Herding and Contrarian Behavior in Financial Markets
based on Park & Sabourian (2010)

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Market Turmoil in the Autumn of 2008: from end September to mid-November

- On 8 days the Dow changed by more than 5% in absolute terms.
- Since WWII there have been only 16 other days with changes > 5%.
- On 6 days the Dow declined, but on 2 days it increased by more than 10%.
- Since WWII this has happened only once, on the day after the 1987 crash.
- Intra-day fluctuations were even more pronounced: 14 days when max and min prices levels were more than 10% apart.
Market Turmoil in the Autumn of 2008: from end September to mid-November II

- Such extreme price fluctuations are possible only if there are dramatic changes in behaviour (from buying to selling or the reverse).
- Such behaviour and the resulting price volatility is often claimed to be inconsistent with rational traders and informationally efficient prices.
- Commentators often attribute dramatic swings to investors’ animal instincts.
- However, appealing to animal spirits or irrationality is not necessary. We argue that it can be the result of fully rational social learning where agents change their beliefs and behavior as a result of observing the action of others.
Rational Herding in a Nutshell
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Herding (following others) may of course be the result of irrationality; however, here we concentrate on traders rationally following others.
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he knows what he’s doing!
A crude example I

- A single asset world: Two values, $V \in \{0, 1\}$, $\Pr(V = 1) = \Pr(V = 0)$.
- Traders arrive in sequence, observe what predecessors did, and can buy or sell.
- Each receive privates (c.i.i.d.) informative signal $S_h$ or $S_\ell$:
  \[
  \Pr(S_h | V = 1) = \Pr(S_\ell | V = 0) = q > 1/2.
  \]
- If asset price $p_t$ is always a constant then analogous to BHW (1992) model with herding cascade possible: after a finite number of buys (sales) all will do the same.
A crude example II

- Suppose asset price is efficient:
  \[ p_t = \mathbb{E}(V|H_t) = \text{expected value given all public info}. \]
  Since

  \[ \mathbb{E}(V|H_t, S_h) > \mathbb{E}(V|H_t) > \mathbb{E}(V|H_t, S_\ell), \forall H_t, \]

  it follows that \( p_t \) is always between the private expectations.

- **Consequence:** \( S_h \) types always buy and \( S_\ell \) types always sell; hence **herding (or social learning) not possible!**
Main points of herding in financial markets

1. Herd behavior = history induced switching in the direction of the crowd $\approx$ momentum trading.
2. contrarianism = history induced switching against the direction of the crowd $\approx$ mean reversion trading
3. Rational herding can emerge in models with richer state space.
4. The conditions themselves are intuitively appealing and lend meaning to the emergence of herding.
5. Herd behavior has exactly the features that one expects
   - during herding prices can move substantially
   - herding can induce lower liquidity and higher price volatility than if there were no herding
Characterization Result I

The simplest possible model that allows for social learning is one with 3 states. For this we show the following.

1. **Herding**

   - **Necessity**: Herding can occur only if the conditional signal distribution (csd) for some signal is \textbf{U-shaped} in liquidation values. This implies that the signal is more likely to be the result of extreme values/states;
   
   - **Sufficiency**: Herding occurs if the csd for some signal is \textbf{U-shaped} and the proportion of informed insiders is not too large - enough noise (not always needed).
Characterization Result II

2. Contrarianism

- **Necessity**: Contrarian behaviour can occur only if the csd for some signal is *Hill-shaped* in liquidation values: extreme values generate this signal with smaller probability relative to middle values.

- **Sufficiency**: Contrarian behaviour can occur if the csd for some signal is *Hill-shaped* and the proportion of informed insiders is not too large - enough noise (not always needed).
Interpretation I

Conditions on signals that allow herding/contrarianism have intuitive appeal (⇒ relevance and applicability):

1. **Herding**

   - People believe that extreme outcomes occurred with higher probability than moderate ones: *fat-tailed* posterior distribution.
   - For posteriors, signal recipient shifts weight away from the centre to extreme values faster than an agent who receives only the public information (market maker).
   - This makes the recipient’s expectation more volatile and prone to changing behaviour and following the crowd even if prices reflect all public information.
2. Contrarian

- Contrarian behavior occurs if traders’ signals generate thin-tailed distribution relative to the prior, indicating that moderate states are more likely than extreme states.
- The signal recipient shifts weight to the center ⇒ expectation more stable.
- Thus, he may act against the general movement of prices (contrarian).

