Measuring and explaining the asymmetry of liquidity

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The context

- Liquidity has always been an important part of finance: in decision making, allocation, risk measurement.
- Difficult to measure.
- Kyle (1985) described three dimensions of liquidity: price, trade size, immediacy (time) – as an input to financial thinking.
- A lot of our understanding about the liquidity of the market was derived after the trade: traded volumes, Roll's spread from prices.
- Electronic limit order book (LOB) markets offer an enhanced scope of measuring and understanding liquidity.

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Our question

- A feature about liquidity observed from traded security prices is the asymmetry of liquidity between buy-side trades and sell-side trades. Ie, sellers of securities face a higher deterioration in transaction price for larger sizes as compared to buyers.

- *Question*: If a security has multiple markets, will all the markets have the same asymmetry of liquidity?

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Factors driving asymmetry of liquidity: Literature

- Information asymmetry:
  - Institutions faced higher costs when selling than buying because buyers fear institutions have better information (Kraus and Stoll (1972), Chan and Lakonishok (1993), Keim and Madhavan (1996))
  - Inventory costs made market specialists offer relatively easier terms to buyers (Ho and Stoll (1981), Subrahmanyam (1991), Brunnermeier and Pedersen (2009))
- Short sales constraints:
  - Short sales constraints can exacerbate information asymmetry (Miller 1977).
  - Because short sales are costly and insiders tend to be long company shares, large sale orders are likely to be treated as insider trading (Brennan, Chordia, Subrahmanyam, and Tong (2010), Nguyen, Duong, Kalev, and Oh (2010))
- Difficult to disentangle factors unique to causing asymmetry in liquidity.

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Our setting

- A unique setting in Indian securities markets: a very liquid spot market and a very liquid related single stock futures (SSF) market.
- Market microstructure and participants are the same in both markets.
- Access to the full LOB for spot and SSF at four snapshots every day.
- SSF and stock are the very similar:
    - More than index futures and spot, since index spot is fragmented across several stocks.
    - More than single stock options, which have non-linear payoffs.
- Differences: SSF have leverage and are cash-settled with no short sales constraints.
- *Our Approach*: Set up a comparison of the liquidity between SSF and spot to help answer how short sales constraints affect liquidity asymmetry.

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Core liquidity measure: the liquidity supply schedules (LSS)

- Trade size Q on the x-axis; price impact of a market order of size Q compared to the bid-ask midquote price on the y-axis.
- We call this the Liquidity Supply Schedule (LSS).
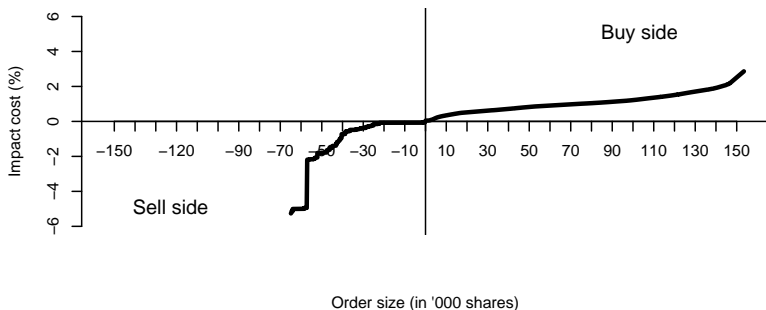

Order size (in '000 shares)

Figure : An example: LSS for Infosys Technologies, 12pm, 8th June 2009

Measures of liquidity asymmetry

We derive three measures of liquidity asymmetry for each market:

1. Non-parametric: Probability of full execution of a market order at Q on the bid side vs. the same probability on the ask side.
   If these are significantly different, there is presence of liquidity asymmetry in the market.

2. Non-parametric: Difference between the price impact cost of a bid-side market order $IC_{B,Q}$ and a ask-side market order $IC_{A,Q}$ of size Q when there is full execution on both sides of the market.
   If $dIC_Q = (IC_{B,Q} - IC_{A,Q})$ are all significantly different, there is presence of liquidity asymmetry in the market.

