Correlated Portfolio Inventory Risk of Liquidity Providers: Frictions and Market Fragility

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Liquidity Providers

"***Liquidity***" is the ability to trade quickly and efficiently. Liquidity providers buy and sell on their own account, carrying inventory as needed, thereby facilitating transactions' flow.

"By the time we got him in here, he had already lost an awful lot of liquidity."

Liquidity Providers

- In old dealer markets, like LSE or NYSE, liquidity providers were affirmatively obliged to post firm bid and ask “quotes”.

- In today’s limit order book markets, some traders patiently post standing limit orders to buy or sell as part of their profit maximizing trading strategies – thereby becoming voluntary liquidity providers or VLPs – while others trade with immediacy by “picking” these limit orders.

- VLPs earn the spread between the buying and selling price; but carry inventory risk exposure. We focus on ”professional” VLPs who go home flat.

Liquidity Provision in Multiple Securities

- A VLP simultaneously participates in multiple securities.
- So, is their trading in one stock influenced by their positions in other correlated securities in their portfolio?
  - It should as per Ho and Stoll (1983).
- In extreme cases, the management of these liquidity providers' correlated portfolio inventories could arguably be a significant source of contagion-induced liquidity fragility, since liquidity shocks in one security can propagate to another through this channel.
- We investigate these cross-security implications of VLPs' portfolio inventory management in LOB markets.

Liquidity Provision in Multiple Securities

- Effect of positions in correlated securities is not entirely obvious
- Naik and Yadav (2003) - The only other study (to our knowledge) to test Ho and Stoll (1983) in the context of correlated portfolio inventories
  - Find that market-maker firms in the old pre-1997 pure dealer market on the London Stock Exchange overlooked inventory risks in correlated securities
    - Organizational agency costs;
    - Difficulties in real-time communication amongst the firm's traders in a telephone-based trading environment
    - Affirmative obligation constraints
- Real-time communication is not an issue anymore
- And VLPs are also not constrained by affirmative obligations

Liquidity Provision in Multiple Securities

- However, in view of the voluntary nature of market-making in today's LOB markets, VLPs could also deviate from a pure market-making strategy and adopt a more information-driven strategy.
- Specifically, VLPs could learn about a security's fundamental value from prices of other securities with correlated returns (Pasquariello and Vega, 2013; Cespa and Foucault, 2014).
  - In such a scenario, they could potentially take similar positions across correlated stocks rather than the offsetting positions predicted by Ho and Stoll (1983).
- Therefore, establishing the net influence of correlated inventories on the trading behaviour of VLPs is not necessarily unambiguous, and requires empirical analysis.

Results: Preview

- In accordance with the predictions of Ho and Stoll (1983), VLPs in LOB markets do manage their inventory risk on a *portfolio* basis in addition to a stock-by-stock basis.
- VLP's trading and order placement strategy is significantly influenced by her inventory in the other correlated securities in her portfolio.
- Consistent with information-driven objectives, the offsetting influence of correlated securities is less pronounced for VLPs whose trading is more likely to be driven by informational strategies.
- Securities experience greater cross-security price pressures and episodes of market stress when VLP positions in correlated securities are large and undispersed.

Contribution: Inventory Management

- Vast literature on the effect of dealer inventories on their trading behaviour
  - Example:Madhavan and Smidt (1993), Manaster and Mann (1996), Hansch, Naik, and Viswanathan (1998), Reiss and Werner (1998), and Naik and Yadav (2003)
- But the literature on portfolio effects in inventory management of LPs is super-tiny – Naik and Yadav (JFE 2003).
  - find no evidence of any portfolio-related influences on the *centralized* inventory risk control of London market making firms.
  - Reasons: Centralized data – Agency issues; Slow OTC markets; Designated market-makers
- We cleanly test the predictions of Ho and Stoll (1983) for the trading of liquidity providers, and our results turn out to be strongly supportive.

