Informational Herding in Financial Markets

University Finance Seminar, Judge Business School

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Overview

- Part 1: What is informational herding?
- Part 2: Herding in financial markets
- Part 3: Multiple states & signals

Part I: What is Informational Herding?

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- Key assumptions: agent's action not information is observable (information may be imputed), agent's private information is bounded in quality, agents have the same quality of private information.

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- Note that $x_i = \{a, b, b, b, ...\}$ (observable, the "history") yields $a_i = \{A, A, A, A, ...\}$: an incorrect cascade.

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- More generally a cascade on A begins whenever $\#A - \#B \geq 1$, and a cascade on B whenever $\#A - \#B \leq -2$. For no cascade we need $a_1 = B$, $a_2 = A$, $a_3 = B$, and so on, the likelihood of which falls to zero very quickly.

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- Also a sequence is not necessary, endogenous time models work just as well (Chamley and Gale, 1994).

Part II: Herding in Financial Markets

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- Depending on priors and signal precisions, this requires a different number of (imputed) a or b signals.
- Exactly as in the restaurant example, if say the prior is $\Pr(A) = 0.55$, and $\Pr(a \mid A) = \Pr(b \mid B) = 0.6$, then an A-cascade starts when $\#A - \#B \geq 1$, and a B-cascade when $\#A - \#B \leq -2$.

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...No! Where are the prices?

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- Confirmed in recent experimental work (Cipriano and Guarino, 2005; Drehmann et al, 2005)

Part III: Multiple States & Signals

What follows is based on a recent working paper by Hamid Sabourian and Andreas Park, who I am working with as part of an ongoing ESRC and CERF funded project.

Full proofs of all the assertions can be found on Andreas Park's website at the University of Toronto on:

http://www.chass.utoronto.ca/~apark/research.html

Following the link to

Herding in models of Sequential Trades with monotonic Signals.

Glosten-Milgrom Sequential Trading

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- Two kinds of traders: informed agents and noise traders, to allow us to avoid the no-trade outcome. Noise traders have no information and trade randomly. These traders are not necessarily irrational, but they trade for reasons not included in this model, such as liquidity.

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- The informed agents are risk neutral and rational. Each receives a private, conditionally *i.i.d.* signal $S \in \{S_1, S_2, S_3\}$ about V.

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- In each t the entering trader is informed with probability $\mu > 0$ and a noise trader with probability $1 - \mu > 0$.
- Trade is organised by a market maker. He has no private information and is subject to competition thus makes zero-expected profit. In every t, prior to the arrival of a trader, he:
  - Posts a bid-price $P_t^B = E\left[V \mid H_t, \text{a sale at time } t \text{ at } P_t^B\right]$ at which he is willing to buy the security;
  - An ask-price $P_t^A = E\left[V \mid H_t, \text{a buy at time } t \text{ at } P_t^A\right]$ at which is willing to sell the security.
  - On average, incurs losses trading against the informed. To compensate the market maker profits from noise traders by setting a spread: $P_t^A > E\left[V \mid H_t\right] > P_t^B$, with this spread $(P_t^A - P_t^B)$ increasing with μ.

Sequential Trading III

- The set of possible actions for each trader is $A \in \{\text{buy, hold, sell}\}$. The informed trader's optimal choice (assume indifferent agents trade):
  - *buy* if $E[V \mid H_t, S_t] \geq P_t^A$
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- The structure of the model is common knowledge. The identity of a trader and his signal are private information. Everyone can observe past trades and prices.
- The history of trades together with the realised transaction prices at t is denoted by $H_t = ((a_1, P_1), \ldots, (a_{t-1}, P_{t-1}))$.

Properties of the Signal Distribution

- We assume signals are strictly monotonic in the sense of MLRP: For any signals $S_l < S_h$ and any values $V_l < V_h$, $\Pr(S_l \mid V_l)\Pr(S_h \mid V_h) > \Pr(S_l \mid V_h)\Pr(S_h \mid V_l)$.

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- EG (note the U-shape of the middle signals here):

$\Pr(S \mid V)$	V_1	V_2	V_3
S_1	0.3	0.2	0.02
S_2	0.6	0.5	0.59
S_3	0.1	0.3	0.39

Glossary

MLRP: (alternative statement)

Let V be the value of the security and let S be the value of the signal. Let $f(S \mid V)$ be the pdf of S for each V. Then the statement that $f()$ has the monotone likelihood ratio property (MLRP) is the same as the statement that:

for $V_l < V_h$, $f(S \mid V_h)/f(S \mid V_l)$ is increasing in S.

This says that S is positively related to V, and something stronger, something like: of two outcomes, the worse one (S_l) will not become relatively more likely than the better one (S_h) if V were to rise. By relatively more likely is meant that the likelihood ratio, above, rises.

