



RETHINKING VOLUME: HAS THE MARKET BECOME MORE LIQUID?

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MOTIVATION

- Widespread view that markets have become more liquid (Chordia et al., 2008)
 - Trading volume has increased fivefold since 1980 (Chordia et al., 2011)
 - Lower spreads over time (Jones, 2002; Bessembinder, 2003; Angel et al., 2011)
 - Entry of HF trading firms with short inventory half-lives (Hendershott and Menkveld, 2014)

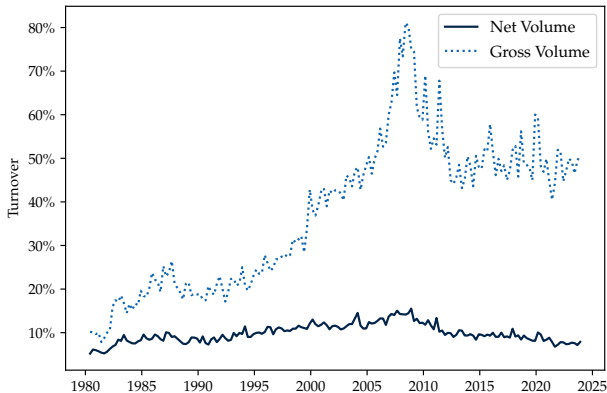
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 - Improve high-frequency liquidity, but **cannot accommodate persistent demand shifts**
 - High-frequency volume not the best measure of “supply” for the long term.

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 - Improve high-frequency liquidity, but **cannot accommodate persistent demand shifts**
 - High-frequency volume not the best measure of “supply” for the long term.
- Long-term liquidity → perhaps better reflected by long-term portfolio reallocations **excluding round-trip trades** by high-frequency intermediaries (“net volume”)
 - Actually we know surprisingly little about *trading* behavior of LT investors

KEY FACT: GROSS VERSUS NET VOLUME



- Gross volume (total # of shares traded per quarter): $\uparrow 5\times$ since 1980.
- Net volume (trading from qrtly portfolio reallocations): **unchanged** since 1980

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Definitions

- **Liquidity:** Price impact of a non-fundamental demand shift ($\neq$ price discovery)
- **Horizon:** Short-term is daily/intraday, long-term is quarterly.
- **Volume:** Always scaled by shares outstanding (= Turnover)

PREVIEW OF MAIN RESULTS

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PREVIEW OF MAIN RESULTS

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- 2 **Net Volume for Aggregate Market**
 - Gross-volume $\approx 25 \times$ net-volume: Roundtrip trades in the cross-section and time series
- 3 **Absence of Trend in Long Term Liquidity:**
 - Simple return volatility/volume ratios
 - Price impact of non-fundamental demand shifts
 - Returns to Liquidity Provision
 - Variance Ratio tests
 - KY (2019) Demand Estimation

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 - KY (2019) Demand Estimation
- 4 **Indirect Evidence from the Cross-Section:**
 - Net volume subsumes gross volume in explaining cross-section of long-term impact

RELATED LITERATURE

Long-Term Price Impact & Demand-Based Asset Pricing

- Lou (2012); Coval and Stafford (2007); Koijen and Yogo (2019); Gabaix and Koijen (2021); Haddad et al. (2021); Greenwood and Sammon (2025); van der Beck et al. (2025)

Volume, Liquidity, and Returns

- Amihud (2002); Jones (2002); Baker and Stein (2004); Nagel (2012); Campbell et al. (1993); Pástor and Stambaugh (2003); Hong and Stein (2007); Lou and Shu (2017); Brennan et al. (2013)

HFT & Market Microstructure

- Bouchaud et al. (2018); Tóth et al. (2011); Chordia et al. (2008, 2011); Hendershott and Riordan (2013); Menkveld (2013); Brogaard et al. (2014); Hendershott et al. (2011); Angel et al. (2011)

CONSTRUCTING NET VOLUME: ILLUSTRATIVE EXAMPLE

According to the 13F filing of Fidelity and Blackrock in 2014 Q2&3:

Fidelity bought $\Delta Q_{\text{Fidelity}}(GE) = +20\text{M Shares}$	} Net Volume = 20M Shares
Blackrock sold $\Delta Q_{\text{Blackrock}}(GE) = -20\text{M Shares}$	

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$$\text{Net Volume}_t(n) = \frac{0.5 \sum_{i=1}^l |\Delta Q_{i,t}(n)|}{\text{Shrout}_t(n)}$$

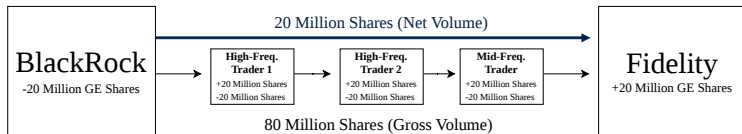
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- **Gross volume** (total trading activity): 80M shares = $4 \times$ Net Volume

