

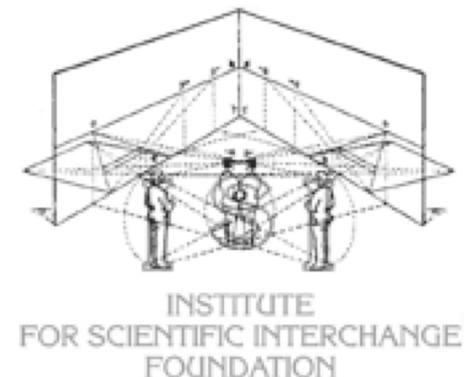
Mark-to-Market Leveraged Trading: Zero-Intelligent Speculation and Counter Cyclical Monetary Policy.

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Agent Based Modeling for Banking and Finance 09
Turin February 9-11 2009



Financial Intermediation

- *Old World: Bank intermediation*
 - assets valued at book value (no market so historic costs)
 - quantity controls on liquidity (reserve requirements, capital asset requirements, leverage requirements), bank regulation
 - borrowing short-term lending long term,
 - bank runs resolved by exogenous central bank
 - central banks control credit through bank transmission mechanism (households, firms, government, foreigners)
- *New World: Market-based intermediation*
 - *shadow* 'banking' system : broker-dealers, hedge funds, private equity groups, structured investment vehicles and conduits, money market funds and non-bank mortgage lenders; borrow short-term lend long term
 - securitization, banks *originate and distribute*,
 - **Pro-cyclical leverage**: debt financed speculation, risk weighted capital/asset ratios, assets mark-to-market, credit expansion, narrowing spreads, reach for yield.
 - Increasingly closed system as FI lending to themselves, growing proportion of GDP.
 - *Troubled* assets off balance sheet (tax & regulation avoidance)
 - Market runs resolved by an exogenous entities with deep pockets

Security Brokers, Dealers and Investment Banks

Strongly positive relationship between changes in total assets and changes in leverage. Leverage is highly pro-cyclical - rises during booms and falls during busts.

Due to:

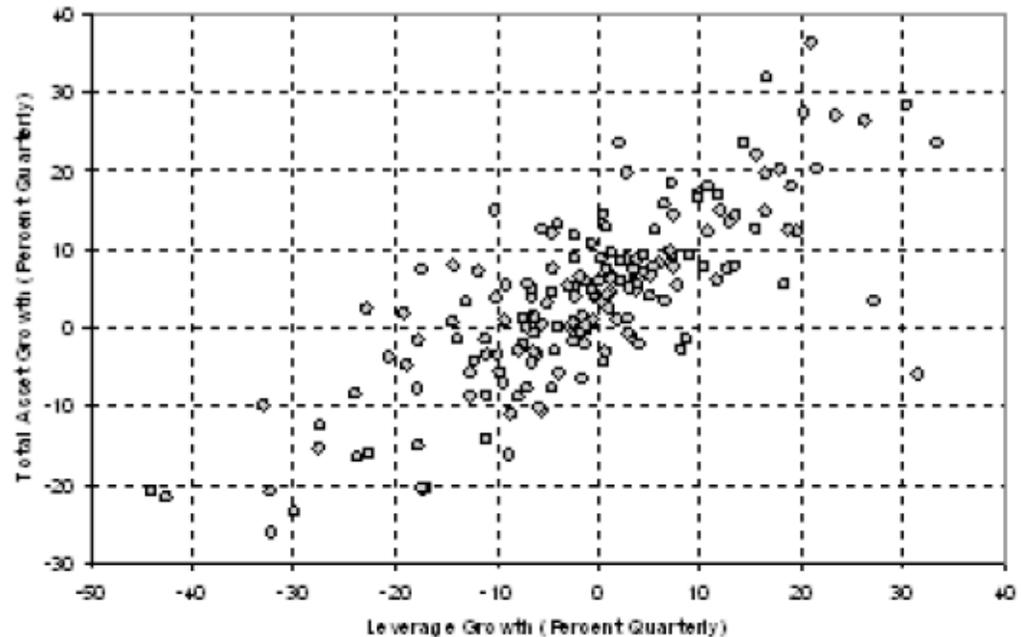
- changing preferences.
- risk weighted capital to asset ratio:
 - Credit ratings on assets fall in busts and rise in booms.
 - Market liquidity will also raise risk weighting

Since the gearing ratio for most investment banks is significantly higher than 10, a fall in subprime prices of 1 requires recapitalization of 10 times this for targeted leverage.

We can potentially have a rather nasty spiral where lower prices lead to sell-offs which again lead to further weakness, and so on.

Total Assets and Leverage of Security Brokers, Dealers and Major investment banks

Quarterly changes in total assets to quarterly changes in leverage as given in the US Flow of Funds 1963-2006.



Source: "Liquidity and Leverage", Adrian & Shin September 2007.

The perverse (positive) nature of the demand curves are even stronger when the leverage of the financial intermediary is pro-cyclical.

The Institute of International Finance

Report for Market Best Practices

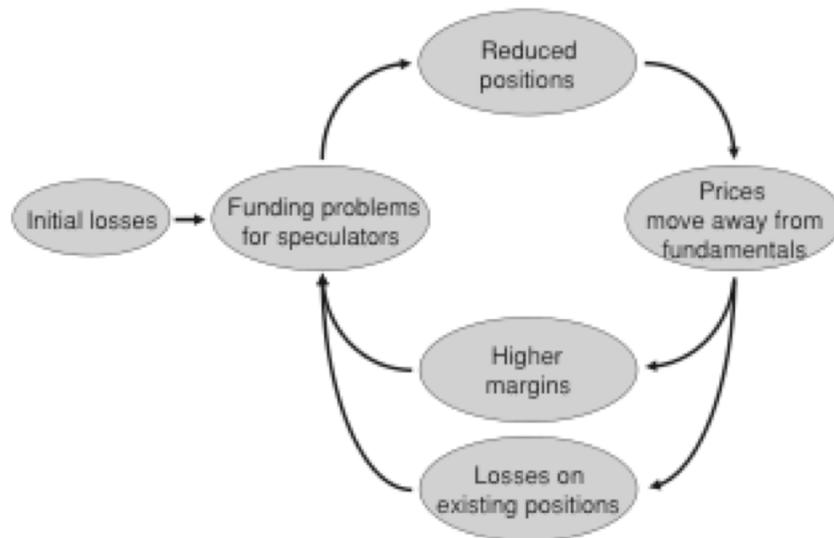
April 2008

“fair-value/mark-to-market accounting ... [in] severely limited liquidity in secondary markets, ... has the potential to create serious and self-reinforcing ... market stress ... [exacerbating] the overall degree of risk aversion in the marketplace ... [i]n circumstances where doubts about products and underlying credit quality undermine valuations inducing extensive margin calls, there is the danger of a precipitous and destructive downward spiral, which reinforces the procyclical impact. ... raising the liquidity premia.”
(2008, pp.15-17)

Liquidity Spirals

Several mechanisms are at work where illiquidity leads to insolvency

1. **Balance Sheet Channel:** Collateral crisis due to increased volatility and leverage
2. **Lending Channel:** Precautionary Hoarding, increased risk aversion, margin spiral raise margin requirements, ease of obtaining external finance
3. **Run on financial institution deposits:** asymmetric information, forced liquidation of assets, losses lead to self-fulfilling expectations on equity
4. **Network effects:** Counterparty credit risk, gridlock risk, supply chain, borrowers bring down lenders (Gallegati 2007)



(Brunnermeir & Pedersen 2007)