FOSD:

Let the possible returns from two states of the world be be described by statistical distributions S_l and S_h, conditional on the value of the state V. The payoff distribution implied by S_h first-order stochastically dominates that implied by S_l if for every possible V, the probability of getting a high payoff is never better in S_l than in S_l.

Basically higher signals mean higher expected returns.

MLRP Signal Distribution: 3 values, 3 signals

$\Pr(S_i \mid V_i)$	V_1	V_2	V_3
S_1			
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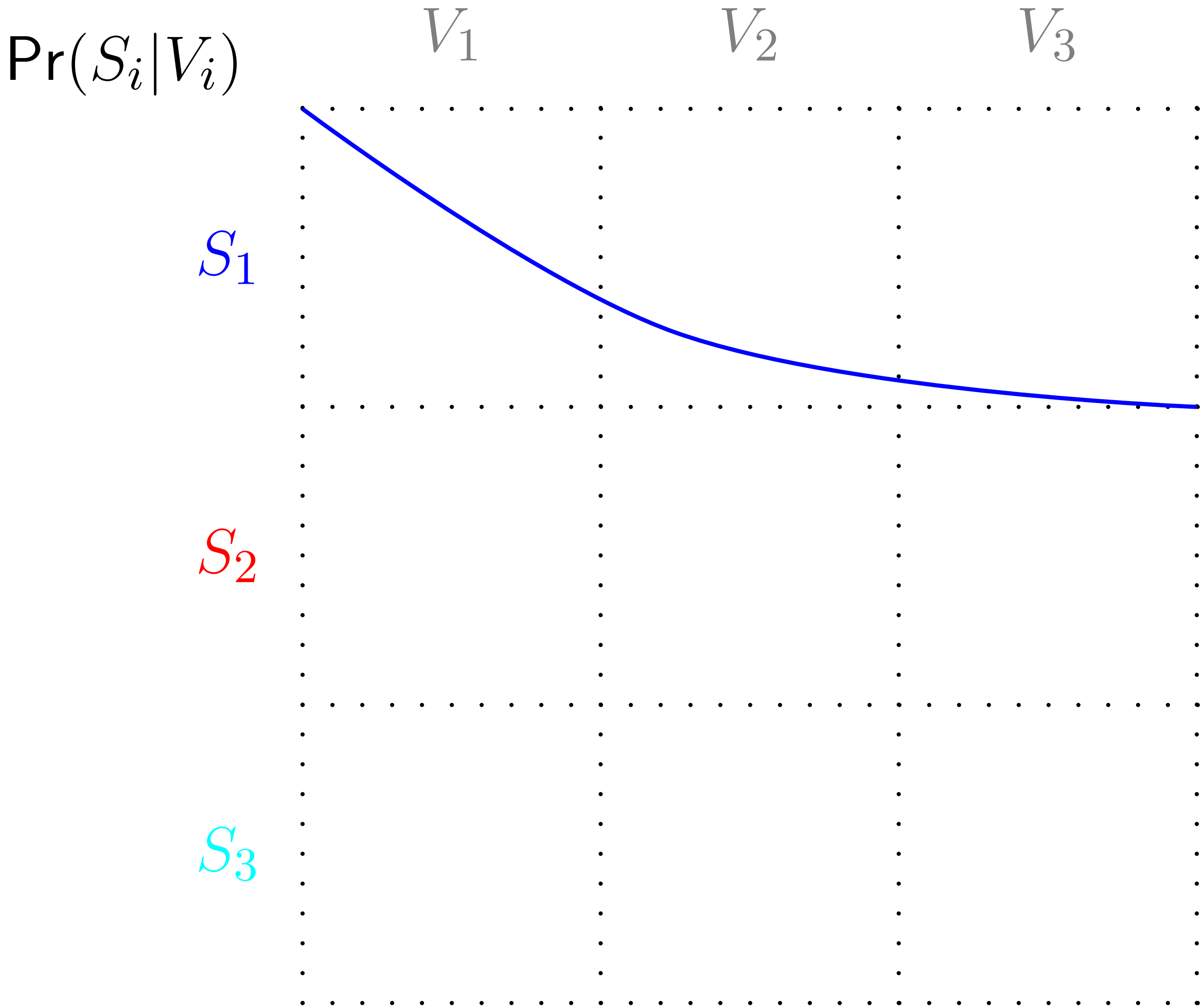

