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The potential for agent based modelling to be helpful for investment or other issues relevant to actuaries

Andrew Slater

27 September 2016

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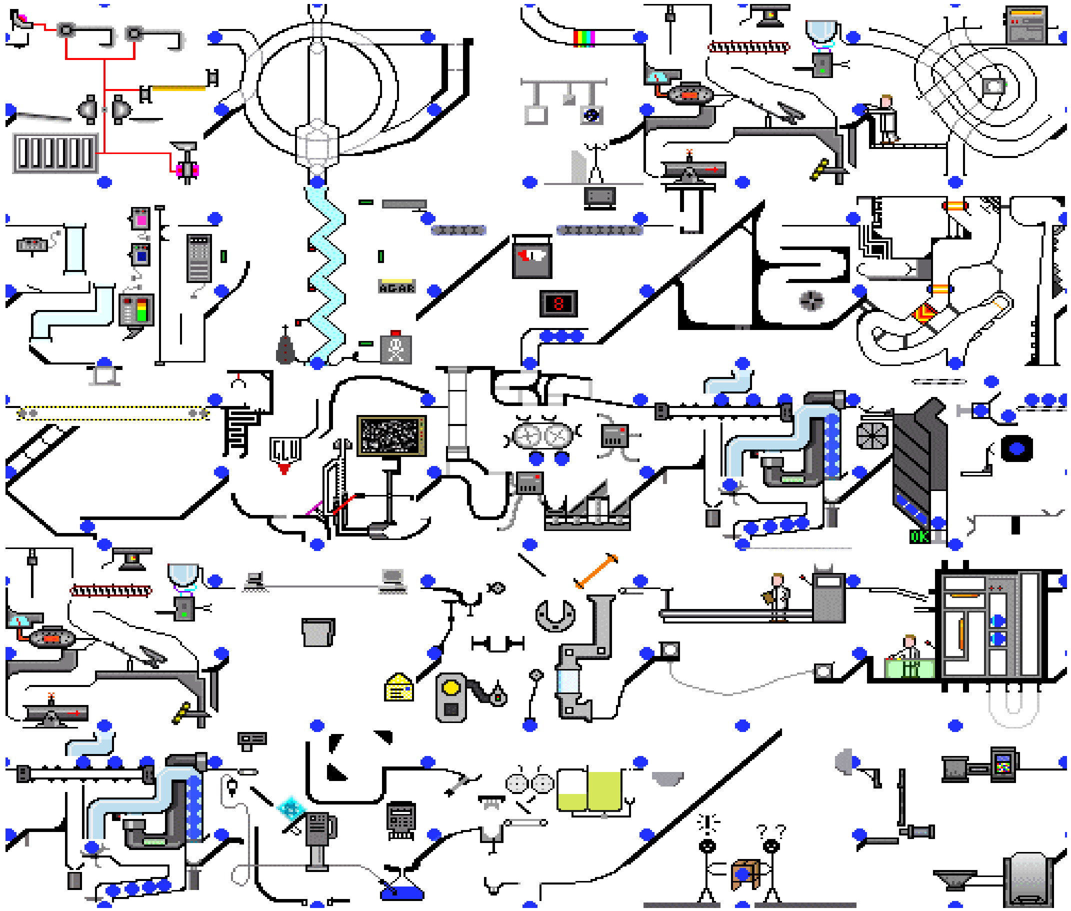

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Agent-Based Modelling Working Party

Complexity Economics
Application and Relevance to Actuarial Work

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Agent-based modelling

Background

- World as complex adaptive system
- Emergence – complex phenomena from simple rules
- Dynamically interacting rule based agents
- Commonality between different systems
- Increase in computer power

