Controlling the Dynamics of Herding Dominant Financial Market

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Control of the socio-economic systems using herding interactions

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HIGHLIGHTS

- We introduce a fixed number of controlled agents into the agent-based herding model.
- The impact of the controlled agents depends only on their number.
- The proposed model may be considered as an explanation of the leadership phenomenon.

Snapshot of (Kononovicius & Gontis, Physica A 405, 2014)
Herding dominance in social systems

Images: D. Helbing (top), C. Detrain (bottom).
Transition rate for agent \( k \):

\[
\mu_k(i \rightarrow j) = \sigma_j + hX_j.
\]

Originally proposed by A. Kirman (1993).
Let us use a small number, $M$, of controlled agents, which are in all senses identical to ordinary agents with the exception that their state is not influenced by the endogenous interactions (i.e. they are “inflexible”):

$$\mu_k(i \rightarrow j) = \sigma_j + h(X_j + M_j).$$

Image: J. Faria

“inflexible” agents: (Galam & Jacobs, Physica A 381, 2007)
Impact of the controlled agents

Figure: Comparison of the non-controlled system PDF (red squares) versus controlled system PDF (magenta circles ($M_1 = 20$) and blue triangles ($M_2 = 20$)): $\sigma_i > h$ (a), $\sigma_i < h$ (b). $N = 10^4$.

\[
\frac{\langle X_1 \rangle}{N} = \langle x \rangle = \frac{hM_1 + \sigma_1}{h(M_1 + M_2) + \sigma_1 + \sigma_2}.
\]

(Kononovicius & Gontis, Physica A 405, 2014)
Herding dominates financial markets

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Controlling herding dominant market

July 8, 2014 7 / 12
Simple buy-sell market

A simplest market:
- optimists - buy,
- pessimists - sell.

Market is influenced by “mood”:

\[ \xi = \frac{X_o - X_p}{N}. \]

Figure: PDF of “mood”: no control (blue curve), “insert inflexible” control strategy (red curve), “insert random” c.s. (magenta curve). \( M = 10, N = 10^3 \).

“insert random” c.s.: (Biondo et al., Phys. Rev. E 88, 2013)
Simple chartists-fundamentalists market

A bit more complex market:

- chartists - noisy traders,
- fundamentalists - aware of fundamentals.

In which price fluctuations are given by:

\[ y = \frac{X_c}{X_f}. \]

**Figure:** PDF of “price fluctuations” given by \( y \): no control (blue curve) and “insert fundamentalists” c.s. (red curve). \( M = 10, N = 10^3 \).

Known to generate \( 1/f \) spectra: (Kononovicius & Gontis, Physica A 391, 2012)
Combining simple approaches - the three state model

Let us combine:
- slow chartist-fundamentalist process \((y)\),
- fast intra-chartist process \((\xi)\).

Walrasian scenario helps us to define log-price:

\[
P = \frac{X_o - X_p}{X_f} = y\xi.
\]

Figure: PDF of log-price: no control (blue curve), “insert fundamentalists” c.s. (red curve), “insert random chartist” c.s. (magenta curve). \(M = 6, N = 300\).

Fractured spectra: (Kononovicius & Gontis, EPL 101, 2013)
Agreement with empirical data: (Gontis & Kononovicius, PLOS ONE, forthcoming)
Even a small number of controlled agents can make impact on a system as whole.

Impact of the controlled agents does not depend on a system size.

After testing two strategies of control in several artificial financial markets we may conclude that in the considered setups only “fundamental” knowledge is effective measure to prevent extreme events.
Thank you!

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