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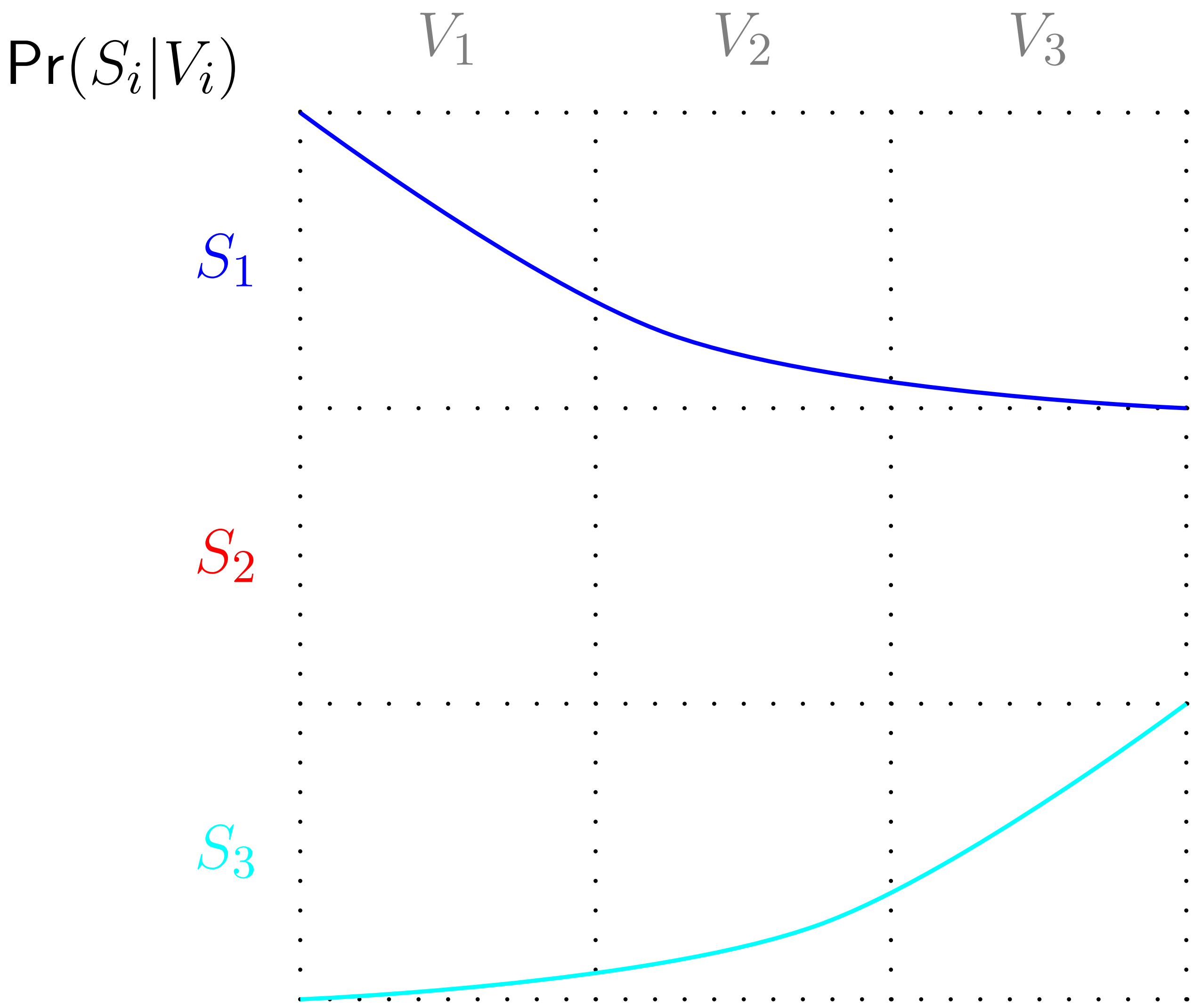

