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http://www.ele.uri.edu/ieee-ssci2017/CIFEr.htm

# Why do Active Funds that Trade Infrequently Make a Market more Efficient?
# -- Investigation using Agent-Based Model

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# Active/Passive Managed Funds

There are two types of portfolio management strategies for funds that invest in stocks,

where a manager chooses stocks expected to raise their prices and invests in them

where a manager expects a return the same as a market index, e.g., Dow Jones, and replicates the components of the index

**Active Funds**

**Assets: Decreasing**

**Passive Funds**

**Assets: Increasing**

Recently,

Because

☆ Some empirical studies [French 08, Bogle 14] argued that The average return of active funds lost that of passive funds.

☆ Recent regulations have made fund sellers accountable for fund costs especially in the United States. [A.T.Kearney 16]

（Costs of passive fund are cheaper than those of active, since passive funds need not research companies.）

# Function and Goodness of Active Funds

## Active Funds have very Important function in capitalism

☆ discover the fundamental value (intrinsic value of companies)
☆ leads to market prices converging with the fundamental price (make a market more efficient)
☆ play an important role in allocating capital, which is an important function in capitalism

［Wurgler 10］

At first glance, there are **Inconsistent?**

［Suominen 11］

**Infrequent trades seem to not impact market prices?**

**Important to discuss whether active funds trade infrequently make a market more efficient or not, if so, to investigate the mechanism of how they do so.**

By the way,

## Good Active Funds

☆ trade on the fundamental value measure precisely
☆ trade infrequently earn more ［Cremers 16］

# Our CONTRIBUTION

## Important function in capitalism of Active Funds

☆ leads to market prices converging with the fundamental price (make a market more efficient)

☆ play an important role in allocating capital, which is an important function in capitalism

[Wurgler 10]

Our Result Indicate

CONSISTENT!!

Though the trading volume of active funds was low throughout the whole period, the volume increased a lot only when the market became less efficient, and these trades then made the market efficient.

## Good Active Funds

☆ trade infrequently earn more

[Cremers 16]

# Difficulty of Empirical Study

Difficulty of Empirical Study

- ✓ such discussion on the mechanism between the micro-macro feedback of certain types of investors is very difficult
- ✓ cannot be conducted to investigate situations that have never occurred in actual financial markets, such as ones in which passive investors are more than present
- ✓ cannot be conducted to isolate the direct effect of changing the distribution of investor types on price formation because so many factors cause price formation in actual markets

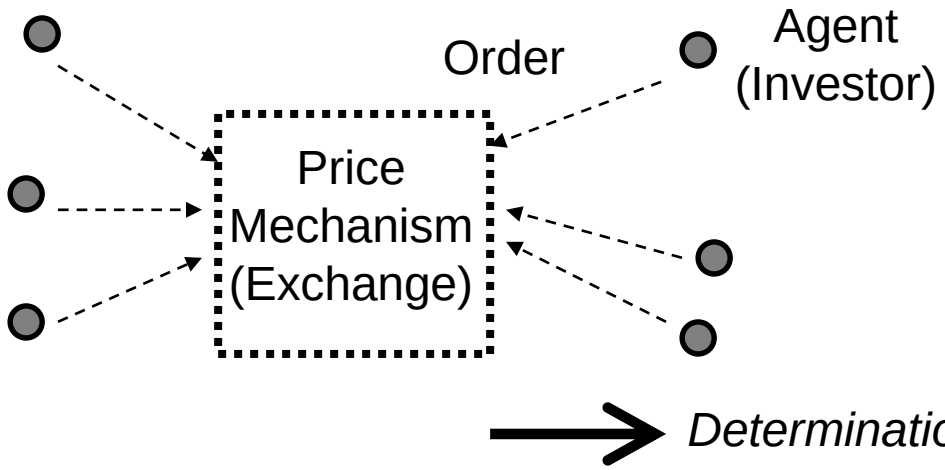
**Artificial Market Simulation**

# Artificial Market Simulation (Agent-Based Model)

## Virtual and Artificial financial Market built on Computers

Models Include

Agents (Artificial Investors)
+
Price Mechanism (Artificial Exchange)




Each Agent determines an order by some rules, Price Mechanism gather agents orders and determines Market Price

## Complete Computer Simulation needing NO Empirical Data

- ✓ can discuss on the mechanism between the micro-macro feedback
- ✓ can be conducted to investigate situations that have never occurred in actual financial markets
- ✓ can be conducted to isolate the direct effect of changing the distribution of investor types on price formation

# Previous Contributions of Artificial Market Simulations

Many studies, including previous CIFEr papers, have investigated the effects of several changing regulations and rules by using artificial market,

Reduction of Tick Size, Up-Tick Rule,
Price Variation Limit, Dark Pool, Frequently Batch Auction,
Contribution of HFTs for share competition among Exchanges,
Suitable Latency of Exchange System, VaR Shock,
Chain Bankruptcy of Banks,
Regulations and Rules to prevent Financial Crush

- Mizuta (2016) A Brief Review of Recent Artificial Market Simulation Studies for Financial Market Regulations And/Or Rules, SSRN Working Paper Series http://ssrn.com/abstract=2710495

## NATURE/SCIENCE articles argued Importance of Simulations

- Battiston et al. (2016) **SCIENCE**, Vol. 351, Issue 6275, pp. 818-819. http://science.sciencemag.org/content/351/6275/818
- Farmer and Foley (2009) **NATURE**, Vol. 460, No. 7256, pp. 685-686. https://www.nature.com/articles/460685a

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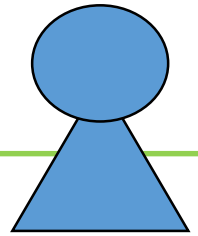
# Our Modeling of Agents(Artificial Investors)

Our Model is different from previous models where



（1） **Agents are reflected the characteristics of investors who trade infrequently**

Real fundamental investors wait a market price reaching their target price.

←(previous) agents re-estimate buy/sell every time

（2） **Focusing how an order price is determined**

It easier to interpret the simulation results since the types of agents only differ in terms of how an order price is determined,
and this allows us to build a model of agents who trade infrequently.

