Are Market Makers Incentivized to Provide Liquidity? Evidence from the Nasdaq

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Incentive Schemes and the Role of Liquidity Provision

- Rise of "endogenous liquidity providers" (ELPs) instead of traditional markets makers has led many equity trading platforms to implement liquidity incentive schemes.

- Questions remain as to the primary role of a liquidity provider:
  - Patient Counterparties: Provision of limit orders (Grossman and Miller, 1988).
  - Contrarian Traders: Price stabilization (Hendershott and Menkveld, 2014; Van Kervel and Menkveld, 2019).

- Most incentive programs focus on the provision of limit orders, but contrarian trading may be essential to mitigating textcolorbluemarket fragility! (Bessembinder et al., 2015; Anand and Venkataraman, 2016; Biais et al., 2017)

- Can an incentive programs be successful if it fails to promote both roles?

Our Paper

Research Questions

- How **effective are liquidity incentive programs** in promoting liquidity provision in modern markets?
  - To what extent do the qualifying orders submitted by market makers serve as (1) **patient counterparties**, or (2) **contrarian traders**?
- How does the **market react** to non-anonymous orders posted by market makers?

- Focus on Nasdaq's Qualified Market Maker (QMM) program, which mandates a certain quota of limit orders per month, because:
  - Choice of when and under what circumstances to provide liquidity at market maker's discretion.
  - Qualifying quotes required to be non-anonymous.
  - Purpose of program was to attract liquidity from non-traditional agents.

Our Approach

- Unique dataset reconstructs limit order book for several Nasdaq-traded stocks, including market participant identifier numbers (MPIDs).
- Drivers of Market Maker Submissions: Fixed effects panel regression of market market MPID submission intensities on lagged market characteristics.
- Market Reactions to Market Maker Submissions: Fixed effects panel regression of market quality measures on lagged market maker MPID submission intensities.
  - Address endogeneity concerns using the Heckman (1979) correction

Drivers of MM Submissions: Hypotheses

H1 If market makers are incentivized to provide liquidity, then we should see an increase in their submissions in response to:

- Lower submission volume and higher execution volumes.
- Lower depth.
- Higher volatility (Chung and Chuwonganant, 2014).
- Higher bid-ask spreads (Chordia et al., 2008).

H1a If market makers act in the capacity as "contrarian traders," then we should *additionally* see an increase in their submissions:

- In the opposite direction of prices changes (Hendershott and Menkveld, 2014).
- In response to an increase in pricing errors (Hasbrouck, 1993).

Market Reactions to MM Submissions: Hypotheses

H2 If the MPID-attributed orders are submitted by market markers in their capacity as liquidity providers, then in response to higher rates of MPID submission we should see:

- Higher execution and submission volume.
- Higher depth.

H2a If MPID-attributed orders succeed in attracting reactive (v. parasitic) counterparties, then we should *additionally* see:

- Lower bid-ask spreads and lower volatility (Harris, 1997).

H2b If market makers act in the capacity as "contrarian traders," then we should *additionally* see:

- Decrease in pricing errors (Watanabe, 2017; Anand and Venkataraman, 2016).

Nasdaq Qualified Market Maker (QMM) Program

- Introduced in 2012 and designates a market participant as a Qualified Market Maker (QMM) if they:
  - Maintained quotes at the national best bid or offer (NBBO),
  - In at least 1,000 securities,
  - During at least 25% of trading hours.
  - Qualifications assessed on a monthly basis.
- In return, QMMs receive credits for submissions and executions, and along with reduced liquidity take fees.
- QMMs need not be registered market makers.
- QMM Program "designed to attract liquidity both from traditional market makers and from other firms that are willing to commit capital to support liquidity at the NBBO." (*SEC Release No. 34-70361, 10 September 2013*)

Data

- Reconstructed Nasdaq limit order book obtained from LOBSTER Academic Data.
  - Order book data on prevailing bid and ask quotes and depths.
  - Message file updates (submissions, partial or total cancellations, and executions of visible or hidden orders).
- Sample composed of eight Nasdaq-listed stocks, mostly in the high-tech industry.
- Sample time period from 4-22 November 2013.
- Data uniquely contains information on the Market Participant Identification Number (MPID) of non-anonymous orders.

