Liquidity and Price Discovery When Some Participants are Irrational: Evidence from the NSE

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Aim of study

- To ascertain the impact of irrational traders on trading efficiency of stocks listed on the National Stock Exchange of India (NSE).
- Irrational trading driven by an exogenous non-information event
  - Rahukalam is a pre-set period of time during a day considered by some Hindus to be inauspicious for conducting commerce.

Contribution of study

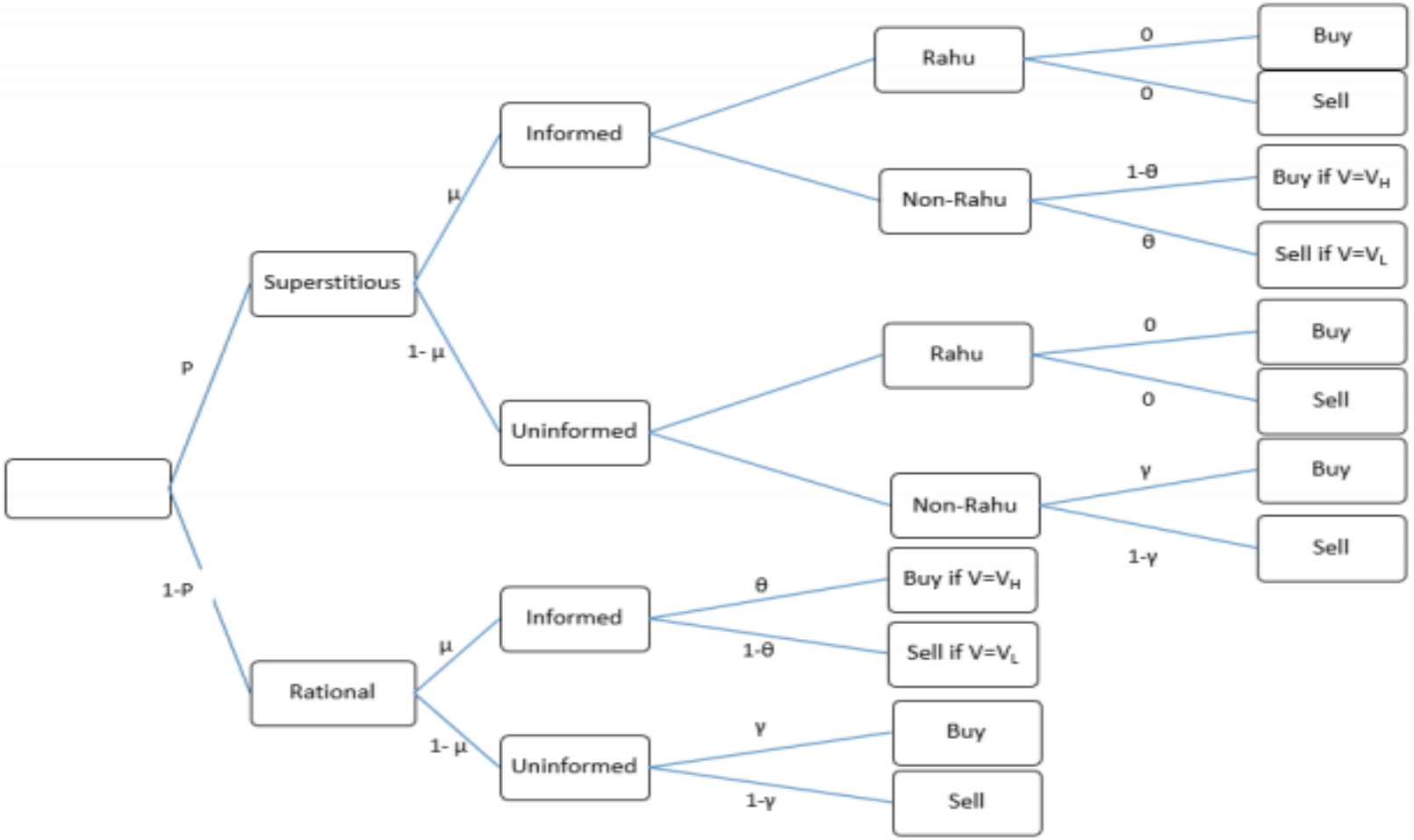
- Contributes to behavioral finance
  - Do irrational traders have an impact on prices and returns?
- Contributes to market microstructure
  - How do microstructure characteristics of stocks affect trading in the presence of irrational investors?
  - What stock and market characteristics make stocks more vulnerable to irrational trading.

Trading Process

- Trading in an order-driven market: Investors choose to submit a market order or a limit order.
  - patient traders submit limit orders, impatient traders usu. market orders
- Investors have an information or liquidity motive to trade: informed traders buy only if firm value is higher than its current value, and sell otherwise. Liquidity traders buy and sell randomly.
- Overlay of traders' religious beliefs: a proportion ρ of sentimental traders will not trade during Rahu, (1- ρ) are rational and will trade.

