

# **From Gravitational Pull to Abnormal Transaction Cost**

**Andre Küster Simic  
Michael Schleef  
Hartmut Schmidt**

Presentation at Zicklin School of Business,  
Baruch College, City University of New York  
October 22, 2003

# Point of Departure

## Theory developed by Cohen, Maier, Schwartz and Whitcomb\*

1. **CMSW market is an order driven securities market**
2. **Only limit orders and market orders, immediate bilateral trades**
3. **Transaction costs comprise cost of order transmission and execution**
4. **Discrete set of order decision points**
5. **Given order arrival rate, finite number of investors**
6. **No lags in the transmission of information and orders**
7. **No partial execution of market and limit orders**

**Focus on orders with limits inside the market spread (spread tightening orders)**

\*Transaction costs, order placement strategy, and the existence of the bid-ask-spread , Journal of Political Economy, Vol. 89 (1981), 287-305.

# Key Choice

**Market order**

**or**

**limit order with price advantage and high execution probability**



**Limit orders with price priority**



**Spread tightening orders (STOs)**

# CMSW Theses

- 1. Given a best ask (or bid), the execution probability of a spread tightening buy order (sell order) is increased as the buy limit is set closer to the best ask (best bid).**
- 2. The execution probability of STOs remains well below 1 (substantial execution uncertainty).**
- 3. The execution uncertainty needs to be compensated by an equally substantial price advantage over simply accepting the best ask or best bid via market order. No substantial advantage is available at small distances between limit and best ask or bid. Therefore, investors are pulled into accepting the best opposite limit (gravitational pull).**

**This gravitational pull explains the existence of bid-ask spread on order driven markets.**

# CMSW Theses

- 4. Limit order execution uncertainty increases as fewer orders arrive per time unit. Consequently, bid-ask spreads are wider for securities with low arrival rates.**
- 5. At the equilibrium spread, a limit order or market order arrives with equal probability. If the spread is wider, the arrival of a limit order is more likely.**

# CMSW and IBIS

## Microstructure of CMSW market and IBIS match closely

- **IBIS is order driven**
- **Only limit and market orders on IBIS**
- **Transmission and execution costs**
- **IBIS traders see all relevant order information when deciding to place order**
- **Order transmission without lag**
- **Market orders are executed immediately and completely\***

## Test CMSW theses with IBIS data!

**\*Does not apply since 1997 when IBIS was upgraded and renamed Xetra**

# Data

**First quarter 1996 - 107<sup>+</sup> stocks - 1,901,700 entries**

Entry		Percentage share	
limit orders		55.75%	
	buy		48.37%
	sell		51.63%
market orders*		19.01%	
	purchase		55.22%
	sale		44.78%
cancellations		25.06%	
other		0.18%	

**+ No STOs in 2 stocks**

**\*Entry of market order constitutes transaction**

# Vigintiles of STO Distribution

## Percentage of spread tightening by

$$\begin{aligned} - \text{ buy order} &= \frac{\text{buy limit} - \text{previous best bid}}{\text{best ask} - \text{previous best bid}} \\ - \text{ sell order} &= \frac{\text{previous best ask} - \text{sell limit}}{\text{previous best ask} - \text{best bid}} \end{aligned}$$