Market Participant Identifiers, Types and Relative Submission Contribution

MPID	Firm Name	MPID Type	%Sub.
ATDF	Automated Trading Desk Financial Services, LLC	Market Maker	0.05%
BARD	Robert W. Baird & Co. Incorporated	Market Maker	$< 0.01\%$
DADA	D.A. Davidson & Co.	Market Maker	$< 0.01\%$
FBCO	Credit Suisse Securities (USA) LLC	Market Maker	0.28%
GSCO	Goldman, Sachs & Co.	Market Maker	1.55%
RHCO	Suntrust Robinson Humphrey, Inc.	Market Maker	$< 0.01\%$
SBSH	Citigroup Global Markets Inc.	Market Maker	17.21%
TMBR	Timber Hill LLC	Market Maker	76.36%
UBSS	UBS Securities LLC	Market Maker	4.44%
WCHV	Wells Fargo Securities, LLC.	Market Maker	$< 0.01\%$
		Total Market Maker	**99.89%**
BOOK	Bloomberg Tradebook LLC	ECN	0.03%
LEHM	Barclays Capital Inc./Le	Nasdaq Participant	0.01%
NITE	Knight Capital Americas LLC	Nasdaq Participant	0.03%
WEMM	Wells Fargo Securities, LLC.	Nasdaq Participant	0.04%
		Total Other	**0.11%**