3. Parametric: Choose a plausible functional form for IC_Q and estimate the parameters $\vec{\beta}_B, \vec{\beta}_A$ separately for the bid-side and the ask-side of the LSS.
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What we find

1. There is *strong* evidence of asymmetry in the liquidity between the bid and ask side in the stock market.

2. There is *no* evidence of asymmetry between the bid and ask side of the SSF market.

3. The illiquidity premium is *significant and larger* on the bid compared to the ask for large orders.
   Further, the illiquidity increases for larger order sizes.

4. This supports the hypothesis that when there are short-sales constraints, the effects of information asymmetry tends to be exacerbated for potential *sellers* compared to buyers.

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Data and analysis

Data description

- LOB snaphots at four times in a day i.e. 11am, 12pm, 1pm, 2pm.
- Access to limit orders available at all prices in the book on both the buy and sell side.
- Data period: Jan 2009 to Dec 2009, a total of 972 snapshots of LOB.
- Sample of 100 stocks: NIFTY and NIFTY Junior. Divided into five quintiles by market cap.

Summary statistics of sample

Table : Summary statistics of spot market liquidity

	Bid-ask spread (%)	Inside depth	Sell-side depth	Buy-side depth
		(Number of shares)		
S-big	0.11	1670	217550	272190
	(0.02)	(1480)	(130290)	(185240)
S2	0.13	1930	204710	269840
	(0.02)	(1840)	(161010)	(237250)
S3	0.16	3440	285180	463270
	(0.04)	(6930)	(492720)	(897420)
S4	0.18	3600	330730	577400
	(0.03)	(5810)	(591150)	(1083280)
S-small	0.20	10580	233460	371810
	(0.03)	(22250)	(340490)	(686130)
Overall	0.15	4270	254700	392100
sample	(0.04)	(11120)	(384290)	(711410)

Results

Results: probability of full execution, spot market

	Sell-side Q (Rs. Mln.)				Buy-side Q (Rs. Mln.)			
	0.025	0.25	1.00	10	0.025	0.25	1	10
S-big	1.00	1.00	0.90	0.78	1.00	1.00	**0.98**	**0.91**
S2	1.00	1.00	0.88	0.71	1.00	1.00	**0.96**	**0.82**
S3	1.00	0.90	0.80	0.65	1.00	**0.96**	**0.90**	**0.70**
S4	1.00	0.88	0.80	0.50	1.00	**0.92**	**0.86**	**0.62**
S-small	1.00	0.80	0.72	0.39	1.00	**0.87**	**0.80**	**0.55**
Overall sample	1.00	0.92	0.78	0.27	1.00	1.00	**0.84**	**0.40**

Results: probability of full execution, SSF market

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	0.025	0.25	1	10	0.025	0.25	1	10
S-big		1.00	1.00	0.98		1.00	1.00	0.98
S2		1.00	1.00	0.95		1.00	1.00	0.93
S3		1.00	0.99	0.82		1.00	1.00	0.81
S4		1.00	1.00	0.74		1.00	1.00	0.70
S-small		1.00	0.98	0.64		1.00	0.99	0.55
Overall sample		1.00	1.00	0.82		1.00	1.00	0.79

Table : Point-to-point difference for spot and SSF market LOB

	Difference in sell and buy price impact (in %) across Q (in Rs. million)								
	Spot market					Futures market			
Q =	0.025	0.25	1	10	50	0.25	1	10	50
S-big	0.01	0.02	0.04	**0.52**	**1.16**	0.00	0.01	0.05	0.12
	(0.00)	(0.03)	(0.12)	(0.81)	(1.34)	(0.00)	(0.01)	(0.09)	(0.34)
S2	0.01	0.04	0.04	**0.78**	**2.34**	0.00	0.02	0.09	**0.40**
	(0.01)	(0.06)	(0.25)	(1.37)	(0.45)	(0.00)	(0.02)	(0.24)	(0.12)
S3	0.02	0.09	0.10	**1.20**	**7.44**	0.01	0.13	0.02	**1.08**
	(0.02)	(0.15)	(0.50)	(1.23)	(0.95)	(0.04)	(0.32)	(0.27)	(0.39)
S4	0.02	0.11	0.12	**0.97**	**8.01**	0.00	0.07	**0.71**	**0.71**
	(0.01)	(0.09)	(0.29)	(1.92)	(-)	(0.01)	(0.06)	(1.14)	(0.48)
S-small	0.03	0.04	**0.39**	**2.68**	**5.35**	0.00	0.05	0.18	**0.74**
	(0.02)	(0.27)	(0.61)	(3.36)	(-)	(0.01)	(0.06)	(0.58)	(-)
Overall	0.02	0.04	0.05	**0.95**	**2.81**	0.00	0.06	0.14	**0.37**
sample	(0.02)	(0.16)	(0.43)	(1.69)	(2.77)	(0.02)	(0.15)	(0.61)	(0.46)