Example: Spread 80 - 90, limit 86.10

13<sup>th</sup> vigintile if buy limit,

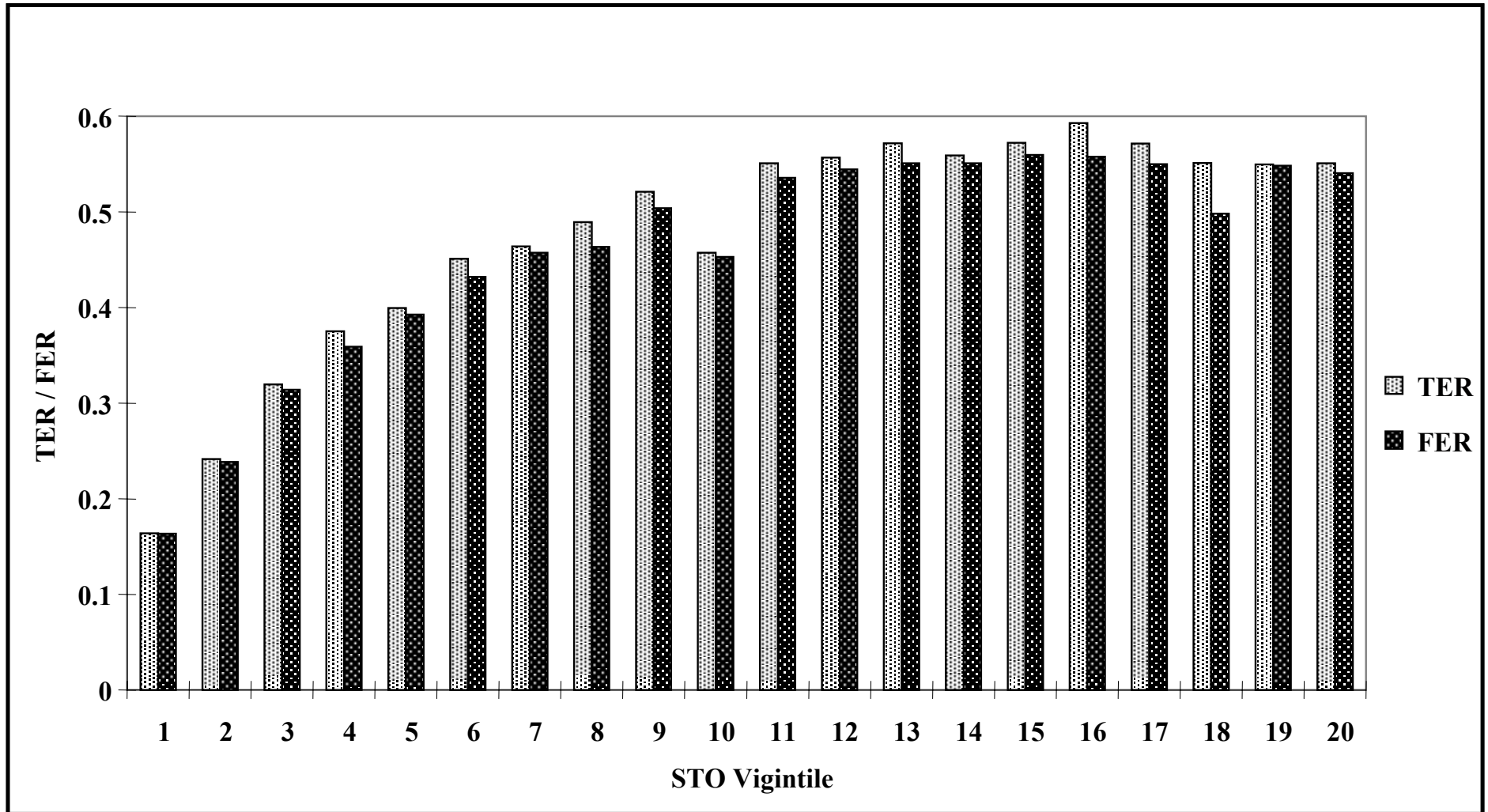
8<sup>th</sup> vigintile if sell limit.

# STO Execution Ratios

**FER** Limit order full execution ratio: Volume of limit orders fully executed to total volume of limit orders in vigintile

**TER** Limit order total execution ratio: Volume of limit orders fully or partially executed to total volume of limit orders in vigintile

# STO Execution Ratios for 105 Stocks



# Speed of STO Execution

**Average time from order entry to execution:**

**Top actively traded  
35 stocks**

**11 seconds**

**Medium actively traded  
35 stocks**

**31 seconds**

**Least actively traded  
35 stocks**

**48 seconds**

# Thesis 1: Increase in Execution Probability

**Execution probability increases in degree of spread tightening.**

**Version tested: FER of stock  $i$  increases in STO vigintile  $j$ .**

$$\text{FER}_{ij} = a_i + \ln \beta_i (\text{Midpoint of vigintile } j)_i$$

**61 stocks have values for 18 and more vigintiles. Estimates of  $\beta$  for all 61 stocks are positive and significant for 44 stocks at 1 percent level.**

