Agent Based Modelling and Artificial Financial Markets

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Where will quant modelling be in 5 years time?

- “It is better to be roughly right than precisely wrong”.
- “The difficulty lies not so much in developing new ideas as escaping from old ones”

John Maynard Keynes

Quant challenges

- Need to go beyond linear factor based risk models.
- Back-testing on historical data is becoming less and less useful.
- How do we optimally use information that is not already fully incorporated in prices?
- How can we best exploit behavioural effects in Financial markets?

Classical model of Financial Economics

- Rational, utility maximizing agents
- Homogeneous expectations
- Market is in equilibrium or close to equilibrium
- Models are solved using the mechanism of a representative agent

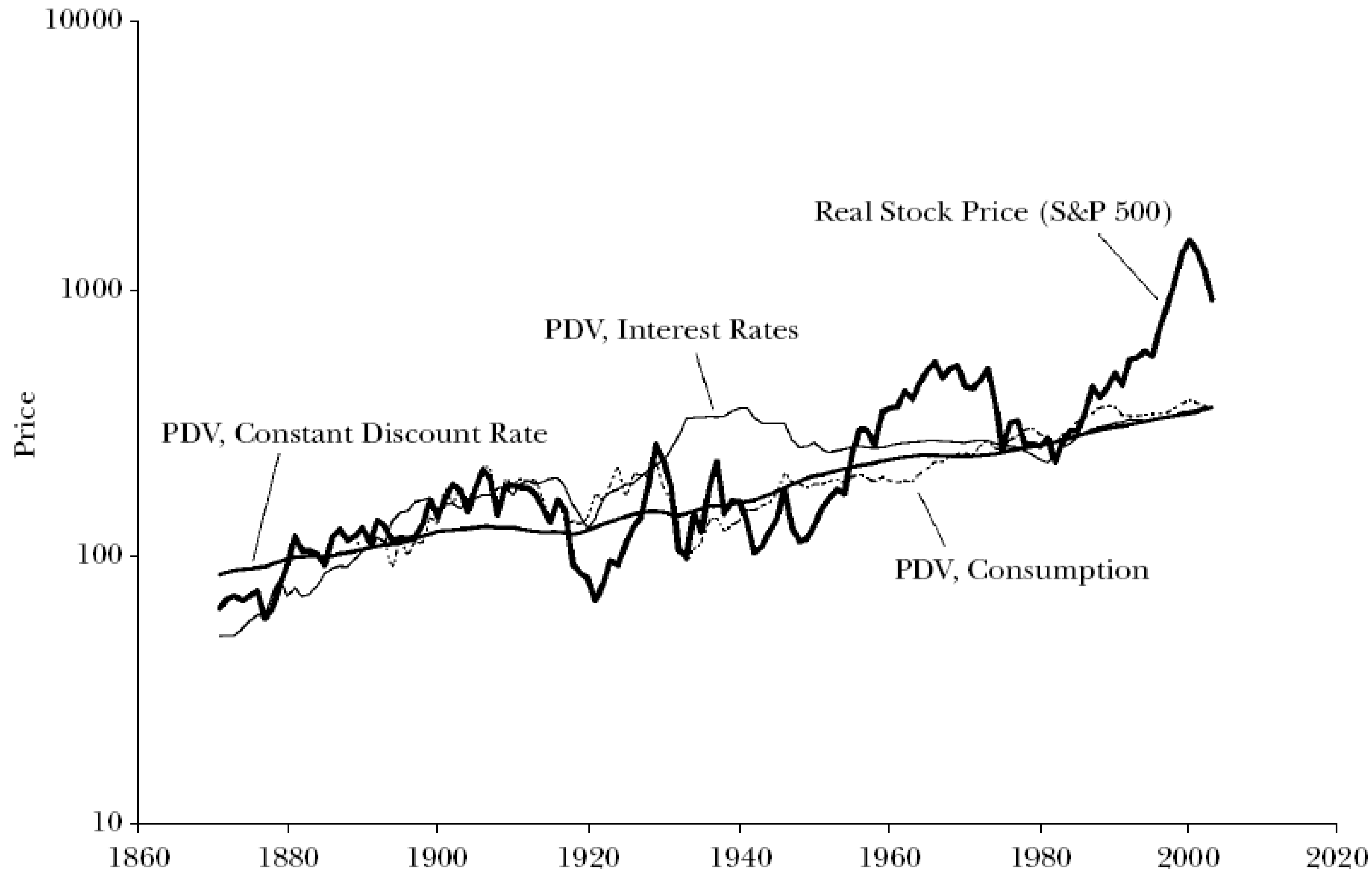
Inconvenient Empirical Facts

- Excess volatility relative to variation in macro-economic time series
- Long term memory in volatility
- Kurtosis / large magnitude returns
- Equity risk premium
- Trading volume is too high