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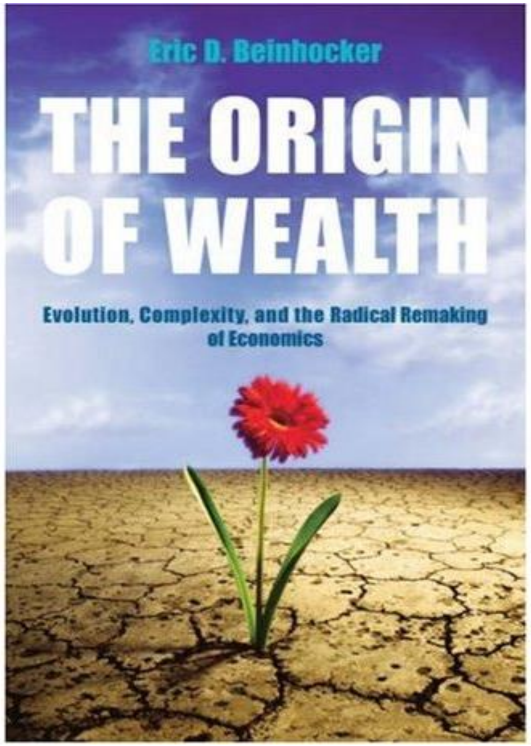
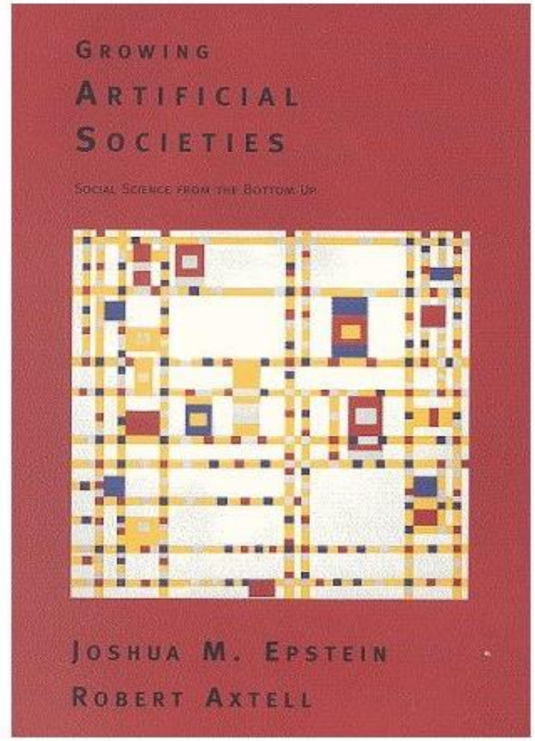
Agent-based modelling

Features of ABMs

- Heterogeneous agents
- Adaptation
- Feedback loops
- Local interactions
- Externalities

Motivation





www.mckinsey.com/ideas/books/originofwealth/pdf/Origin_of_Wealth_Ch_1.pdf

http://books.google.co.uk/books?id=xXvelSs2caQC&printsec=frontcover&dq=animation+IV-2&source=gbs_summary_r&cad=0

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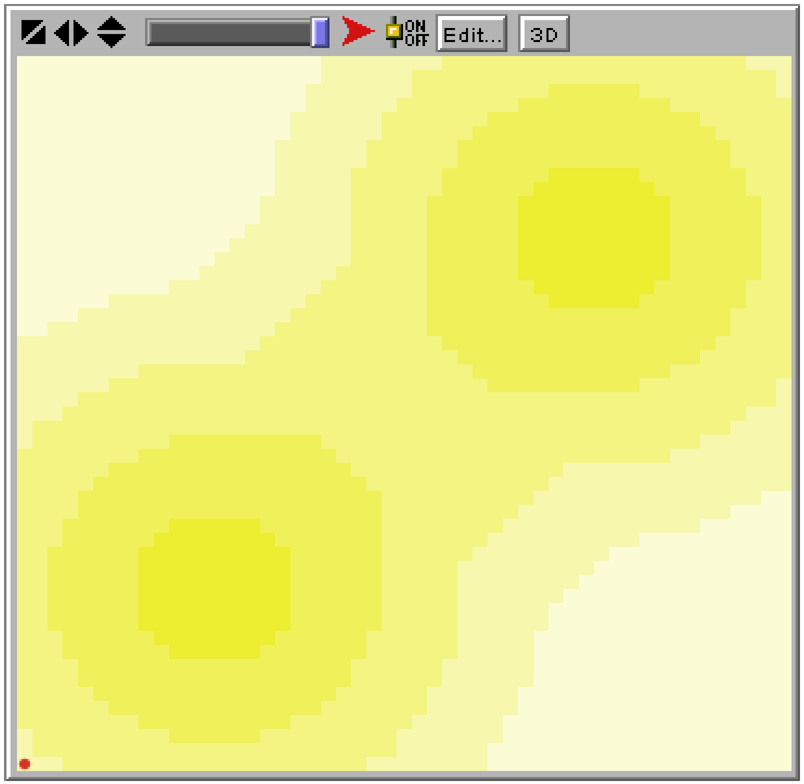
Sugarscape