Forced Selling

Several mechanism are at work where illiquidity leads to insolvency

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$$\text{Assets} = \text{Liabilities} + \text{Equity}$$

Financial entity	
<i>Assets</i>	<i>Liabilities</i>
Loans Mortgages Comm. Paper Bonds Liquid Loans T-Bills Reserves Currency Currency Stocks	Funding Deposits Issued Securities Equity
<i>Off Balance Sheet</i>	
derivatives SIVs	contingent liability deposit services for clients

Forced Selling in Futures

Balance Sheet Channel

- Fixed Margin Trading and Real Time Gross Settlement: mark-to-market (M2M). Changes in asset prices are realized or settled *immediately*
- The net worth of financial intermediaries and speculators are extremely sensitive to asset prices given their high leverage ratios.
- Market Liquidity, ease of selling, or borrowing - tied into lending channel
- Feed back of market liquidity onto funding

$$\text{Assets} = \text{Liabilities} + \text{Equity}$$

Broker		A	L
Cash/Margin	10	90	Funds
Stocks	90		
		10	Equity
	100	100	
Off Balance Sheet as future payment, but daily Marked-to-Market <i>Futures</i> *			
bought	200		
sold	100		
net long	<u>100</u>		
*Margin requirement on Futures is 5% , Margin/Net Futures			

Futures Broker		A	L
Cash/Margin	10		
		10	Equity
	10	10	
Off Balance Sheet as future payment, but daily Marked-to-Market <i>Futures</i> *			
bought	200		
sold	100		
net long	<u>100</u>		
*Margin requirement on Futures is 5% , Margin/Net Futures			

Leveraged trading on a Zero Intelligent (ZI) Futures Exchange

- Simulation of price and liquidity from the balance sheet channel
- The corner solutions of the behavioral models:
 - super rational, representative agent, and the
 - ZI agent with specified market microstructure (Gode, Sunder & Spear 2004)
- Institutionally rich yet relatively simple model, providing microfoundations to liquidity and price volatility characteristics: “cascade of deleveraging”
- The goal with this ABM is to understand price movements and the generative process of illiquidity and insolvency, not to forecast prices.

Zero Intelligence (ZI) Models: Institutions & Environment vs Behavior

Vernon Smith (1982) defines three categories that determine the performance of a **micro system**. The first two with the exclusion of the third characterizes a ZI model, *a la* Gode and Sunder (1993) and Gode, Spear and Sunder 200.,

Institutional structure: the market protocol and the rules that govern trading;

Environment: the initial conditions, number of markets and agents, agent's endowed tastes, risk profile, information and wealth.

Agent Behavior: behavior that can be modified through learning, adapting ones risk profile, using information, modifying a trading strategy over time is said to have intelligence. If it is static, then behavior is a given and has no intelligence, it is instinctive rather than intelligent.

Zero Intelligence GSS versus My Model

Gode Spear and Sunder (2003) ZI stock market

- Fixed Distribution of Reservation Prices
- Random Order Flow
- Random (constrained) Limit Orders
- Double Auction with temporary limit order book

This model of ZI Speculative Futures Market

- Fixed Distribution of Reservation Prices = Limit Orders “Truth Telling”
- Random Order Flow
- Double Auction with Open Outcry

In an Open-Outcry model, all limit orders that arrive in the market either

- replaces the best buy and/or sell,
- expires, or
- crosses the best bid or ask, and a transaction price occurs

Because traders do not learn or update their expectations, then they are considered zero-intelligent even though they are truth telling.

Although the narrowing of the bid-ask spread follows Chan et al 1997

A Speculative Zero Intelligent (ZI) Model

“A Zero Intelligence Market is a Study of Market Intelligence”

Extensions of the Gode, Spear and Sunder (2004) ZI agent model with *random mark-up*:

Fixed behavior with no learning - ZI

- a speculative futures market with a non-storable underlying commodity
- retrading
- heterogeneous price expectations Beta[2,2]
- if expectations within the spread use algorithm similar to Chan, LeBaron, Lo and Poggio (1998) (*mark-up pricing*).
- limit orders are truth telling as speculators desire immediacy, they have zero-patience
- speculators are risk neutral

Institutional and Environmental (under the control of the futures exchange)

- open outcry double auction (no limit order book)
- short selling is allowed
- leverage of wealth positions (impositions of a fixed margin requirement)
- real-time- settlement (mark-to-market every t)
- transaction costs
- tick prices and ordersize are rational numbers

Traders Abiding Rules vs Adapting Expectations in Leveraged Illiquid Markets

Quotes from the *Financial Times* during the 2007-2008 Sub-prime Market Crisis

“Financial markets were experiencing waves of deleveraging” (Buffet March 2008)

"Market movements across many hedge fund strategies continue to be characterised by irrational behaviour, liquidations and deleveraging

...Credit providers have been severely tightening terms without regard to credit worthiness or track record of individual firms, which has compounded our difficulties and made it impossible to meet margin calls,”

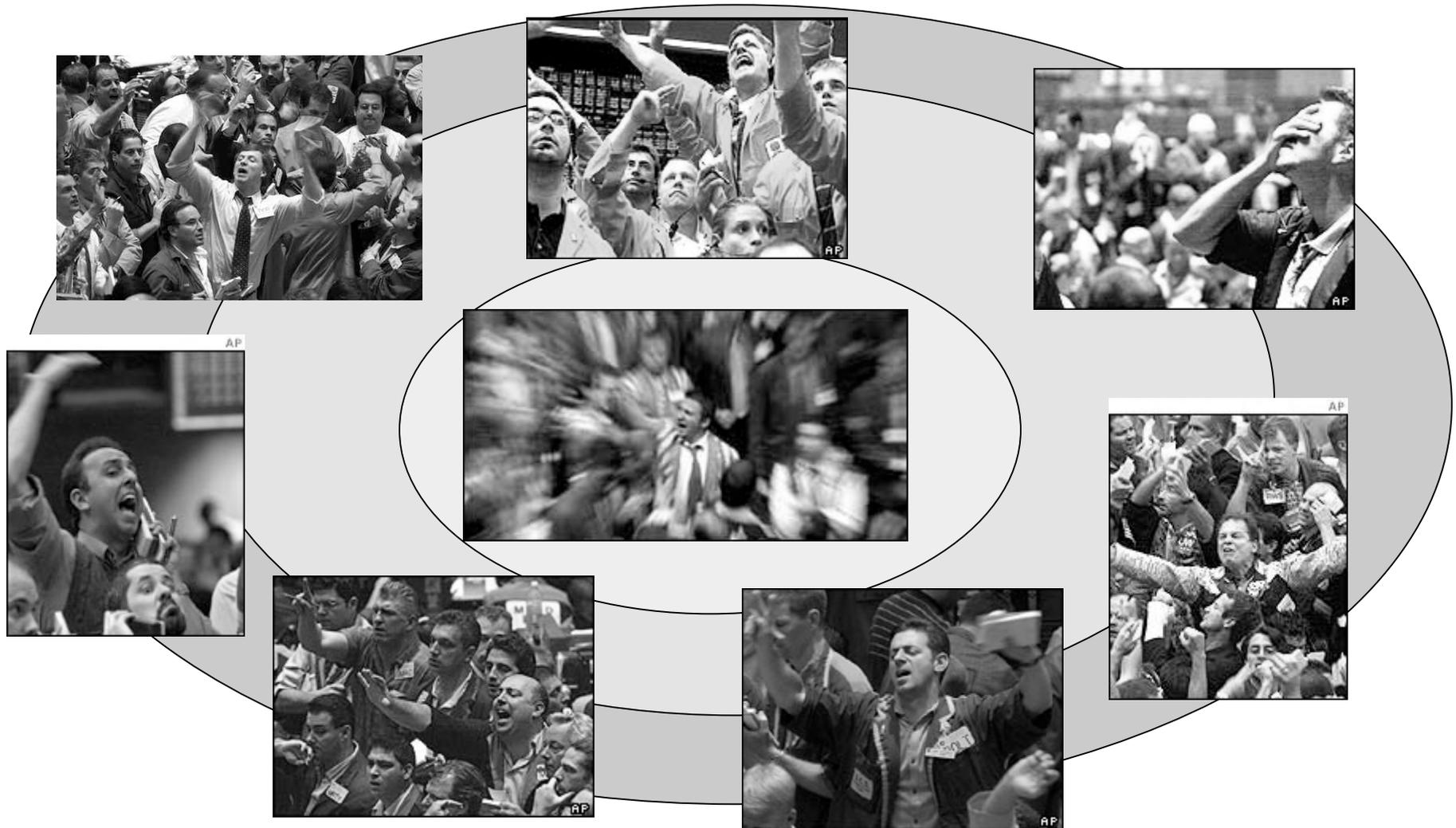
“... a wave of forced sales could depress assets prices further, which would ... force banks to recognize new losses as a results of pressure to mark their books to market.