Figure 1

Real Stock Prices and Present Values of Subsequent Real Dividends

(*annual data*)



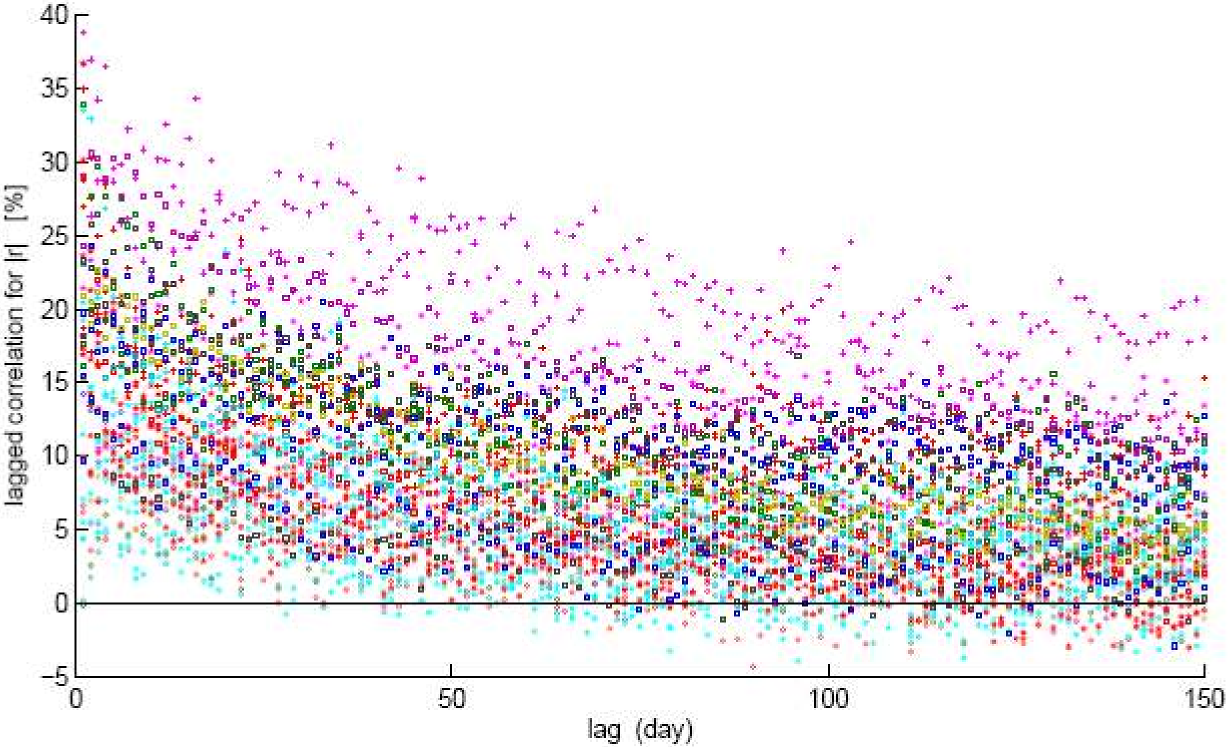


Figure 2: The lagged correlation of $|r|$ for 40 time series. The same color is used for broad asset class, like FX, stock indexes, etc...