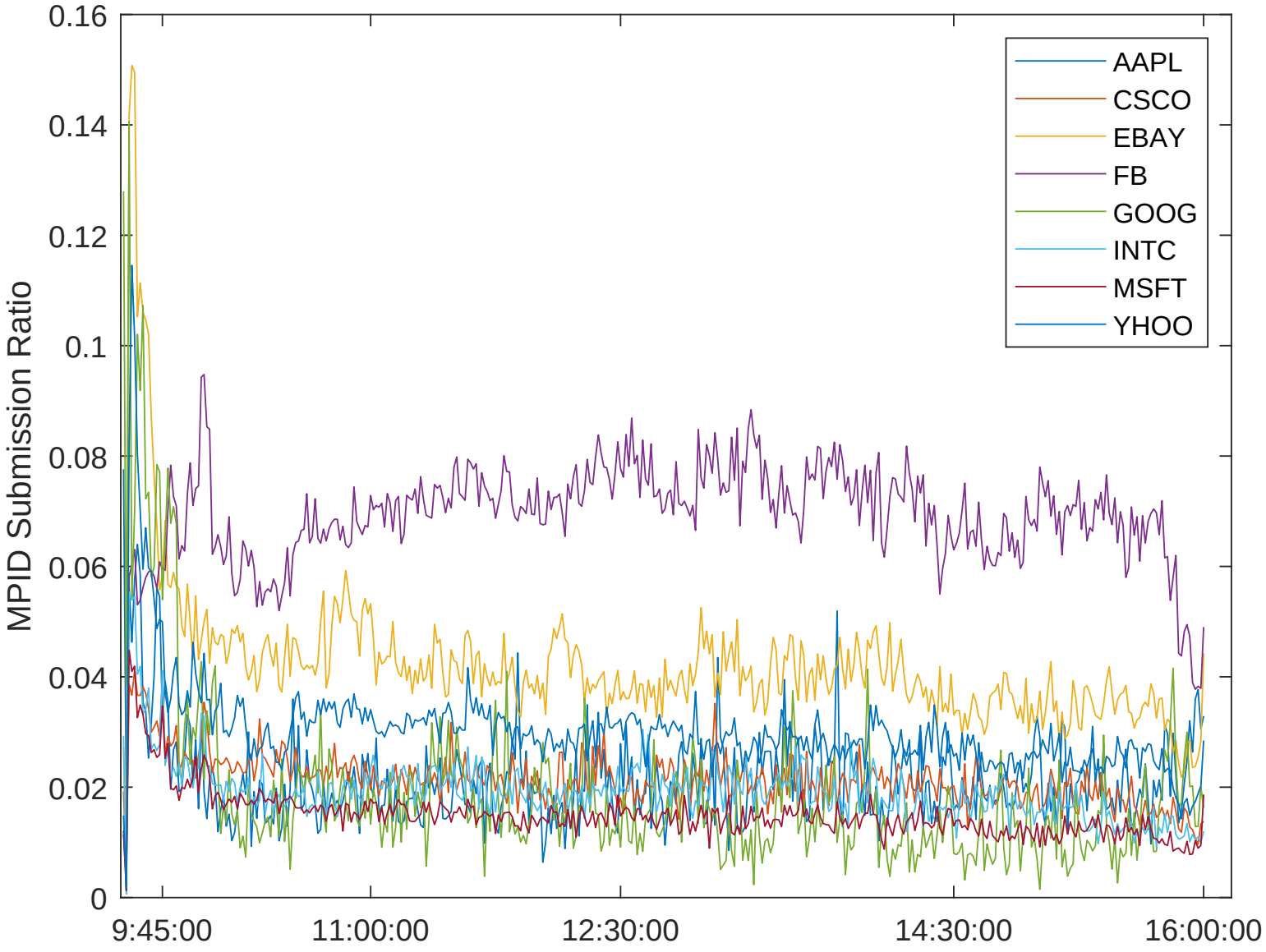
MPID Submission Intensities

- Decision to submit an MPID-attributed order $\approx$ decision to submit a QMM-qualifying order.
- MPID Submission intensities defined for stock i in interval $[t, t+1]$ as:

$$MPID_t^i = \frac{\#MPIDSubmissions_t^i}{\#TotalSubmissions_t^i}.$$

- Focus on *number* of submissions isolates submission decision from other order choices (i.e., the size and price of the order).
- Aggregate over 60-second intervals.

Average Daily MPID Submission Intensities, by Stock



Determinants of MPID Order Submissions

- Fixed effects panel regression for stock i in interval $[t, t+1]$:

$$MPID_t^i = \alpha_0^i + \theta' \sum_{p=1}^{20} MPID_{t-p}^i + \beta' \mathbf{x}_t^i + \gamma' \mathbf{m}_{t-1}^i + \delta' DAY_t + \varepsilon_t^i,$$

  - $\mathbf{x}_t^i$: average characteristics of MPID-attributed orders.
  - $\mathbf{m}_{t-1}^i$: market conditions.
  - DAY_t, α_0^i: day and stock fixed effects.
  - $MPID_{t-p}^i$: to account for high autocorrelation.
- Order Characteristics: order aggressiveness and size.
- Market Conditions: relative bid-ask spreads, volatility, submission and execution volumes, depth, (unsigned) change in price, negative/positive price change dummy, pricing error (Hasbrouck, 1993), dummy capturing market open.

Determinants of MPID Order Submissions

Dep.Var	(1) $MPID_t^i$	(2) $MPID_t^{i;BUY}$	(3) $MPID_t^{i;BUY}$	(4) $MPID_t^{i;SELL}$	(5) $MPID_t^{i;SELL}$
$\mathbb{I}_t^{OPEN}$	0.139***	0.154***	0.147***	0.129***	0.132***
	(5.907)	(6.646)	(6.393)	(5.302)	(5.349)
Rel. Bid-Ask Spreads	0.0631***	0.0504***	0.0521***	0.0441***	0.0440***
	(7.575)	(6.462)	(6.682)	(5.682)	(5.735)
Volatility	0.0744***	0.0654***	0.0637***	0.0589***	0.0620***
	(6.474)	(6.599)	(6.523)	(4.696)	(5.119)
Observations	43,520	43,520	43,520	43,520	43,520
Number of Stocks	8	8	8	8	8
Stock FE	YES	YES	YES	YES	YES
Day FE	YES	YES	YES	YES	YES
Lagged Dep. Var	YES	YES	YES	YES	YES
Within R^2	0.352	0.283	0.283	0.264	0.264

- Market markers submit MPID orders when spreads and volatility are high.

$\Rightarrow$ Supports Hypothesis H1.

Determinants of MPID Order Submissions

Dep.Var	(1) $MPID_t^i$	(2) $MPID_t^{i;BUY}$	(3) $MPID_t^{i;BUY}$	(4) $MPID_t^{i;SELL}$	(5) $MPID_t^{i;SELL}$
Submissions	-0.0513***				
	(-6.146)				
Executions	0.0284**				
	(2.473)				
Depth	-0.0169***				
	(-3.779)				
Buy-Side Submissions		-0.0366***		-0.0318***	
		(-5.605)		(-4.277)	
Buy-Side Executions		0.000979		0.0161*	
		(0.125)		(1.649)	
Buy-Side Depth		-0.00973*		-0.0179***	
		(-1.889)		(-3.927)	
Sell-Side Submissions			-0.0418***		-0.0309***
			(-6.025)		(-4.542)
Sell-Side Executions			0.0127		0.0110
			(1.621)		(1.171)
Sell-Side Depth			-0.0105***		-0.0104**
			(-2.628)		(-2.309)
Observations	43,520	43,520	43,520	43,520	43,520
Number of Stocks	8	8	8	8	8
Stock FE	YES	YES	YES	YES	YES
Day FE	YES	YES	YES	YES	YES
Lagged Dep. Var	YES	YES	YES	YES	YES
Within R^2	0.352	0.283	0.283	0.264	0.264

- Market markers submit MPID orders when submissions and depth are low and when executions are high.