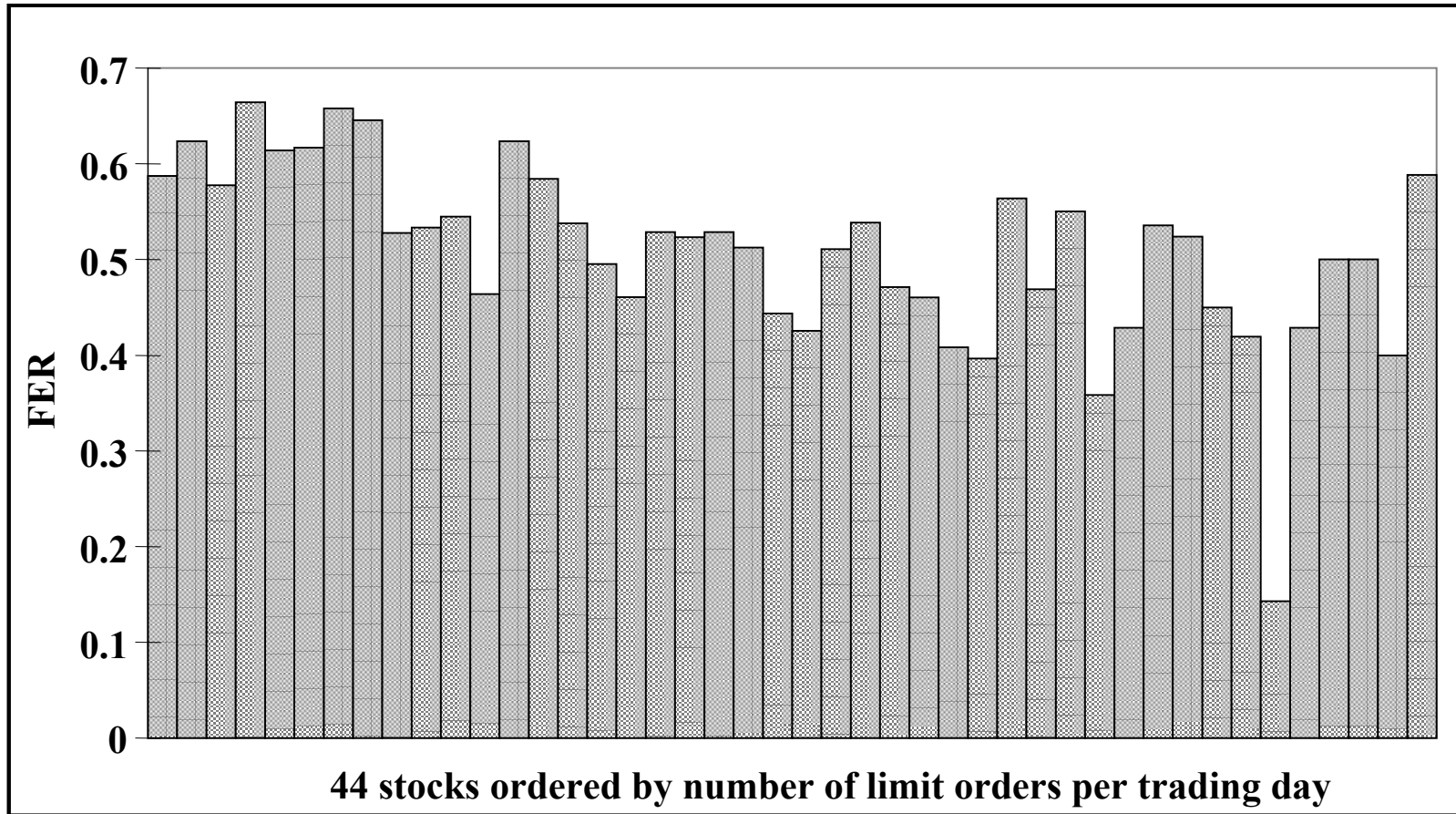
## Thesis 2: Bounded Execution Probability

**The execution probability remains well below 1 even for high degrees of spread tightening.**

**Version tested: FER remains well under 1 for highest STO decile.**

**The FER for STOs in vigintiles 19 and 20 was significantly smaller than 90% for 57 stocks out of 72 stocks in which orders in these vigintiles were observed (1 percent level).**

