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Analysis of the Impact of Leveraged ETF Rebalancing Trades on the Underlying Asset Market Using Artificial Market Simulation

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(2) Artificial Market Model

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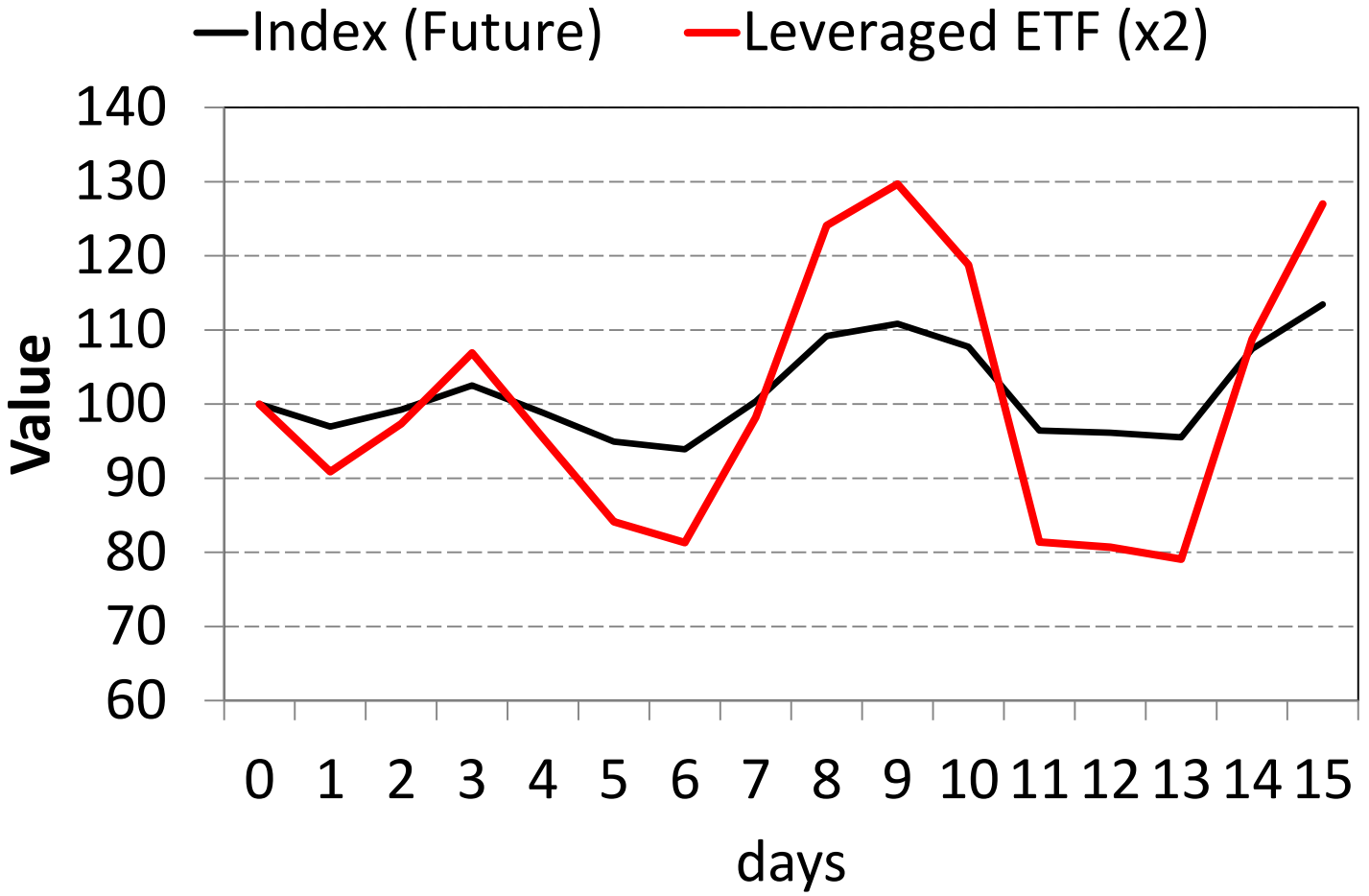
Leveraged ETF

ETF = Exchange Traded Funds is an investment fund traded on stock exchanges, much like stocks.