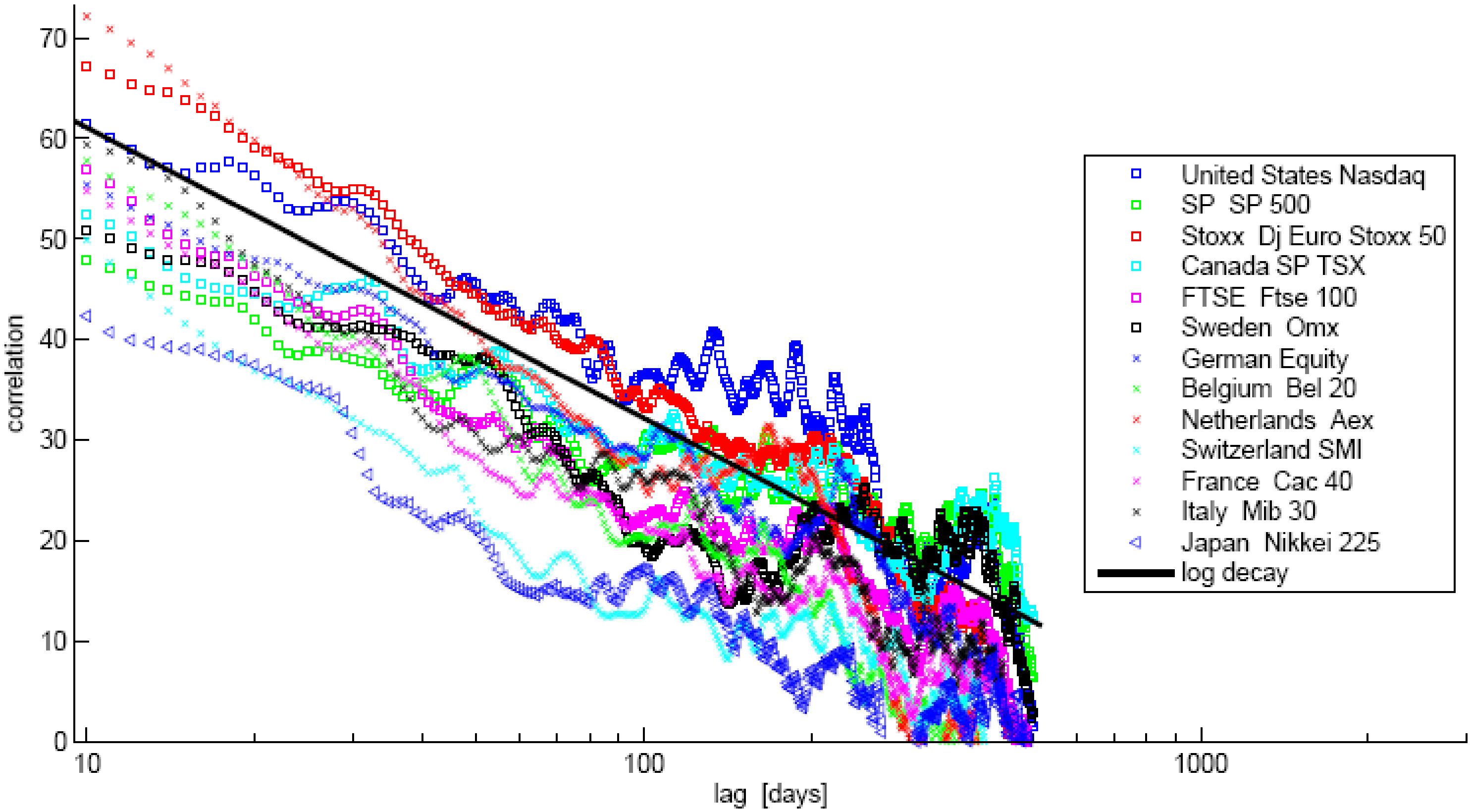