# Thesis 2: Bounded Execution Probability



**FER in vigintiles 19 and 20 of 44 stocks with at least 10 STO per trading day**

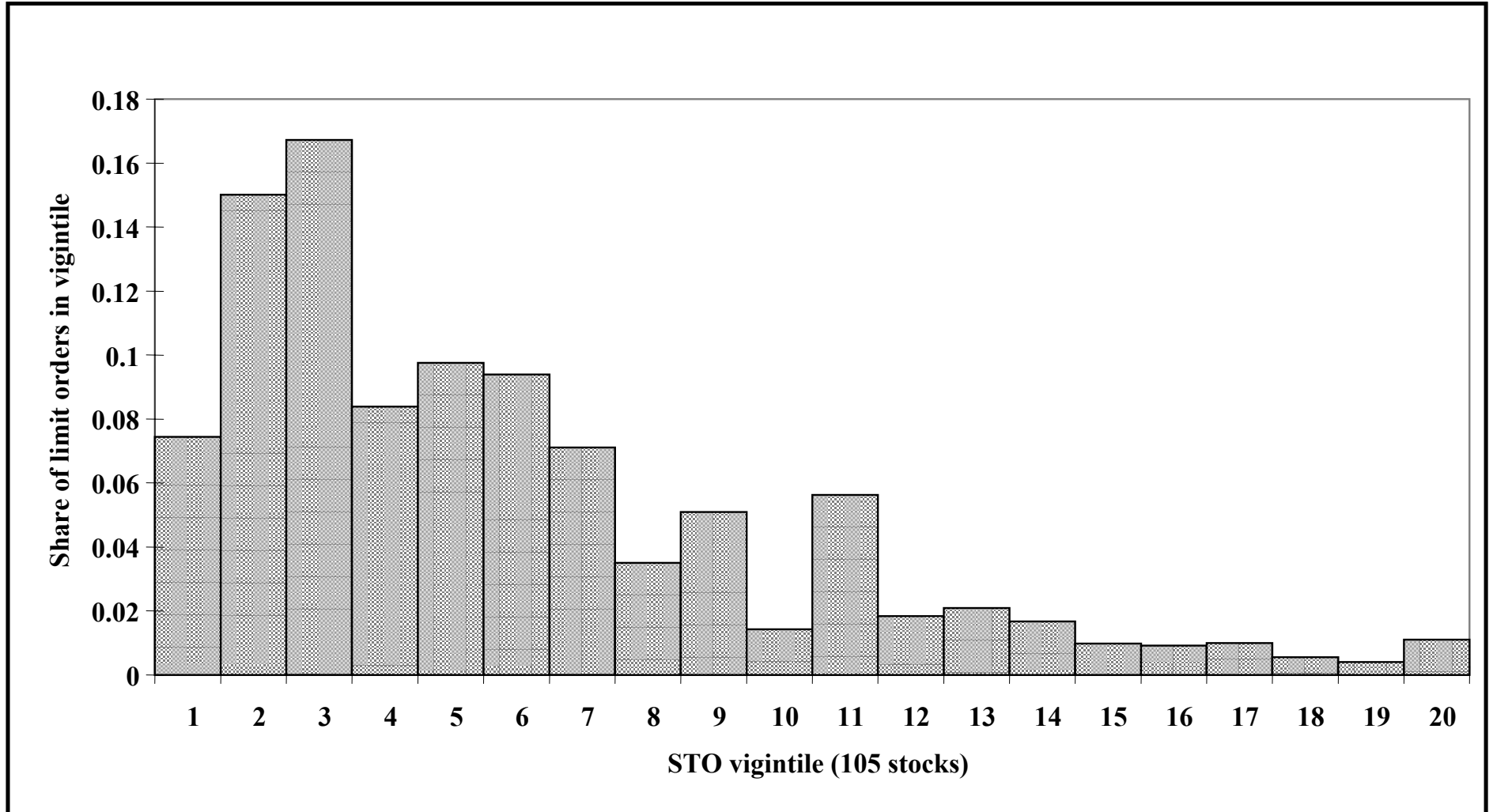
## Thesis 3: Gravitational Pull

**Investors who consider setting a limit close to the best opposite limit will use market orders due to gravitational pull.**

**Version tested: Only a small share of all STOs is placed in high STO percentiles.**

**Out of 105 stocks, 56 had a STO share of less than 5 percent in the top decile (significant at the 1 percent level).**

# Thesis 3: Gravitational Pull



## Thesis 4: Arrival Rate, Potential Price Advantage, and Spread

**Limit order execution uncertainty decreases as the arrival rate increases. Bid ask-spreads are wider for stocks with low arrival rates.**