A Leveraged ETF is designed to deliver several times the return of its benchmark index (future), e.g. S&P 500, Euro Stoxx 50, FTSE 100, Nikkei 225.



Actually, Leveraged ETF has to trade the index on daily to maintain its leverage (Rebalance).

Rebalance to maintain its leverage

For example, when the index returns are +10% on day 1 and -10% on day 2
The Leverage is twice (x2)

Days	Index (a) Return	Leveraged ETF (x2) is Designed as (b) Return = 2x(a)	(c) Value Will be by (b)	Leveraged ETF (x2) Holding Index (future) Value (d) Should have = 2x(c)	(e) Will be by (a)	(f) Rebalance = (d)−(e)
0			$100	x 2 $200	+10% $200	
1	+10%	+20%	+20% $120	x 2 $240	$220	+20
2	−10%	−20%	-20% $96	x 2 $192	-10% $216	−24

So, leveraged ETF

buy the index when its price goes up
sell the index when its price goes down

This leads

Momentum Trading

This momentum trading Rebalance concern some people,

This Rebalance makes Financial Market Unstable?

Previous Studies for Leveraged ETF

Many Empirical Analysis

For examples,

Cheng and Madhavan(2009): “In USA market, the index moves 1% in one day, the volume of rebalancing trading of a leveraged ETF may account for 16.8% of total trading in the index at the close of trading on that day.”

Deshpande et. al.(2009): “Leveraged ETFs accounted for a mere 0.0079% of trading in the S&P 500.”

Trainor Jr. (2010): “Examined the impact of leveraged ETF rebalancing on the volatility of the S&P 500 but was unable to draw any firm conclusions.”

These shows

Very Different Results about an Impact on the Financial Market

In actual markets, there are

So many factors cause price formation. An empirical study cannot isolate the direct effect of leveraged ETFs.

Therefore, In this Study,

We built an Artificial Market Model (Agent Based Model for Financial Market) to investigate the market impact of leveraged ETF rebalancing on the index price formation.

- There are no previous study investigating the market impact of leveraged ETF using an Artificial Market Simulation.
- Our model is based on the model of Yagi et. al. (2010).

Strong Advantages: Artificial Market Simulations can

isolate the direct effect of leveraged ETFs.
analyze micro process and give us new knowledge.
treat situations have never occurred.
(e.g. There are more Leveraged ETFs than current)

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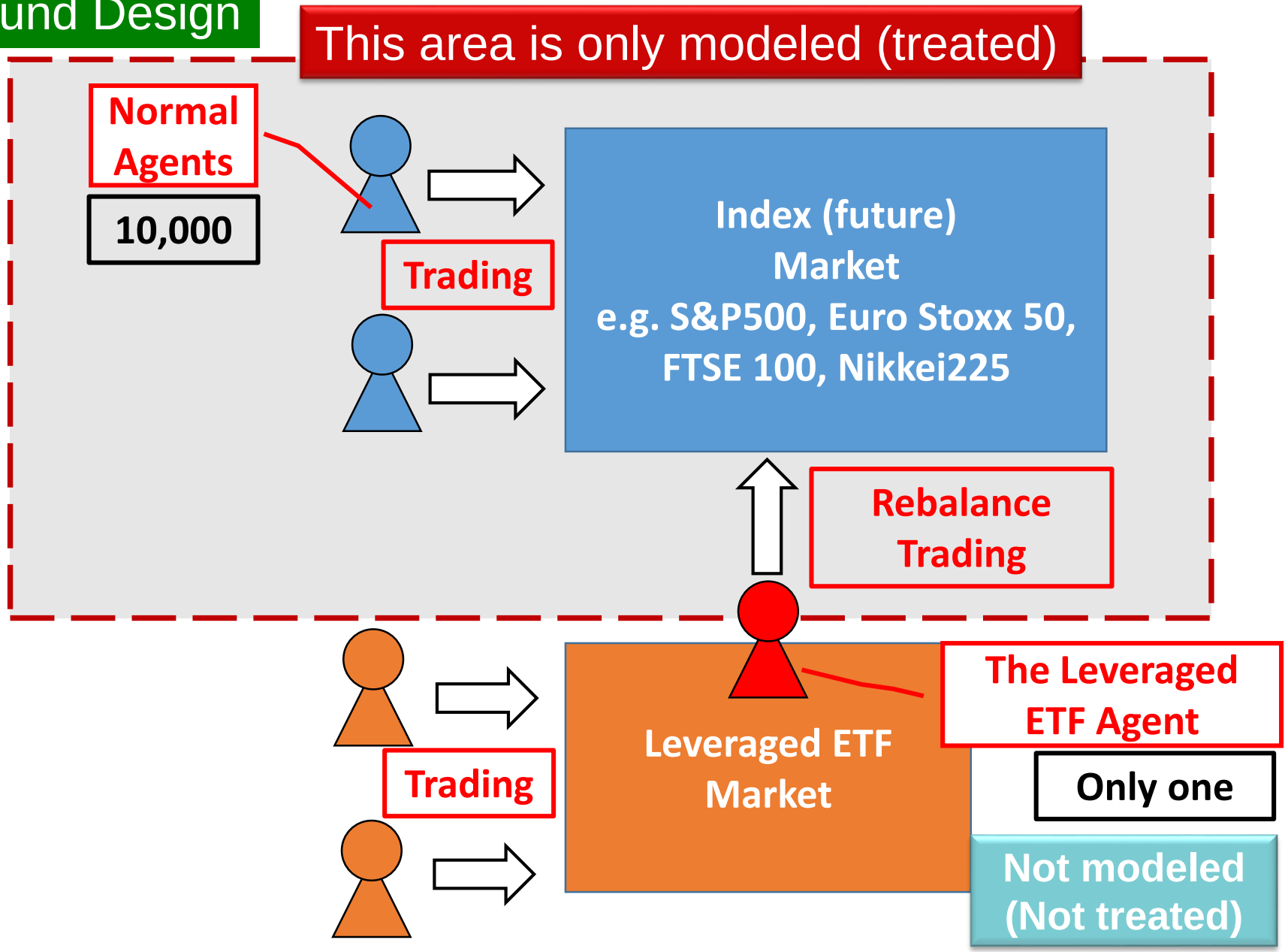
Ground Design