“..Geared investors are forced to sell to lower their borrowings, pushing down the market and forcing other leveraged investors to sell – with the potential nightmare being a wave of forced deleveraging...those that have stepped in to catch the falling knife [buying cheap assets] are finding themselves seriously injured.”

Just over a year ago (before June 2007), Malcolm Knight, the general manger of the Bank for International Settlements, the central bankers’ bank in Basel, confessed that one of his greatest concerns about the financial outlook was ‘deleveraging.’

Random Trading in a Futures Pit

ENVIRONMENT: CDA, open outcry, no limit order book, short selling, real time settlement, margin trading, transaction costs



ZI Speculative Agent Decision Rule: buy, hold, sell

This produces a demand function:

Maximize:

$$\pi_{t+1}^e = (p^\theta - p_t)x_t + m_t$$

Subject to:

$$p_t x_t \geq -\kappa \left((p_t^m - p_{t-1}^m)x_{t-1} + m_{t-1} - \omega p_t (x_t - x_{t-1}) \right)$$

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$$m_t \leq (p_t^m - p_{t-1}^m)x_{t-1} + m_{t-1} - \omega p_t (x_t - x_{t-1})$$

$$m_t \leq (p_t^m - p_{t-1}^m)x_{t-1} + m_{t-1} + \omega p_t (x_t - x_{t-1})$$

$$0 \leq (p_t^m - p_{t-1}^m)x_{t-1} + m_{t-1} - \omega p_t (x_t - x_{t-1})$$

$$0 \leq (p_t^m - p_{t-1}^m)x_{t-1} + (p_t^m - p_t)(x_t - x_{t-1}) + m_{t-1} + \omega p_t (x_t - x_{t-1})$$

$$m_t \geq 0$$

$$x_t^i \left(p_t; p^{i,\theta}, \varepsilon, x_{t-1}^i, m_{t-1}^i, p_t^m, p_{t-1}^m, \kappa, \omega \right)$$

where:

p_t = Price at tick t , which must be at either a bid p_t^b , or an ask p_t^a

$p^{i,\theta}$ = Price valuation of the next futures price p_{t+1} (and long run spot price)

x_{t-1}^i = Previous contract position,

m_{t-1}^i = Previous cash position in margin account following last transaction,

p_t^m = Current mid-price, used by exchange to mark-to-market position x_t^i under RTS

p_{t-1}^m = Previous mid-price, used by exchange to calculate position change $\Delta p_t^m x_t^i$ under RTS

$1/\kappa$ = Percentage margin requirement (where $\kappa > 1$) of futures position $x_t^i p_t^m$ valued at p_t^m

ω = Percentage transaction tax on a one-way trade (i.e. paid each way).

ε = Interpolation parameter to solve for indeterminacy

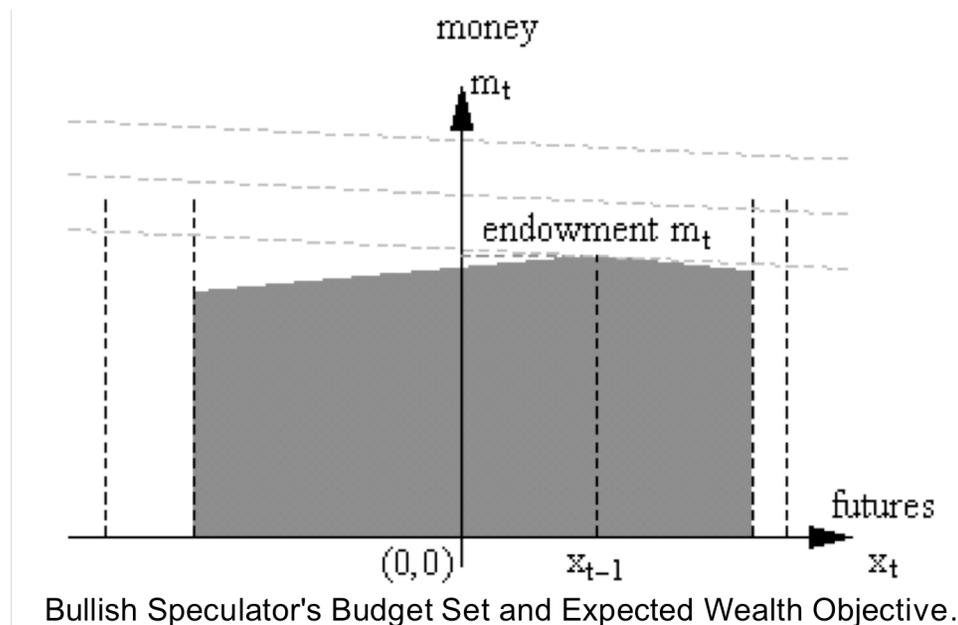
ZI Speculative Agent Decision: buy, hold, sell

max

$$\pi_{t+1}^e = (p^\theta - p_t)x_t + m_t$$

s.t. constraints

- wealth distribution, m
- margin requirements, $1/k$
- Taxes ω
- short selling,
- real-time-settlement



These constraints are all part of the environment, and not part of “intelligence”