Environment



Agents

- Genetic characteristics
  - Sugar metabolism (1 to 4)
  - Level of vision (1 to 6)
  - Maximum age (could be infinite)
- Variable states
  - Position (x,y)
  - Amount of sugar
- Each time period agents
  - Move, harvest, metabolise
  - Die if sugar=0 or age=max

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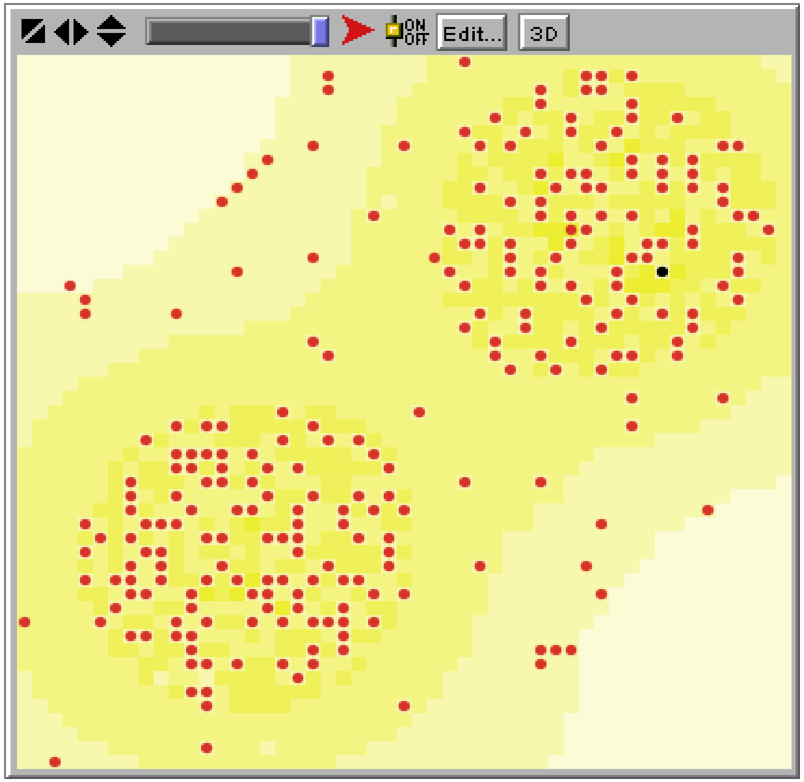
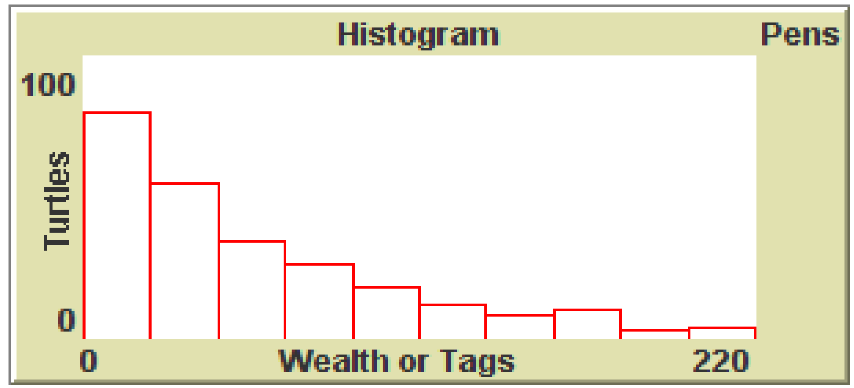
Simulation $(\{G_1\}, \{M, R_{[60,100]}\})$