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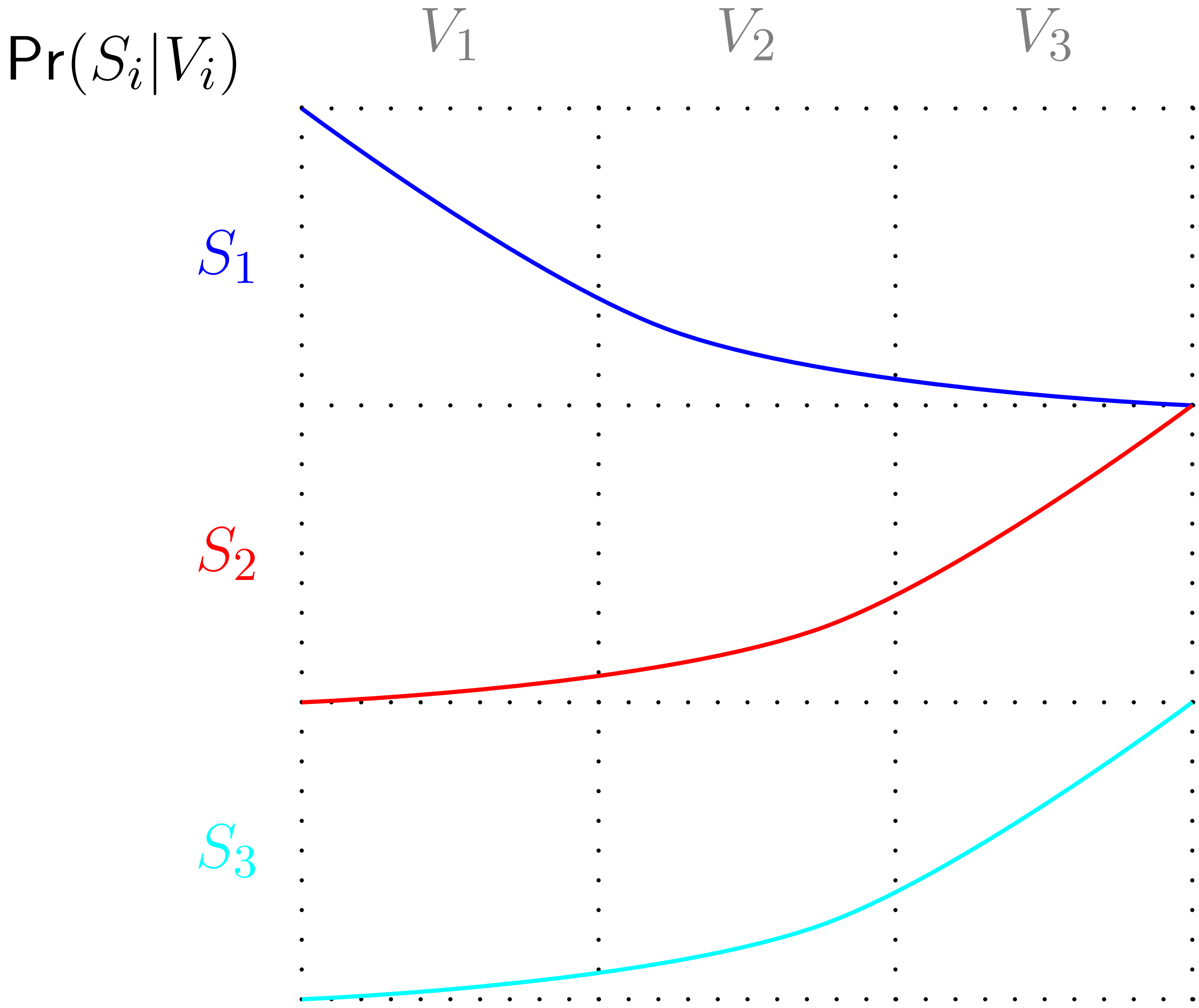

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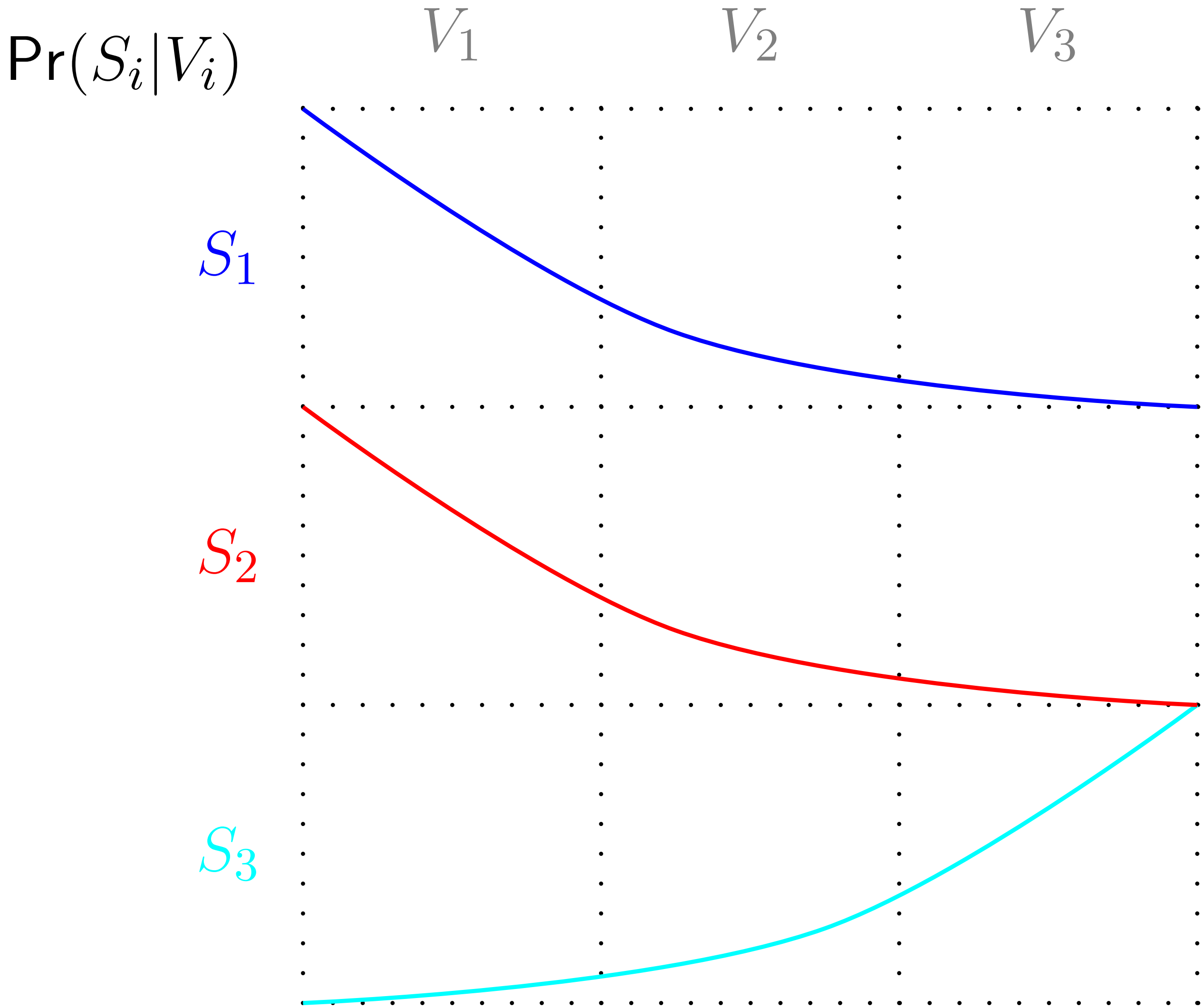