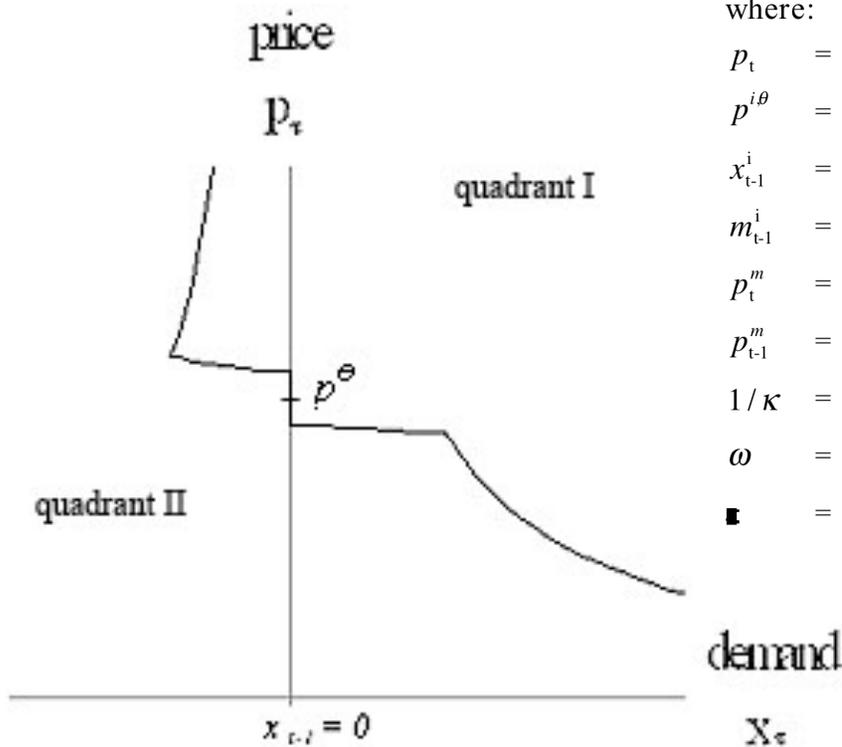
Zero-Intelligent Speculator i

Demand for futures contracts x_t^i

$$x_t^i(p_t; p^{i,\theta}, \varepsilon, x_{t-1}^i, m_{t-1}^i, p_t^m, p_{t-1}^m, \kappa, \omega)$$

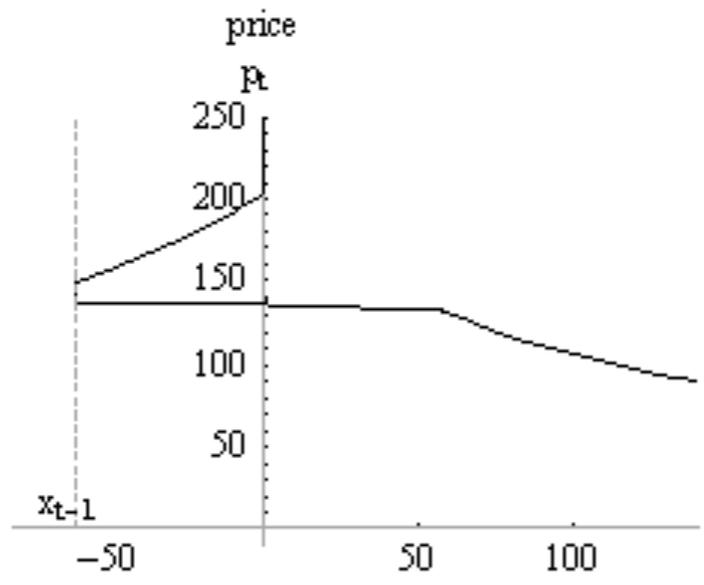
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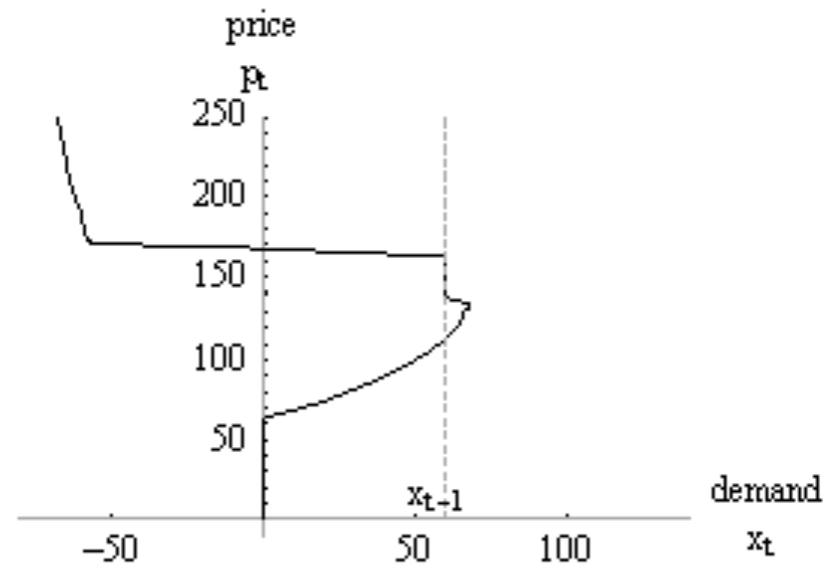


Capital position begins as cash only

Speculative demand for futures x_t , with margin calls demand with RTGS across prices



Short x_{t-1}



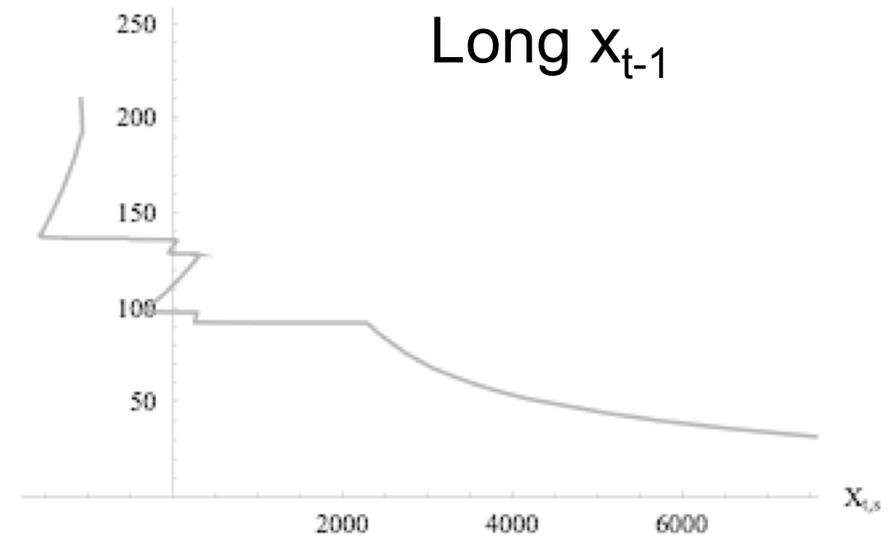
Long x_{t-1}

Speculator Identical Elements across i :

- Functional form with short selling
- Margin limits κ
- Transaction taxes $\bar{\omega}$
- Risk Neutrality

Different Elements across i :

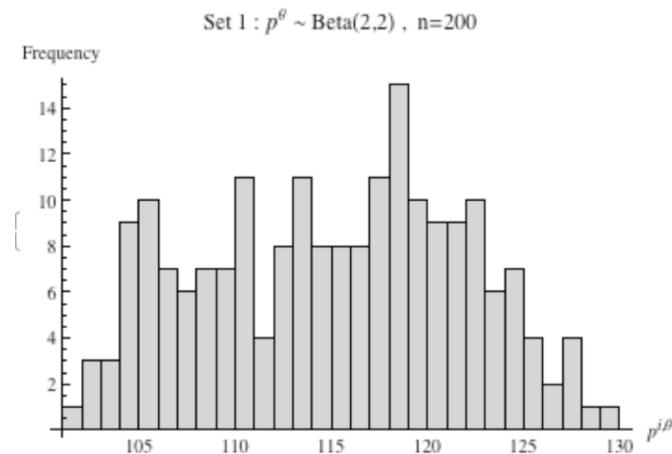
- Endowment (m, x)
- Reservation Price $p^{i,e}$