←(previous) agents determine target no. of shares, not order price

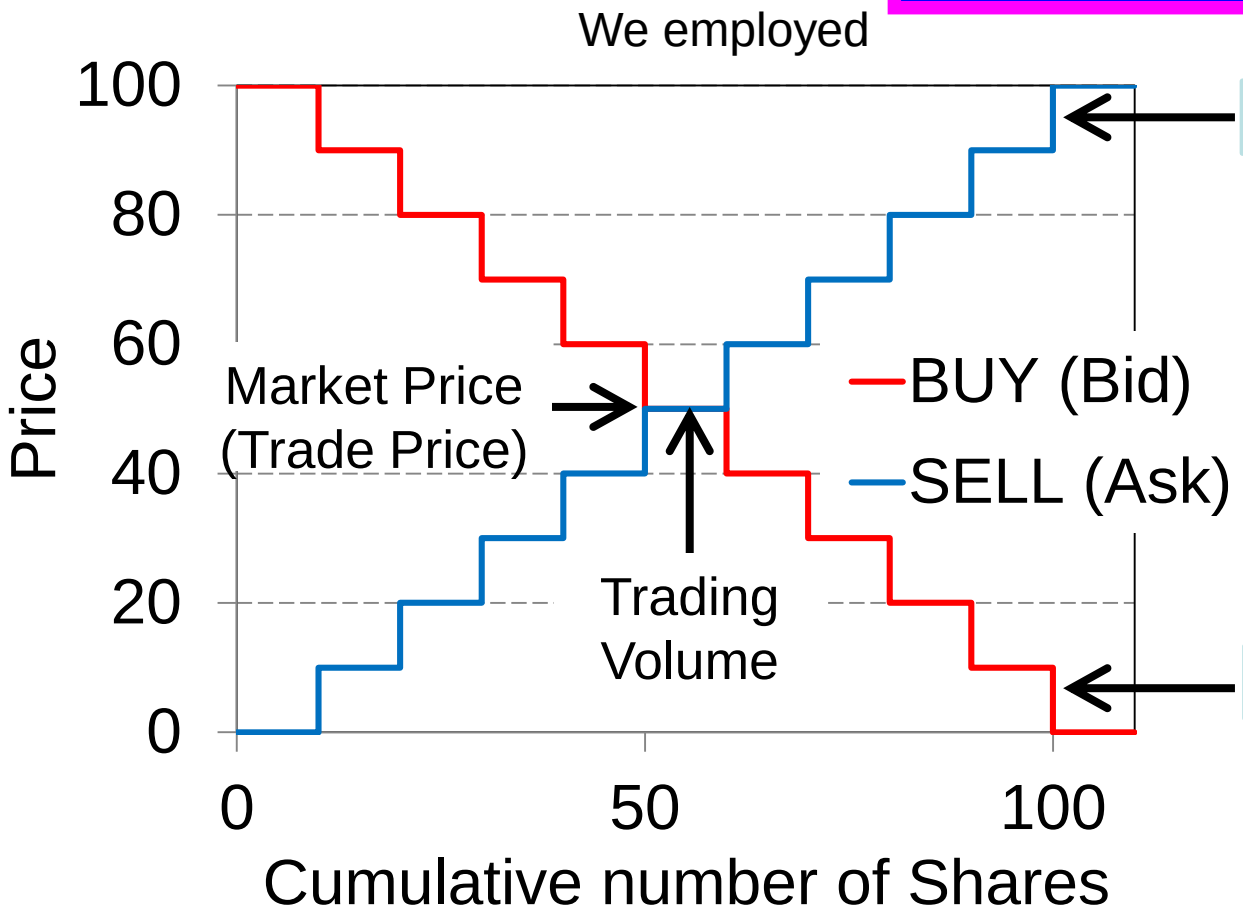
No previous model has these characteristics

We constructed an artificial market model that is as simple as possible having these characteristics

The simplicity of the model is very important for this study because unnecessarily replicating macro phenomena leads to models that are over-fitted and too complex, and such models would prevent us from understanding and discovering the mechanisms that affect price formation because the number of related factors would increase.

# Price Determination Model

## Call Market (Batch Auction)




Supply Curve

Cumulative number of Shares that sellers want to **sell over** this price

Demand Curve

Cumulative number of Shares that buyers want to **buy under** this price

In a call market, buy and sell orders are grouped together and then executed at specific times (rather than executed one by one continuously). We determine Market Price and Trading Volume at the crossing point of supply and demand curves.

# Our Agent Model: Common Setting for every Agent Types

Initial Holdings of Agents

One share or Cash 10,000

← Half and Half of all agents

(Initial Market price=10,000)

Determig Buy/Sell

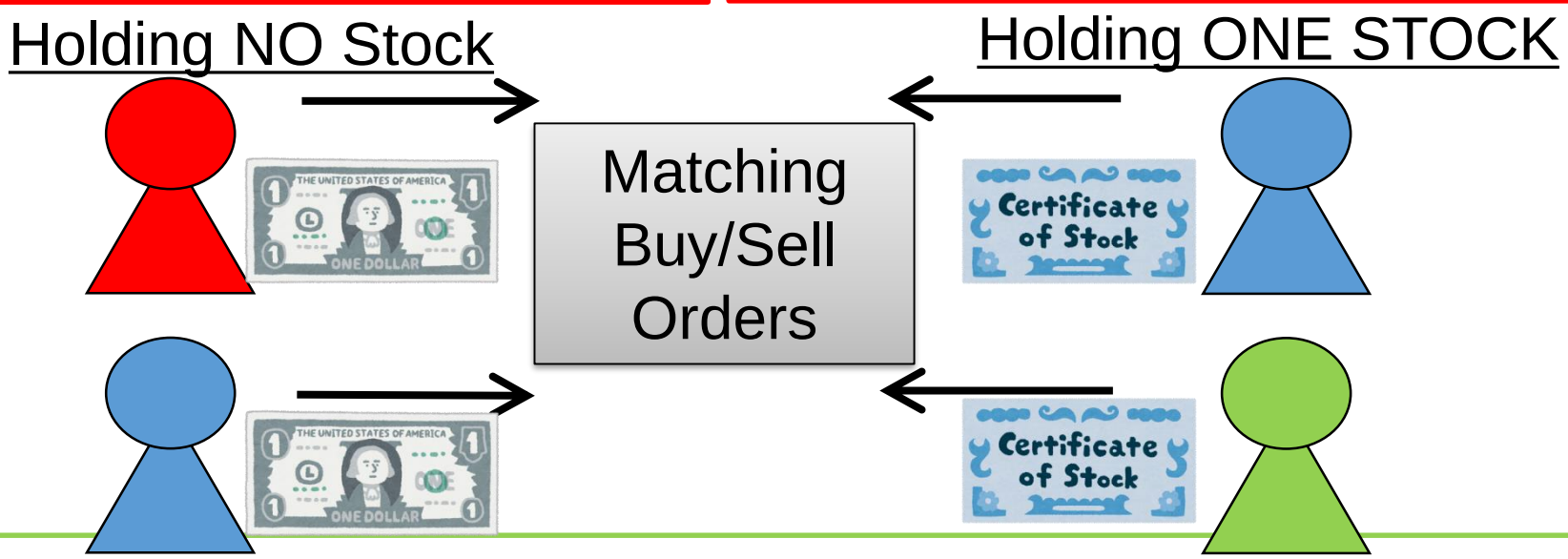
Holding One Share stock : SELL

Holding no stock : BUY

(No more than 2 shares, no negative no.)m

**Always place a BUY order**

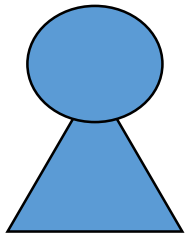
**Always place a SELL order**




The number of shares and buy or sell of orders are determined not depending on Agent Types. Agent Types only differ in terms of how an order price is determined. We can focus difference from the ways determining order prices.