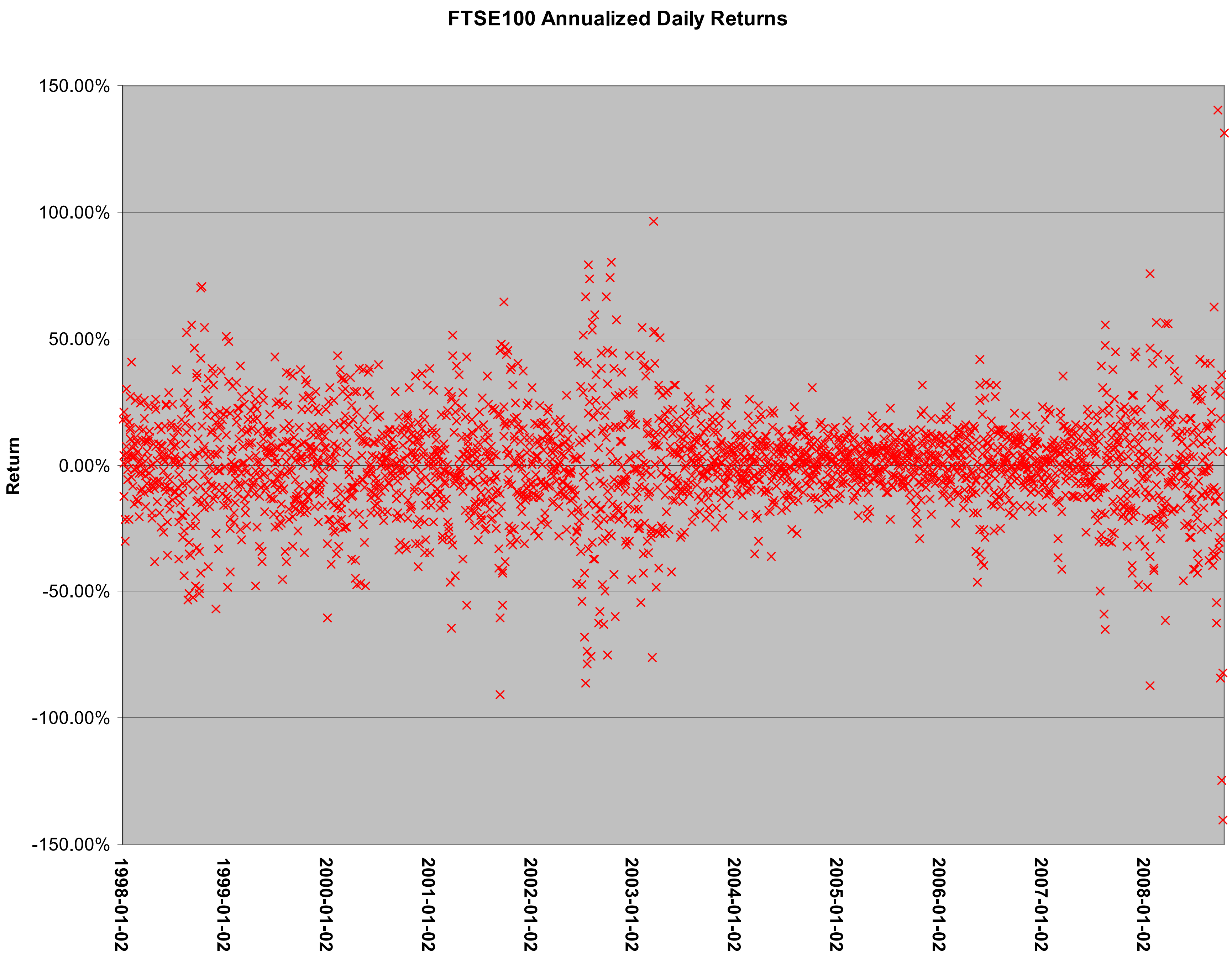