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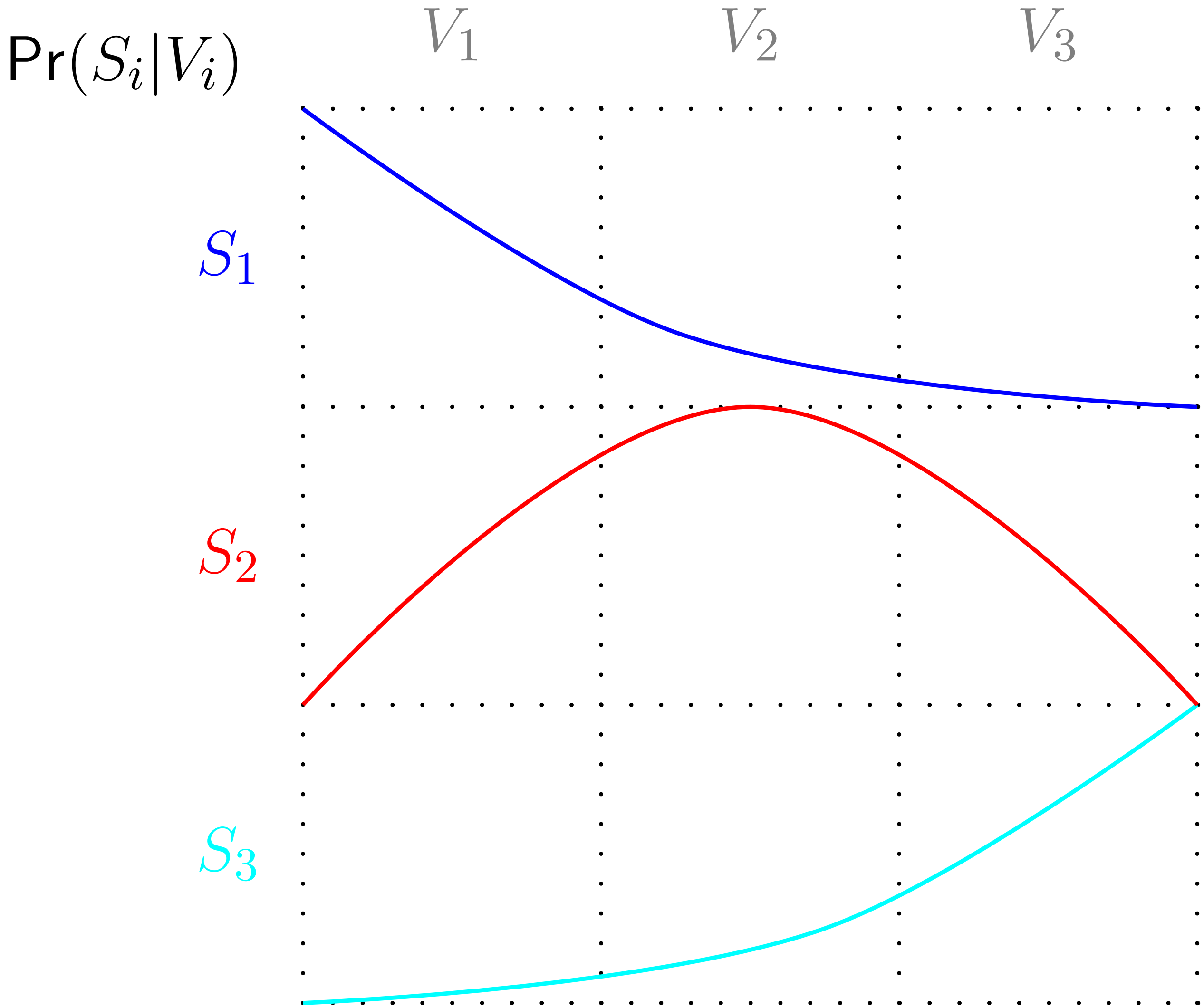