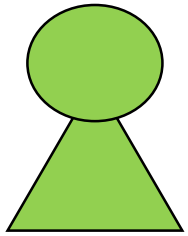
# Our Agent Model: Three Agent Types

Agent Types only differ an Order Price



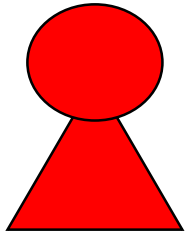
## Noise Agents

Around Market Price Randomly



## Technical Agents

Referring only Historical market prices



## Fundamental Agents

Corresponding

Active Funds
In real financial market

Referring only their Estimated Fundamental Price with Enough Margin of Safety

Explain Details of Three Agent Types in Following some Slides

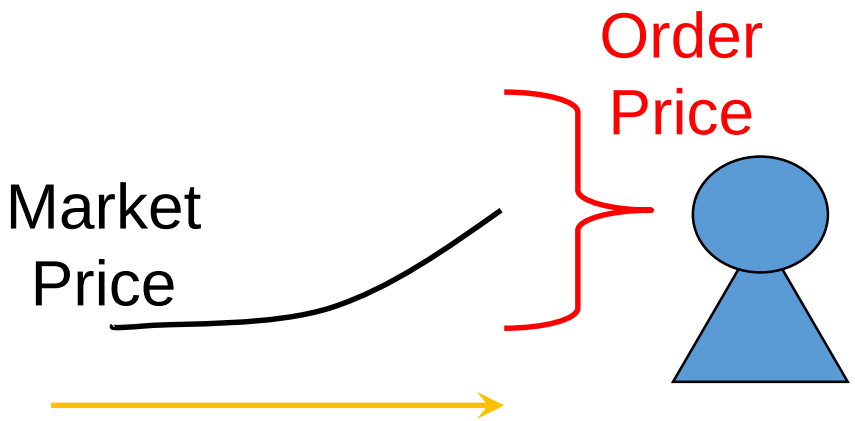
# Noise Agents

Number of Agents = 1,000

**Order Price**

$$P_{o,j} = P_t \exp(\eta \sigma_{t,j})$$

$P_o$ : Order Price
$P_t$ : Market Price
$\eta$ : Constant (=10%)
$\sigma_{t,j}$ : random variables that follow a standard normal distribution
$t$: time
j: Agent no.




They order around Market Price Randomly.

In this study, we handle a stock traded at a high enough volume.
We introduce noise agents to supply enough liquidity.
(Also, in real financial markets, there are such many liquidity suppliers)

# Technical Agents

Number of Agents = 100

Momentum and Contrarian exist
Half and Half of all Technical Agents

**Order Price**

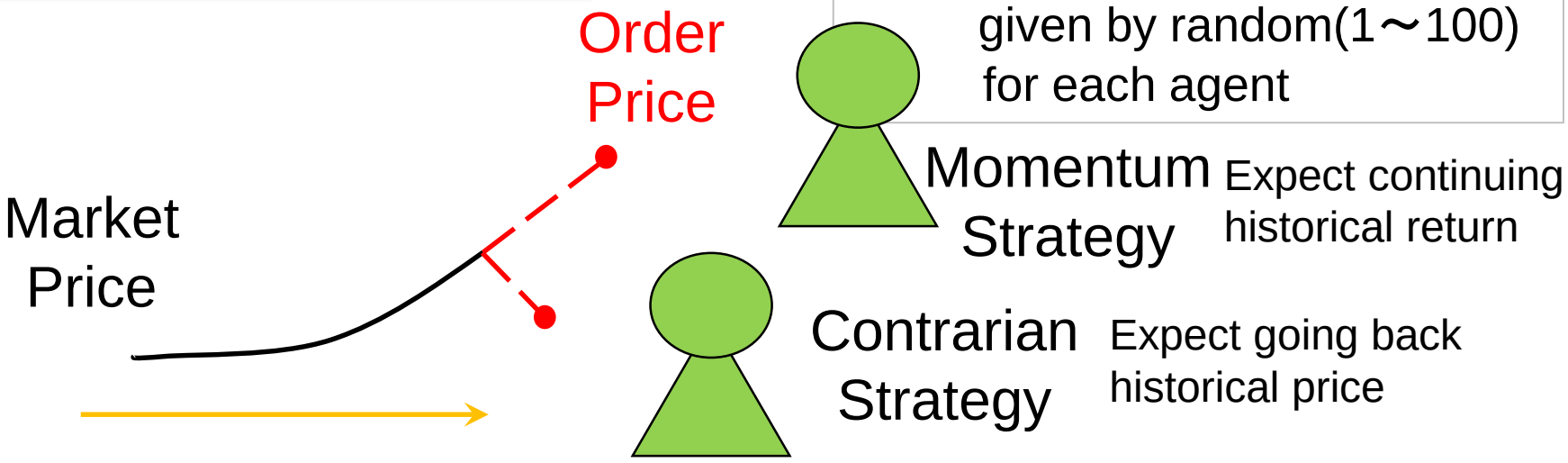
## Momentum Strategy

$$P_o = P_t \frac{P_t}{P_{t-tm_j}}$$

## Contrarian Strategy

$$P_o = P_{t-tm_j}$$

$tm_j$: reference term
given by random(1～100)
for each agent




Determine Order price Referring only historical market price

Previous studies showed that such technical agents are needed to replicate price formations observed in real financial markets