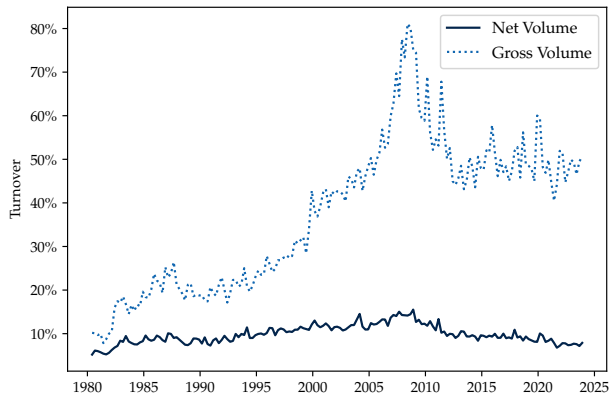
CONSTRUCTION OF NET VOLUME

Definition

$$\text{Net Volume}_t(n) = \frac{0.5 \sum_{i=1}^I |\Delta Q_{i,t}(n)|}{\text{Shrout}_t(n)}$$

- $\Delta Q_{i,t}(n)$: quarterly split-adjusted change in shares held by institution i (13F filings)
- Factor 0.5 corrects double-counting; normalized by shares outstanding
- Removes round-trip trades (investors who close positions within quarter)
- **Quarterly Gross Volume** defined as sum of daily volumes over quarter: $\frac{\sum_{d \in \mathcal{D}_t} V_d(n)}{\text{Shrout}_t(n)}$

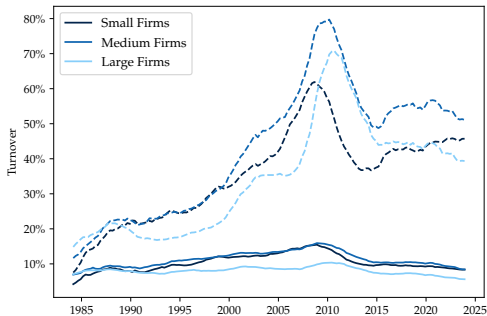
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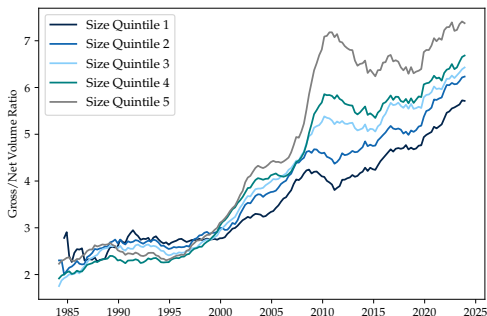
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THE GAP ACROSS THE SIZE DISTRIBUTION

Gross vs. Net Volume



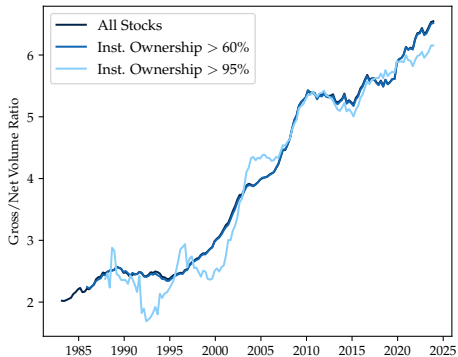
Ratio: Gross / Net



- Divergence of gross and net volume holds across **all firm sizes**.
- Gross/net ratio rose from ~ 2 to ~ 6 for every size quintile

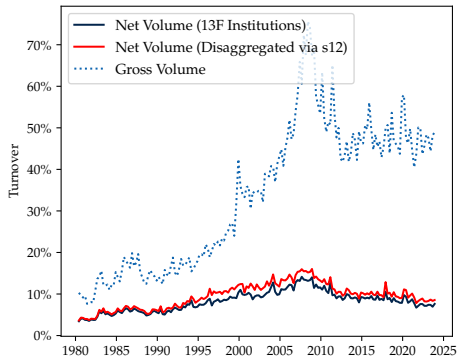
NOT A DATA ARTIFACT: ROBUSTNESS

...holds even for stocks with >95% institutional ownership



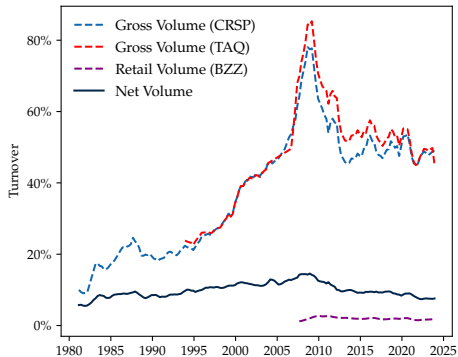
NOT A DATA ARTIFACT: ROBUSTNESS

...disaggregating 13F managers into their underlying mutual funds



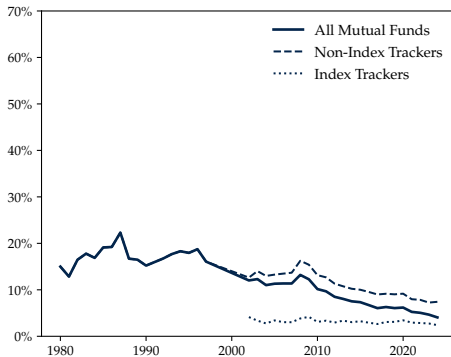
NOT A DATA ARTIFACT: ROBUSTNESS

...not driven by retail investors



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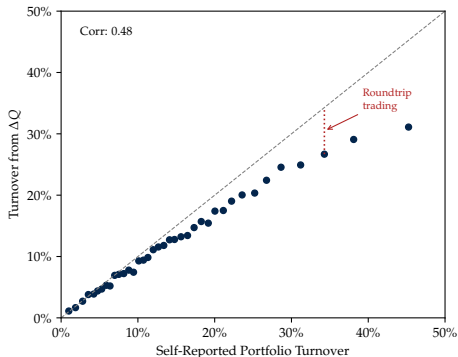
...in line with self-reported mutual fund turnover