**Version tested: FER increases for stocks  $i$  with higher limit order arrival rate (105 stocks).**

$$\text{FER}_i = 0.0152 + 0.0606 \ln N_i \text{ (number of limit orders)}$$

**(17.04)**

**$N_i$  is highly correlated with volume. Volume explains more than 80 percent of differences in bid-ask spreads.**

## Thesis 5: Equilibrium Spread Deviations

**If the spread is wider than the equilibrium spread, limit order arrivals are more likely than market order arrivals.**

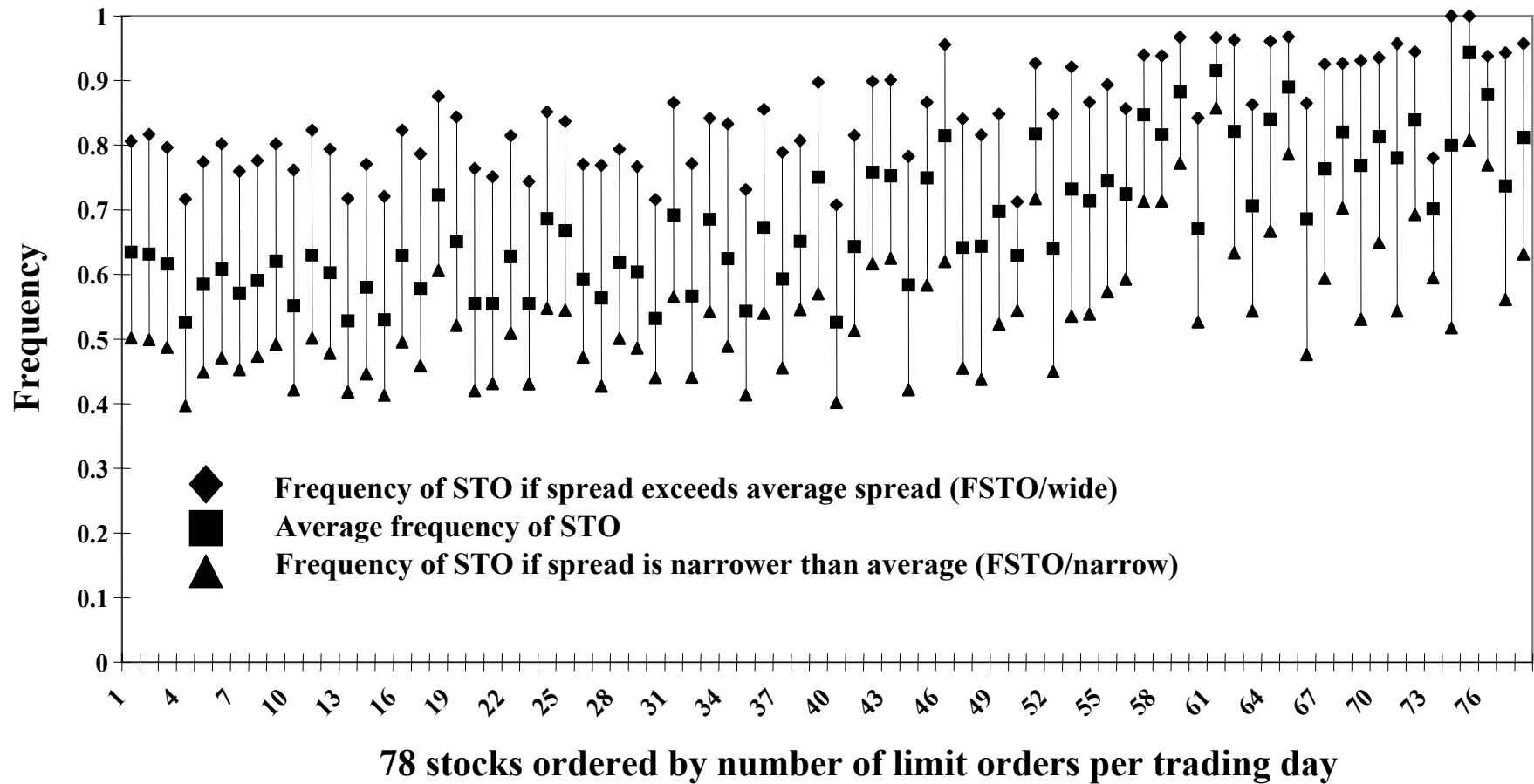
**Version tested: When the spread exceeds the average spread in stock  $i$ , we expect high values for the frequency of STO (FSTO).**

**FSTO      Number of STO to number of STO and market orders**

**For all 78 shares with sufficient data, the FSTO/wide is larger than FSTO/narrow. There are relatively more market orders if spread is narrow.**