# Fundamental Agents

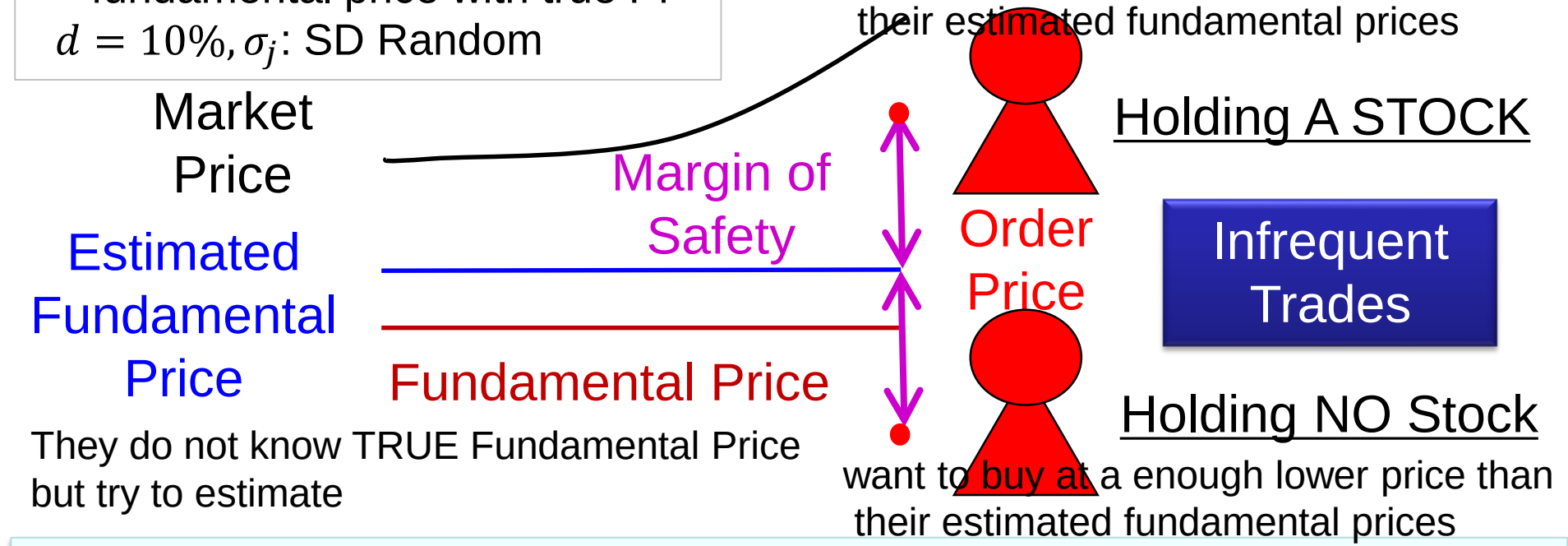
## Order Price

$$P_o = P_f \exp\left[d\sigma_j \pm m_s\mu_j\right]$$

$P_f = 10{,}000$: Fundamental Price
$d\sigma_j$: Difference estimated fundamental price with true Pf
$d = 10\%, \sigma_j$: SD Random

## Various Number of Agents

$m_s\mu_j$: Margin of Safety
$m_s = 10\%$
$\mu_j$: Uniform Random(0∼1)
$\pm$: when holding stock ”+”
when holding No stock ”-”




Determine order prices by depending not on the market price, but on the Estimated Fundamental Price with Enough Margin of Safety which leads Infrequent Trades.

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# Verification of Model

Stylized Facts In the case of No existing Fundamental agents

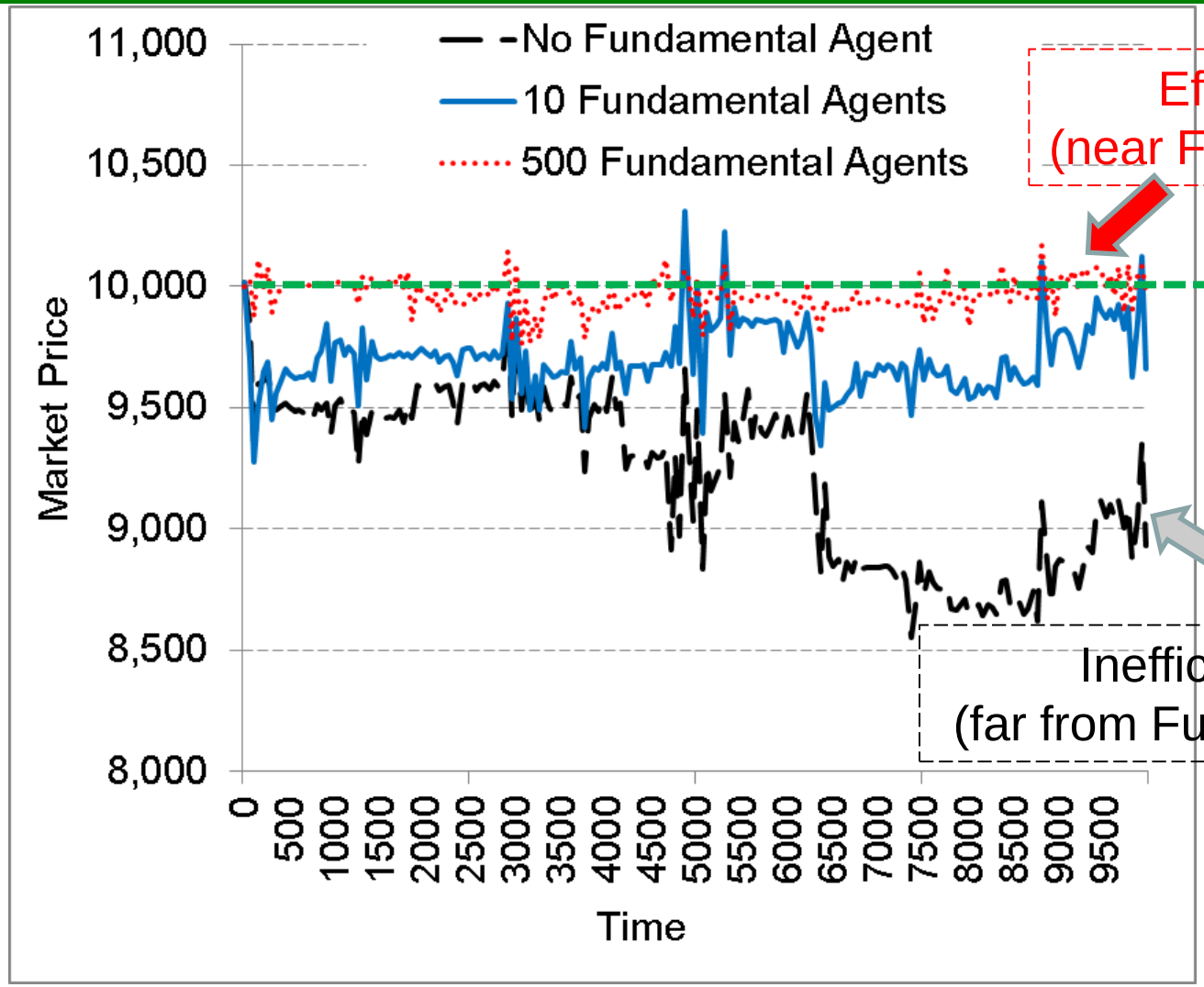
| | |
|---|---|
| standard deviation of returns | 0.22% |
| kurtosis of price returns (Fat-Tail) | 2.37 |

autocorrelation coefficient for square returns (Volatility-Clustering)

| lag | |
|---|---|
| 1 | 0.18 |
| 2 | 0.14 |
| 3 | 0.13 |
| 4 | 0.15 |
| 5 | 0.12 |

Our model replicated the statistical characteristics (Stylized Facts), fat-tails, and volatility-clustering, observed in real financial markets.