Normal Agents

We modeled Normal Agents as 3 kinds of agents, fundamentalists, Chartists and Noise traders.

Fundamentalists **4,500**

expects a **positive** return when the market price is **lower** than the Fundamental Price (externally given and constant), and vice versa.

Chartists **4,500**

Market followers mode: an agent expects a **positive** return when historical market return (moving average) is **positive**, and vice versa.

Contrarians mode: an agent expects a **positive** return when historical market return is **negative**, and vice versa.

Noise Traders **1,000**

orders to buy, sell, and wait with equal probabilities.

Learning Process

Fundamentalists and Chartists learn some parameters of high-performance agents and switch mode.

Exactly same as Yagi et. al.(2010)

Fundamentalists and Chartists

* Fundamentalists

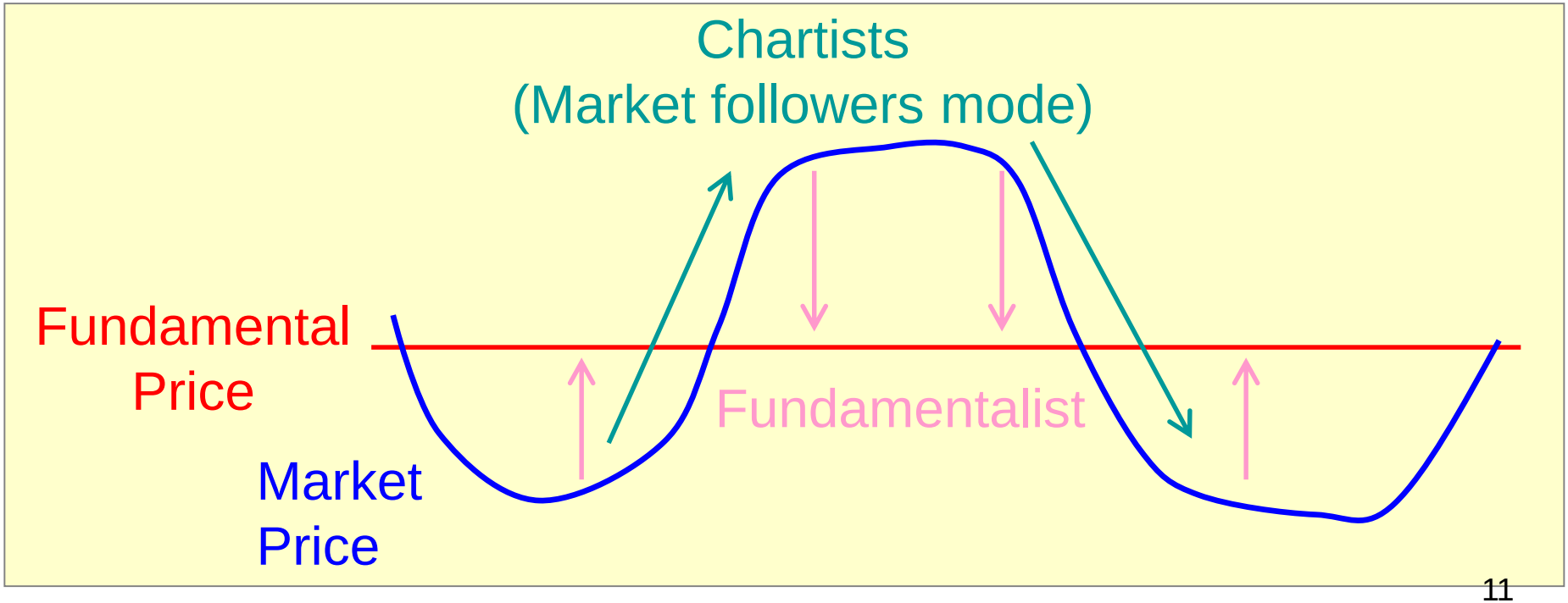
Fundamental Price > Market Price → expect Positive return