$\Rightarrow$ Supports Hypothesis H1.

Determinants of MPID Order Submissions

Dep.Var	(1) $MPID_t^i$	(2) $MPID_t^{i;BUY}$	(3) $MPID_t^{i;BUY}$	(4) $MPID_t^{i;SELL}$	(5) $MPID_t^{i;SELL}$
Pricing Errors	-0.00105	0.000648	-0.00202	0.00651*	0.00690*
	(-0.264)	(0.186)	(-0.602)	(1.720)	(1.806)
Price Changes	-0.0332***	-0.0340***	-0.0288***	-0.0431***	-0.0230**
	(-4.360)	(-4.305)	(-3.403)	(-5.367)	(-2.469)
$\mathbb{I}_{t-1}^{i;\Delta PR<0}$	0.00930	0.0117		-0.00827	
	(0.705)	(0.902)		(-0.595)	
Price Changes $\times\mathbb{I}_{t-1}^{i;\Delta PR<0}$	0.0126	0.0156		0.0315**	
	(1.057)	(1.279)		(2.341)	
$\mathbb{I}_{t-1}^{i;\Delta PR>0}$			-0.0173		0.0227*
			(-1.378)		(1.690)
Price Changes $\times\mathbb{I}_{t-1}^{i;\Delta PR>0}$			0.00875		-0.0145
			(0.750)		(-1.146)
Observations	43,520	43,520	43,520	43,520	43,520
Number of Stocks	8	8	8	8	8
Stock FE	YES	YES	YES	YES	YES
Day FE	YES	YES	YES	YES	YES
Lagged Dep. Var	YES	YES	YES	YES	YES
Within R^2	0.352	0.283	0.283	0.264	0.264

- Market makers less likely to submit following price changes (and more likely to sell following negative price changes).

$\Rightarrow$ Less evidence to support Hypothesis H1a.

Market Reactions to MPID Order Submissions

- Endogeneity problem between the market maker's submission decision and ex-post market conditions.
- Solution: Heckman (1979) correction model.
- First Stage: Probit model to obtain *Heckman selectivity correction term*

$$y_t^i = \alpha_0^i + \delta \mathbf{X}_{t-1}^i + \varepsilon_t^i,$$

$$\mathbb{I}_t^{i;MPID} = \begin{cases} 1 & \text{if} \quad y_t^i > 0 \\ 0 & \text{otherwise,} \end{cases}$$

  - $\mathbb{I}_t^{i;MPID} = 1$ if $MPID_t^i$ is in the upper stock-day quartile.
  - $\mathbf{X}_{t-1}^i$: control variables.
- Heckman selectivity correction term uses predicted values:

$$\lambda_t^i = \frac{\phi(-\hat{y}_t^i)}{1 - \Phi(-\hat{y}_t^i)}.$$

  - ϕ, Φ: standard normal density and cumulative distribution functions.

Market Reactions to MPID Order Submissions

- Second Stage:

$$q_t^i = \alpha_0^i + \alpha_1^i \lambda_{t-1}^i + \gamma \mathbb{I}_{t-1}^{i;MPID} + \beta' \mathbf{x}_{t-1}^i + \gamma' \mathbf{m}_{t-1}^i + \delta' DAY_t + \varepsilon_t^i$$

  - λ_{t-1}^i: Heckman correction term.
  - q_t^i: ex-post market quality measure.

- Market Quality Measures:
  - Relative Bid-Ask Spreads, volatility, pricing errors, price changes.
  - (Buy- and sell-side) Submissions, executions, and depth.