NOT A DATA ARTIFACT: ROBUSTNESS

...in line with self-reported mutual fund turnover

- Few round-trip trades within mutual funds
- Growth in gross volume is unlikely driven by mutual funds



THE TERM STRUCTURE OF NET VOLUME

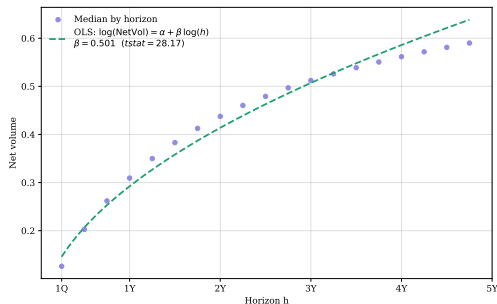
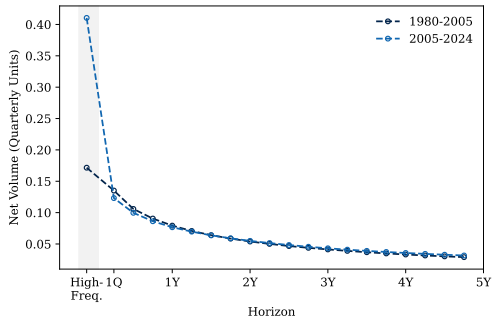
- Compute net volume at varying horizons (at daily level: use gross volume $\approx$ net volume)

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- Compute net volume at varying horizons (at daily level: use gross volume $\approx$ net volume)
- Plot net volume normalized by horizon (downward-sloping term structure $\rightarrow$ Roundtrips cancelling)
- Benchmark: i.i.d. trades $\Rightarrow$ net volume grows like $\sqrt{h}$ (log-log slope $\hat{\beta} \approx 0.5$)



AGGREGATE STOCK MARKET: NET VOLUME

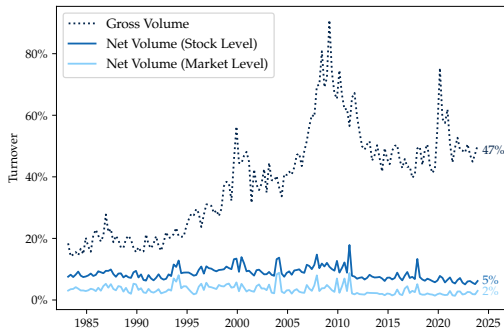
Definition

$$\text{Market Net Volume}_t = \frac{0.5 \sum_{i=1}^I \left| \sum_{n \in N_i} \Delta Q_{i,t}(n) P_t(n) \right|}{\text{Total Stock Market Equity}_t}$$

... Net volume at market level nets out both **cross-sectional** and **time-series roundtrips**

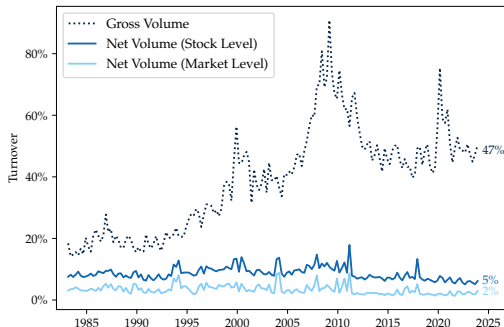
- Cross-sectional Roundtrips: Buy \$1 AAPL, sell \$1 MSFT: \$0 Market Volume
- Time-Series Roundtrips: Buy & sell the market within a quarter.

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- Gross Volume $\sim$ 25x Net Volume (Cross-section 3x, Time-Series 8x)
 - Market-Level Net Volume: 2.5%

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 - Market-Level Net Volume: 2.5%
- Buying 1% of market leads to 5% return (Gabaix and Koijen, 2021)... sounds large?
 - 1% of market is 40% of net volume!