Trading participants

Figure 1



Rational Trader Strategies

- In Rahu: Rational limit order traders post less aggressive prices since a fraction ρ are absent from the market.
  - Rational informed traders may still trade if: i) trader's private valuation is better than the unfavorable price; higher than A for a market buy, or lower than B for a market sell, and, or, ii) the trader is reluctant to postpone trading to the post-Rahu period.
- In post-Rahu: pent-up demand from sentimental liquidity traders creates liquidity shock.

Rational Trader Strategies

- In post-Rahu (contd.):
  - liquidity motivated trades are executed against quotes posted by patient limit order traders.
  - Patient traders capture larger rents by posting less aggressive orders.
  - Foucault, Kadan and Kandel (2005) and Rossu (2008) label a market where spreads do not revert to competitive levels following liquidity shocks as being *not resilient*.

Rational Trader Strategies

- Interaction between Rahu and post-Rahu:
  - Informed trader prefers to move her trades to Rahu if market is not resilient to absorb liquidity shock.
  - Risk that prices will move away from equilibrium values in a market that is not resilient.
  - The shift encourages patient rational limit order traders to post aggressive prices
  - Narrower spreads attract rational liquidity traders to also shift to Rahu period.

Testable Hypotheses

- *H_A: Volume of trading during Rahu is significantly lower than the volume of trading during non-Rahu in a resilient market*

- *H_B: There is less informed trading in the post-Rahu period than in the pre-Rahu period.*

NSE Data

- Tick-by-tick transaction data for stocks listed on NSE between 2004-2010.
- Sample description:

Total # of tickers.	1786	# of tickers with trading day starting before 10 am	
Total tickers in sample with more than 30 trading days in a year	1304	Exactly 0%	260
# of tickers with 1 year of data	183	0-1%	167
# of tickers with 2 years of data	225	1-5%	645
# of tickers with 3 years of data	277	5-10%	108
# of tickers with 4 years of data	188	>10%	124
# of tickers with 5 years of data	145		
# of tickers with >5 years of data	286		

Liquidity measures

- V_i = volume in period i
- $Size_i = V_i / number\ of\ trades_i$, i=1,2,3
- $Trading\ intensity_i = V_i / length_i$, i=1,2,3
- Signal-to-noise ratio: beta coefficient in:

$$r = \alpha_i + \beta_i r_{ci} + \varepsilon_i$$

- Amihud measure: $Illiquidity_i = |r_i| / V_i$

Market Resilience

- Derive equation for limit price using modified Madhavan, Richardson and Roomans (1997) model:

$$P_t - P_{t-1} = \left(\theta + \frac{1}{\Lambda}\left(\frac{1}{\omega} - 1\right)\rho\right) x_t - \theta\rho x_{t-1} \qquad (4)$$

the market resilience parameter, $1/\omega$, and others in equation (4) solved using a GMM methodology:

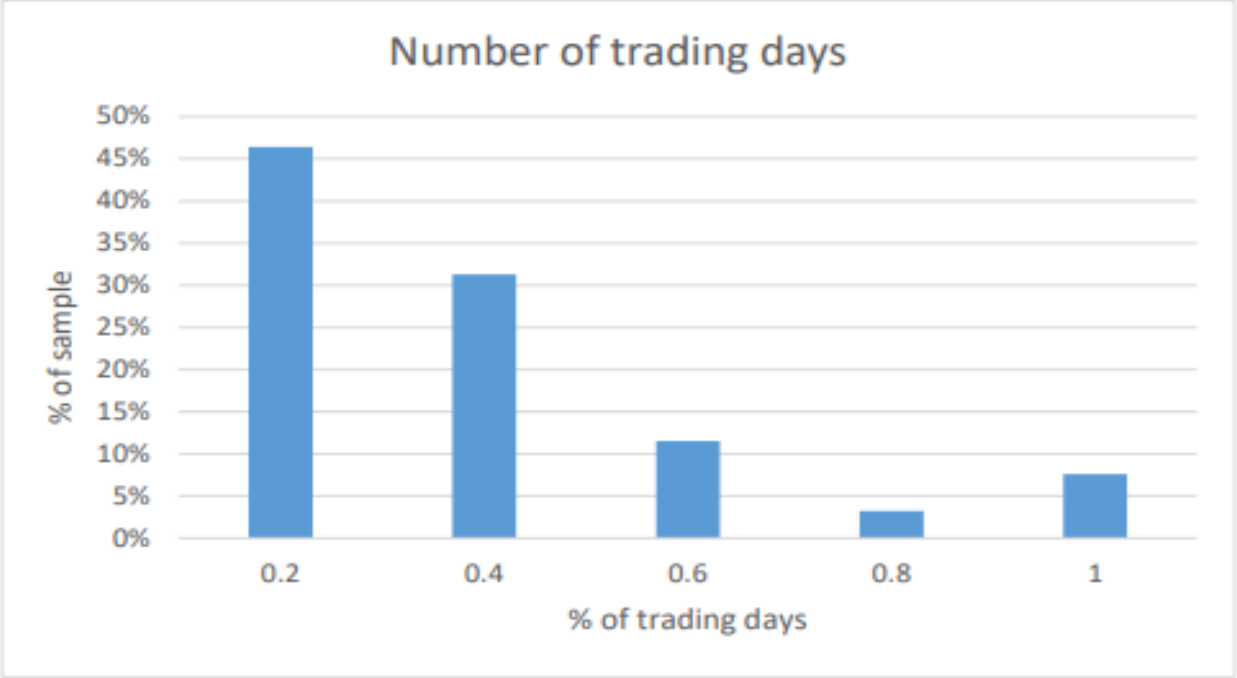
$$\mathrm{E}\begin{pmatrix} x_t x_{t-1} - x_t^2\rho \\ |x_t| - \frac{1}{\Lambda} \\ u_t - \alpha \\ (u_t - \alpha)x_t \\ (u_t - \alpha)x_{t-1} \end{pmatrix} = 0 \qquad (5)$$