# Time Evolution of Market Prices for various No. of Fundamental Agents




Efficient market
(near Fundamental Price)

Fundamental Price

Inefficient market
(far from Fundamental Price)

The higher the number of fundamental agents, the more efficient the market became Market Prices oscillated in a narrower range near the Fundamental Price.

# Market Inefficiency

$$M_{ie} = \frac{1}{t_e} \sum_{t=1}^{te} \frac{\left| P^t - P_f \right|}{P_f}$$

Average of Absolute Difference between Market Price and Fundamental Price

Directly measuring market efficiency (Never observed in empirical studies)
Mie is always greater than zero, and Mie=0 means a market is perfectly efficient

| | Number of Fundamental Agents | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0 | 10 | 20 | 50 | 100 | 200 | 500 |
| Market Inefficiency | 7.7% | 3.0% | 2.2% | 2.4% | 1.4% | 0.7% | 0.6% |

The higher no. of Fundamental Agents, lower Market Inefficiency, the market became more efficient

This indicates the possibility that a decrease in the number of active investors makes a market less efficient, and this implies that money moving from active funds to passive funds leads to a market becoming less efficient.

# Trading volume share for various No. of Fundamental Agents

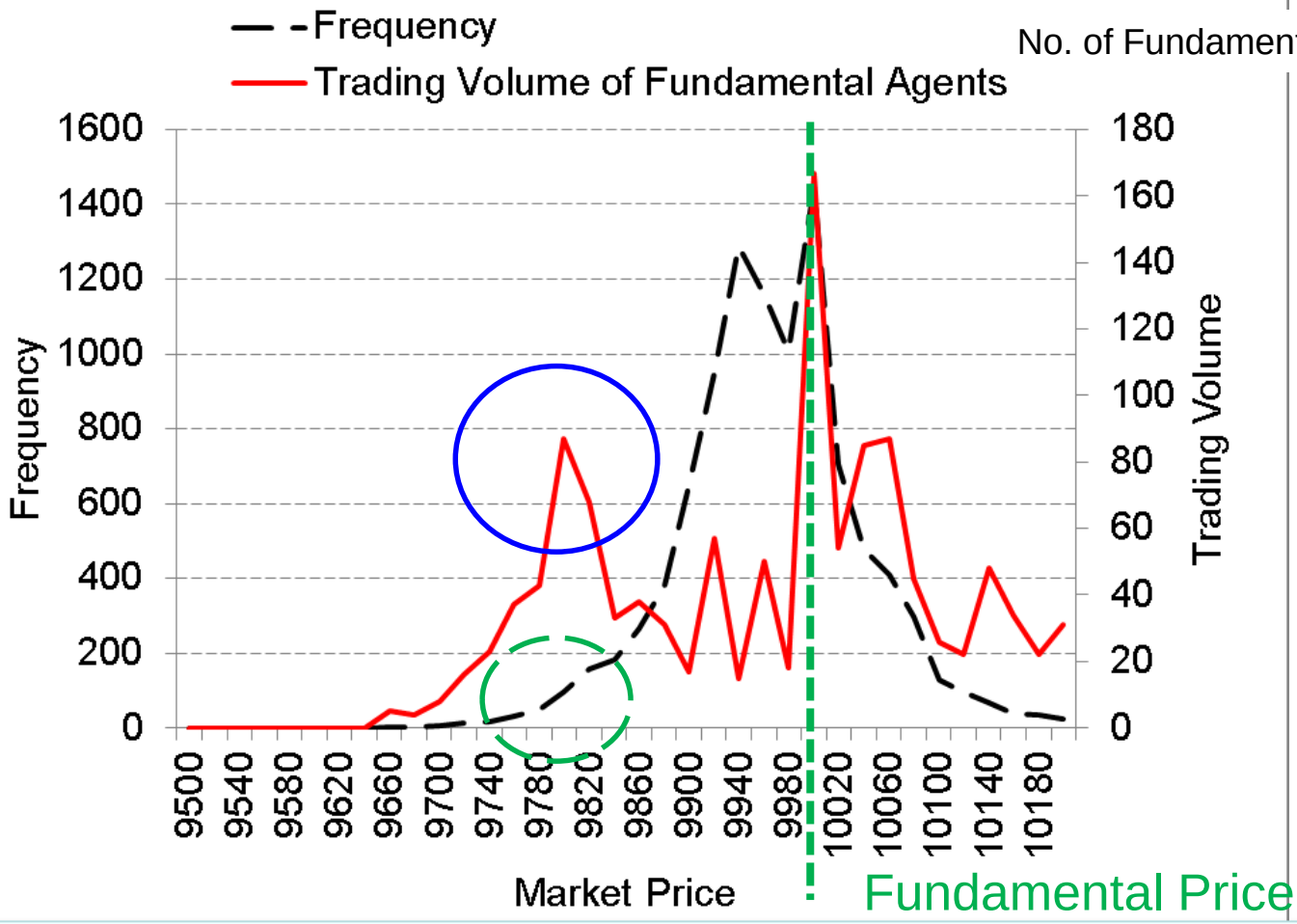
(total volume of a type of agent/total volume of all types of agents)

| Trading volume share | Number of Fundamental Agents | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0 | 10 | 20 | 50 | 100 | 200 | 500 |
| Noise (No.=1000) | 97.3% | 97.2% | 97.2% | 97.0% | 97.0% | 96.9% | 96.9% |
| Technical (No.=100) | 2.7% | 2.8% | 2.8% | 3.0% | 3.0% | 3.1% | 3.1% |
| Fundamental | --- | 0.002% | 0.002% | 0.006% | 0.010% | 0.011% | 0.023% |

The trading volume of fundamental agents was much smaller than those of other type agents.

To discuss why fundamental agents whose trading volume is low make a market more efficient, we show three figures on following slides.

# Distribution of the frequencies of market price (Black) & Of Trading volume of fundamental agents (Red) for various market price ranges