BACK-OF-THE-ENVELOPE EVIDENCE: LIQUIDITY TRENDS

- Back-of-envelope estimate for price impact (Amihud, 2002; van der Beck et al., 2025):

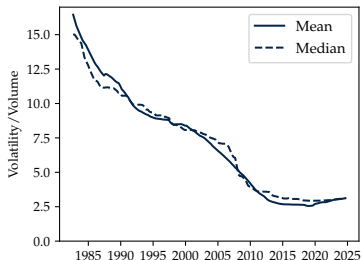
$$\text{Price Impact} \propto \frac{\sigma(\text{Returns})}{\text{Volume}}$$

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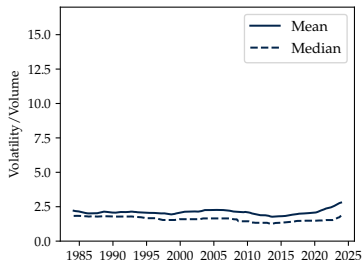
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Daily Ratio



Quarterly Ratio

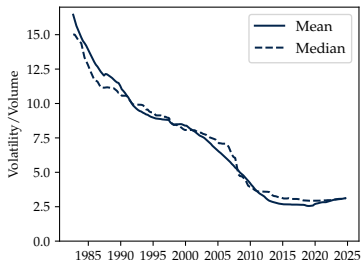


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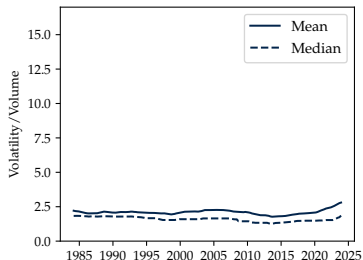
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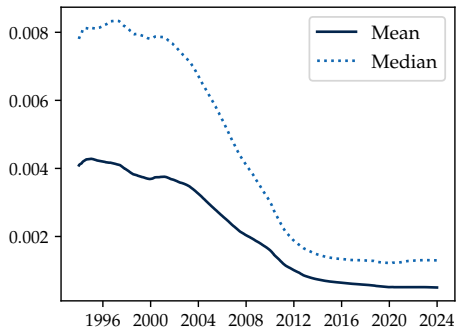
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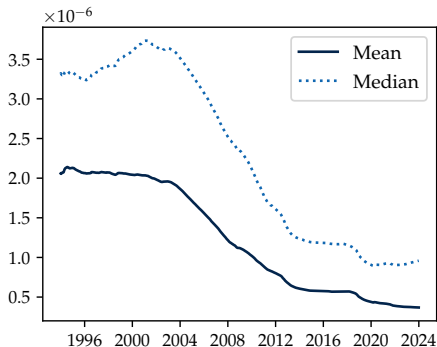
Short-term price impact has **converged toward** the stable long-term impact.

HIGH-FREQUENCY LIQUIDITY HAS IMPROVED

(a) Effective Spreads (%)



(b) 5-Minute Price Impact (λ)



- Effective spreads: ↓ from $\sim 1\%$ to $\sim 0.1\%$; 5-min price impact: ↓ by $\sim 4\times$
- Consistent with Chordia et al. (2008, 2011); Hendershott et al. (2011); Menkveld (2013)

LONG-TERM PRICE IMPACT HAS *NOT* CHANGED

- Need non-fundamental demand shifts to distinguish from price discovery:
Flow-induced trades (FIT), dividend-induced trades (DIT)
- Rolling quarterly regressions $r_t(n) = \alpha_t + \beta_t \cdot \text{FIT}_t(n) + \gamma_t X_t + \varepsilon_t(n)$
Control variables: $\log(ME)$, $\log(BE)$, market β , investment, profitability

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- $\hat{\beta}_t$ is **essentially constant** since the 1980s; no significant time trend

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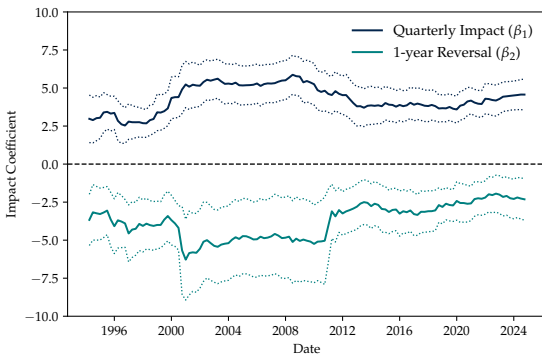
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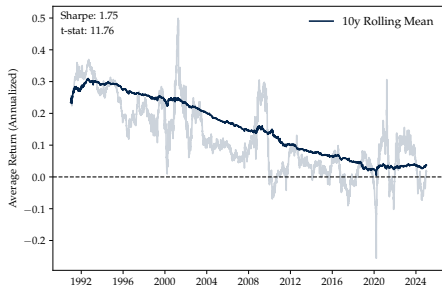
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- On average, 75% of the demand shock reverts within 1y
- Reversal has remained roughly unchanged over time

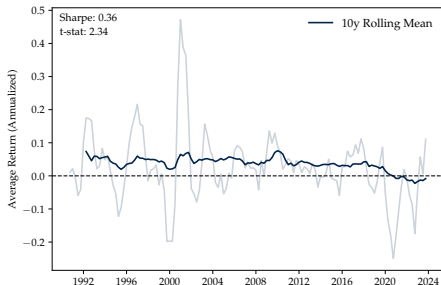
RETURNS TO LIQUIDITY PROVISION

(a) High Frequency Liquidity Provision



- LS>Returns to high-frequency reversal strategy based on past 5 day returns have declined.