NetLogo



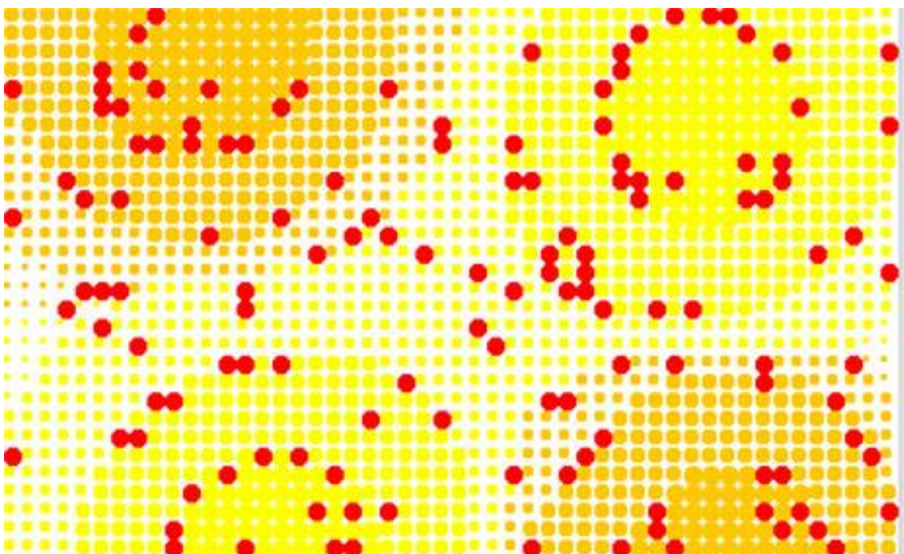
"If you didn't grow it, you didn't explain it"

http://complexityworkshop.com/models/sugarscape.html experiment 3

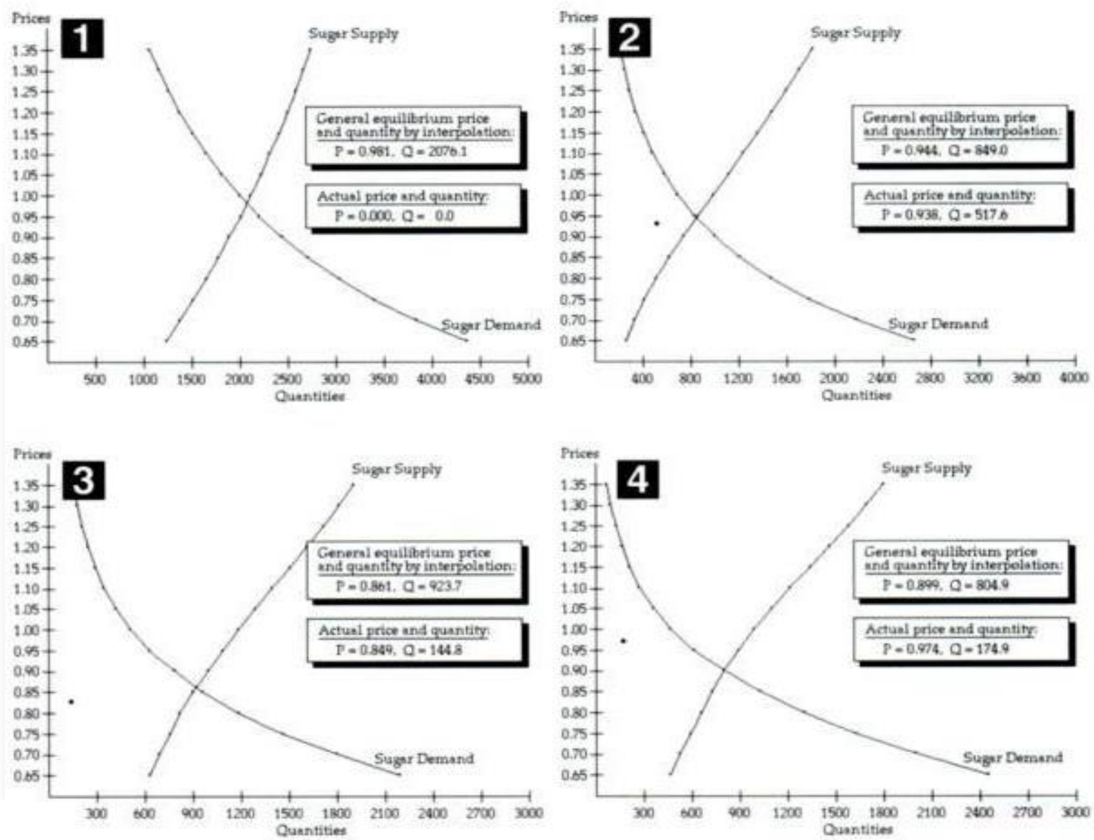
Simulation ({G_1}, {M, T})