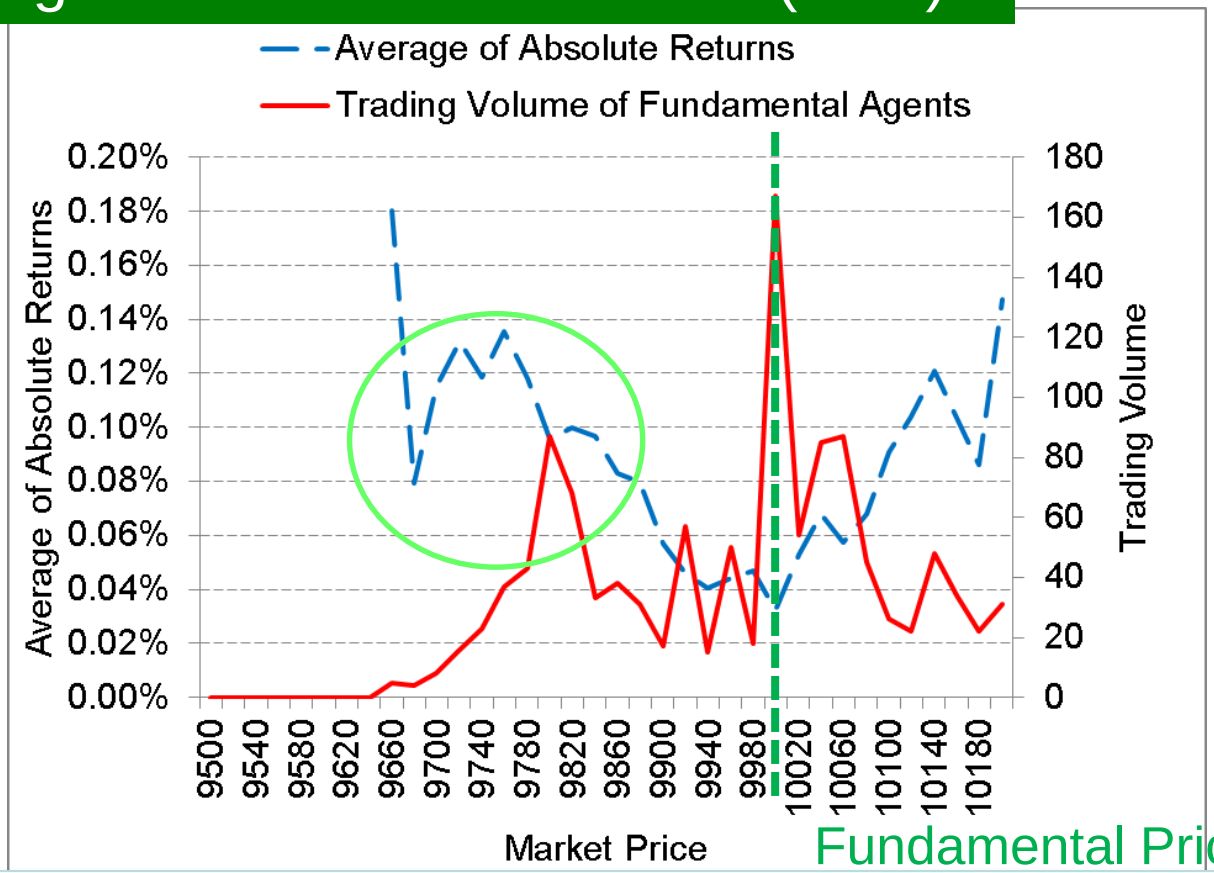



Market Prices(Black):
Peek around FP
Far FP, lower Fq. rare

Trading Volume(Red):
Double Peek:
Second Peek is
Low Frequency
=> Rare Case

Fundamental agents traded (second) Frequently at 9800, far from FP (Red), though here is rare case(Black).
They traded frequently only when the market became inefficient (rare case) as Market Price moved farther away from FP.

# Average of the absolute returns (Blue)



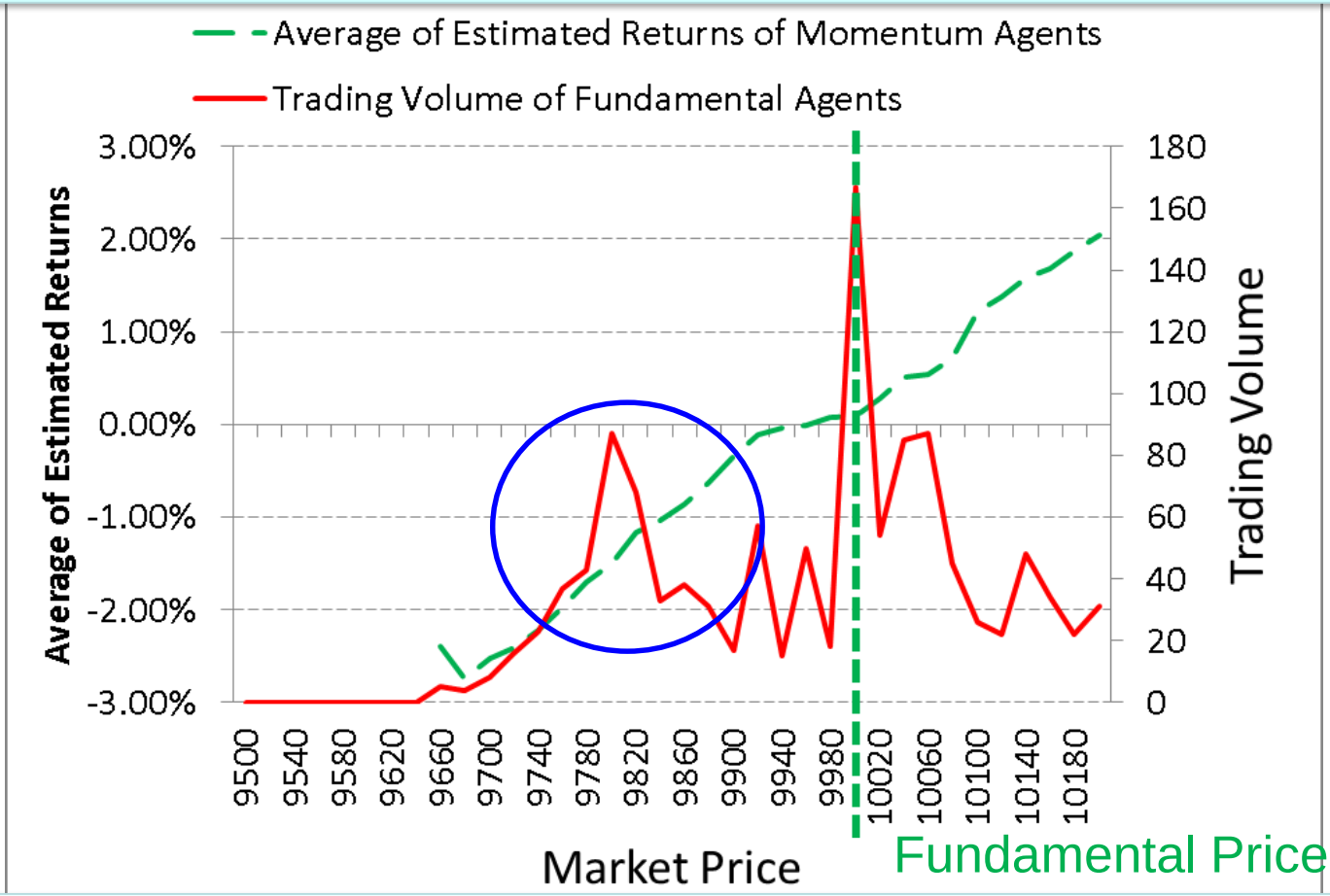

Absolute return near 9800 was large (Blue)
this means market volatility (dispersion of returns) increased

Fundamental agents traded frequently when market prices sharply declined and market volatility was excessive.