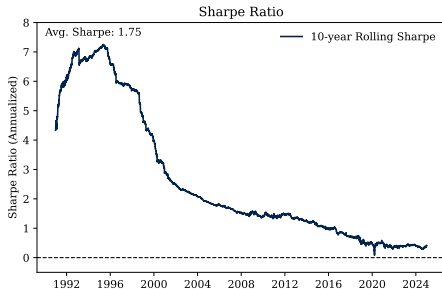
(b) Low Frequency Liquidity Provision



- LS>Returns to low-frequency liquidity provision based on past 1-year FIT unchanged.

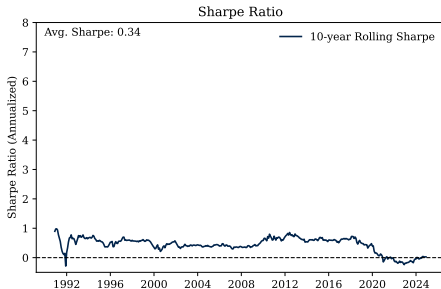
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VARIANCE RATIOS: SHORT- VS. LONG-HORIZON

- Construct Variance Ratios at different horizons using abnormal returns $r_t^a(n)$.

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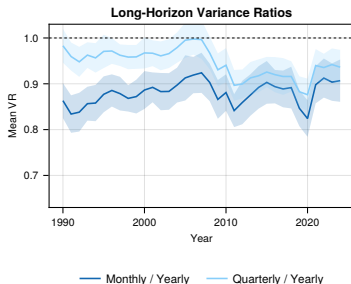
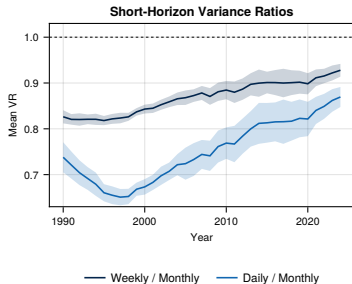
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 - (a) Short-Horizon VRs
 - (b) Long-Horizon VRs

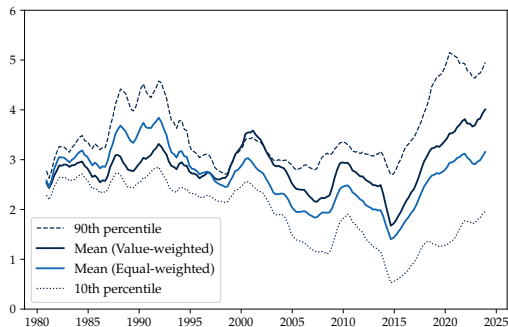


STRUCTURAL EVIDENCE: KOIJEN & YOGO (2019)

- Co-liquidity matrix in KY (2019): $\sum_i \frac{\partial \mathbf{p}_t}{\partial \ln \epsilon_{i,t}} = (\mathbf{I} - \sum_i \beta_{0,i,t} \mathbf{A}_{i,t} \mathbf{H}_t^{-1} \mathbf{G}_{i,t})^{-1} \sum_i \mathbf{A}_{i,t} \mathbf{H}_t^{-1} \mathbf{G}_{i,t}$
- Loosely: Estimate investors' elasticities from cross-section of holdings and take average

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- Diagonal of aggregate coliquidity matrix $\sim$ long-term price impact
- Average impact: **not materially changed**

CROSS-SECTIONAL APPLICATIONS: NET VERSUS GROSS VOLUME

Indirect test: If net volume outperforms gross volume as a liquidity proxy in the cross-section, its stability implies liquidity has remained constant.

Three applications:

- 1 Long-term impact in the cross-section
- 2 High-frequency liquidity in the cross-section
- 3 Return predictability

LONG-TERM PRICE IMPACT: NET SUBSUMES GROSS VOLUME

$$r_t(n) = \alpha_t + \beta_1 \frac{\text{Demand Shift}}{\text{Shrout}} + \beta_2 \frac{\text{Demand Shift}}{\text{Gross Vol}} + \beta_3 \frac{\text{Demand Shift}}{\text{Net Vol}} + \varepsilon_t(n)$$

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	(1)	(2)	(3)	(4)	(5)
FIT	3.006*** (0.498)			1.792** (0.598)	
gross FIT		0.861*** (0.109)		0.075 (0.158)	0.158 (0.151)
net FIT			0.542*** (0.062)	0.269** (0.096)	0.458*** (0.084)
Observations	423911	410650	423911	410650	410650
R^2	0.172	0.174	0.172	0.174	0.174

HIGH-FREQUENCY LIQUIDITY AND NET VOLUME

	Effective Spread				5-min λ	
	(1)	(2)	(3)	(4)	(5)	(6)
Net Volume	-0.204***	-0.064***	-0.150***	-0.052***	-0.018***	-0.014***
Daily Gross			-0.064***	-0.025***	0.008***	0.020***
Qtrly Gross			-0.109***	-0.089***	-0.022***	-0.024***
HFOIV			0.102***	0.072***	-0.063***	-0.061***
Day FE	✓	✓		✓	✓	✓
Stock FE		✓		✓		✓

- Net volume: strongly related to HF liquidity **controlling for gross volume**
- Liquidity provision is inherently intertemporal → net volume matters even at HF

RETURN PREDICTABILITY

■ Value-weighted four-factor alphas (% per month), NYSE breakpoints

	Low	2	3	4	High	H—L
Gross Volume	0.196	0.215	0.255	0.189	0.246	0.049
Net Volume	0.424	0.186	0.196	0.144	0.093	— 0.331***