where $u_t = P_t - P_{t-1} - \left(\theta + \frac{1}{\Lambda}\left(\frac{1}{\omega} - 1\right)\rho\right) x_t + \theta\rho x_{t-1}$

The Rahu period

Median length of Rahu	91.000
Average length of Rahu (in minutes)	91.067
Maximum length of Rahu in the sample period	100
Minimum length of Rahu	82
Standard deviation of length of Rahu	5.976
When Rahu falls at market open	12.93%
When Rahu falls at market close	27.14%
When Rahu falls during morning trading (before noon)	57.15%
When Rahu falls during evening trading (after noon)	42.85%

Trading Frequency



Trading activity around Rahu

	Before	During	After	F-test
Trades per interval	8.78	7.13	8.12	0.001
Size of trade	184.58	190.85	195.02	0.514
Intensity of trading	1099.54	1021.67	1026.27	0.066
Amihud measure	0.00009	0.00019	0.00013	0.001
Signal-to-noise ratio	0.968	0.715	0.901	0.001

Liquidity and sentiment

	soft=1			soft=2			soft=3			soft=1-2			soft3-2		
	intercept	Volume ventile	Adj Rsq	intercept	Volume ventile	Adj Rsq	intercept	Volume ventile	Adj Rsq	intercept	Volume ventile	Adj Rsq	intercept	Volume ventile	Adj Rsq
Size of trade	57.77	8.82	83.58	40.29	9.79	77.44	55.42	9.62	55.9	17.48	-0.97	-0.67	15.13	-0.17	-5.5
	5.41	9.89		2.79	8.14		2.41	5.01		1.4	-0.93		0.75	-0.1	
Intensity of trading	-847.03	130.79	24.88	-626.38	102.14	28.66	-675.66	110.8	25.68	-220.66	28.64	13.94	-49.28	8.65	4.4
	-1.46	2.7		-1.5	2.94		-1.4	2.75		-1.3	2.02		-0.65	1.37	
Amihud Illiquidity	0.001	-0.00006	49.88	0.002	-0.0001	54.99	0.001	-0.00005	50.77	-0.0008	0.00005	19.88	-0.0009	0.00005	45.38
	6.1	-4.46		7.06	-4.92		6.63	-4.54		-3.65	2.39		-5.77	4.1	
Signal to noise ratio	0.97	0.001	24.29	0.33	0.039	58.62	0.92	0.004	10.21	0.63	-0.037	55.56	0.61	-0.037	52.43
	144.74	2.6		3.61	5.15		31.84	1.78		6.69	-4.85		6.18	-4.56	

Conclusions

- Tentative evidence that irrational traders can compromise trading efficiency.
- Higher liquidity dampens the impact of irrational traders on trading efficiency
- Numerous studies document that liquidity risk is a priced risk factor for stocks.
- Evidence in this paper suggests another channel through which liquidity reduces risk:
  - greater liquidity reduces the vulnerability of a stock to irrational trading.

Summary of results

- Trading is subdued during Rahu

	Pre-Rahu	Rahu	Post-Rahu
# of trades/minute	8.78	7.13	8.12
Price impact of a 1000 share trade	0.09 INR	0.20 INR	0.11 INR
Signal-to-noise ratio	1.0	0.70	1.0

- Stocks in the Nifty 50 index suffer a smaller impact from superstitious traders.