Fundamental Price < Market Price → expect Negative return

* Chartists (Market followers mode)

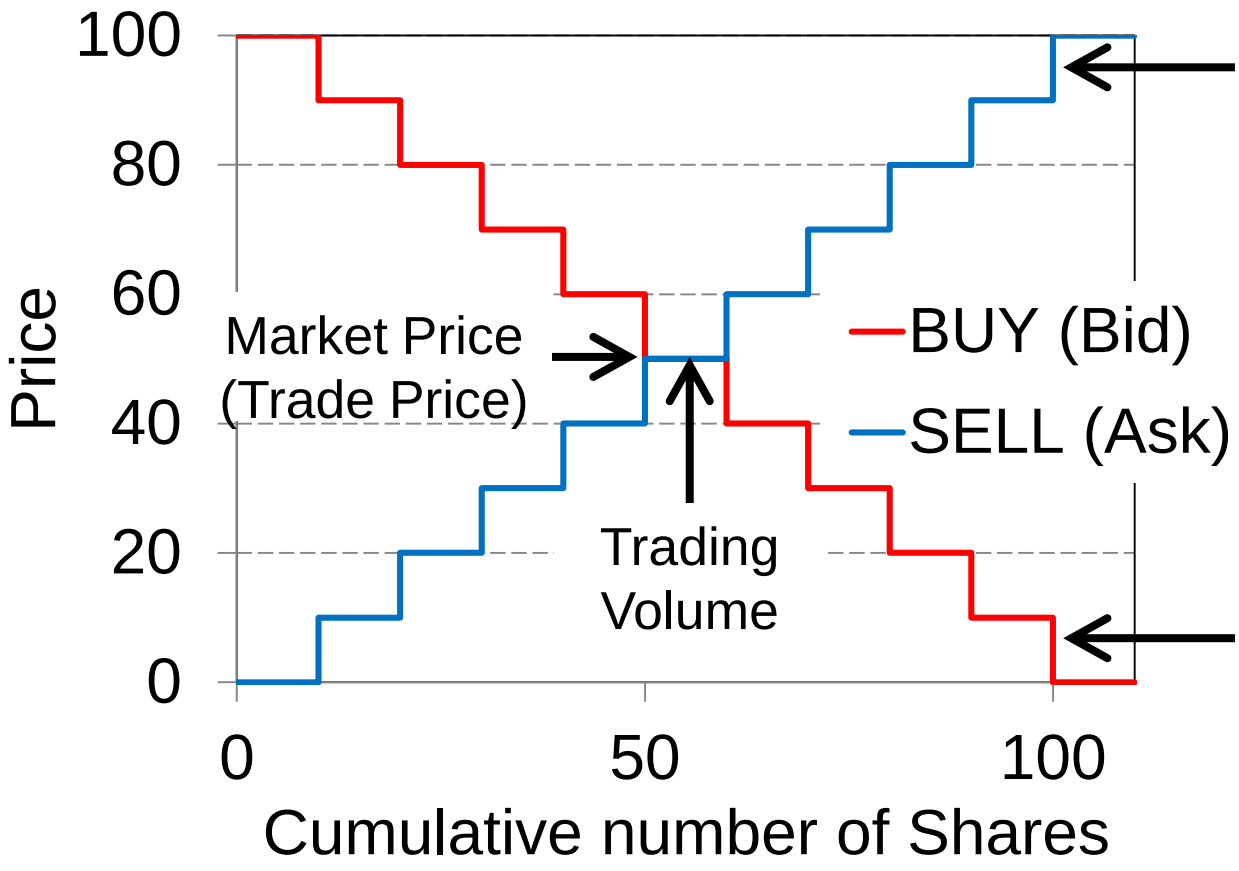
Historical return > 0 → expect Positive return

