A Century of Market Reversals: Resurrecting Volatility

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ABFER

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Liquidity and return reversals

Liquidity provision:

- Buy when influx of sell orders
- Sell when influx of buy orders

Inventory models posit that return autocorrelations reflect compensation for liquidity provision

- Reversals are larger when volume is higher
- Reversals are larger when expected volatility is higher
- Collateral concerns and risk aversion

Evidence

Negative relation between volume and market return autocorrelation, and volatility not significant:

- Time series: Campbell, Grossman, and Wang (1993, CGW)
- Cross-section: Conrad, Hameed, Niden (1994)

Negative relation between volatility and return autocorrelations:

- Time series: LeBaron (1992); Sentana and Wadhwani (1992)
- Cross section: Nagel (2012); Collin-Dufresne and Daniel (2015)
- All of these paper do **not** consider volume

Collateral (asymmetry):

- Chordia, Roll, and Subrahmanyam (2002); Hameed, Kang and Viswanathan (2010)

This paper: Goals

1. Long time series (century) testing using intra-day data on the Dow Jones
    - Better volatility estimates (realized volatility)
    - Partially screen out news-driven returns (overnight)
2. Disentangle the impact of predicted volume and volatility versus shocks to volume and volatility
3. Re-estimate Pastor and Stambaugh's (2003) Liquidity Risk Factor with a volatility-inspired measure

This paper: Results

1. Volatility effect is strong (resurrected)
2. Volume effect is weaker and unstable
3. Only predicted volume matters ??
4. Pastor and Stambaugh (2003) is stronger and more robust when volume is replaced with volatility

Volatility Resurrected

Volatility has been written off too soon by the liquidity literature

Volatility seems closer in spirit to our theoretical understanding of liquidity

Data

CRSP: Center for Research on Security Prices

- Dow constituents’ prices and dividends (overnight and total returns)

ISSM/TAQ: Trades and Quotes for recent intraday return data

GFD: Global Financial Data

- Intraday Dow pricing back to 1933
- First, hourly, then 30 minutes
- Note: Correlation between Dow total return and CRSP value-weighted index is 0.95 over most of our sample (Shoven and Sialm (2000))

Hours

Period	Hours	Frequency	Selected Open	Source
1/4/1933-9/26/1952	10am-3pm M-F + 10am-12pm S	Hourly	11am	GFD
9/29/1952-1/19/1968	10am-3:30pm M-F	Hourly[b,c]	11am	GFD
9/29/1952-1/19/1968	10am-3:30pm M-F	Hourly[b,c]	11am	GFD
1/22/1968-3/1/1968	10am-2pm M-F	Hourly	11am	GFD
3/2/1968-1/1/1969	10am-3:30pm M-F	Hourly	11am	GFD
1/2/1969-7/3/1969	10am-2pm M-F	Hourly	11am	GFD
7/7/1969-9/26/1969	10am-2:30pm M-F	Hourly	11am	GFD
9/29/1969-5/1/1970	10am-3pm M-F	Hourly	11am	GFD
5/4/1970-9/30/1974	10am-3:30pm M-F	Hourly	11am	GFD
10/1-1974-9/26/1985	10am-4pm M-F	Hourly	11am	GFD
9/30/1985-12/31/1987	9:30am-4pm M-F	Half-hourly	10am	GFD
1/1/1988-12/31/2022	9:30am-4pm M-F	Half-hourly	10am	ISSM/TAQ

Use first price after the open in our data (opens at 10AM, we use 11AM)

Stoll and Whaley (1990), Bogousslavsky (2021)

Black Monday: 10/15-10/21/1987 omitted

Why a modified open?

Data issues

- Some stocks report close(t-1) as open(t)

Institutional issues

- Opening auctions/synchronization

Common in volatility/microstructure world

Variable construction: Volume

Following CGW

Turnover = trading volume/shares outstanding

Volume trending up over time

Log(turnover) divided average turnover over last 251 days

Variable construction: Volatility

Use intraday data to estimate realized volatility

$$\mathrm{RV(day)}_t = \frac{r_{t,night}^2}{h_{night} + h} + \sum_{k=2}^{K} \frac{r_{t,k}^2}{h}$$

$$\mathrm{RV(intraday)}_t = \sum_{k=1}^{K} \frac{r_{t,k}^2}{h}$$

Improves greatly over daily squared returns (GARCH family)

