``cue-taking" in presidential nomination campaigns, in which one person's assessment of a candidate is influenced by the choices of others: ``. . . `25,000 solid New Hampshirites (probably) can't be too far wrong.' " Several studies have found that respondents who are aware of favorable poll results rate a candidate more favorably. Bartels points out (consistent with the cascades theory) that ``There need not be any actual process of persuasion . . . the fact of the endorsement itself motivates me to change my substantive opinion of ... [the candidate]." While non-informational theories can explain why poll results influence *voting,* they do not explain why poll results influence *approval ratings.* According to the cascades theory, approval ratings of a candidate should increase after early victories. Bartels found such an ``internalized effect" in the early stages of the 1984 Hart-Mondale contest for the Democratic nomination.

A common criticism of the primary system is that voters in early primaries carry disproportionate weight, as with the Iowa voters who gave an obscure candidate named Jimmy Carter a conspicuous early success In the 1976 US presidential campaign. As a result, many Southern states have coordinated their primaries on the same date (``Super-Tuesday"). Many regard early reporting of election results as undesirable because results may influence later voters. Several European countries prohibit publication of poll results close to the dates of elections.

Public protests, demonstrations and political riots can also convey information to observers. In Lohmann (1992), such actions occur repeatedly over time, and turnout fluctuates until a cascade forms. Since people have different gains from a political regime change, and choose when to protest, protests conveys information gradually over time. An unexpectedly high turnout, even if the numbers are small, communicates stronger opposition to the regime, stimulating further turnout. Based on evidence from sequences of polls of demonstrators in 5 cycles of protest in Leipzig and the public at large, Lohmann (1994) argues that a dynamic informational cascades model provides the most satisfactory explanation for the process by which communism fell in then-East Germany.

4.2 Zoology

Even for animals, vicarious learning beats hard experience. Animals frequently copy the behavior of others in territory choice, mating, and foraging. Innovations known to have spread by imitation include sweet potato washing by Japanese macaques and milk-bottle-opening by British tits.

Territorial animals cluster more than can be accounted for by the clustering of high-quality sites; territories are often not clumped at the best available sites (Stamps [1988]). According to the cascades theory, the location of clusters will be fairly idiosyncratically determined by the choices of a few early settlers. Indeed, some zoologists argue that males take the presence of nearby males territories as an indicator of high resource quality.

In several species females copy other females in choosing a mate. Pomiankowski (1990) discusses evidence of female imitation in fallow deer and sage grouse. Gibson, Bradbury and Vehrencamp [1992] found that sage grouse females make more uniform mate choices when they arrived at the male mating display area together, so that they can observe which males other females choose. The unanimity of mate choice is not explained by any characteristics of males or sites detectable to human researchers. This arbitrariness is consistent with informational cascades.

Remarkably, Dugatkin (1992) shows that ``... females [of the Trinidadian guppy *Poecilia reticulata*] copy the choice of mates made by other females by viewing such interactions, remembering the identity of the chosen male, and subsequently choosing that male in future sexual endeavors." Dugatkin and Godin (1993) find that ``... younger females copy the mate choice of older females, but older females do not appear to be influenced by the mate choice of younger individuals." This is consistent with the ``fashion leader" model at the end of Section 2. Older females, being more experienced at choosing males, are presumably presumably able to interpret environmental cues more accurately than youger females. Dugatkin and Godin (1992) established that

> ... copying can even override a female's original preference of mates ... That is, a female's preference for a particular male ... can be reversed if she has the opportunity to see a (model) female choose the male she herself did not choose previously.

This experiment identifies a key aspect of informational cascades, that an individual's private information can be overridden by the observation of others' actions.

4.3 Medical Practice and Scientific Theory

Most doctors are not at the cutting edge of research; their inevitable reliance upon what colleagues have done or are doing leads to numerous surgical fads and treatment-caused illnesses (``iatroepidemics") (Robin [1984] and Taylor [1979]). The cascades theory predicts fads, idiosyncrasy, and imitation in medical treatments. The practice of bleeding to remove bad blood, popular until the 19th century is a familiar example. Many dubious practices seem to have been initially adopted based on weak information. Examples include the popularization in the 1970's of elective hysterectomy (the routine surgical removal of the uterus of women past childbearing age), and routine tonsillectomy (the surgical removal of tonsils). An English panel asserted that tonsillectomy was being ``...performed as a routine prophylactic ritual for no particular reason and with no particular result." Also notable are the extreme differences in tonsillectomy frequencies in different countries and regions.