Though the trading was low throughout the whole period, the volume increased a lot only when the market became less efficient, and these trades then made the market efficient.

# Average of Estimated Returns of Momentum Agents (Green)

Estimated Return = (Order Price − Market Price)/Market Price



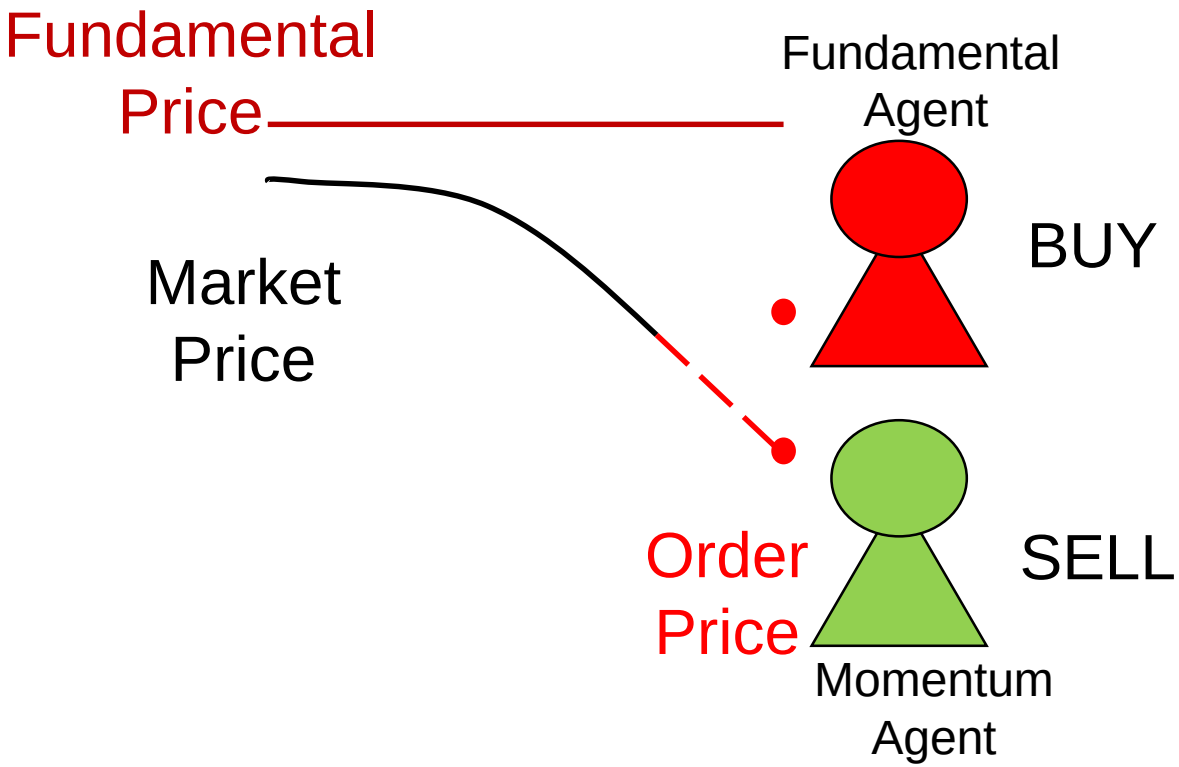

Increasing market volatility makes the order prices of momentum strategy agents move further away from FP, and this leads to amplifying market volatility more excessively.

Orders of fundamental agents prevent this amplification.

In short, In the case of Sharply Falling Market Price (Rarely Occurred)

(Only when such the Rarely Occurred Case)

**Many Orders Prevent This Accelerations**




Falling Market Price
→ Accelerate Falling Speed

# Comparing with Empirical Study

These simulation results in short,

Though the trading was low throughout the whole period, the volume increased a lot only when the market became less efficient, and these trades then made the market efficient.

［Albagli 15, Cremers 15］

Support — [Fact] Active Funds make Markets Efficient

Different — ［Reason, Mechanism］ Active Funds that perform well measure fundamental value more precisely

［Suominen 11］

Not Support — [Fact] Funds trading infrequently do not make a market efficient

［Pastor 16］

Consistent — ［Reason］the volume of active funds varies over time and that funds earn when the volume is larger

# Averages of the profits of agents for various No. of Fundamental Agents

| Averages of the profits | Number of Fundamental Agents | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0 | 10 | 20 | 50 | 100 | 200 | 500 |
| Noise (No.=1000) | -0.06% | -0.07% | -0.13% | -0.18% | -0.30% | -0.52% | -0.85% |
| Technical (No.=100) | 0.64% | -0.09% | 0.24% | -0.31% | -0.62% | -0.80% | -0.91% |
| Fundamental | --- | 8.36% | 5.18% | 4.22% | 3.61% | 3.02% | 1.87% |

(Again)

| | Number of Fundamental Agents | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0 | 10 | 20 | 50 | 100 | 200 | 500 |
| Market Inefficiency | 7.7% | 3.0% | 2.2% | 2.4% | 1.4% | 0.7% | 0.6% |

The averages of the profits for the fundamental agents was higher than those of the other types of agents.

Lower no. of Fundamental Agents, the fundamental agents earn. There are more opportunities for fundamental agents to earn when the market becomes less efficient.

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# Conclusion

- ✓ We built a model of agents who trade infrequently in an artificial market model and investigated the effects of active investors who trade infrequently on market prices and whether they make a market more efficient or not by using the artificial market model.
- ✓ The fundamental agents traded frequently in the rare situation that the market becomes unstable and inefficient due to the market price moving further away from the fundamental price. These trades, occurring only at a necessary time, impacted the market prices and lead them converging with the fundamental price. This lead to preventing the market from becoming more unstable and less efficient.
- ✓ Though the trading volume of fundamental agents was low throughout the whole period, the volume increased a lot only when the market became less efficient, and these trades then made the market efficient.
- ✓ It is implied that money moving from active funds to passive funds leads a market to become less efficient because these orders of active funds decrease.

# Future Work

- ✓ There are many types of Fundamental Investors. Especially “patient” investors who rarely loss-cut and “impatient” investors who frequently loss-cut are important because of first one earns more than second one showed by empirical study [Cremers 16]. Therefore, We should investigate the case that money moving from “impatient” investors to “patient” investors.