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- Monthly FMB Regressions: Four-Factor-adjusted Returns

gross Vol.	-0.378 (-0.64)		0.144 (0.25)	0.248 (0.42)
net Vol.		-0.925*** (-3.27)	-0.961*** (-3.75)	-0.778*** (-3.25)
ln(Mcap)				-0.167*** (-4.75)
Adj. R^2	0.006	0.002	0.008	0.011
Avg. Obs	1872	1853	1853	1853

CONCLUSION

- 1 **Gross volume increased strongly since 1980, but net volume is flat**
 - Gap driven by HF round-trip trades that cannot provide long-term liquidity
 - We have become better at moving risk around, not at holding it (Duffie, 2010; Duffie and Strulovici, 2012; Duffie, 2018)
- 2 **Long-term liquidity has not improved:**
 - Flow/dividend-induced price impact: unchanged
 - Returns to Long-Term Liquidity Provision: unchanged
 - Long-horizon variance ratios: stable
 - KY structural estimates: stable
- 3 **Net volume is the right measure for explaining long-term impact**
 - subsumes gross volume in the cross-section, predicts returns
- 4 **Gap between Gross and Net Even More Striking at Market-Level**
 - Gross Volume $\approx 25\times$ Net Volume

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- 1 **Gross volume increased strongly since 1980, but net volume is flat**
 - Gap driven by HF round-trip trades that cannot provide long-term liquidity
 - We have become better at moving risk around, not at holding it (Duffie, 2010; Duffie and Strulovici, 2012; Duffie, 2018)
- 2 **Long-term liquidity has not improved:**
 - Flow/dividend-induced price impact: unchanged
 - Returns to Long-Term Liquidity Provision: unchanged
 - Long-horizon variance ratios: stable
 - KY structural estimates: stable
- 3 **Net volume is the right measure for explaining long-term impact**
 - subsumes gross volume in the cross-section, predicts returns
- 4 **Gap between Gross and Net Even More Striking at Market-Level**
 - Gross Volume $\approx 25\times$ Net Volume

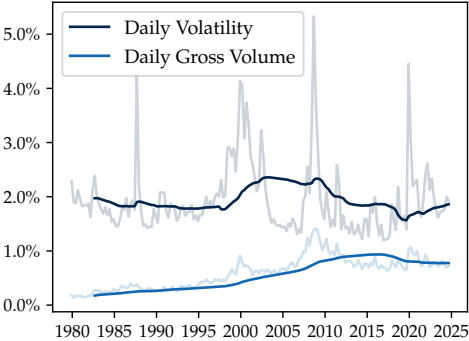
SUMMARY STATISTICS: NET VS. GROSS VOLUME

		1980s	1990s	2000s	2010s	2020s
Net Vol.	Mean	0.062	0.092	0.130	0.110	0.097
	Median	0.048	0.073	0.112	0.091	0.077
	IQR	0.058	0.078	0.096	0.077	0.062
Gross Vol.	Mean	0.176	0.337	0.638	0.632	0.680
	Median	0.124	0.191	0.470	0.483	0.472
	IQR	0.151	0.272	0.543	0.446	0.418
CS Corr. $\rho(\text{Net,Gross})$		0.484	0.618	0.654	0.611	0.642
TS Corr. $\rho(\text{Net,Gross})$		0.125	0.146	0.225	0.206	0.225

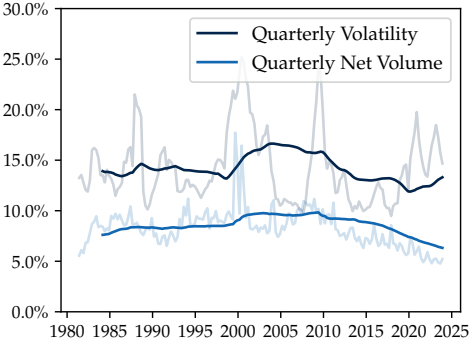
QUALITATIVE EVIDENCE: SHORT- VERSUS LONG-TERM IMPACT

The top two figures plot volatility and (net) volume across stocks at the daily and quarterly level