Burnum (1987) discusses ``bandwagon diseases" diagnosed by physicians who behave ``. . . like lemmings, episodically and with a blind infectious enthusiasm pushing certain diseases and treatments primarily because everyone else is doing the same." Since even one adoption can start a cascade, patients seeking a second opinion should consider withholding the first doctor's diagnosis.

Academia is notorious for fads and fashions. The volume and complexity of material a scholar must process makes it impossible to examine critically the evidence underlying all major theories relevant for a line of research. Since knowledge is interrelated, scholars are compelled to specialize and then accept useful theories and techniques from other areas because *others have done so.*

In the fashion leader model, the decision by the first (well-informed) individual persuaded everyone after to imitate. In academics, nascent theories do seem to enjoy greater success when the initiator is famous and from a major university. The cascades theory implies that academics eminence is itself idiosyncratic. Since it is costly to assess the achievements of another researcher, we accord respect to those who have been acclaimed. As Ghiselin (1989) says: "The mere fact of eminence provides a cheap substitute for inquiring as to the basis upon which that eminence rests." Similarly, an academic job applicant who receives a few prestigious interviews or early job offers may become a "star," attracting offers widely as a result. Similar imitation is common in tenure decisions and the appointments to chaired professorships. The idiosyncrasy of academic eminence makes the choices of academic fashion leaders noisier, which can cause errors in the initial acceptance or rejection of new ideas.

4.4 Finance

Foresi and Mei (1991, 1992) provide evidence consistent with imitation in corporate investment decisions. An important discrete investment is the purchase of another firm. Firms that are "put into play" by takeover bid often receive immediate competing offers. Yet competing for an in-play target is more expensive than buying a target not sought by a competitor. This suggests that potential bidders learn from the first bid that the target is an attractive candidate for takeover. More broadly, 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, and the subsequent refocusing of firms through restructuring and bustup takeovers in the 1980's.

Several models of individual investment are based on imitation of predecessors. Welch (1992) focuses on informational cascades among purchasers of equity being issued publicly for the first time; see also Noah (1997). 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 follow, leading to a bank run. In both examples, there is a payoff as well as an informational interaction: early withdrawals hurt loyal depositors. However, at the very start of the bank run, when only a few depositors have withdrawn, the *information* conveyed by actions may be the dominating influence upon other depositors. An analysis of informational cascades in the start of bank runs is provided by Corb

(1993). Chen (1993) examines contagious cascades of runs between banks.

Stock market price fluctuations have often been described with such phrases as ``manias," ``panics," ``fads," ``animal spirits," ``investor sentiment" and ``bubbles." In the basic cascades model the cost of ``adopting" (buying a stock) is constant. In practice, a wave of purchases will drive up price. Lee (1993) has shown that market booms and crashes can occur in a cascades model that endogenizes price. Gervais (1997) shows that cascades can occur that limit the information investors learn through price about other investors.

4.5 Peer Influence and Stigma

Why does crime vary widely over time and location, even after holding constant socioeconomic factors such as poverty? According to Kahan (1997), a crucial source of variation is that individuals learn about what sort of behavior is profitable and acceptable by observing the actions of others. Thus, either high- or low-crime equilibria are possible under a given set of external conditions. Consistent with the cascades approach, he suggests that policies which affect the ability of individuals to observe criminal behavior of others (such as curfews, anti-loitering, and `zero tolerance' policies) can dramatically affect overall crime rates.

Acording to Keegan (1987), based on his personal conduct on the battlefield, Alexander the Great was ``. . . the supreme hero." For example, ``at Multan, he attempted to take the city virtually single-handed. It was thus that he suffered his nearly fatal wound." The example of Alexander's astonishing courage inspired others to fight harder. Packenham (1979, p. 133) describes the willingness of English officers to risk their lives in order to rally the troops in the Boer War. More generally, in battle, waves of optimism or pessimism often make the difference between victory and defeat. A deserter not only denies *aid* to comrades (payoff interaction), but may cause an *inference* that he viewed victory unlikely (du Picq 1921). Thus, heroic leadership may have an informational basis. As in the fashion leader model, the actions of officers who know more about the prospects for victory should strongly influence the morale and behavior of the troops.

Conformity to peers in general is often assumed automatically to be due to coercion rather than informational effects. (Contrast the popularity of the pejorative phrase ``peer pressure," with the more neutral term ``peer influence.") The cascades theory emphasizes the voluntary nature of conformity, especially among the inexperienced and uninformed. Genuine coercion can arise from the threat of stigma, a shared negative treatment of someone who violates group norms. But stigma may sometimes have informational roots: a frequent job- or marriage-partner- switcher may have been rejected by others.