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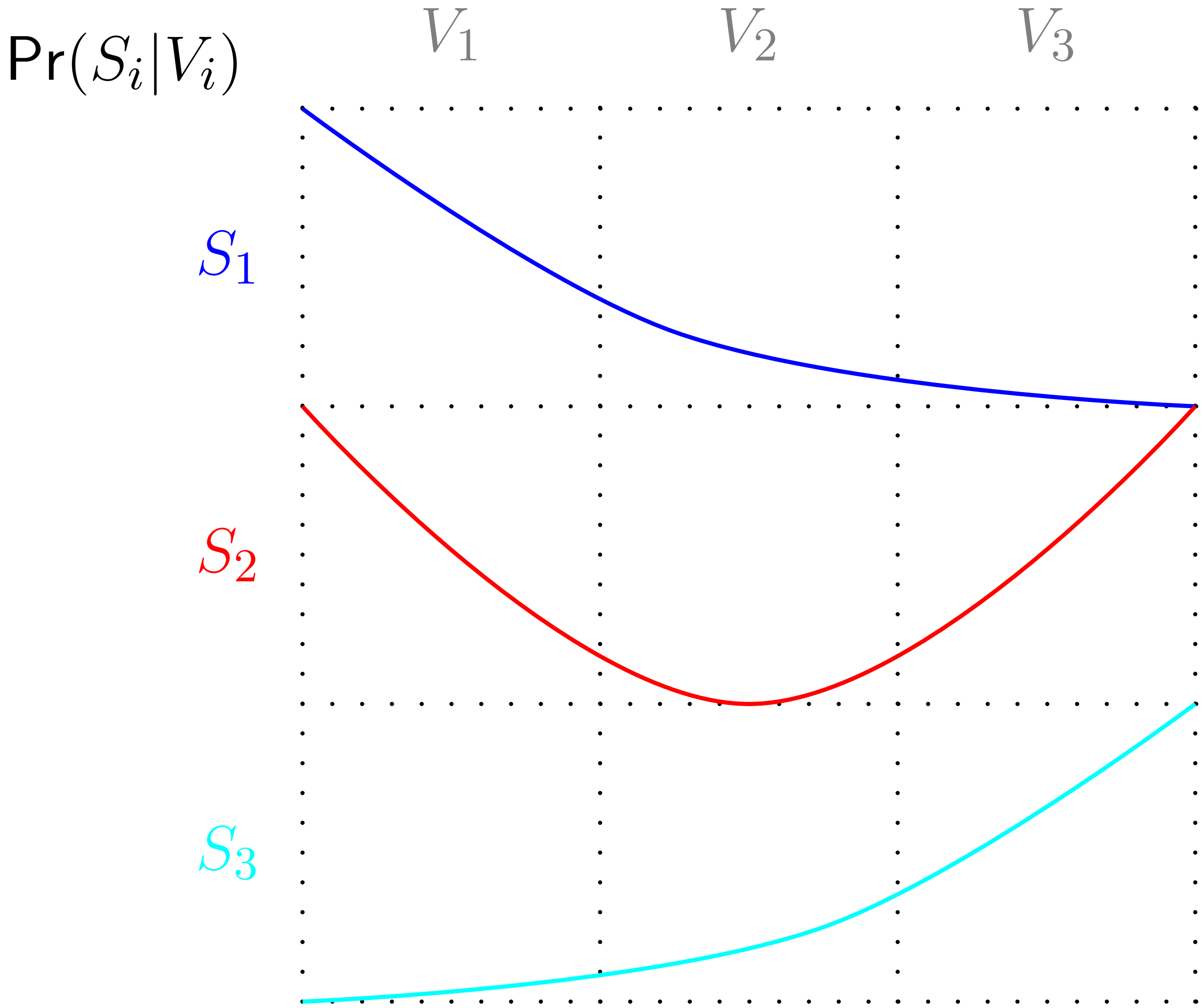