(a) Daily

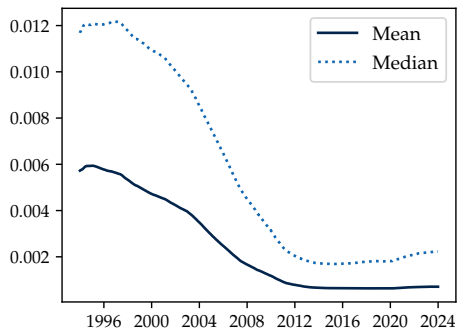


(b) Quarterly

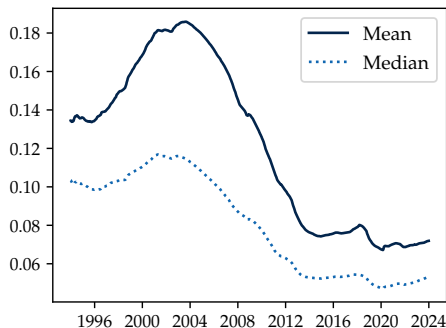


HIGH-FREQUENCY LIQUIDITY HAS IMPROVED

(a) Quoted Spreads (%): $(\text{ask} - \text{bid})/\text{midpoint}$



(b) 5-Minute Price Impact (λ) **Scaled** by Mcap



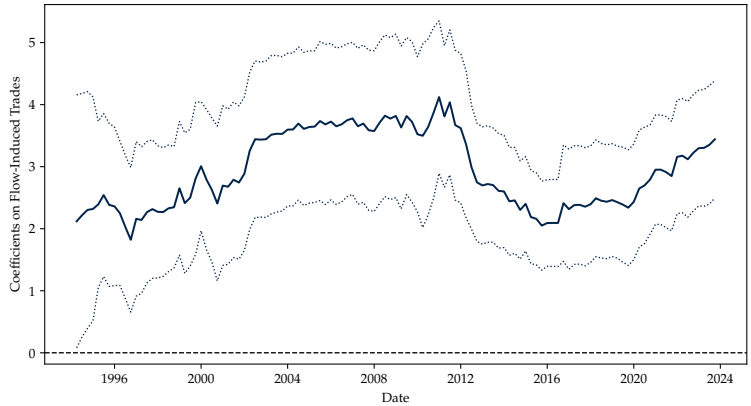
→ **Scaled price impact** accounts for the fact that a dollar trade today represents a much smaller fraction of total supply than in 1990

LONG-TERM PRICE IMPACT HAS *NOT* CHANGED



- Dividend induced trades: $DIT_t(n) = \frac{\sum_i w_{i,t-1}(n) \text{Div.-Flow}_{i,t}}{ME_t(n)}$
- $\text{Div.-Flow}_{i,t}$ is total cash from dividends received between $t - 1$ and t .

LONG-TERM PRICE IMPACT HAS *NOT* CHANGED



Price impact from unexpected flows over time. Unexpected flows are defined as the residuals from regressing fund flows on its own lagged flows, a time trend, and a constant.

LONG-TERM PRICE IMPACT HAS *NOT* CHANGED

	Quarterly Returns		
FIT	3.006*** (0.498)	3.018*** (0.445)	
FIT × Time Trend		-0.005 (0.043)	
FIT × D(1980s)			4.500 (3.402)
FIT × D(1990s)			2.743*** (0.674)
FIT × D(2000s)			3.935*** (0.548)
FIT × D(2010s)			1.941* (0.757)
FIT × D(2020s)			4.531*** (0.691)
Date	x	x	x
Observations	423911	423911	423911
R ²	0.172	0.172	0.172

LONG-TERM PRICE IMPACT HAS NOT CHANGED

	Quarterly Returns			
DIT	11.508*** (1.405)	13.246*** (1.624)	13.493*** (1.635)	
Dividend Payout Ratio		0.071*** (0.020)	0.073*** (0.021)	0.071*** (0.021)
DIT × Time Trend			0.187 (0.120)	
DIT × D(1980s)				11.050*** (2.079)
DIT × D(1990s)				14.043*** (3.854)
DIT × D(2000s)				11.784* (5.187)
DIT × D(2010s)				11.552*** (1.819)
DIT × D(2020s)				30.482** (9.563)
Day	x	x	x	x
Observations	811347	731032	731032	731032
R ²	0.165	0.166	0.166	0.166

LONG-TERM PRICE IMPACT HAS NOT CHANGED

(a) Earlier Sample: 1980–2005

	Log Return (Quarterly)				
	(1)	(2)	(3)	(4)	(5)
$\frac{FIT}{Shrout.}$	3.472*** (0.493)				2.571*** (0.507)
$\frac{FIT}{Gross Vol.}$		0.175*** (0.042)			-0.270*** (0.062)
$\sqrt{\frac{FIT}{Gross Vol.}}$			0.108*** (0.020)		-0.032 (0.065)
$\sigma \sqrt{\frac{FIT}{Gross Vol.}}$				0.562*** (0.084)	0.675** (0.238)
Date	x	x	x	x	x
Observations	197420	197420	197420	190278	190278
R ²	0.145	0.144	0.145	0.150	0.150
R ² Within	0.002	0.000	0.002	0.008	0.009

Significance levels: * p < 0.05, ** p < 0.01, *** p < 0.001. Format of coefficient cell: Coefficient (Std. Error)

(b) Later Sample: 2005–2024

	Log Return (Quarterly)				
	(1)	(2)	(3)	(4)	(5)
$\frac{FIT}{Shrout.}$	3.445*** (0.400)				2.931*** (0.408)
$\frac{FIT}{Gross Vol.}$		0.281*** (0.074)			-0.225*** (0.064)
$\sqrt{\frac{FIT}{Gross Vol.}}$			0.124*** (0.023)		-0.022 (0.065)
$\sigma \sqrt{\frac{FIT}{Gross Vol.}}$				0.592*** (0.086)	0.431 (0.256)
Date	x	x	x	x	x
Observations	214678	214678	214678	208895	208895
R ²	0.207	0.205	0.206	0.210	0.211
R ² Within	0.003	0.001	0.002	0.003	0.004