Market Reactions to MPID Order Submissions

Dep.Var	(1) $RELSPR_t^i$	(2) VOL_t^i	(3) $PR.ERR_t^i$
$\mathbb{I}_{t-1}^{i;MPID}$	0.0322***	0.00753	0.0191*
	(3.620)	(0.717)	(1.786)
Within R^2	0.398	0.329	0.147
Observations	43,520	43,520	43,520
Number of Stocks	8	8	8
Stock FE	YES	YES	YES
Day FE	YES	YES	YES
Lagged Dep. Var	YES	YES	YES

- Spreads increase, no decrease in volatility. $\Rightarrow$ No support for Hypothesis H2a.
- Increase in pricing errors. $\Rightarrow$ No support for Hypothesis H2b.
- Market maker MPID orders do not stabilize markets.

Market Reactions to MPID Order Submissions

Dep.Var	(5) $SUB_t^{i;BUY}$	(6) $SUB_t^{i;BUY}$	(7) $SUB_t^{i;SELL}$	(8) $SUB_t^{i;SELL}$
$\mathbb{I}_{t-1}^{i;MPID;BUY}$	0.00887		-0.0407***	
	(0.919)		(-4.269)	
$\mathbb{I}_{t-1}^{i;MPID;SELL}$		-0.0563***		-0.0291***
		(-6.308)		(-2.986)
Within R^2	0.372	0.368	0.343	0.340
Observations	43,520	43,520	43,520	43,520
Number of Stocks	8	8	8	8
Stock FE	YES	YES	YES	YES
Day FE	YES	YES	YES	YES
Lagged Dep. Var	YES	YES	YES	YES

- Submission volumes decrease (particularly on the opposite side of the book) by about \$300,000-\$500,000.

$\Rightarrow$ No support for Hypothesis 2.

Market Reactions to MPID Order Submissions

Dep.Var	(9) $EXE_t^{i;BUY}$	(10) $EXE_t^{i;BUY}$	(11) $EXE_t^{i;SELL}$	(12) $EXE_t^{i;SELL}$
$\mathbb{I}_{t-1}^{i;MPID;BUY}$	-0.0187*		-0.00820	
	(-1.943)		(-0.900)	
$\mathbb{I}_{t-1}^{i;MPID;SELL}$		-0.00973		-0.0342***
		(-1.029)		(-3.463)
Within R^2	0.272	0.259	0.219	0.236
Observations	43,520	43,520	43,520	43,520
Number of Stocks	8	8	8	8
Stock FE	YES	YES	YES	YES
Day FE	YES	YES	YES	YES
Lagged Dep. Var	YES	YES	YES	YES

- Execution volumes decrease (particularly on the same side of the book) by about \$25,000-\$60,000.

$\Rightarrow$ No support for Hypothesis 2.

Market Reactions to MPID Order Submissions

	(13)	(14)	(15)	(16)
Dep.Var	$DEPTH_t^{i;BUY}$	$DEPTH_t^{i;BUY}$	$DEPTH_t^{i;SELL}$	$DEPTH_t^{i;SELL}$
$\mathbb{I}_{t-1}^{i;MPID;BUY}$	0.00176		-0.0385***	
	(0.187)		(-4.534)	
$\mathbb{I}_{t-1}^{i;MPID;SELL}$		-0.0353***		0.00957
		(-4.203)		(0.917)
Within R^2	0.390	0.389	0.314	0.319
Observations	43,520	43,520	43,520	43,520
Number of Stocks	8	8	8	8
Stock FE	YES	YES	YES	YES
Day FE	YES	YES	YES	YES
Lagged Dep. Var	YES	YES	YES	YES

- Depth decreases (particularly on the opposite side of the book) by about \$6,000-\$9,000.

$\Rightarrow$ No support for Hypothesis 2.

- Market maker MPID orders do not encourage market participation.

Robustness Checks

- ✓ Shorter time intervals (30-seconds).
- ✓ Running regressions individually on a stock-by-stock basis.
- ✓ Only consider submissions from Timber Hill, LLC (market maker that accounts for 76% of total MPID submission volume in our sample).

Summary

- Examines whether MPID-attributed orders by participants in Nasdaq's QMM program are aligned to the market maker role.
- Results show that market makers for the most part respond to market conditions in which liquidity provision is needed.
  - High spreads, high volatility, low submissions, low depth, high executions.
- However, less evidence that they submit contrarian orders.
- Therefore, little evidence that the non-anonymous orders submitted by QMMs help to improve market quality (and may even have negative effects).
- Exchanges may do well to extend liquidity incentive programs beyond the provision of limit orders.
  - E.g., NYSE Designated Market Maker program explicitly require participants to maintain price continuity and intervene when volatility is high.

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