Growing Artificial Societies, page 115

http://www.brook.edu/es/dynamics/sugarscape/animations/AnimationIV.mov



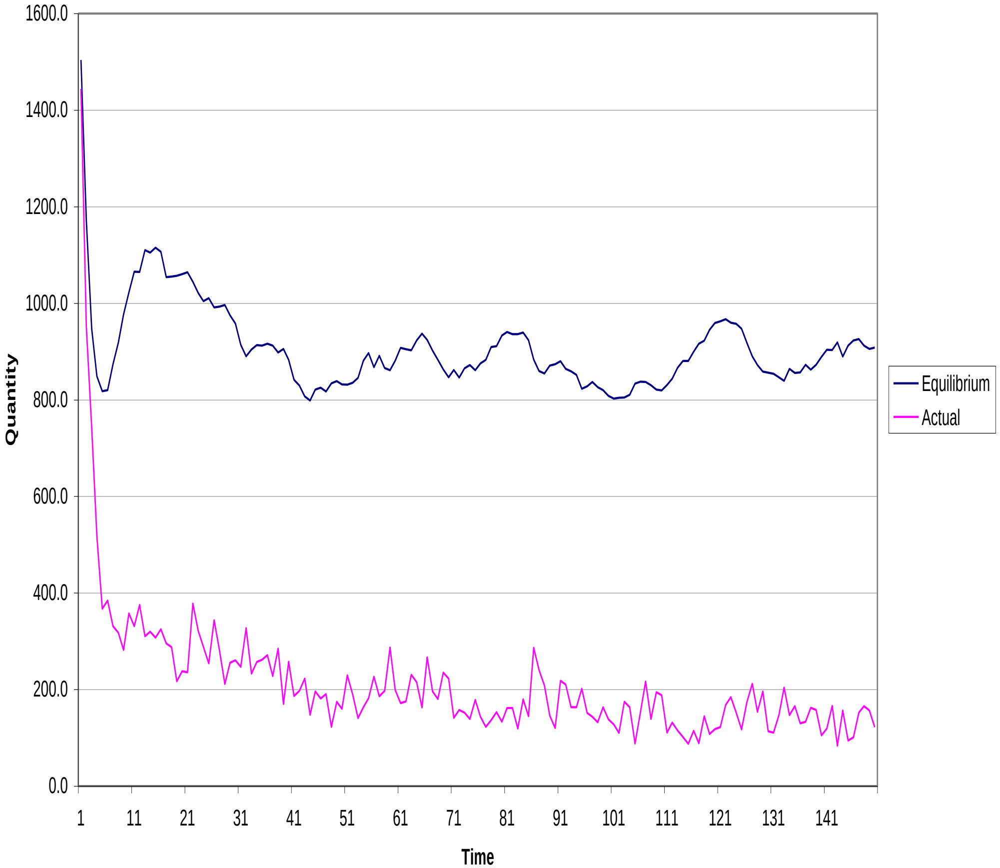
Animation IV-2. Evolution of Supply and Demand under Rule System ({$\mathbf{G}_1$}, {**M**, **T**})