Significance levels: * p < 0.05, ** p < 0.01, *** p < 0.001. Format of coefficient cell: Coefficient (Std. Error)

LONG-TERM PRICE IMPACT: NET SUBSUMES GROSS VOLUME

	(1)	(2)	(3)	(4)	(5)
DIT	11.421*** (1.433)			5.860*** (1.255)	
gross DIT		1.543*** (0.222)		0.336 (0.195)	0.619** (0.190)
net DIT			1.592*** (0.200)	1.043*** (0.170)	1.253*** (0.175)
Observations	796058	758301	796001	758253	758253
R ²	0.164	0.163	0.165	0.165	0.164

- Jointly: net volume interaction **significant**; gross volume interaction less so
- Same pattern as with flow-induced trades

RETURN PREDICTABILITY

(a) Net volume then gross volume: α_{FF4}^{EW} (%)

	low gross Vol.	2	3	4	high gross Vol.	H - L
low net Vol.	0.308	0.233	0.393	0.429	0.562	0.255
2	0.068	-0.005	0.184	0.153	0.352	0.283*
3	0.008	0.286	0.047	0.078	0.358	0.349**
4	0.039	0.151	0.180	0.080	0.183	0.145
high net Vol.	0.005	0.168	0.121	-0.083	0.120	0.115

(b) Gross volume then net volume: α_{FF4}^{EW} (%)

	low net Vol.	2	3	4	high net Vol.	H - L
low gross Vol.	0.421	0.181	0.079	0.045	-0.032	-0.452***
2	0.448	0.206	-0.063	0.176	0.125	-0.323**
3	0.494	0.253	0.054	0.142	0.171	-0.323**
4	0.407	0.024	0.127	0.062	0.154	-0.253*
high gross Vol.	0.421	0.288	0.225	0.155	-0.058	-0.479***

RETURN PREDICTABILITY

(a) Portfolio sorts on gross and net Amihud: α_{FF4}^{EW} (%)

low Gross Amihud	2	3	4	high gross Amihud	H - L
0.017	0.137	0.152	0.184	0.437	0.420***

low Net Amihud	2	3	4	high net Amihud	H - L
0.070	0.198	0.151	0.201	0.408	0.339***

(b) Fama–MacBeth Regressions

Dependent Variable: Four-Factor-adjusted Returns									
In(Gross Amihud)	0.261*** (4.66)	0.162* (1.89)	0.089 (1.37)		0.286*** (5.18)		-0.035 (-0.36)	-0.036 (-0.38)	
In(Net Amihud)		0.239*** (4.60)	0.170** (2.11)		0.177*** (3.49)		0.254*** (4.96)	0.224*** (2.58)	0.230*** (2.83)
In(Mcap)				-0.179*** (-7.41)	-0.177*** (-8.51)			-0.181*** (-6.90)	-0.211*** (-6.64)
Ret[−1]						-0.043*** (-3.13)	-0.042*** (-3.07)		-0.045*** (-3.18)
Ret[−12, −2]						0.000 (0.14)	0.000 (0.01)		0.001 (0.36)
Avg. R ²	0.004	0.002	0.006	0.005	0.004	0.052	0.051	0.008	0.057
Avg. Obs	942	935	935	939	935	899	899	935	899

Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

AGGREGATE STOCK MARKET: PREDICTABILITY

	1Q	4Q	8Q	12Q	16Q	20Q
<u>Univariate</u>						
Gross Volume	0.002 (0.24)	-0.005 (-0.17)	-0.005 (-0.16)	-0.005 (-0.11)	0.019 (0.34)	0.042 (0.57)
Adj. R^2	-0.006	-0.005	-0.006	-0.006	-0.004	0.002
N	168	168	164	160	156	152
Net Volume	-0.012* (-1.84)	-0.047** (-2.29)	-0.069** (-2.04)	-0.077* (-1.84)	-0.089* (-1.78)	-0.143** (-2.43)
Adj. R^2	0.015	0.067	0.074	0.059	0.051	0.087
N	168	168	164	160	156	152
<u>Multivariate</u>						
Gross Volume	0.004 (0.62)	0.004 (0.17)	0.009 (0.27)	0.014 (0.35)	0.045 (0.84)	0.095 (1.27)
Net Volume	-0.013* (-1.97)	-0.047** (-2.38)	-0.070** (-2.11)	-0.080* (-1.95)	-0.101** (-2.04)	-0.172*** (-3.00)
Adj. R^2	0.012	0.062	0.069	0.055	0.058	0.119
N	168	168	164	160	156	152

ALPHAS: LIQUIDITY PROVISION

	Avg Ret	Sharpe	α	β^{Mkt}	β^{SMB}	β^{HML}
High-Freq.	13.00	1.75	12.17*** (1.14)	0.11*** (0.01)	0.03 (0.02)	-0.04* (0.02)
High-Freq. (post-2010)	4.80	0.58	3.53* (1.90)	0.11*** (0.02)	-0.01 (0.04)	-0.03 (0.03)
Low-Freq.	3.19	0.34	2.91** (1.45)	-0.01 (0.05)	-0.13** (0.06)	0.30*** (0.11)

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