Table : Adjusted R^2 of alternate functions for the spot market LSS

	Sell side				Buy side			
	Model1	Model2	Model3	Model4	Model1	Model2	Model3	Model4
S-big	0.53	0.81	0.85	**0.90**	0.51	0.79	0.85	**0.98**
	(0.16)	(0.13)	(0.13)	(0.06)	(0.16)	(0.10)	(0.12)	(0.05)
S2	0.54	0.80	0.88	**0.97**	0.59	0.80	0.90	**0.91**
	(0.13)	(0.10)	(0.09)	(0.03)	(0.14)	(0.11)	(0.08)	(0.03)
S3	0.57	0.83	0.88	**0.97**	0.59	0.83	0.90	**0.90**
	(0.13)	(0.10)	(0.10)	(0.04)	(0.13)	(0.10)	(0.09)	(0.04)
S4	0.57	0.84	0.89	**0.98**	0.56	0.82	0.89	**0.92**
	(0.13)	(0.09)	(0.10)	(0.04)	(0.13)	(0.10)	(0.09)	(0.03)
S-small	0.58	0.85	0.89	**0.97**	0.57	0.83	0.90	**0.90**
	(0.13)	(0.09)	(0.10)	(0.03)	(0.13)	(0.10)	(0.09)	(0.03)

Table : Adjusted R^2 of alternate functions for the futures market LSS

	Sell side				Buy side			
	Model1	Model2	Model3	Model4	Model1	Model2	Model3	Model4
S-big	0.45	0.74	0.78	**0.80**	0.48	0.71	0.80	**0.84**
	(0.18)	(0.13)	(0.04)	(0.06)	(0.16)	(0.10)	(0.02)	(0.05)
S2	0.42	0.80	0.80	**0.82**	0.45	0.67	0.80	**0.82**
	(0.16)	(0.07)	(0.04)	(0.06)	(0.14)	(0.11)	(0.04)	(0.03)
S3	0.48	0.81	0.84	**0.86**	0.52	0.63	0.74	**0.82**
	(0.21)	(0.04)	(0.02)	(0.04)	(0.14)	(0.10)	(0.05)	(0.06)
S4	0.31	0.84	0.86	**0.89**	0.47	0.72	0.78	**0.86**
	(0.11)	(0.10)	(0.10)	(0.04)	(0.18)	(0.10)	(0.09)	(0.02)
S-small	0.38	0.82	0.81	**0.90**	0.46	0.73	0.80	**0.88**
	(0.15)	(0.11)	(0.10)	(0.03)	(0.13)	(0.10)	(0.09)	(0.03)

Conclusion

- Significant evidence of asymmtery in liquidity provision for large sized orders.

- Non parametric approach indicates price impact cost for sell market orders is higher on average than for buy market orders.

- Greater asymmetry for small sized firms.

- In the SSF market, large firms have no asymmetry; small firms have much smaller degree of asymmetry in SSF liquidity compared to stock liquidity.

- Exponential function with a curvature term as the best functional form capturing the relationship between price impact and order size.

- Kolmogorov-Smirnov test of stochastic dominance indicates there is sell side illiquidity in parameters of the function.

- Short sale constraints do contribute to explain the asymmetry across buy and sell side in the spot market.

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