5 Fads

Customs and standards sometimes shift abruptly without obvious reason. Since in the basic cascades model individuals make irrevocable decision in strict sequence, fads are defined here as shifts in behavior between early and later individuals based on little news. However, the cascades concept extends to settings in which individuals choose a time to switch from one behavior to another (Chamley and Gale (1992), Lohmann (1992), Caplin and Leahy (1994), Grenadier (1997).)

This kind of shock to the system considered here is a small probability that the underlying value of adopting versus rejecting can change after the 100th individual (say). If it used to be better to adopt, and now it is better to reject, then people may notice this fact and act accordingly. More interestingly, the cascade can switch not just because the right action has changed, but because people *think it may* have changed. Since individuals are not confident that the initial cascade was correct, they shift at the slightest provocation. For example, even if adopting was optimal and the original cascade was correct, individual 101 may happen to observe an L signal and wrongly switch to rejecting because he thinks that now rejection has become superior. Thus, the likelihood of an action change (from a cascade of rejection to one of acceptance, or *vice versa*) can be far greater than the probability that the correct choice has changed. BHW (1992) provide a numerical example in which, after the 100'th individual, there is a 5% chance of a switch in best action (from Adopt to Reject, or vice versa). This leads to a probability of over 9.35% that the cascade is at some point reversed, which is 87% higher.

I have focused on one source of fads, value changes. Other types of noise or shocks can have similar effects. For example, individuals who can't perfectly observe or recall what predecessors did (as in Banerjee/Fudenberg 1995, Cao/Hirshleifer 1995a), or think their costs and benefits differ may be inclined to switch. Again, this can lead to abrupt shifts in the behavior of many.

6 The Decision to Acquire Information

It's cheaper to rely on the decisions of others than to investigate yourself. Suppose that identical individuals decide in sequence whether to pay to investigate or to decline, and then whether to adopt or reject. Then whenever an individual declines to investigate, all followers do likewise. For example, if Desi declines, then Eric knows no more than Desi, and his decision problem is identical. This reasoning extends to all successors.

A late individual is virtually sure to be in a cascade, in which case he would not use any purchased information. Thus, individuals who are late in the queue virtually never acquire information. Rogers and Shoemaker (1971) conclude from 12 empirical studies on diffusion of innovations that ``early adopters seek more information about innovations than later adopters."

Even when individuals observe the *signals* of predecessors (not just actions), cascades can form and bring about idiosyncratic behavior and fragility (see Smith/Sorenson (1995), Cao and Hirshleifer 1995b). As soon as public information favors one action over another enough to dominate one individual's signal, later individuals will imitate without investigating. The ability to observe predecessors can even reduce decision quality, if followers stop investigating and observe predecessors with noise (Cao and Hirshleifer 1995a). This is consistent with evidence of Gibson et al (1992) that decision quality in sage grouse apparently declined when there were opportunities to observe others.

7 Conclusion

The theory of informational cascades helps explain how conventions arise, are maintained, and are broken. Since cascades start readily based on very weak information, the conformist outcome is often mistaken. While this cascade of conventional behavior can become quite *long*, it is not *strong*. A small shock, such as a public information disclosure, a value change, or even the possibility of such a change, can lead to an abrupt shift. In some theories of change, actions are unstable only if the system coincidentally is balanced near a knife-edge. Under informational cascades the system *systematically* moves to a precarious position everyone is doing the same thing but just barely prefers to do so.

The basic cascades model implies occasional, irregular bouts of sudden change when people reestimate the costs and benefits of decision alternatives. In some theories of fads or fashion, change occurs regularly because individual's preferences over alternatives directly depends on what others are doing. For example, whether a short skirt is acceptable this season depends on what others do. In practice, several forces may operate simultaneously. But even if people want to conform, for example, they face the informational issue of determining what decision others are expecting to be the norm (e.g., short or long skirts). Cascades theory suggests that in such situations the actions of the first few individuals will still be extremely influential, and can help explain the *process* by which society switches from one steady state to another.

I will mention two possible further extensions of the cascades approach to social conventions and change. First, in designing organizations or societies, it may be desirable to separate groups and later combine them, so that the information of several cascades can be aggregated. Khanna and Slezak (1996) study information flows in organizations. If subordinates have useful but noisy information, then an upward flow of project recommendations may preserve their information much more effectively than a decision process that moves downward through the hierarchy.