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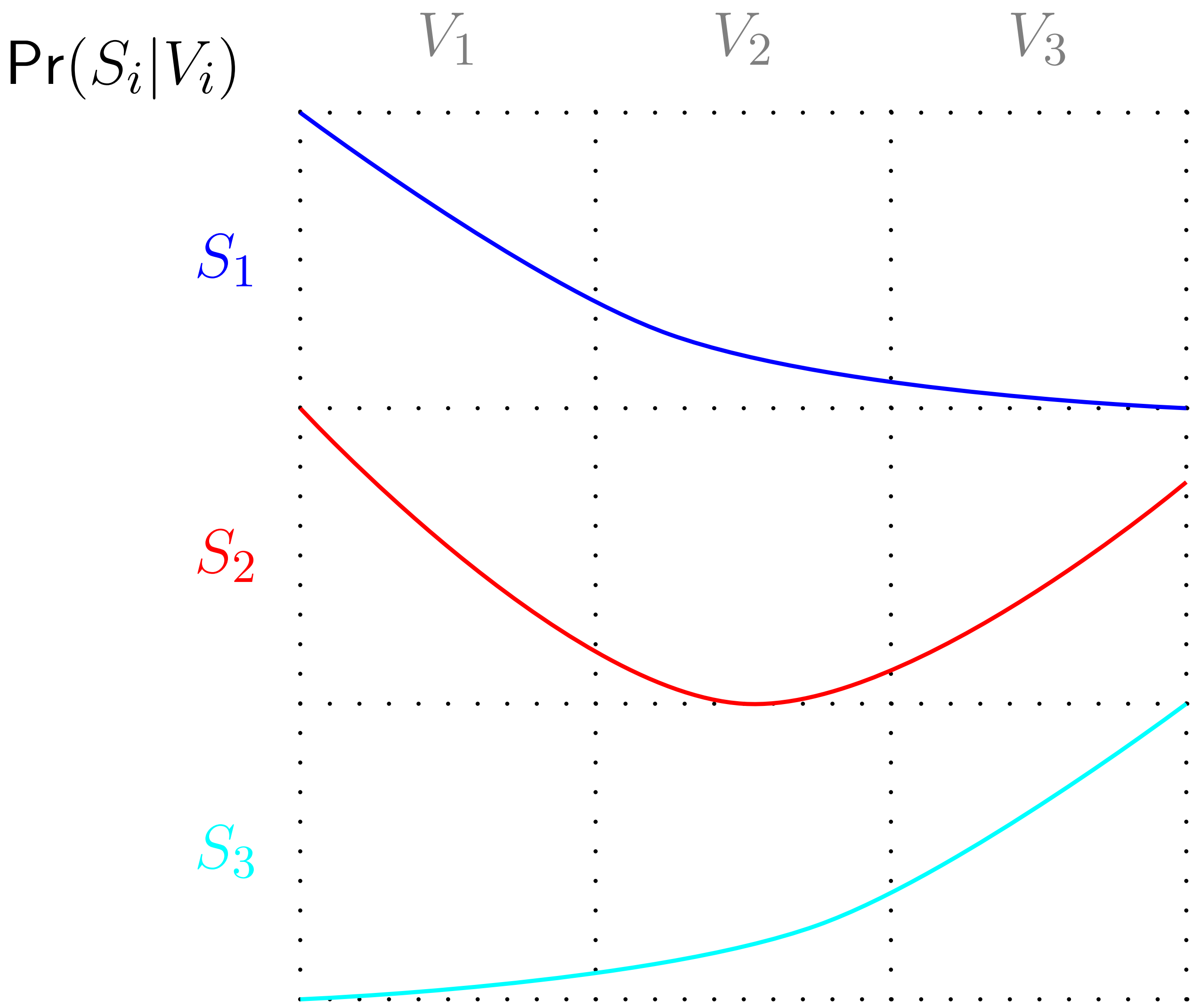