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# Discussion for rising Passive funds is VERY VERY IMPORTANT

| Active Funds | Passive Funds |
| --- | --- |
| Discovering Fundamental Price | Not Discovering it |
| Taking Liquidity | No Taking Liquidity |

Both has strengths, weaknesses

Most important point we should discuss is

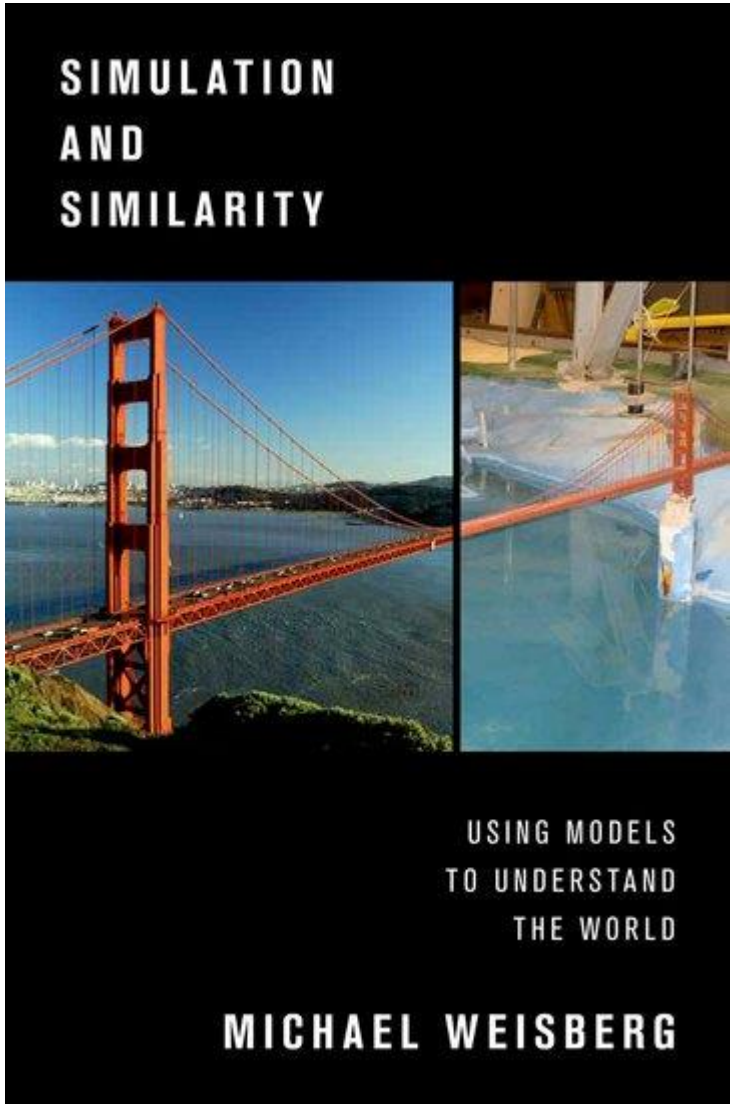
**How much maximum existing rate of Passive Not to destroy price discovery function**

To discuss this we should know mechanism how infrequent trades of Active funds impact market prices

So, we emphasis that our study is a part of most important discussion about the entire system of capitalism and market mechanisms that facilitate an increase in the general welfare

# What is a role of Simulation Models?

This book answer the question.
And also answer “What is a model?”




Simulation and Similarity Using Models to Understand the World, 2012
https://global.oup.com/academic/product/9780199933662

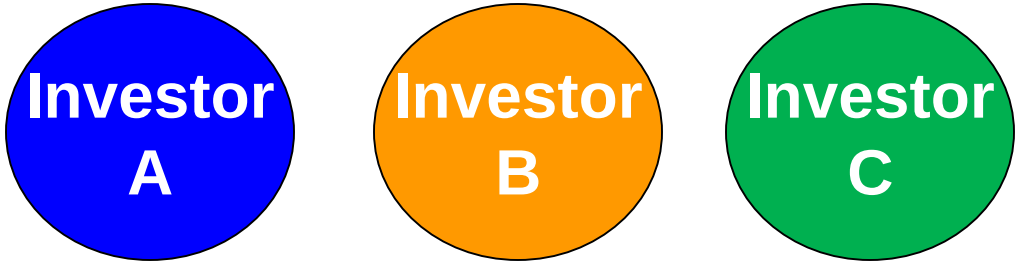
# Aim is not replicating nor forecasting real world

In time, those Unconscionable Maps no longer satisfied, and the Cartographers Guilds struck a Map of the Empire whose size was that of the Empire, and which coincided point for point with it . . . In the Deserts of the West, still today, there are Tattered Ruins of that Map, inhabited by Animals and Beggars;

On Exactitude in Science Jorge Luis Borges

* Modeling, (is) the indirect study of real-world systems via the construction and analysis of models.
* Modeling is not always aimed at purely veridical representation. Rather, they worked hard to identify the features of these systems that were most salient to their investigations.
* Textbook model of the cell is both abstract and idealized relative to any real cell. It is abstract because it isn't a model of any particular kind of cell; it is a model of properties shared by all eukaryotic cells. Relatedly, it is idealized because its generality forces some parts of the model to be distorted relative to any real cell. I think these are both interesting properties,

# Role of Model (in the case of Agent-Based Artificial Market Model)




Inherit Only Important Properties
(Behaviors, Algorithms) for Investigating Phenomena

Other Investigating Phenomena,
Other Important Properties,
Other Good Models

**Model of Investors**

Never Real-Existing Investor
For Understanding Properties of
Real-Existing Investors

e.g.: Fashion Model: Understanding Closes
Model Home: Understanding Home

An Aim is to understand how Important Properties (Behaviors, Algorithms) affect Investigating Macro Phenomena and play Roles in System.

It is NOT aim Replicating real-existing Investors A, B and C.
It is aim Understanding real-existing Investors.

Other Focusing Phenomena, Other Good Models

# What simulation(computational) model can do and mathematical model can not do

* When one invokes a computational model to explain some phenomenon, one is typically using transition rules or algorithm as the explanans. Schelling explained segregation by pointing out that small decisions reflecting small amounts of bias will aggregate to massively segregated demographics. Neither the time sequence of the model's states nor the final, equilibrium state of the model carries the explanatory force; the algorithm itself is needed.

Algorithms: The As want at least 30% of their neighbors to be As and likewise for the Bs. An agent standing on some grid element e can have anywhere from zero to eight neighbors in the adjoining elements.


*Figure 2.2* An example of Schelling's model of segregation on a 51 × 51 grid with 2000 agents. Each agent prefers 30% of its Moore neighbors to be the same shape and color. The initial distribution of agents was random, and the model equilibrated after fourteen time steps.

# Role of Model (cont.)

We want know a relationship between
Micro Process:
Deciding Orders, Rules of Exchange
& Macro Phenomena: Price Formation

Mathematical Model
Macro Model
can treat only this region

**Model of Investors**

Inherit Only Important Properties

**Investor A**

**Investor B**

**Investor C**

Deciding Orders
(Algorithms)

**Model of Exchange**

**Change Rules**

**Stock Market Country A**

**Bond Market Country A**

**Stock Market Country B**

Replicate Only Important Properties

**Price Formation (Simulation Result)**

Matching Orders
(Aggregation of Algorithms)

**We want know a relationship between them**