Second, if costs of adoption vary acrosss individuals, then cascades of adoption can be broken. Hirshleifer and Welch (1995; in progress) show that cascades are just a special case of a more general phenomenon which we call inertia. When an individual such as a corporate manager can observe previous decisions (of his predecessor) but not previous signals, the new manager is often biased in favor of continuing and even *escalating* the old policies.

References

Akerlof, George A. 1976 ``The Economics of Caste and of the Rat Race and Other Woeful Tales." *Quarterly Journal of Economics* 90 (4) (Nov): 599-617.

Akerlof, George A. 1980 ``A Theory of Social Custom, of which Unemployment May Be One Consequence." *Quarterly Journal of Economics* 94 (June): 749-75.

Arthur, Bryan. 1989 ``Competing Technologies, Increasing Returns, and Lock-in by Historical Events." *The Economic Journal* 99 (March): 116-31.

Bandura, Albert. 1977 *Social Learning Theory.* Englewood Cliffs, New Jersey: Prentice Hall.

Banerjee, Abhijit. 1992 ``A Simple Model of Herd Behavior." *Quarterly Journal of Economics,* 107, August:797-818.

--------- and Fudenberg, Drew. 1995 ``Word of Mouth Learning." Mimeo, MIT, September.

Bartels, Larry M. 1988*Presidential Primaries and the Dynamics of Public Choice.* Princeton University Press, Princeton, New Jersey.

Becker, Gary S. 1991``A Note on Restaurant Pricing and other Examples of Social Influences on Price." *Journal of Political Economy* 99 (October): 1109-16.

Bikhchandani, Sushil; Hirshleifer, David; and Welch, Ivo. 1992"A Theory of Fads, Fashion, Custom and Cultural Change as Informational Cascades." *Journal of Political Economy,* 100(5), October:992-1026.

Burnum, John F. 1987*New England Journal of Medicine,* 317, vol. 19 (November): 1220-1222.

Cao, Henry and Hirshleifer, David. 1995a "Limited Observability, Reporting Biases, and Informational Cascades", August, University of Michigan mimeo.

Cao, Henry and Hirshleifer, David. 1995b, "Costly Investigation and Informational Cascades", April, University of Michigan mimeo.

Caplin, Andrew and Leahy, John. 1994"Business as Usual, Market Crashes, and Wisdom after the Fact," American Economic Review, 84, :548-565.

Chamley, Cristophe and Gale, Douglas. 1993 ``Information Revelation and Strategic Delay in Irreversible Decisions." Econometrica, 62, :1065-85.

Chen, Yehning. 1993"Payoff Externality Information Externality, and Banking Panics." UCLA Anderson Graduate School of Management, October .

Coleman, James. 1987``Norms as Social Capital." in *Economic Imperialism: The Economic Approach Applied Outside the Field of Economics,* G. Radnitzky and P. Bernholz eds., NY: Paragon House .

Corb, Howard M. 1993"The Nature of Bank Runs." Graduate School of Business, Stanford

University.

du Picq, Charles Ardant. 1921*Battle Studies: Ancient and Modern Battle.* New York: MacMillan Press.

Dugatkin, Lee A. 1992``Sexual Selection and Imitation: Females Copy the Mate Choice of Others." *American Naturalist*, 139, : 1384-9.

Dugatkin, Lee A. and Godin, Jean-Guy J., 1992``Reversal of Female Mate Choice by Copying in the Guppy *Poecilia reticulata*), *Proceedings of the Royal Society of London*, Series B.

Dugatkin, Lee A. and Godin, Jean-Guy J., 1993``Female Copying in the Guppy *Poecilia reticulata*): Age-Dependent Effects." *Behavioral Ecology.*

Farrell, Joseph and Saloner, Garth. 1985"Standardization, Compatibility, and Innovation." *Rand Journal of Economics*, Spring , 16:1, pp. 70-83.

Foresi, Silverio and Mei, Jianping. 1991``Do Firms `Keep up with the Joneses?': Evidence on Cross-Sectional Variations in Investment." NYU Salomon Center Working Paper S-91-41, June .

Foresi, Silverio and Mei, Jianping. 1992``Interaction in Investment among Japanese Rival Firms." NYU mimeo, August .

Galef Jr., Bennet G. 1976 ``Social Transmission of Acquired Behavior: A Discussion of Tradition and Social Learning in Vertebrates." *Advances in the Study of Behavior* 6 : 77-100.

Ghiselin, Michael. (1989), *Intellectual Compromise: The Bottom Line*, New York, Paragon House.