3. We also show that no social learning (no change of behaviour) if the conditional signal distribution is neither U nor Hill (is monotonic)
Implications of social learning I

1. Prices can move substantially during herding and contrarian episodes even with MLRP. Surprising! (Loose but wrong intuition: little information revealed during a herding episode).

2. To measure impact on liquidity and price volatility compare price paths:
   - when agents know public information (transparent market) to
   - hypothetical economy in which herding/contrarian does not occur (e.g. agents are naïve and ignore the public information).

3. Result:
   - price rises and falls are more extreme in transparent market
   - Liquidity (measured by bid-ask spreads) declines when social learning starts.
Economic Intuition 1

- Take the banking crisis of 2007-08.
- Consider the situation of a financial institution $A$ that is a competitor to a bank $B$ that has recently been closed.
- E.g. the collapse of Lehman Brothers in 2008 or any of the around 160 financial institutions that the FDIC (Federal Deposit Insurance Corporation) closed between the Summer of 2007 and December 2009.
Three scenarios are imaginable:

1. Bank $A$ may be closely linked with bank $B$ (e.g. deals with $B$ will not be honored or $A$’s and $B$’s business models are similar (they have similarly toxic assets on their books))
   - $\Rightarrow$ bank $A$’s share price is $0$.

2. Bank $A$ is entirely unrelated and bank $B$’s collapse won’t affect $A$ at all.
   - $\Rightarrow$ bank $A$’s share price is $15$.

3. Bank $A$ benefits greatly from the failed bank’s collapse (it attracts $B$’s customers and most capable employees).
   - $\Rightarrow$ bank $A$’s share price is $30$. 
 Investors’ information might have implied that

1. the most likely outcome is either that this institution will go
down as well or that this institution will benefit greatly from
the failed banks’ demise.
   - Such information is an example of a U shaped signal.

2. investors’ assessments might have implied that this institution
   is unaffected.
   - Such information is an example of a Hill shaped signal.

It is conceivable that in the Fall of 2008 and Spring of 2009
(when things started to look better after the 2007-8 crisis)
many investors believed that for individual institutions the two
extreme states (collapse or thrive) were the most likely outcomes.
PS’s theory predicts the potential for herd behavior, with investors changing behavior in the direction of the crowd, causing strong short-term price fluctuations.

Hill shaped private signals, signifying that a bank is most likely to be unaffected by a competitor’s fall, may also arise with contrarians displaying rapid changes of behaviour that cause volatility.
Simplified Model

- Values: \( V = (V_1, V_2, V_3) = (0, 15, 30) \).
- Signal distribution is \( \text{Pr}(S|V) = (\alpha, \beta, \gamma) \).
- Assume \( \alpha > \gamma \); thus type \( S \) is negatively inclined — we call this a signal with a negative bias.
- Idea: Signal \( S \) is created in \( \alpha \) of the cases (e.g. 50%) when the true state is \( V_1 = 0 \) (i.e. bank \( A \) will fail).
- There are other signals which we ignore for this example.
- Trades occur at the public expectation, traders arrive in some exogenous sequence (as in a Glosten-Milgrom (1985) model).
- A trader buys if his expectation exceeds the price and sells when his expectation is below the price.
Prerequisites

- The benchmark situation: $\text{Pr}(V_1) = \text{Pr}(V_3) = p$, $\text{Pr}(V_2) = 1 - 2p$, $p \leq 1/2$.
- Public expectation: price = $15$.
- Private expectation:
  \[
  \mathbb{E}[V|S] = 15 \times \frac{\beta(1 - 2p) + 2\gamma p}{(\alpha + \gamma)p + \beta(1 - 2p)} < 15 \quad \forall p.
  \]
- Since $\mathbb{E}[V|S] < 15$, type $S$ sells.
- We define that
  1. Type $S$ buy herds when $S$, who sells at the benchmark buys if prices rise above $15$.
  2. Type $S$ acts as a buy contrarian when $S$, who sells at the benchmark buys if prices fall below $15$. 