Historical return < 0 → expect Negative return



Price Determination Model

Call Market (Batch Auction)



Supply Curve

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

Demand Curve

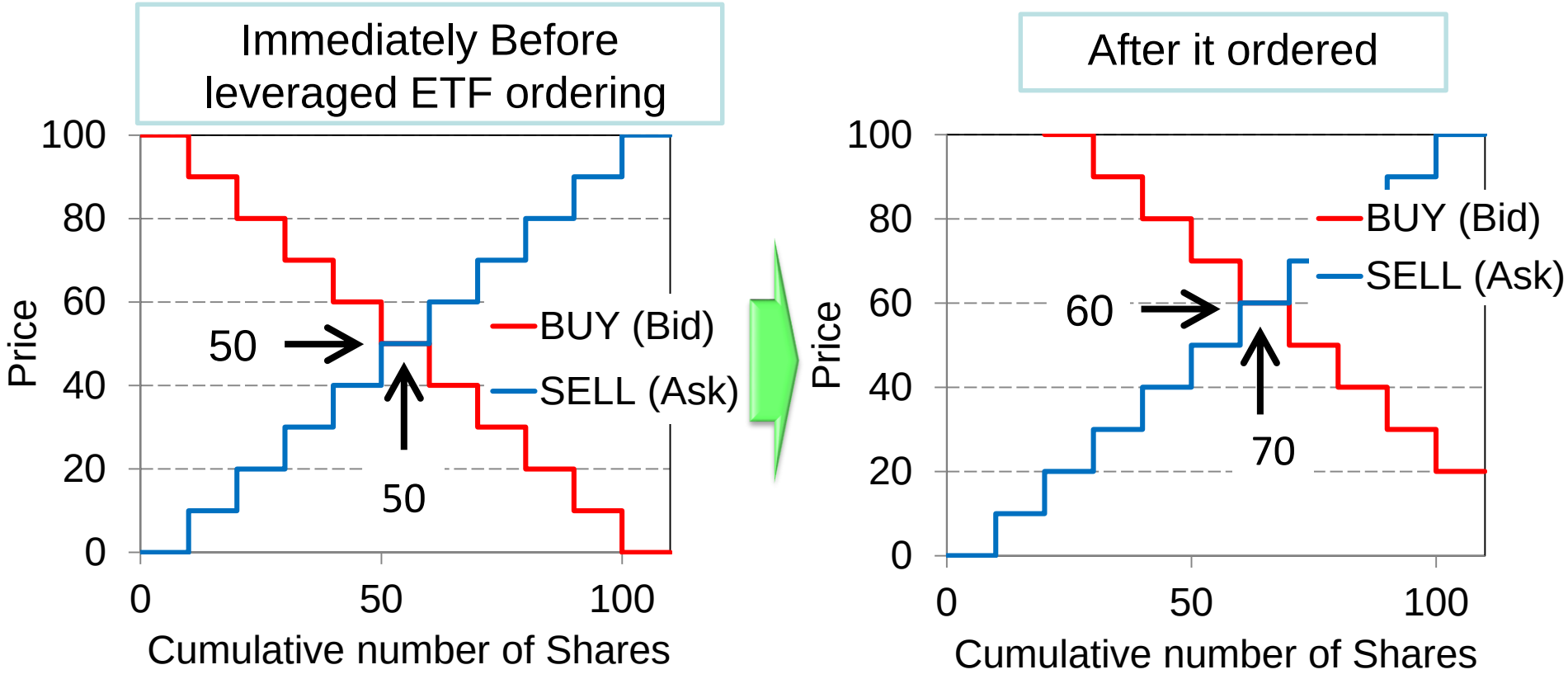
Cumulative number of Shares that buyers want to **buy under** this price

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.