Contribution: Market Liquidity

- Most empirical studies that examine liquidity in LOB markets have ignored inventory costs altogether.
- Those that have examined the role inventory costs on market liquidity have only considered stock-level inventories
  - Example: Hendershott and Menkveld (2014)
- We explore and show how VLP portfolio inventories are a significant and incremental determinant of LOB market quality.
  - Wider bid-ask spreads and larger price pressure effects with higher aggregate magnitude of VLP portfolio inventories and lower dispersion of VLP portfolio inventories across different liquidity providers.

Contribution: Liquidity Fragility

- There has been great regulatory concern that LOB markets remain uncomfortably dependant on stability in the supply of liquidity from VLPs, especially in peak load and stress periods.
- Yet, there is very little we know about the determinants of liquidity-induced market fragility in LOB markets.
- Papers that study firm-wide inventory effects have typically only considered NYSE specialists (e.g. , Comerton-Forde et al., 2009; Coughenour and Saad, 2004)
  - However, NYSE specialists are affirmatively obligated to supply liquidity, studies focusing on NYSE specialists cannot answer questions about the influence of purely voluntary liquidity provider inventories on market fragility.

Contribution: Liquidity Fragility

- Papers that study inventory effects in LOB markets, typically have examined only stock-level inventories.
  - Example: Anand and Venkatraman (2016), Kirilenko et al. (2017), and Getmansky et al. (2018)
  - show that VLPs turning from liquidity providers to liquidity demanders due to unsustainable levels of inventory imbalances is an important precursor to episodes of market fragility
- Our paper builds on this literature by specifically focusing on how trading, liquidity provision, liquidity fragility, and market quality in ***one security are influenced by liquidity providers' inventory risk exposure to other securities in their portfolios.***
- Our results show that, along with stock-level inventories, large and correlated portfolio inventories significantly increase
  - the likelihood of market fragility, measured using extreme price movements and transitory jumps in stock returns.

Data

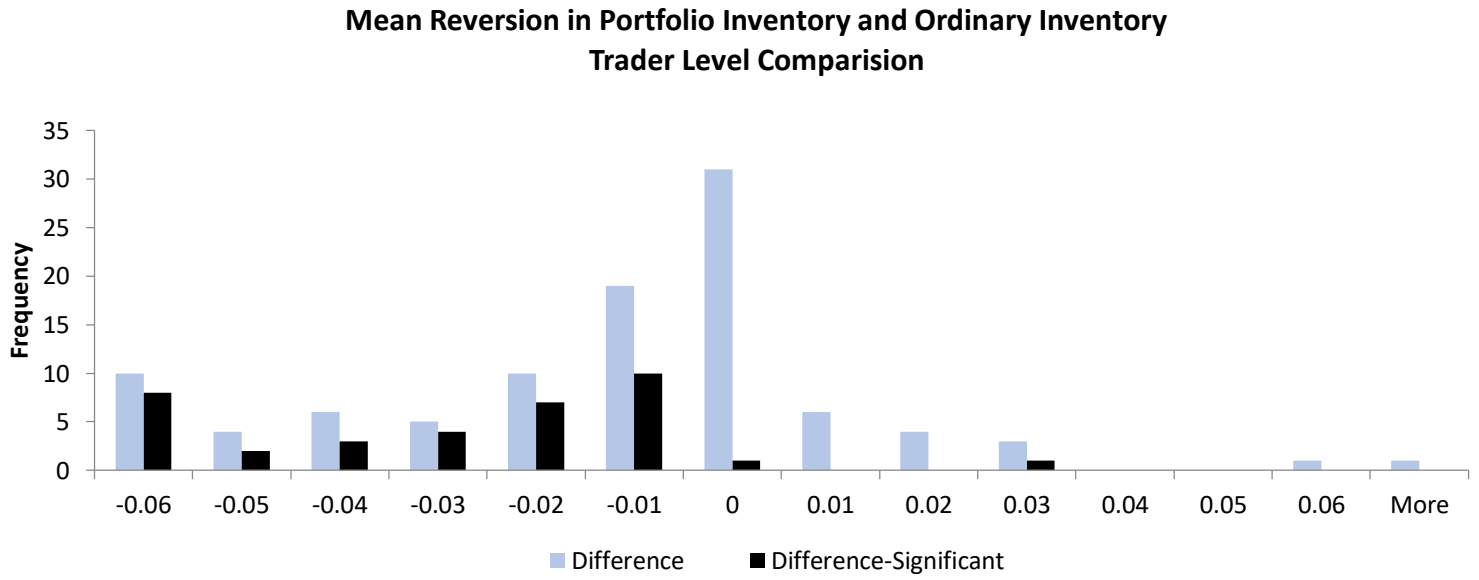
- Our 3-month 2006 data sample of 50 S&P Nifty index stocks represents about 60% of NSE market capitalization across 21 sectors, and provides complete information on trades and orders, including trader identification codes and trader-type classifications.
  - Enables reconstruction of the order book to obtain best quotes and depth information.
  - Enables tracking trader inventories over time and across stocks.
  - There was no algorithmic trading in India in 2006: it was prohibited.