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Model

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Analysis: Case 1

- Suppose there is a public announcement $H_1$.
- After $H_1$, $Pr(V|H_1) = (0, p, 1-p)$.
- Then the price is $E[V|H_1] = 15 \times (2 - p)$.
- Moreover, $E[V] < E[V|H_1]$ for all $p$.
- The private expectation is

$$E[V|S, H_1] = 15 \times \frac{\beta p + 2\gamma (1-p)}{\beta p + \gamma (1-p)} \leq 15 \times (2-p) \quad \text{for} \quad \beta \geq \gamma.$$
Analysis: Case 2

- Suppose there is a public announcement $H_2$.
- Signal $H_2$ so that $\Pr(V|H_2) = (p, 0, 1 - p)$.
- The price is $E[V|p] = 15 \times 2(1 - p)$.
- Moreover, $E[V] \leq E[V|H_2]$ for $p \leq 1/2$.
- The private expectation is

\[
E[V|S, H_2] = 15 \times \frac{2\gamma(1 - p)}{\alpha p + \gamma(1 - p)} < 15 \times 2(1 - p) \text{ for all } \alpha > \gamma.
\]
Analysis: Case 3

- Suppose there is a public announcement $H_3$.
- Signal $H_3$ so that $\Pr(V|H_3) = (p, 1-p, 0)$.
- Then the price is $\mathbb{E}[V|p] = 15 \times (1-p)$.
- Moreover, $\mathbb{E}[V] > \mathbb{E}[V|H_3]$ for all $p$.
- The private expectation is

$$
\mathbb{E}[V|S, H_3] = 15 \times \frac{\beta(1-p)}{\alpha p + \beta(1-p)} \leq 15 \times (1-p) \text{ for all } \alpha \geq \beta.
$$
Theorem

1. If and only if $\alpha > \gamma$, type $S$ sells at the initial situation $\rightarrow$ negative bias necessary and sufficient for selling at the benchmark.
2. If and only if $\alpha > \beta > \gamma$, type $S$ sells in all three cases $\rightarrow$ no herding or contrarian behavior with decreasing signal.
3. If and only if $\alpha > \gamma > \beta$, type $S$ sells with signal $H_3$ and $H_2$, and buys with signal $H_1$. In the latter case, there is a switch to buying and prices have risen $\rightarrow$ U shape yields herding.
4. If and only if $\beta > \alpha > \gamma$, type $S$ sells with signal $H_1$ and $H_2$, and buys with signal $H_3$. In the latter case, there is a switch to buying and prices have fallen $\rightarrow$ Hill shape yields contrarian behavior.
Observations

- This “result” is merely illustrative as $H_1, H_2, H_3$ depict extreme outcomes.
- But the idea applies more generally (see Park & Sabourian (2010) for the details).
- Note we learn from the behavior with $H_2$ that it is not sufficient that prices rise.
- The general result shows that the low state $V_1$ must be unlikely relative to both $V_2$ and $V_3$. 
Is Herding economically significant? 1

- Answer: Depends on the prevalence of herding types.

| Pr(S|V) | V₁   | V₂   | V₃   |
|-------|------|------|------|
| S_D   | .01  | .009 | 0    |
| S_U   | .99  | .98  | .985 |
| S_I   | 0    | .011 | .015 |

- Signal $S^U$ is the herding-U-shaped signal.
- At least 98% of informed traders switch behavior when herding begins.
- Herding may have large effect.
Example 2

| Pr(S|V) | V₁   | V₂   | V₃   |
|--------|------|------|------|
| S_D    | .99  | .5   | 0    |
| S_U    | .01  | .006 | .009 |
| S_I    | 0    | .494 | .991 |

Observation: At most 1% of informed traders switch behavior when herding begins.

Thus herding likely has small effect.