Gibson, Robert M., Bradbury, Jack W., and Vehrencamp, Sandra L. 1992``Mate Choice in Lekking Sage Grouse Revisited: The Roles of Vocal Display, Female Site Fidelity, and Copying." *Behavioral Ecology*, 2, : 165-80.

Grenadier, Steven R. (1997), "Information Revelation through Option Exercise." Stanford University Graduate School of Business mimeo.

Hirshleifer, David, and Rasmusen, Eric. 1989 ``Cooperation in a Repeated Prisoners' Dilemma with Ostracism." *Journal of Economic Behavior and Organization* 12 (August): 87-106.

Hirshleifer, David, and Welch, Ivo. 1995``Institutional Memory, Inertia, and Impulsiveness." , University of Michigan Business School, Mitsui Life Working Paper No. 95-27.

Hirshleifer, David, and Welch, Ivo. ``Institutional Memory, Escalation, and Investment Decisions." (in progress).

Jones, Stephen R.G. 1984, *The Economics of Conformism.* Oxford: Basil Blackwell.

Kahan, Marcel, 1997, "Social Influence, Social Meaning, and Deterrence,", Virginia Law Review, 83(3), :276-304.

Katz, Michael L. and Shapiro, Carl. 1994 "Systems Competition and Network Effects." *Journal* *of Economic Perspectives*, 8(2), Spring :93-115.

Keegan, John. 1987 *The Mask of Command*, Ch. 1, Elisabeth Sifton Books-Viking. New York (pp. 13-91.).
Khanna, Naveen and Slezak, Steven. 1994, "The Effect of Organizational Form on Information Aggregation and Project Choice: The Problem of Informational Cascades. " University of Michigan Business School, September.

Kuran, Timur. 1989 ``Sparks and Prairie Fires: A Theory of Unanticipated Political Revolution." *Public Choice* 61 (April): 41-74.

Kuran, Timur. 1991``Now out of Never: The Element of Surprise in the East European Revolution of 1989." *World Politics* 44 (October): 7-48.

Lee, In Ho. 1992 ``Market Crashes and Informational Cascades." UCLA Economics Department, September .

Liebowitz, S. J. and Margolis, Stephen E. 1994. ``Network Externality: An Uncommon Tragedy." *Journal of Economic Perspectives*, 8(2), Spring :133-150.

Lohmann, Susanne. 1992) ``Rationality, Revolution and Revolt: The Dynamics of Informational Cascades." Graduate School of Business Research Paper No. 1213, Stanford University, October (.

Lohmann, Susanne. 1994 ``The Dynamics of Informational Cascades: The Monday Demonstrations in Leipzig, East Germany, 1989-91," *World Politics*, 47, October :42-101.

Meltzoff, Andrew N. 1988, "The Human Infant as *Homo Imitans.*" In T. R. Zentall and J. B. G. Galef (Eds.), *Social Learning: Psychological and Biological Perspectives*, pp. 319-341, Hillsdale, NJ: Erlbaum.

Noah, Robert B. 1997"Reputation Effects, Sequential Cascades and Speculative Investment." University of Michigan, mimeo.

Packenham, Thomas, 1979, The Boer War. New York, Random House .

Pomiankowski, Andrew. 1990``How to Find the Top Male." *Nature* 347 (October): 616-617.

Robin, Eugene D. 1984*Matters of Life and Death: Risks vs. Benefits of Medical Care.* New York: Freeman and Co..

Rogers, Everett M., and Shoemaker, F. Floyd. 1971*Communication of Innovations: A Cross-Cultural Approach*, (2d Edition). New York: Macmillan Press.

Rogers, Everett M. 1983 *Diffusion of Innovation*, 3rd Edition. New York: Free Press, Macmillan Publishers.

Ryan, Bryce, and Gross, Neal C. 1943``The Diffusion of Hybrid Seed Corn in Two Iowa Communities." *Rural Sociology* 8 (March): 15-24.

Schelling, Thomas C., 1978, *Micromotives and Macrobehavior.* New York: Norton Publisher.

Smith, Lones and Sorenson, Peter. 1995 "Pathological Outcomes of Observational Learning." MIT mimeo, November .

Stamps, J.A. 1988 ``Conspecific Attraction and Aggregation in Territorial Species." *American Naturalist* 131 (March): 329-347.

Taylor, Richard. 1979, *Medicine Out of Control,* Melbourne: Sun Books.

Welch, Ivo. 1992 ``Sequential Sales, Learning and Cascades." *The Journal of Finance* 47:695-732.

Zhang, Jianbo. forthcoming"Strategic Delay and the Onset of Investment Cascades " *Rand Journal of Economics.*