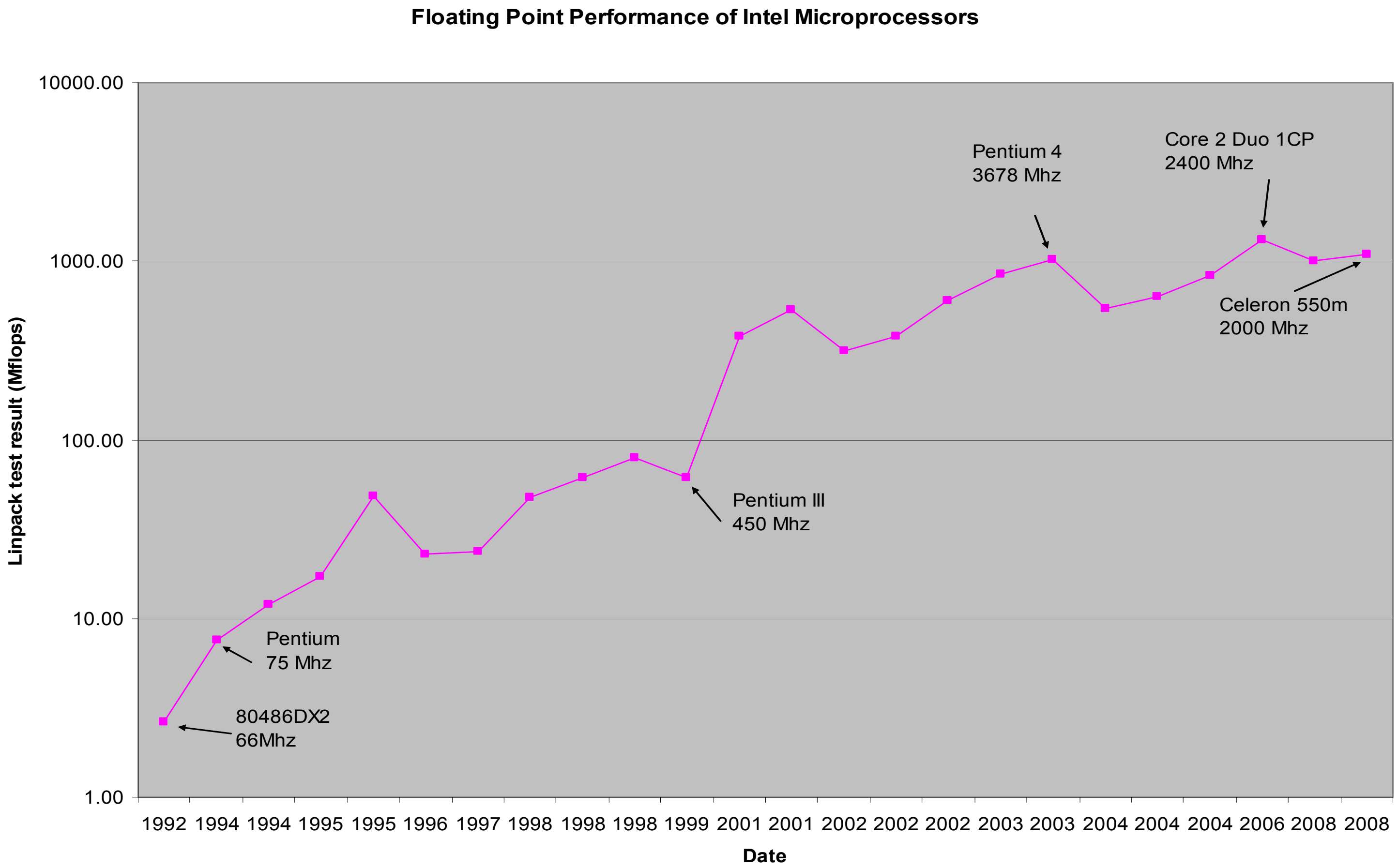
Figure 8: Lagged correlation for the 10 days realized volatility, for the stock indexes in the G10 countries. The parameters for the theoretical curve are as follows: log decay: ρ_0 = 90%, τ_0 = 5 years.


FTSE100 Annualized Daily Returns
150.00%
100.00%
50.00%
0.00%
-50.00%
-100.00%
-150.00%
Return
1998-01-02
1999-01-02
2000-01-02
2001-01-02
2002-01-02
2003-01-02
2004-01-02
2005-01-02
2006-01-02
2007-01-02
2008-01-02

Where next?

- Allow agents to be heterogeneous
- Incorporate bounded rationality and insights from Behavioural Economics
- Agents interact – they observe each others actions and act on their observations
- Problem – generally can’t use analytic mathematics to solve models

Evolution of PC Performance



Evolution of Supercomputer performance

Artificial Financial Markets

- First attempt at microscopic simulation of a financial market was by Kim & Markowitz in 1989
- Santa Fe Artificial Stock Market probably best known example
- More recent ASMs, such at NatLab, get the institutional details of trading right

Further reading

- Blake LeBaron's article in "The Handbook of Computational Economics Vol 2" by L. Tesfatsion & K. L. Judd, 2006.
- Philip Ball's book "Critical Mass: How one thing leads to another", 2005.