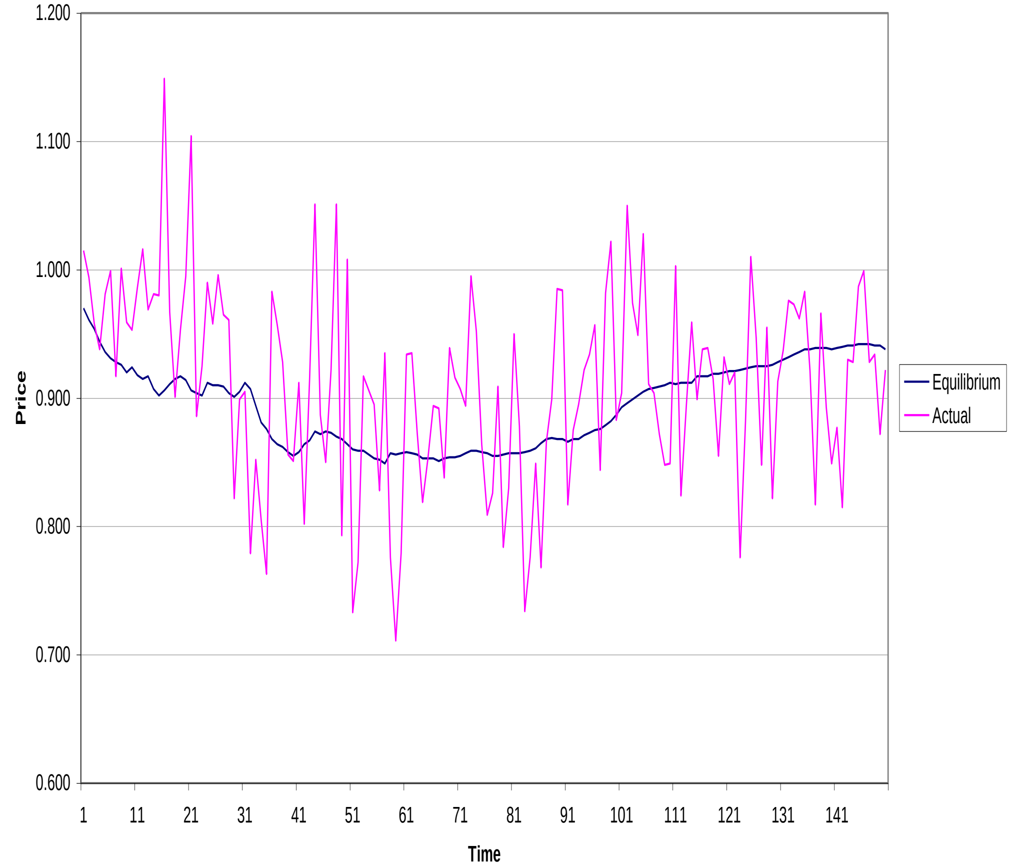
Local efficiency, global inefficiency

Disequilibrium

Quantity



Price



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Agent-based modelling

Current drawbacks

- Lack of calibration
- Lack of predictive power
- Often arbitrary choice of assumptions
- Parsimony vs realism

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Agent-based modelling

Possible future applications

- Market prediction
- Risk management
- Aid regulatory design
- Model cyclicality of insurance market
- Test investment policy

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Appendix

- Agent-based stock market models

Complexity Economics
Application and Relevance to Actuarial Work

A Report from the Agent-Based Modelling Working Party

Jon Palin
Nick Silver
Andrew Slater
Andrew D Smith

Introduction

The purpose of this paper is to introduce the concepts of agent based modelling to the actuarial community. The paper will provide a brief introduction to the subject, will look at examples of agent based models, and will identify where they might be used in future and what the implications might be for actuarial practice and theory.