**For 76 stocks the positive difference between FSTO/wide and FSTO/narrow is significant at 1 percent level.**

# Frequency of STO at Narrow and Wide Spreads



# Review of Results

- **CMSW theses not rejected.**
- **IBIS traders require substantial potential price advantage to balance execution uncertainty. But there seem to be some exceptions.**
- **IBIS microstructure does not provide price improvement for market orders by specialist or crowd. Market structure disincentive for market orders.**
- **Do-it-yourself price improvement by addressing electronic crowd by using limit orders. Bargaining for the price of immediacy via limit order.**
- **Contrary to conventional wisdom, limit orders are used both to supply and to demand liquidity.**

# Three Pools of Liquidity

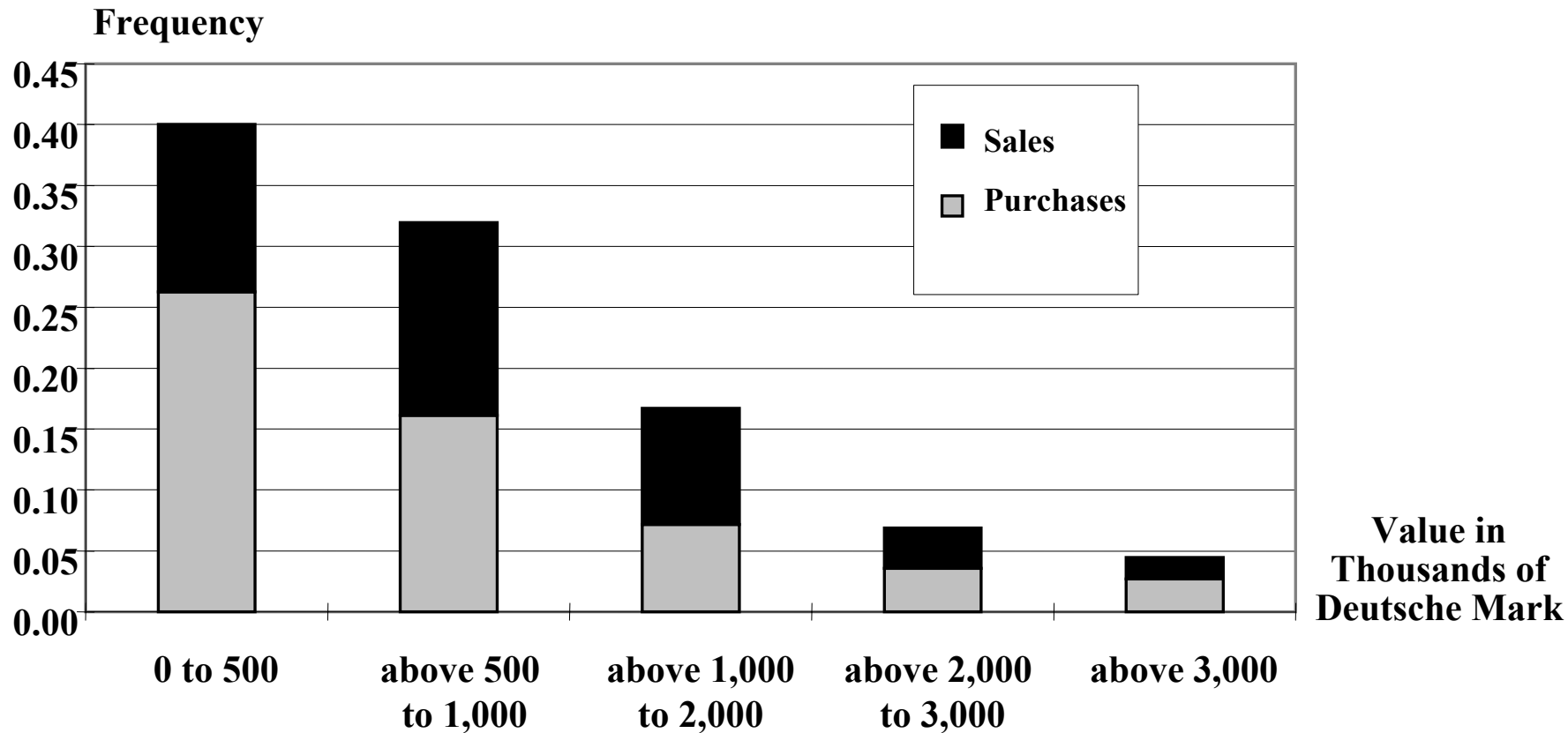
<b>Liquidity providers</b>	<b>Liquidity type</b>	<b>Access</b>
<b>Market makers, Limit-order traders</b>	<b>Book liquidity</b>	<b>Accept quotes or limits</b>
<b>Screen-watching traders</b>	<b>Electronic crowd liquidity</b>	<b>Broadcast attractive limits</b>
Investors related to certain stocks	Call-on or upstairs liquidity	Call and make proposition

