

# Evidencing the “Robot Phase Transition” in Human-Agent Experimental Financial Markets

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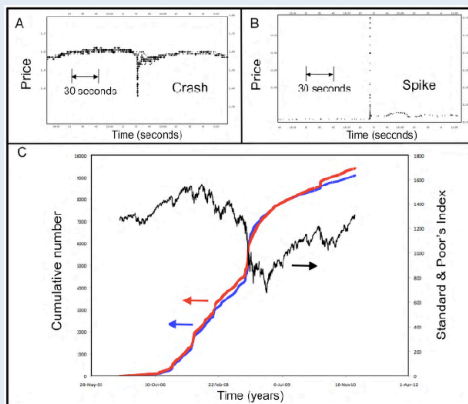
## Conclusion

The financial markets have recently been shown to exhibit a “robot phase transition”, such that, at sub-second timescales the markets are dominated by trades between high-frequency trading algorithms (Johnson et al., 2012). In this robot-only domain, the markets exhibit “fractures”: ultra-fast price swings that are linked to market instabilities over much longer timescales.

We run real-time financial trading experiments between human traders and robot trading agents in an attempt to synthesise the robot phase transition in a controlled environment. Results show that, when agents are able to act on super-human timescales, we see a greater proportion of agent-only (and human-only) transactions than we would expect by chance, thus providing evidence of the phase transition. This result demonstrates that relatively simple controlled financial markets are able to reproduce real-world market dynamics, thus offering a powerful platform with which to engineer and test solutions for financial market stability.

## Background

At sub-second time-scales—beyond the limits of human response times—the financial markets transition from a mixed human-robot phase to an all-robot phase characterised by “fractures” with ultrafast durations.



## Aim

To synthesise the robot phase transition in an experimental financial market containing human traders and automated trading agents.

## Method

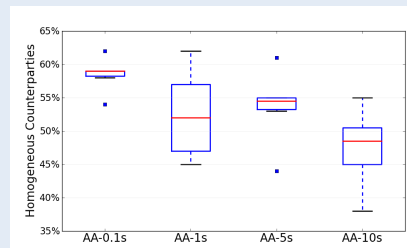
In March 2012, we performed a series of twenty-four human-versus-robot financial trading experiments. Each market contained 6 humans and 6 robots. Participants traded in real-time for 10 minutes, with the aim of making as much profit as possible. The speed of robots was controlled using a “sleep” parameter that was varied between runs: from 0.1s (much faster than human reaction times), to 10s (slower than the fastest humans react).



Photograph of experimental hardware and arrangement of participants © John Cartlidge, 2012.

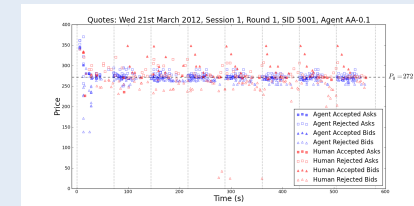
## Results

When robots act on timescales similar to that of humans, the market is mixed, with half of all trades being heterogeneous human-robot. However, when robots act on super-human timescales of 0.1s—faster than the limit of human reaction—we see a significantly greater proportion of homogeneous trades (robot-robot or human-human) than we would expect by chance. This is the first evidence of the robot-phase transition in a controlled experimental market.

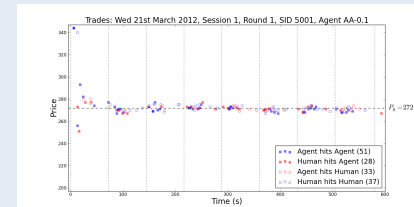


Proportion of homogeneous counterparties—trades that take place between two robots or two humans rather than between a human and a robot. Agent types are plotted on the x-axis. Note: this is not a continuous time-scale (AA-10s have a sleep time two orders of magnitude greater than AA=0.1s).

## Market Dynamics



Time series of quotes for a typical experiment.



Time series of trades for a typical experiment.

	Trials	Efficiency (Agents)	Efficiency (Humans)	Efficiency (Market)	Δ Profit (A-H)
AA-0.1	6	0.992	0.975	0.984	1.8%
AA-1	5	0.991	0.977	0.984	1.4%
AA-5	6	0.990	0.972	0.981	1.8%
AA-10	6	0.985	0.981	0.983	0.4%
All	23	0.990	0.976	0.983	1.34%

Summary of results. Under all conditions, robots achieve greater efficiency than humans and gain extra profit of between 0.4% and 1.8%.

## References

- Johnson et al. (2012) Financial black swans driven by ultrafast machine ecology. Working paper published on arXiv repository. <http://arxiv.org/pdf/1202.1448v1.pdf>
- Cartlidge & Cliff (2013) Evidencing the “robot phase transition” in experimental human-algorithmic markets (ICAART). SciTePress. <http://www.cs.bris.ac.uk/~cszjpc/pubs/CC-ICAART2013-CR.pdf>
- Cartlidge & Cliff (2012) Exploring the “robot phase transition” in experimental human-algorithmic markets. Foresight Driver Review, DR25: Crown Copyright. <http://bitly.com/Svnoh>

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