The Leveraged ETF Agent

Our Original Model

The leveraged ETF ONLY does Rebalance Trading.



The leveraged ETF orders after all Normal Agents ordered.
It determines rebalance trading using the temporary market price, 50 (Left).
If it need buying 20 shares, it makes buy 20 shares order at very high price.
The order changes Supply and Demand Curve (Right).
The market price is changed to 60 (from 50).
The price difference, 10 is the **market impact** of the rebalance.

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Search Parameter

We investigated how the leverage ETF impacts market prices, relationship between size (total value) of the leverage ETF and the magnitude of the market impact.

We executed simulations for several size of the leveraged ETF.
We defined the size of leveraged ETF as

Total Value of the leveraged ETF / Total Value of all Normal agents

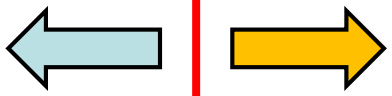
and the size is changed to 0.1%, 1%, 10%, 15%, 16%, 17%
This is Search Parameter.

Note that in our proceeding we tried on greater number of parameters, however here we only show important results for simplicity.

Volatility, stylized facts

Volatility = Standard Deviation of Returns
Kurtosis = Kurtosis for Return distribution

		Size (Total Value of the leveraged ETF / Total Value of all Normal agents)						
		NO Leveraged ETF	0.1%	1%	10%	15%	16%	17%
Volatility(%)		1.13	1.18	1.4	1.47	1.39	6.42	29.5
Kurtosis		4.64	4.34	2.56	6.29	19.2	15.8	3.41
	Lag							
	1	0.52	0.49	0.38	0.39	0.56	0.48	−0.49
Autocorrelation	2	0.71	0.70	0.72	0.64	0.45	0.48	0.79
of the squared	3	0.52	0.50	0.42	0.35	0.31	0.27	−0.55
rate of return	4	0.65	0.64	0.66	0.52	0.21	0.28	0.73
	5	0.53	0.51	0.44	0.31	0.13	0.11	−0.60



Stable
(small volatility)

Unstable
(large volatility)

There is clearly the threshold for stable or unstable market between 15%-16%

Market Impact Volatility Ratio

We defined the Market Impact Volatility Ratio (MIVR)
= market impact (averaged absolute market impact / market price)
/ Volatility (in the case of no leveraged ETF)

	Size (Total Value of the leveraged ETF / Total Value of all Normal agents)						
	NO Leveraged ETF	0.1%	1%	10%	15%	16%	17%
No. of Orders	0	8	72	88	90	6,341	57,617
(a) Market Impact (%)	0	0.00493	0.0396	0.0539	0.0785	2.18	12.5
Volatility (%)	1.13 (*1)	1.18	1.4	1.47	1.39	6.42	29.5
[MIVR] Market Impact Volatility Ratio = (a) / (*1)	0	0.00434	0.0349	0.0476	0.0692	1.92	11