Aggregate Demand function with multiple equilibrium

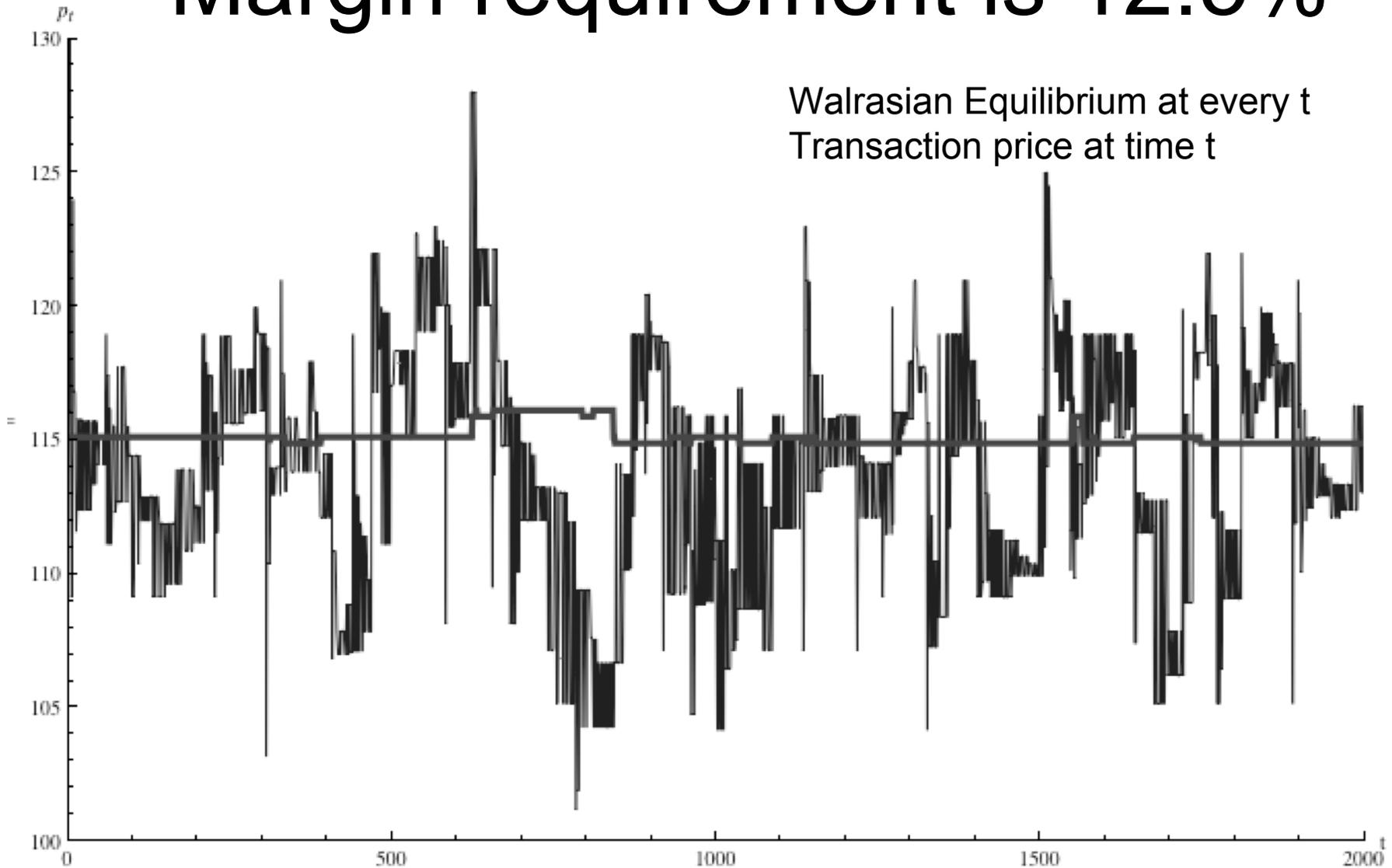
Parameters of the Simulation

n	= 200	\mathcal{K}	= 8
t	= 2000	ω	= 0.001
m_0^i	= \$10,000 for all i	ε	= 0.001
$p^{i,\theta}$	$\sim 100+30*\text{Beta}(2,2)$	$p_0^{7,b} : p_0^{5,a}$	(120:130)

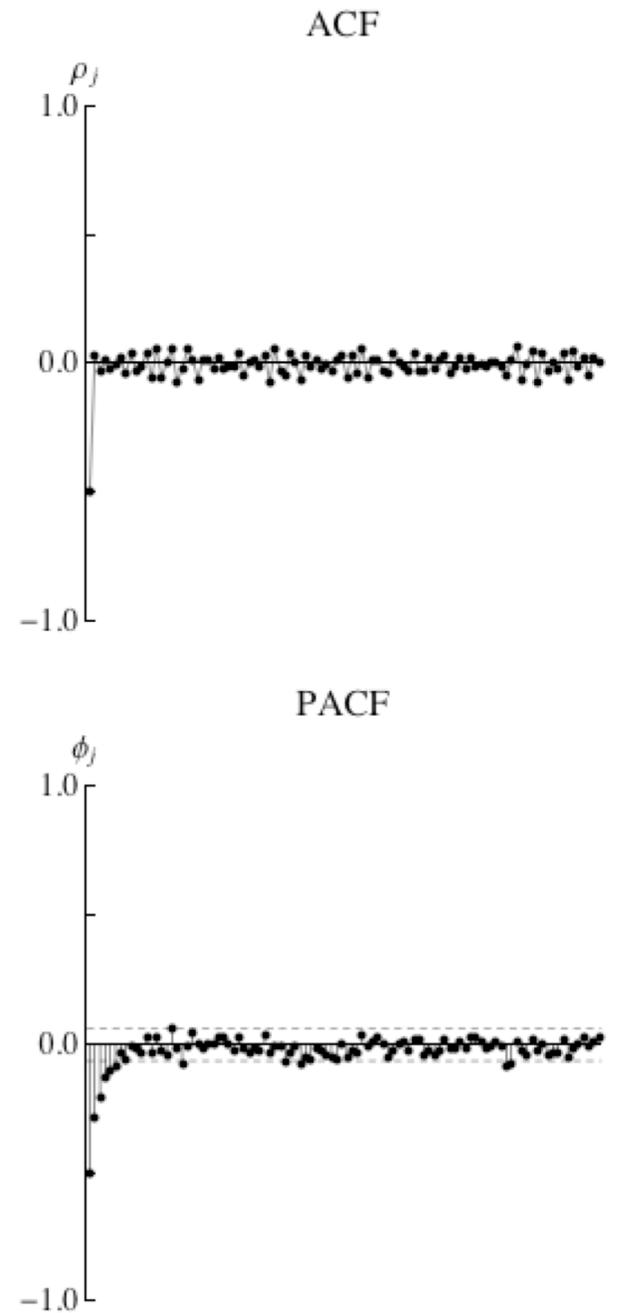
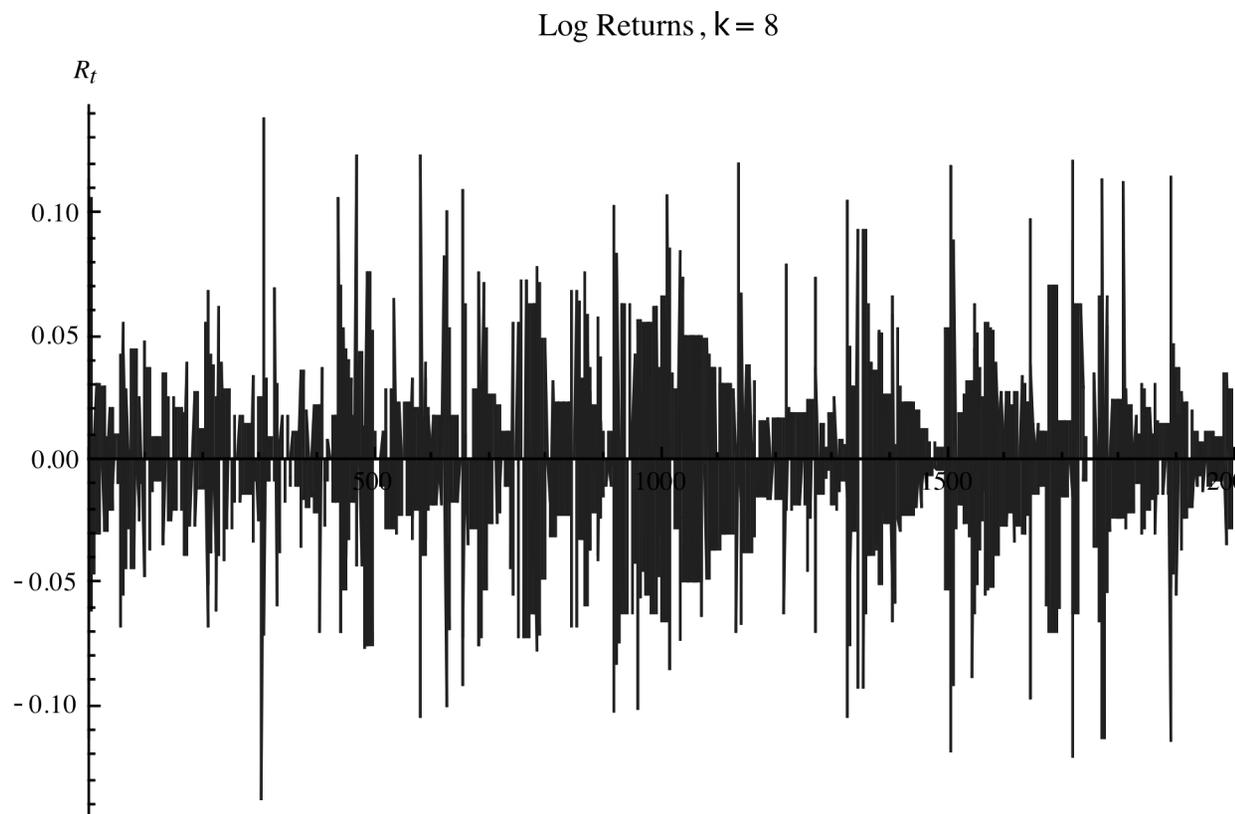