# Application to Problem

**Task: Judge the execution prices of 335 not-held orders of four Hamburg institutional investors in stocks predominantly traded on IBIS.**

- **Time of order placement known to the minute.**
- **All orders were completely filled.**
- **Single execution price known for each order, commission not included.**
- **Nothing known about trades done to fill orders.**
- **Day of completion of execution known for 133 orders.**
- **All orders were placed and executed during January through November 1997. Full set of IBIS data available for these eleven months.**

# Distribution of 335 Institutional Orders in Sample by Size and Direction



# Approach to Solution

- **Bank executing order is agent, institution is principal.**
- **Single execution price includes agency cost (excessive or abnormal implicit transaction cost).**
- **No agency cost, if institution would be able to trade on its own in a fully professional fashion (competent actor).**
- **How would the competent actor trade?**
- **No single answer: Define grid of increasingly demanding trading strategies of the competent actor.**
- **Each strategy defines a level of normality, of normal implicit transaction cost.**

# Grid of Strategies for Institutional Purchase

- 1. Walk up the asks in the IBIS book until full number of shares ordered is bought (consume book liquidity).**
- 2. Watch screen patiently and accept asks (consume book liquidity / provide electronic-crowd liquidity).**
- 3. Watch screen patiently and accept spread tightening asks only (consume competitive book liquidity / provide electronic-crowd liquidity).**
- M Patiently accept asks and place bids (comprises strategies 2\* and 5).**
- 4. Watch screen and patiently place spread tightening bids (consume electronic-crowd liquidity, supply competitive book liquidity).**
- 5. Patiently place bids (5 includes strategies 4 and 6).**
- 6. Place bids below current best bid (provide book liquidity).**

\* Strategy 2 includes strategy 3.

# Strategy-Related Benchmark Execution Prices for Not-Held Buy Orders

**Share-volume weighted average of**

- **asks in book required to fill order (1)**
- **asks actually accepted during simulation period (2)**
- **spread tightening asks actually accepted during simulation period (3)**
- **bids and asks actually accepted during simulation period (M)**
- **spread tightening bids actually accepted during simulation period (4)**
- **bids actually accepted during simulation period (5)**
- **bids placed below best bid and actually accepted during simulation period (6)**