Data

- There are over 1.2 million traders in the dataset.
- We identify liquidity providers as the most active 100 limit order traders (VLPs). These account for:
  - 40% of all limit orders
  - 57% of all trades in a median stock
  - About 50% of all volume and limit order volume.
  - The median *Churning Ratios* – ratio of end-of-day inventory and daily trading volume – is 0.00%.
  - 73% are exchange members, 17% financial institutions, and 10% individuals or hedge funds.

Summary of Salient Results

- Liquidity providers' portfolio inventories – that include the effect of the correlated risk exposures arising from the other stocks in the liquidity provider's portfolio – mean revert at a statistically and economically significant rate, that is also significantly – more than 30% – faster than the mean reversion in stock-level inventories.



Summary of Salient Results

- Portfolio inventory imbalances influence trading behaviour more than ordinary inventory imbalances. This is especially so when:
  - Portfolio inventories are large
  - Stock returns are highly volatile
  - VLPs suffer abnormal losses in their portfolio holdings.
  - And for VLPs whose trading is more likely driven by pure market-making reasons, relative to those who may be trading for more speculative or informational reasons.

- VLPs' portfolio inventories influence their order placement as well.
  - is significantly more likely to place sell (buy) orders than buy (sell) orders in a stock to offset the excess positive (negative) correlated inventory risk exposure in the rest of her portfolio

Summary of Salient Results

- Market liquidity (bid-ask spreads) improves when the variation in VLP portfolio inventory levels across different VLPs is high, and worsens when the magnitude of VLPs' aggregate portfolio inventories are relatively high.

	Dependent Variable: Bid-Ask spread			
Intercept	0.199***	0.032	-0.123***	-0.084***
$invrange_{i,t-1}$	-0.008	0.006		
$pinvrange_{i,t-1}$	-0.222***	-0.095***		
$\lvert invav_{i,t-1} \rvert$			-0.058	-0.049
$\lvert pinvav_{i,t-1} \rvert$			0.212***	0.048*
$volatility_{i,t-1}$		0.017**		0.017**
$volume_{i,t-1}$		0.038***		0.038***
$open\ close_{t-1}$		0.044***		0.047***
$pspread_{i,t-1}$		0.124***		0.124***
$\lvert oibfin_{i,t-1} \rvert$		-0.002		-0.002
$\lvert poibfin_{i,t-1} \rvert$		0.033***		0.033***
N	33,060	32,908	33,060	32,908
Adj R-Square	0.58%	5.13%	0.60%	5.08%