Stable
Very Small Impact

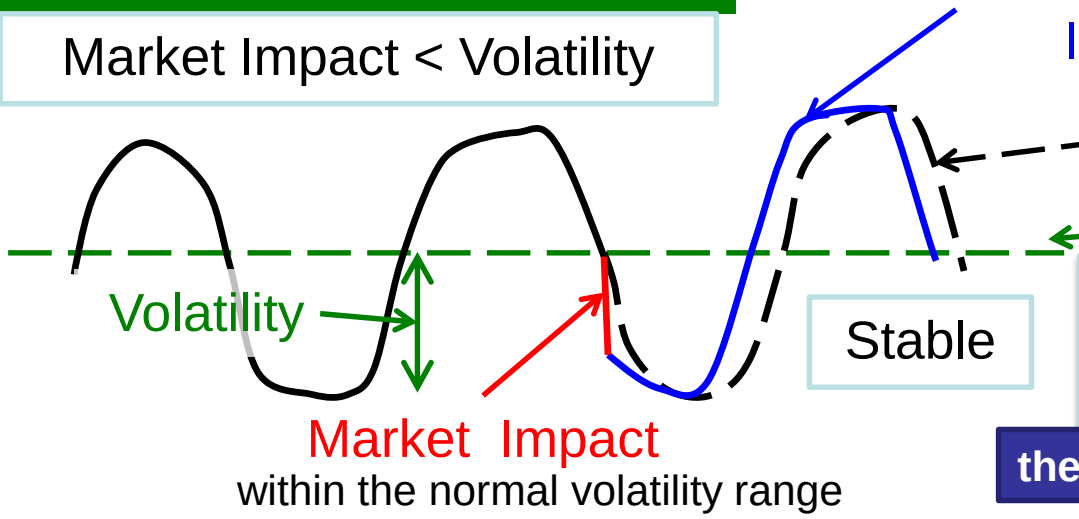
Unstable
Large Impact

MIVR is very important Key Parameter
MIVR < 1: Stable, MIVR > 1: Unstable

Market is Destabilized when Market Impact > Volatility

Possible Mechanism

Market Impact < Volatility

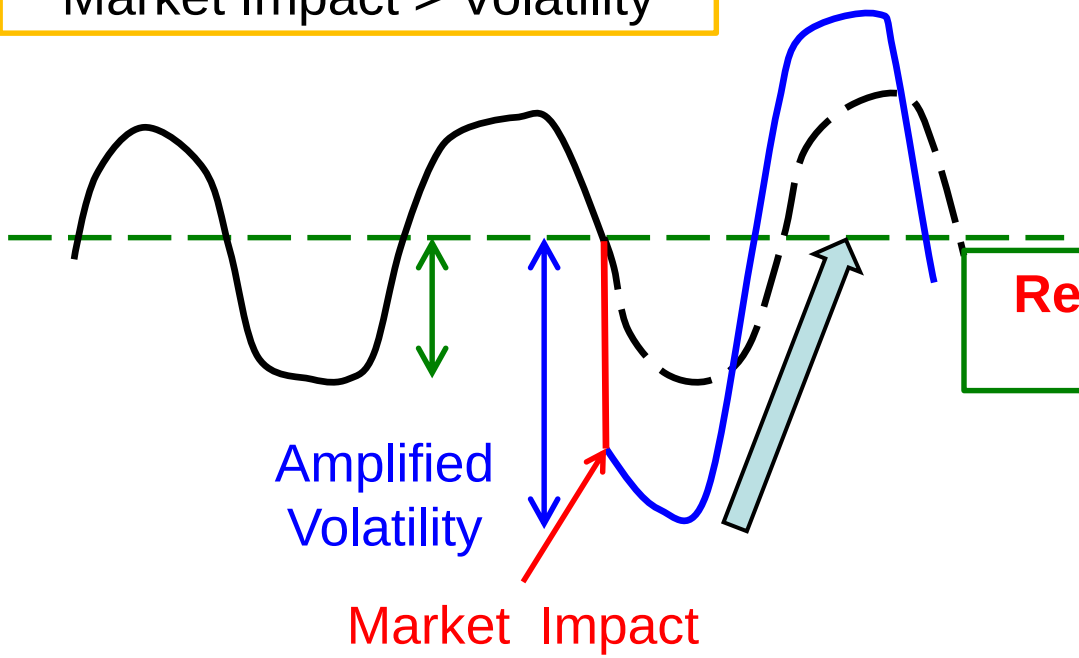


within the normal volatility range

Prices remain within the Normal Volatility Range

the market impact do NOT amplify volatility

Market Impact > Volatility



pushed out prices outer the normal volatility range

Unstable: Destabilize Financial Market

Recovering to Fundamental Price > normal Volatility range

Volatility Range wider

market impact amplify volatility range

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Summary

* We built an artificial market model (a kind of agent based model) to investigate the impact of leveraged ETF rebalancing on the index price formation.

* We found that Market Impact (MI) per Volatility (V) is very important Key Parameter, MI < V: Stable, MI > V: Unstable.

* We showed the possible Mechanism of Destabilizing Market.

Future Works

* search the threshold more precisely, 15%-16% is true?
* discuses Mechanism of Destabilizing Market more deeply
* do Empirical Study focusing the relationship between Market Impact and Volatility

That's all, thank you!!

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