Calibrating Agent-Based Models of Financial Markets\textsuperscript{a}

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Summary

1. Introduction
2. ATOM presentation
3. How to validate it?
   (a) Using real data
   (b) Verifying stylized facts
   (c) With agents behavior
4. Conclusion
1 Introduction

– An important (and growing) literature about Artificial Stock Market
– Several platforms are available coming from research field
– The main lacks for these works are:
  – They are not able to use real order flows
  – They are frequently synchronous platforms
– We present in this paper a new platform called ATOM and its calibration using real-world data
1.1 Literature

- The Santa-Fe artificial stock market, (Palmer 1994)
  macroscopic equation based on demand and supply

  \[ p_{t+1} = p_t (1 + \beta I_t) \]  
  \[ (1) \]

- The $− \text{game}$ (AndSor 2003)
  To solve the question of market clearing, they add a market maker to the model

  \[ (\ln(p_t) - \ln(p_{t-1})) = \frac{I_t + \sum_{i=t-1}^{i=0} I_i}{\lambda} \]  
  \[ (2) \]

- The Genoa artificial stock market (Raberto 2003)
  agents are allowed to emit classical limit orders to the market but it is still asynchronous

  → It exists several asynchronous ASM such as the one of Solomon and Muchnik.
2 ATOM presentation

ATOM (http://atom.univ-lille1.fr) is a general environment for agent-based simulations of stock markets written in JAVA

Philosophy :
- It’s an API, not a stand-alone program!
- ATOM is built on several independant packages: core, net, gui, behaviors, ...
- It works very fast and is able to be used on networks, with or without GUI, with or without human Agents
- It is able to use any real orders of EuroNext-NYSE
Three main notions:

- **MarketPlace**: a set of order books
- **OrderBook**: receives orders and fix prices
  ATOM can have several order books running simultaneously
- **Agent**: available to send orders to any order book of the market.
  Agents can have a behavior or not.
  ATOM allows human agents, distributed agents, ZIT, Intelligent agents,...
Figure 1 – ATOM GUI with 100 artificial agents
Figure 2 – ATOM GUI with 20 artificial agents and 2 Human traders
3 A Calibration of ATOM

How to verify that the market algorithm and clearing does not biases the results?

- Using real-world order flows
- Emergence of various stylized facts with ZIT agents
4 Real OrderFlow

One minimum verification consists in creating a ”wrapper agent” reading a real-world order-flow, sending the corresponding orders to the order books and compare to the real series of prices.

- EURONEXT-NYSE system on June, 26th, 2008 for one stock ”France Telecom” (FTE)
- LimitOrders, MarketOrders, CancelOrders, ....
- We observed 8800 transactions during this trading day for 83616 orders

Thanks to ATOM we have been able to play-again this day in less that 5sec
Figure 3 – Real-World quotes vs. ATOM quotes
5 Stylized facts

Are zero intelligent traders (ZIT) in ATOM able to produce stylized facts in line with those observed over real world data?

1. Non Gaussianity of asset returns
2. Autocorrelation in asset returns and volatility clustering
3. Long memory
4. Volume-Volatility relation
5.1 Non-Gaussianity of asset returns

Figure 4 – Histogram of returns and normal distribution with the same mean and variance
5.2 Autocorrelation and volatility clustering

(a) ACF of ATOM generated returns for first 40 time lags

(b) ACF of ATOM generated returns for first 5 time lags

Figure 5 – Autocorrelation properties
6 Conclusion

In this paper we have presented ...

- ATOM, a new multi-order book, multi-agent artificial stock market
- This platform relies on an asynchronous and continuous double auction
- It allows to mix agents populations (heterogeneous artificial agents and human beings) in a multi asset quotation environment
- Can employ all orders admitted on the EURONEXT-NYSE stock exchange.
- Validated in this research with a real-world order-flow delivering quotations in line with their real-world counterparts
- delivers quite well a series of remarkable stylized facts observed on real-world financial places.
- Calibrated with respect to real stock market data
Questions?

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