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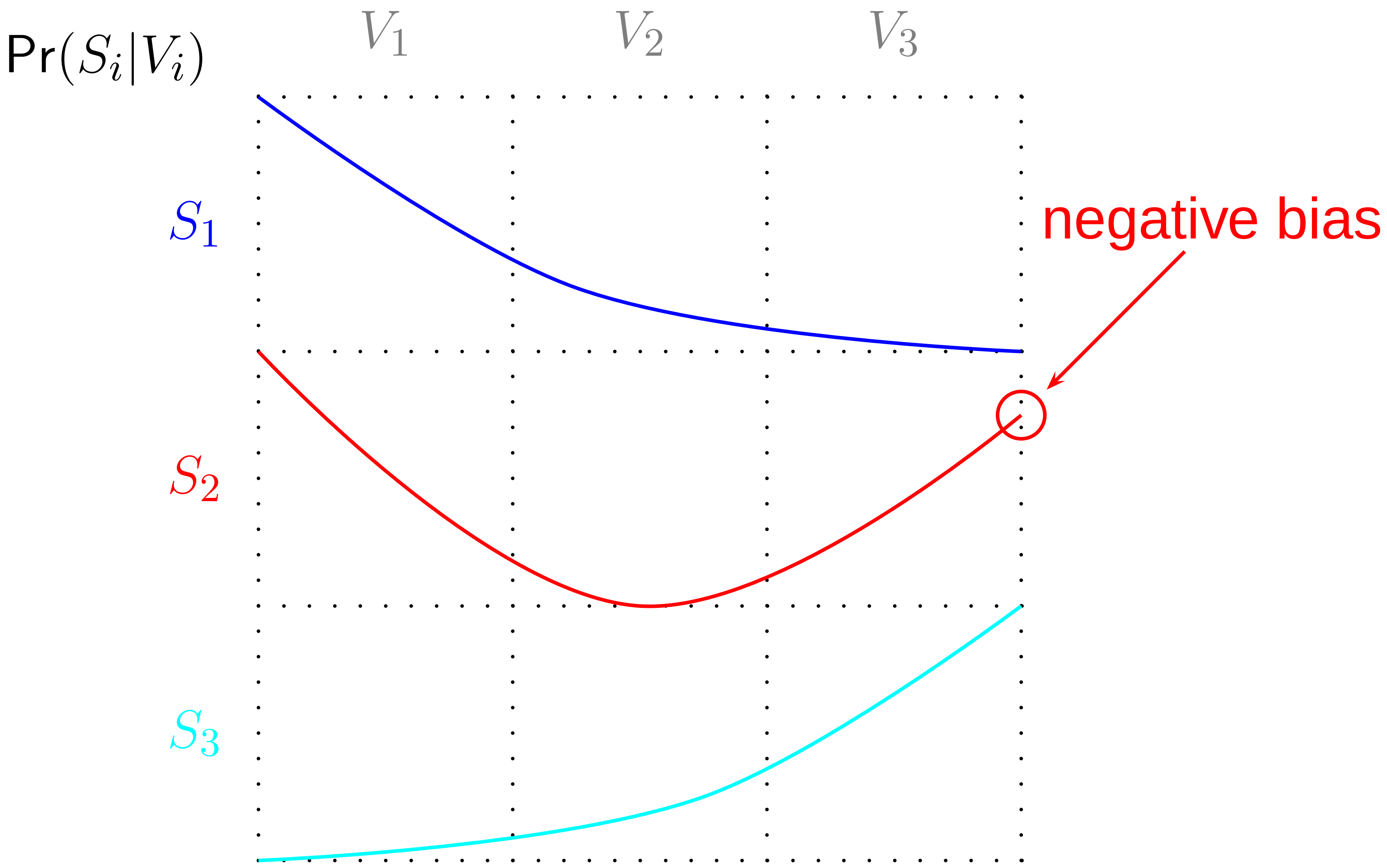

Definition of Herding in this Framework

- Definition. A trader with signal S engages in herd-buying in period t after history H_t iff
  - Before anything happens the trader has a negative opinion and would sell, so $E[V \mid S] < P_1^B$.
  - After a history H_t the S-trader buys, so $E[V \mid H_t, S] > P_t^A$.
  - Prices move into the direction of the herd, so $E[V \mid H_t] > E(V)$.
- Herd selling is defined analogously.
- So can there be herding with MLRP signals in a multiple state world?

Yes!

- A set of necessary and sufficient conditions for herding are:
  - 'Enough' noise;
  - U-shaped signal distribution for signal S_2;
  - Negative bias in the S_2-distribution for buy-herding, positive bias for sell-herding.
- Note that under the MLRP U-shape can only occur on the middle sginals.

Intuition

- The S_2-type's information comes from extreme sources - either V_1 or V_3.

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- But negative bias means he would sell before anything happens.
- We need a sufficiently small bid-ask spread to trigger a switch of opinion (recall definition of a herd) - achieved through sufficient noise! (recall bid-ask spread increases in percentage of informed).

Implications

- Here, once buy-herding starts then further buys will increase the herders' expectation more than the market maker's and thus the herd is not broken. As a result,
  - Prices may move significantly during herding and herding can persist (if buying persists and no sales, herding will not stop).
  - Once herding starts, buying will also get more likely as S_3- and S_2-types buy.
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- Similar story for sell-herding.
- How large can the price movements during buy-herding be?
  - Depends on the prior distribution.
  - With $\Pr(V_2)$ near 1 it can start at V_2 and with sufficiently many buys it can approach V_3.

Contrarian Behaviour

- Define a *buy-contrarian* as someone who acts against the crowd and changes his opinion (simlarly to herder) so:
  - Before anything happens the trader has a negative opinion and would sell, so $E[V \mid S] < P_1^B$.
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  - Contrarians act against the movement of prices, so $E[V \mid H_t] < E(V)$.
- And for "contrarian" behaviour we need:
  - ‘Enough’ noise;
  - Hill-shaped signal distribution for signal S_2;
  - Negative bias in the S_2-distribution for buy-herding, positive bias for sell-herding.

Summary & Conclusions

- Informational herding can explain clustering on rational grounds.
- It may need multiple states/signals to work in a financial market.
- With multiple states/signals we can have all the hallmarks of herding, such as suboptimal outcomes, long-lasting incorrect behaviour, extreme outcomes, etc. in financial markets.
- For more realism:
  - News constantly breaks, do old cascades will make way for new ones;
  - Traders don't work in a sequence, so need to add the ability to wait (especially here as waiting means you can observe others);
  - As the model grows in complexity Bayesian updating becomes more difficult, as does the entire decision-making process.
- We are working on these extensions now, both thoeretically and through laboratory experimentation.