Agent based modelling (ABM) was motivated by the observation that there appears to be a commonality between different systems in the world – including ecosystems, financial markets and the weather. Their development was facilitated by the increased availability of computing power and the development of computational models (Miller and Page, 2007).

ABM was not developed specifically for finance, but there is a growing interest in its use in the field. We believe that the insights from ABM could have profound consequences for the risk management of financial institutions, and could also be fruitfully utilised by actuaries. However, in saying that ABM is currently in an early stage of development – whilst current models produce outputs which look like the real markets – they are a long way from producing reliable calibrated models with predictive power.

Agent-based stock market models

- Stock markets have stylised features:
  - fat tails
  - persistent volatility
- Why should these features occur?
- Can we build a model that can:
  - reproduce them without hard-coding them
  - let us turn them on and off

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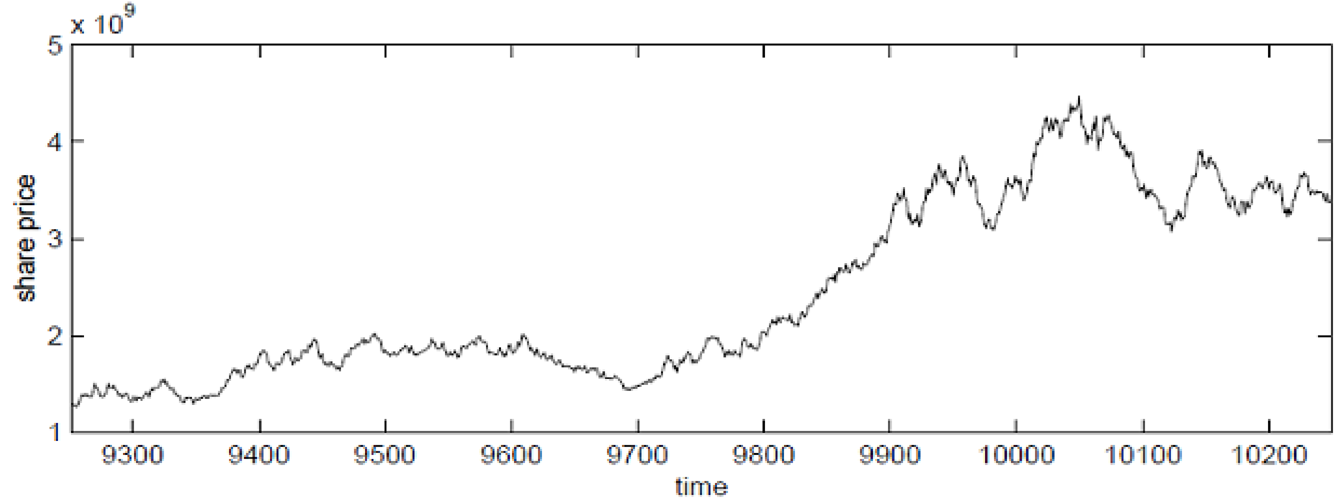
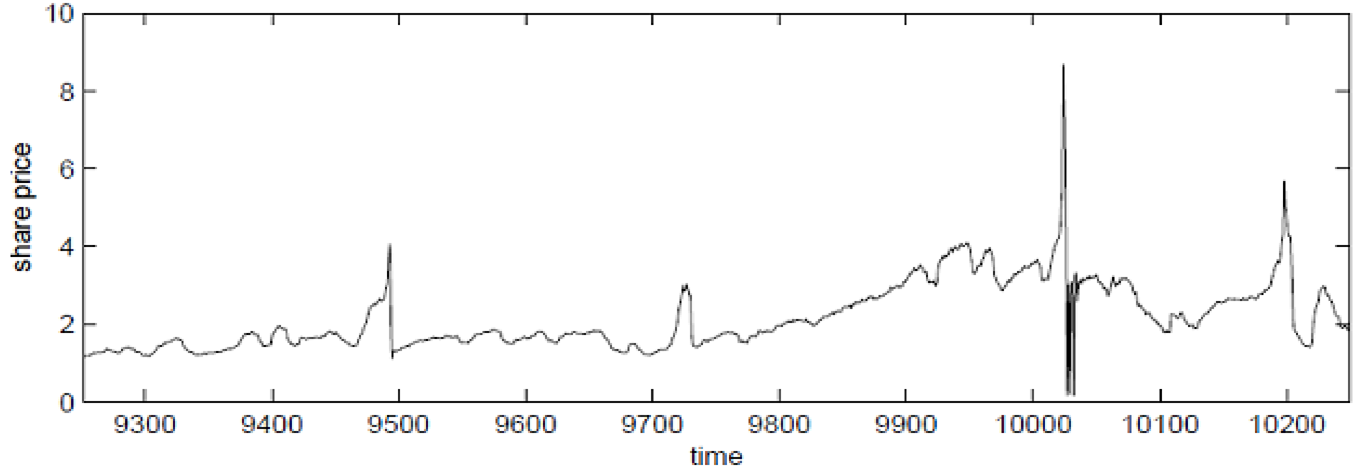
Le Baron's model