Simulation of 200 agents

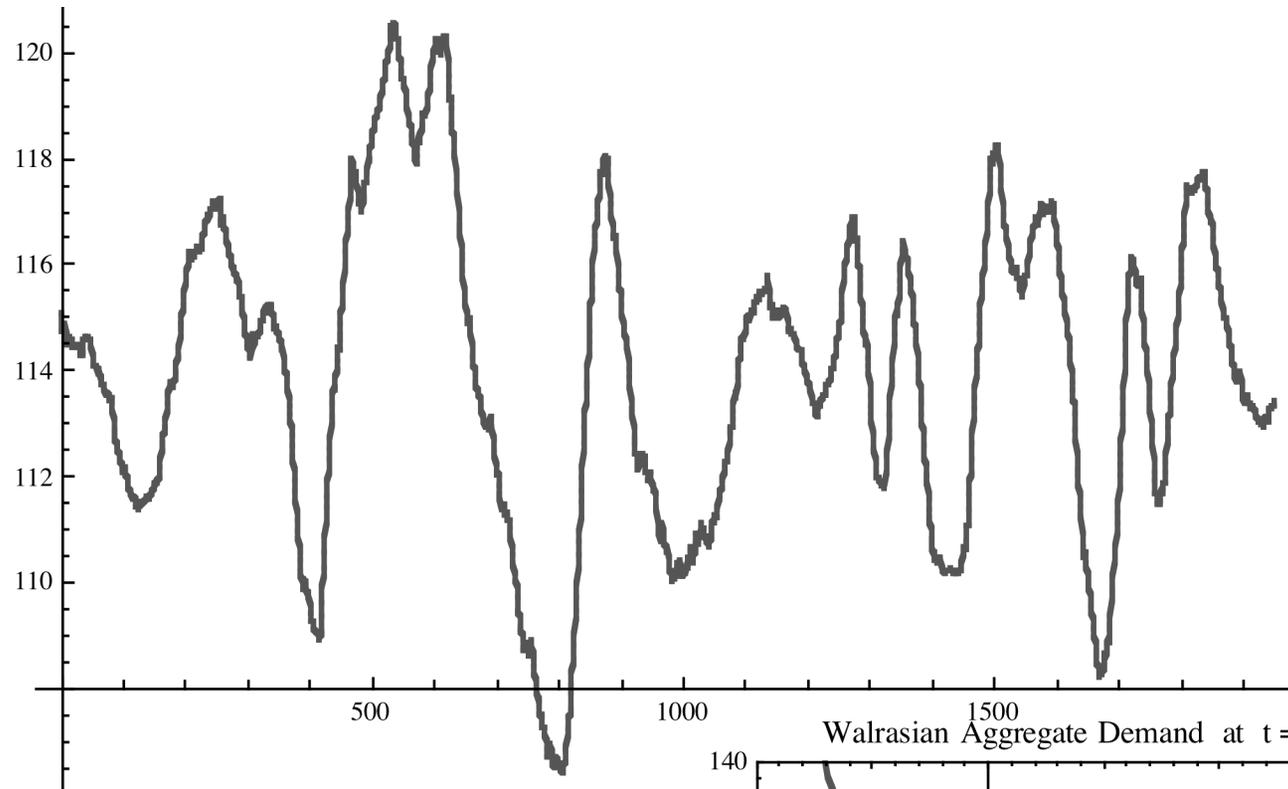
Margin requirement is 12.5%



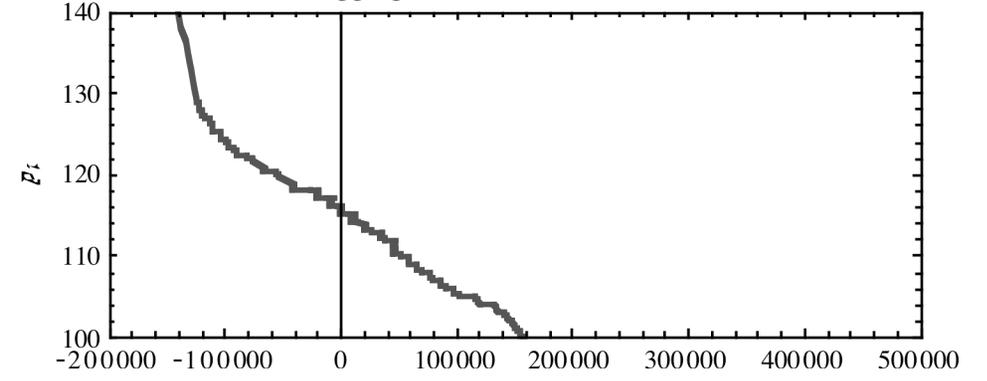
Log Returns $k=8$



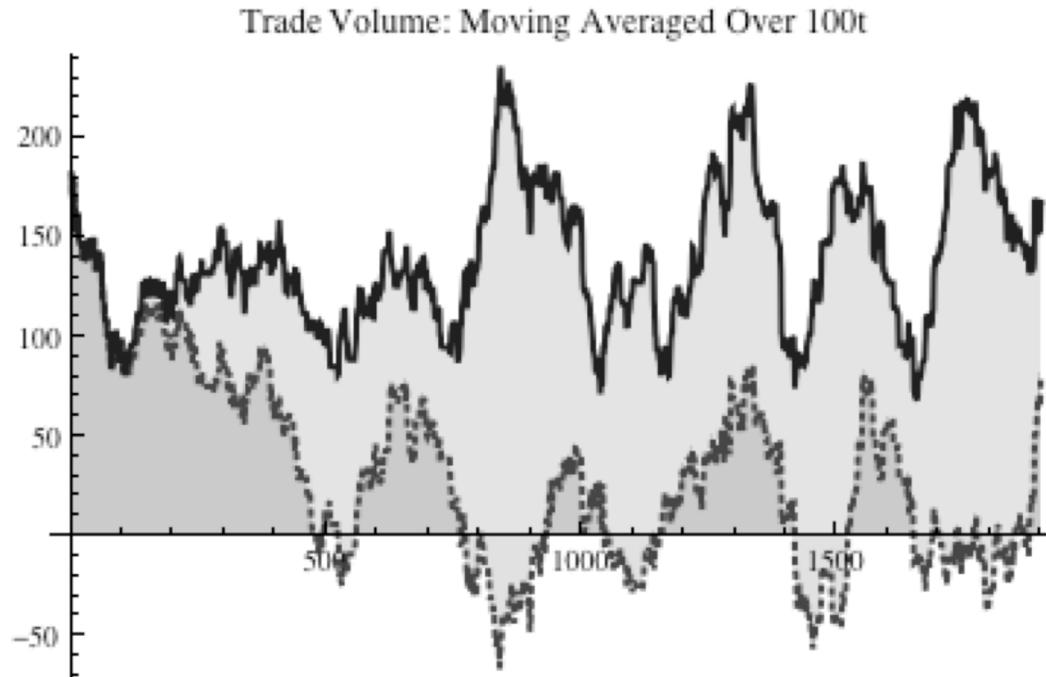
Transaction Price as moving average over 100t



Walrasian Aggregate Demand at $t = 800$ and $k = 4$



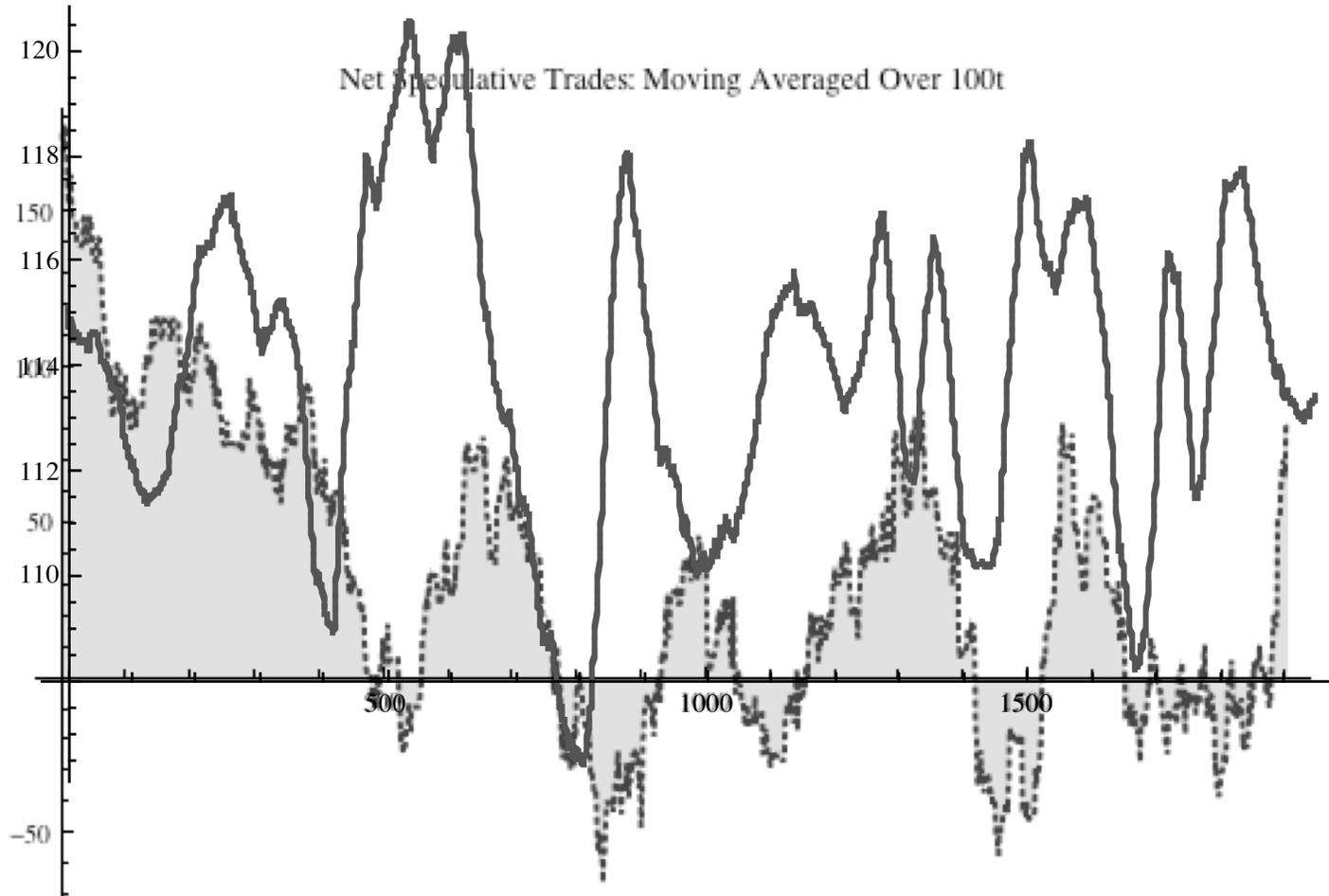
Forced Trading



“..Geared investors are forced to sell to lower their borrowings, pushing down the market and forcing other leveraged investors to sell – with the potential nightmare being a wave of forced deleveraging...those that have stepped in to catch the falling knife [buying cheap assets] are finding themselves seriously injured.”

FT March 5, 2008.