# Execution Simulation Periods

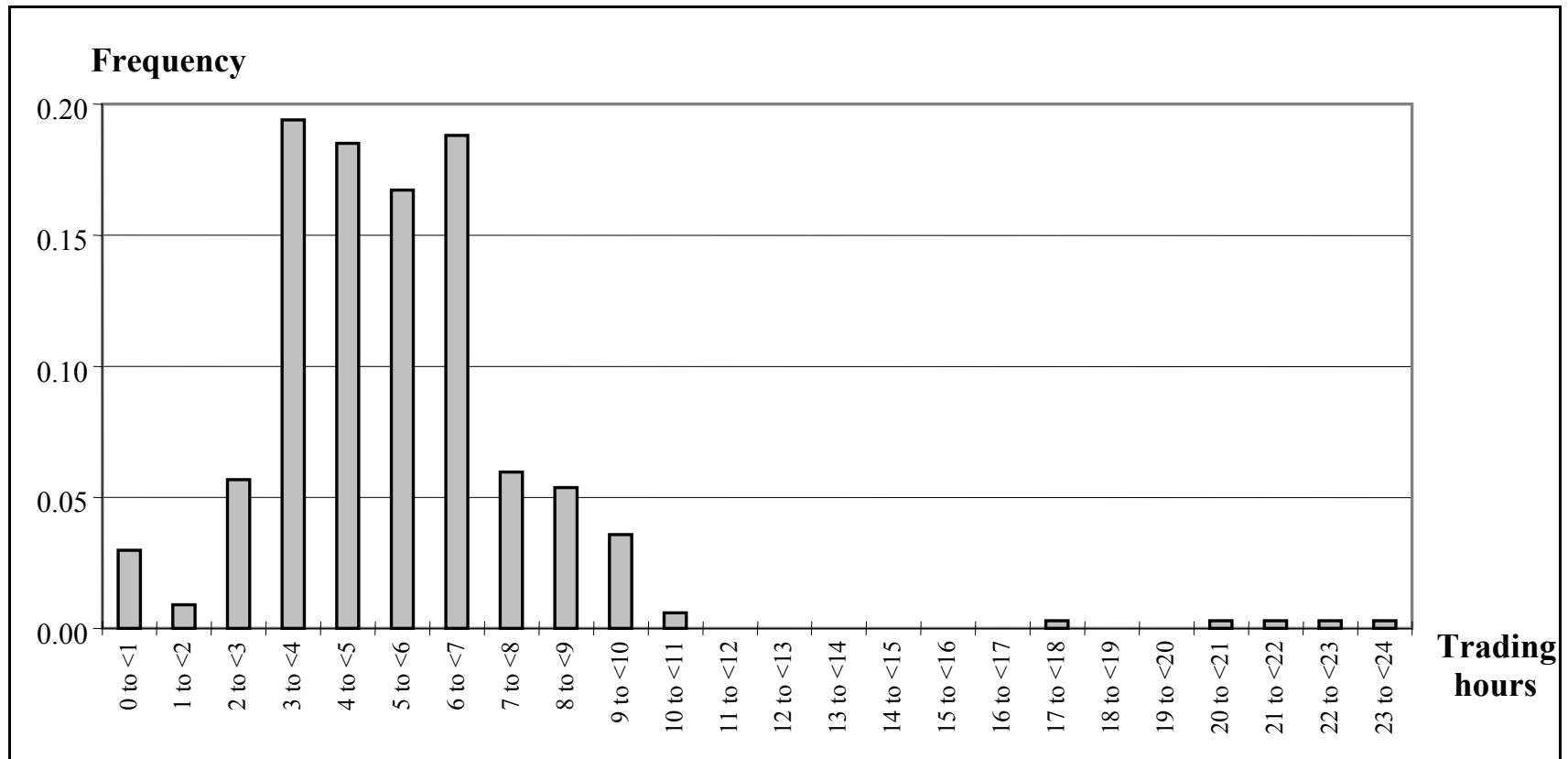
## **Time-bounded simulation period:**

**Simulation of execution begins with minute after placement of order and ends at trading close of same day or any stated completion day.**

## **Volume-bounded simulation period:**

**Simulation of execution begins with minute after placement and ends once the number of shares stated in the order equals the aggregate number of shares traded in IBIS.**

# Time-Bounded Simulation Period in Trading Hours



# Measures of Abnormal Transaction Cost

Order execution  
by agent



Actual execution  
price (AEP)

Simulated trading by  
competent actor



Benchmark execution price ( $BEP_j$ )  
of strategy  $j$

**Absolute abnormal transaction cost per share (AATC)**

$$AATC_j = \begin{cases} AEP - BEP_j & \text{(purchase)} \\ BEP_j - AEP & \text{(sale)} \end{cases}$$

# Percentage Abnormal Transaction Cost (PATC)

**Percentage abnormal transaction cost (PATC)**

$$\text{PATC}_j = \frac{\text{AATC}_j}{\text{BEP}_j}$$

# PATC for Time-Bounded Simulation Period

Strategy j	Number of orders fully executed	Mean of order PATC <sub>j</sub>	t-statistic (*/** significant at 5 percent/1 percent level)
1	323	-0.23	-5.74**
2	328	-0.24	-5.18**
3	312	-0.20	-4.50**
M	332	-0.08	-1.72*
4	309	0.07	1.54
5	327	0.10	2.15*
6	248	0.27	5.20**

## Strategy M PATC for Volume-Bounded Simulation Period

Quartile	Number of orders	Mean of order $PATC_M$	t-statistic (*/** significant at 5 percent/1 percent level)
1	83	0	-0.05
2	83	0.05	0.92
3	83	0.12	3.00**
4	83	0.11	1.23

## Summary and Conclusion

- **Advice from CMSW theory: Wait for STO if spreads are wide.**
- **Advice from STO use in IBIS: Use STO to tap electronic crowd liquidity.**
- **Both pieces of advice help to define strategy grid.**
- **Grid seems to work in quest to judge agent and to measure agency cost.**
- **Grid provides additional rationale for the widespread use of price averages in judging order executions (Strategy M).**
- **Exchanges should provide much more ex-post transparency to enable institutions to check up on their agents.**