- Two assets:
  - cash pays guaranteed return
  - equity pays random (lognormal) dividend
- Many agents:
  - trade cash and equity to maximise lifetime utility
  - using "trading rules" which have worked in the past
  - using different periods of "memory"
- Stock price is an emergent property
- More detail: http://citeseer.ist.psu.edu/palin02agentbased.html

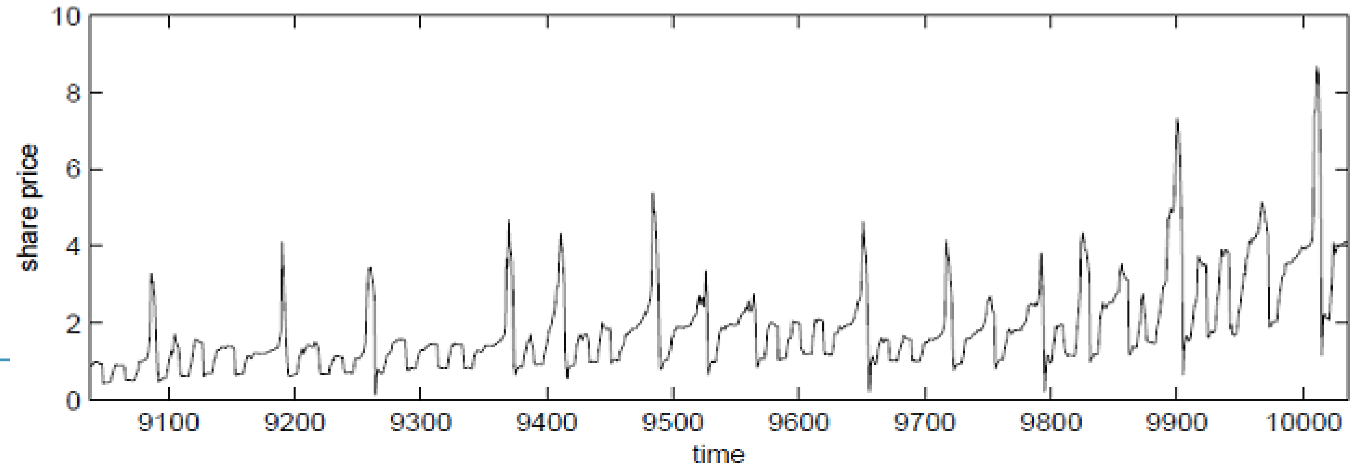
Long memory



Mixed memory



Short memory



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Successes and failures

- Successes:
  - demonstrates complexity of markets
  - emergent price is qualitatively sensible
  - changing a parameter (memory) changes dynamics
- Failures:
  - emergent price is quantitatively extreme
  - cannot calibrate using smooth changes
  - different models suggest different causes of fat tails