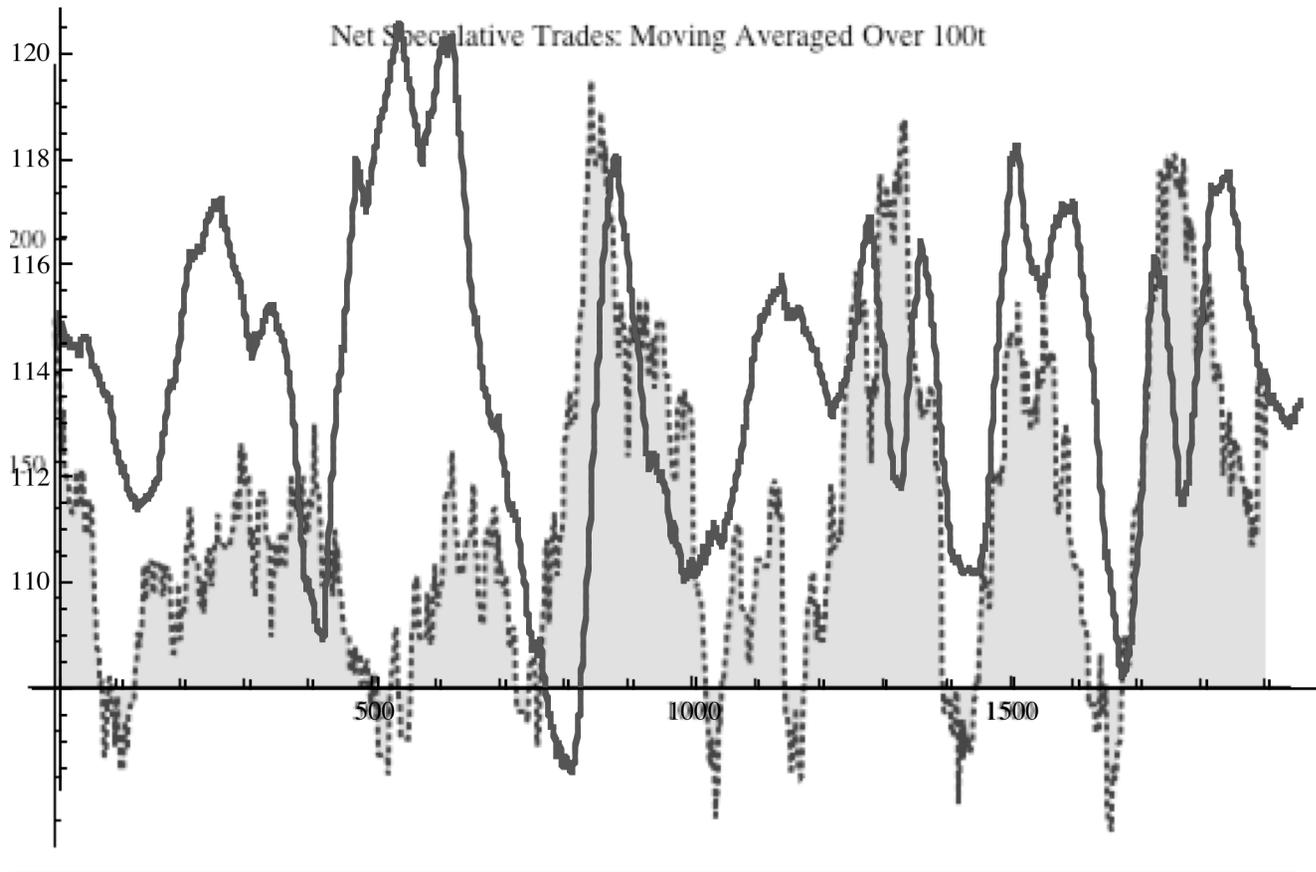
Forced Selling



“..Geared investors are forced to sell to lower their borrowings, pushing down the market and forcing other leveraged investors to sell – with the potential nightmare being a wave of forced deleveraging...those that have stepped in to catch the falling knife [buying cheap assets] are finding themselves seriously injured.”

FT March 5, 2008.

Trading Volume



Remarks

- Under the ZI approach, the wealth constraint, the auction mechanisms and trading rules can be seen as an environmental factor that can incorporate institutional constraints, wealth distribution, margin requirements, taxes, short selling.
- With such an institutionally rich yet behaviorally simple model, microfoundations of the institutional interface in markets can be added to study the generation of liquidity (market liquidity or funding liquidity), and its impact on price volatility dynamics. One can design mechanisms to optimize policy responses under different behavioral scenarios.
- A ZI model can serve as a way to benchmark a model, prior to the addition of expectations.
- It emphasizes the mechanics or hydraulics in a system, which can offer warnings and policy design

POLICIES

Settlement Frequency (terms of borrowing) matters

- In the financial world balance sheets are continuously marked to market
- Changes in asset prices are realized or settled on the balance sheet (almost) *immediately*
- The net worth of financial intermediaries and speculators are extremely sensitive to asset prices given their high leverage ratios.
- Tradeoffs between micro and macro goals: Individual counter party risk increases with low settlement frequency, but systemic procyclicality may increase with high settlement frequency.

Leverage ratio matters (policy for fixed, flexible, or countercyclical)

- Empirically, leveraged trading by financial traders has a positive feedback on prices
- Volatility in prices can increase leverage if prices move against expectations

Bank Runs and Market Runs

Central Bank	
A	L
↑ Repurchase Agreements Comm. Paper Fed Loans Treasuries Foreign Ex. Reserves	Government Deposits Bank Reserves ↑ Currency in Circulation

Consolidated Banks	
Assets	Liabilities
Loans ↓ Mortgages Comm. Paper Treasuries ↑ Reserves Repos & Fed Funds Currency other	Deposits Fed Loans other Equity

Consolidated Shadow Banks	
Assets	Liabilities
Loans Troubled Assets Currency other	Deposits Bonds Comm. Paper other Equity

“nothing on the left-hand side is right
and nothing on the right-hand side is left”

Market Run with Balance Sheet using Asset backed reserve requirements

Central Bank	
A	L
↑ Financial sector reserves	Government Deposits
	Repurchase Agreements ↑
	Discounted Loans
	Currency in Circulation
	Foreign Ex. Reserves

Consolidated Financial Institutions	
Assets	Liabilities
Loans	Deposits
Treasuries	Mortgages
Mortgages	bonds/com paper
↓ bonds/com paper	Repos & Fed Funds
↑ Repos & Fed Funds	Reserves ↑
Currency	other
Shares	Equity
other	

Instead of *forced selling*, the Financial Sector has *forced borrowing*

Solution to the Pro-cyclicality of Market Intermediation : Asset Based Reserve Requirements

Problems now

- Excess liquidity and build up of debt
- Debt financed Asset bubbles (leverage) (monetary and regulatory failure)
- Weakening of Central Bank's (CB) ability to implement monetary policy
- Capital asset requirements procyclical in macro setting
- Mark-to-Market and increase in frequency of settlement and Volatility in net worth
- Change margin requirements (Exchange margin setting is a function of volatility)
- Forced selling and liquidity spirals

Monetary Policy can and must be restored to ensure fiscal stimulus

Counter Cyclical Policy with Asset Backed Reserve Requirements

- CB can stabilize asset prices by repos *directly*
- Reserves can be used to protect capital
- Institutions have *forced borrowing* from the CB in liquidity crunch and then lend to the public - reactivating the expansionary monetary policy
- Non-interest bearing reserves can be transformed into interest earning assets.
- Reduce M2M frequency by taking assets off balance sheet
- Restrict credit creation by imposing reserve requirements to on balance sheet assets.

Example of Current Open Market Operations

Depository Institutions		Federal Reserve System	
Assets	Liabilities	Assets	Liabilities
EXPANSION			
		1) + Government securities (or repos or discounts)	1) + Bank reserves
2) + Reserves			
3) + Loans	3) + Deposits		
CONTRACTION			
		1) - Government securities (or repos or discounts)	1) - Bank reserves
2) - Reserves			
3) - Loans	3) - Deposits		

Jane D'Arista (2009, p.22)

Open Market Operations Using Asset-Based Reserve Requirements

	Financial Institutions		Federal Reserve System	
	Assets	Liabilities	Assets	Liabilities
EXPANSION				
STEP 1	1000	900 (to customers, investors, lenders) 100 reserves	100 reserves	100 (cash, deposits, repos & discounts)
	1000	1000	100	100
STEP 2	- 1 asset		+ 1 reserve	+ 1 repo
	+ 1 repo	+ 1 reserve		
	1000	1001	101	101
STEP 3	+ 10 assets	+ 9 liabilities (to customers, investors, lenders)		
	1010	1010		
CONTRACTION				
STEP 1	1000	900 (to customers, investors, lenders) 100 reserves	100 reserves	100 (cash, deposits, repos & discounts)
	1000	1000	100	100
STEP 2	- 1 repo		- 1 reserve	- 1 repo
	+ 1 asset	- 1 reserve		
	1000	999	99	99
STEP 3	-10 assets	- 9 customer liabilities		
	990	990		

Jane D'Arista (2009, p.23)