Summary of Salient Results

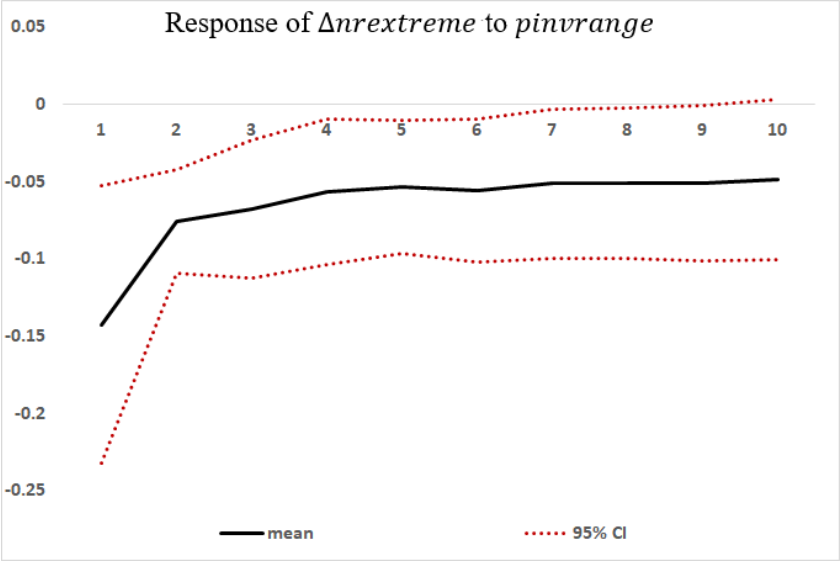
- Portfolio and equivalent inventories are also a significant source of price pressures.
  - Even after controlling for the effect of stock-level inventory, a one-standard deviation increase in portfolio inventories decreases returns by -5.40 basis points, which is almost double the bid-ask spread.
  - The effect of portfolio inventories is particularly high during periods of low dispersion of VLP portfolio inventories across different VLPs.

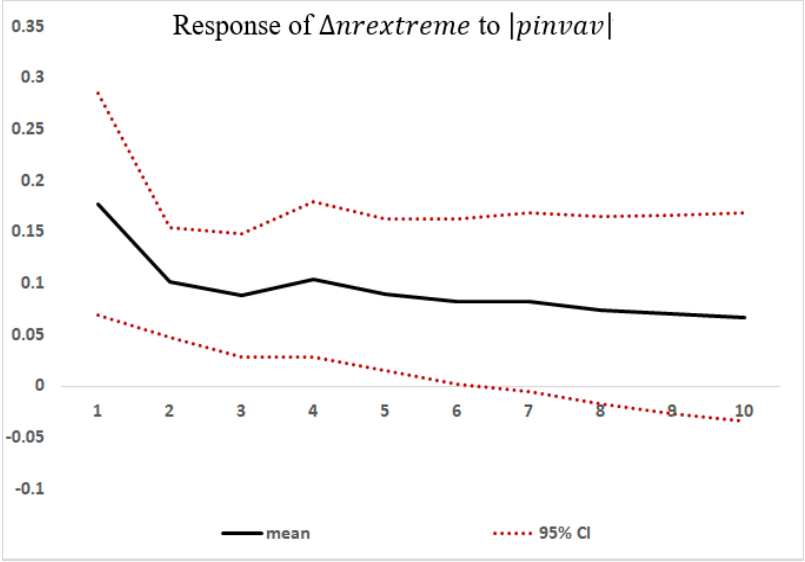
Summary of Salient Results

- Finally, liquidity providers' portfolio inventories influence the likelihood of market fragility, measured using extreme price movements (EPMs) and transient jumps in stock returns.
  - The likelihood and the number of extreme price movements significantly increase with the magnitude of aggregate portfolio inventories and reduce with the dispersion of these portfolio inventories across different VLPs.
  - A one-standard deviation increase in the magnitude of aggregate portfolio inventories is associated with an increase in the odds of observing an extreme price movements episode by a factor of 37; and transient jumps in stock returns by a factor of 1.3.
  - A one-standard deviation increase in the dispersion of aggregate portfolio inventories across VLPs is associated with a decrease in the odds of observing an extreme price movements episode by 85%; and transient jumps in stock returns by 75%.

Summary of Salient Results

- Consistent with our OLS regression results, the impulse response functions from a VAR analysis show that EPMs and transient jumps in stock returns are higher in number following periods of large and correlated portfolio inventories.
- IRF : Extreme Price Movements





Conclusion

- We investigate how trading, liquidity provision, and the overall market quality in one security are influenced by correlated inventory risk exposures of liquidity providers to other securities in their portfolios.
- Our results are consistent with large and correlated portfolio inventories worsening different measures of market quality – including bid-ask spreads and pricing errors – and increasing the number and likelihood of extreme price movements and transitory jumps in stock returns.
- We highlight a significant but often overlooked source of market frictions, contagion, and fragility.