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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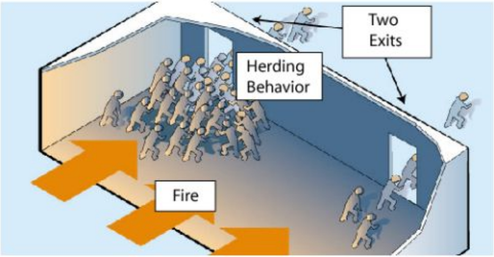
HIGHLIGHTS

- 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.

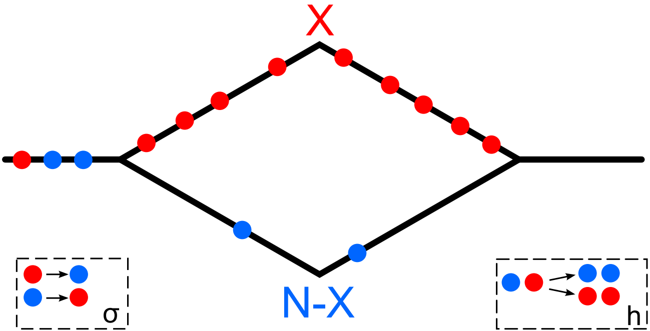
Snapshot of (Kononovicius & Gontis, Physica A 405, 2014)

Herding dominance in social systems



Images: D. Helbing (top), C. Detrain (bottom).

Simple agent-based herding model

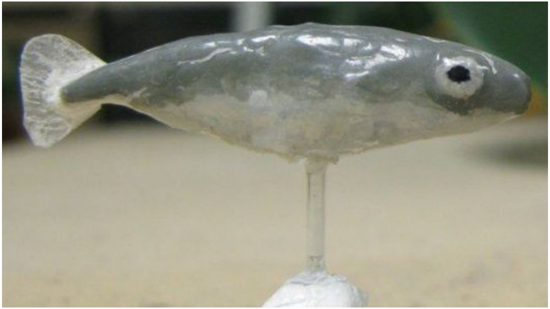


Transition rate for agent k:

$$\mu_k(i \to j) = \sigma_j + hX_j.$$

Originally proposed by A. Kirman (1993).

Introducing controlled agents



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"):

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

Image: J. Faria

"inflexible" agents: (Galam & Jacobs, Physica A 381, 2007)

Impact of the controlled agents

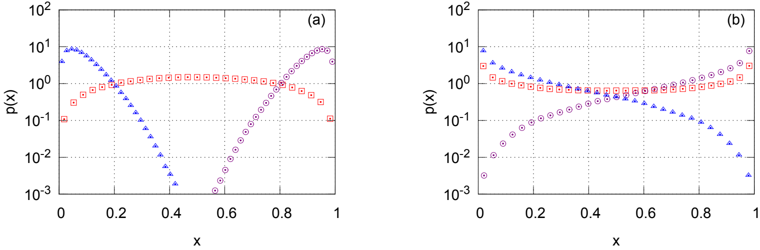


Figure: Comparison of the non-controlled system PDF (red squares) versus controlled system PDF (magenta circles ($M_1 = 20$) and blue triangles ($M_2 = 20$)): $\sigma_i > h$ (a), $\sigma_i < h$ (b). $N = 10^4$.

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

(Kononovicius & Gontis, Physica A 405, 2014)

Herding dominates financial markets

Simple buy-sell market

A simplest market:

- optimists - buy,
- pessimists - sell.

Market is influenced by "mood":

$$\xi = \frac{X_o - X_p}{N}.$$

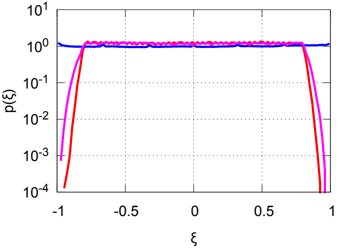


Figure: PDF of "mood": no control (blue curve), "insert inflexible" control strategy (red curve), "insert random" c.s. (magenta curve). $M = 10$, $N = 10^3$.

"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:

$$y = \frac{X_c}{X_f}.$$

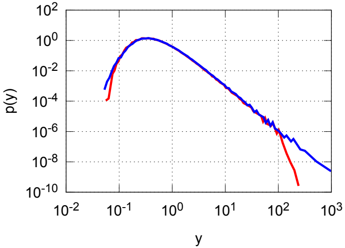


Figure: PDF of "price fluctuations" given by y: no control (blue curve) and "insert fundamentalists" c.s. (red curve). $M = 10$, $N = 10^3$.

Known to generate $1/f$ spectra: (Kononovicius & Gontis, Physica A 391, 2012)

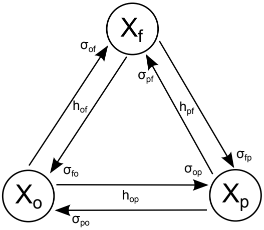
Combining simple approaches - the three state model

Let us combine:

- slow chartist-fundamentalist process (y),
- fast intra-chartist process (ξ).

Walrasian scenario helps us to define log-price:

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



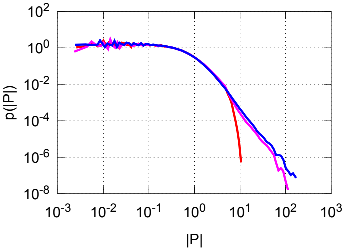


Figure: PDF of log-price: no control (blue curve), "insert fundamentalists" c.s. (red curve), "insert random chartist" c.s. (magenta curve). $M = 6$, $N = 300$.

Fractured spectra: (Kononovicius & Gontis, EPL 101, 2013)
Agreement with empirical data: (Gontis & Kononovicius, PLOS ONE, forthcoming)

Conclusions

- 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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