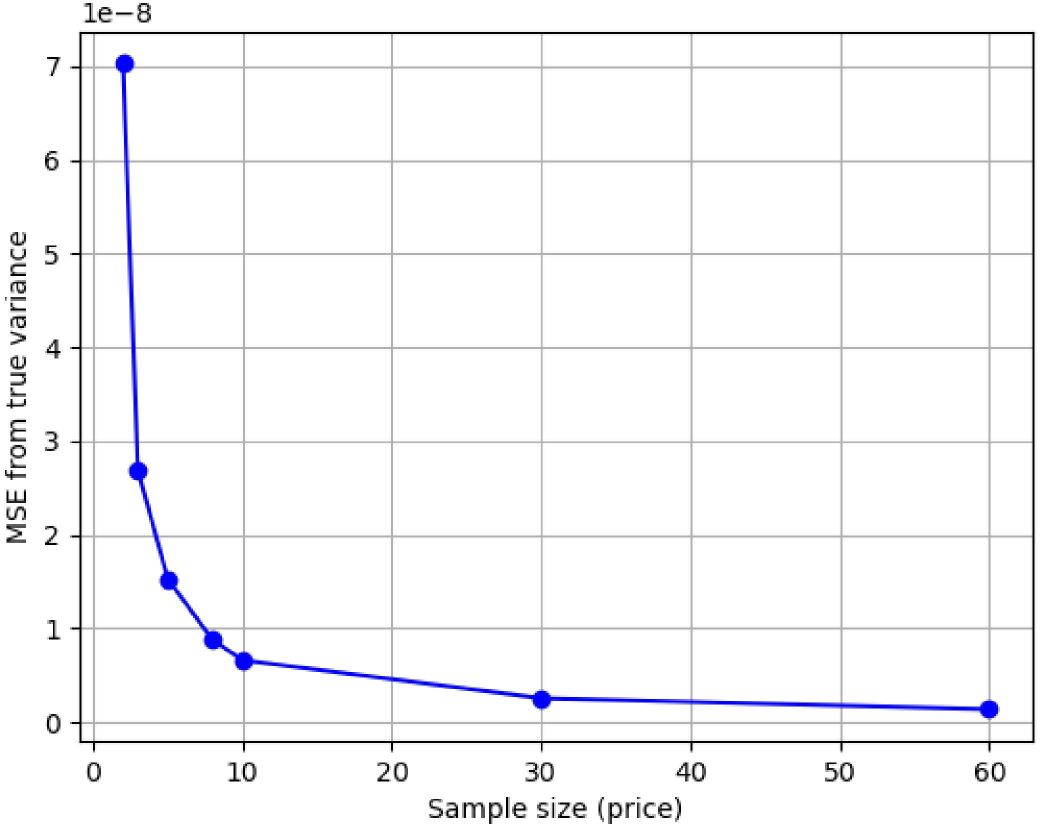
- French, Schwert, Stambaugh(1987), Barndorff-Nielsen and Shephard(2002), Andersen et al.(2003)

Monte-Carlo experiment:

- With only 8 returns MSE in variance estimate is reduced by 86% over using daily data
- A good reason to revisit CGW results

Realized volatility sampling:

2(1 day), 5(1 hour), 10(30 min), 60(5 min)



Basic CGW regressions

Linear form for conditional autocorrelations

Daily dummy variables

5th order autoregressive for errors

Two models:

- Daily returns and volume/volatility as in CGW
- Intraday day returns and volume/volatility (at time t)

Full Day (CGW): $r_{t+1} = \alpha + (\sum_{i=1}^{6} \beta_i D_i + \gamma_1 V_t + \gamma_2 \sigma_t + \gamma_3 \sigma_t^2) r_t$

Sample	γ_1	γ_2	γ_3
1933-2022	-0.10		-98.74
	(-5.81)		(-14.00)
	-0.06	-7.82	
	(-3.16)	(-14.86)	
1933-1952	-0.06		-147.73
	(-2.36)		(-3.34)
	-0.04	-8.69	
	(-1.39)	(-4.85)	
1953-1989	-0.20		-87.60
	(-5.83)		(-4.80)
	-0.15	-7.67	
	(-4.21)	(-6.65)	
1990-2000	-0.98		-142.79
	(-1.21)		(-3.42)
	-0.08	-7.51	
	(-0.88)	(-3.18)	
2001-2022	-0.07		-78.86
	(-1.70)		(-7.05)
	-0.05	-5.72	
	(-1.21)	(-5.87)	

Intraday:

$$r_{t+1} = \alpha + (\sum_{i=1}^{6} \beta_i D_i + \gamma_1 V_t^{\text{intra}} + \gamma_2 \sigma_t^{\text{intra}} + \gamma_3 \sigma_t^{2,\text{intra}}) r_t^{\text{intra}}$$

Sample	γ_1	γ_2	γ_3
1933-2022	-0.08	-6.94	
	(-3.13)	(-9.68)	
	-0.13		-74.06
	(-5.88)		(-7.74)
1933-1952	-0.01	-6.18	
	(-0.22)	(-2.96)	
	-0.05		-31.83
	(-1.54)		(-0.71)
1953-1989	-0.19	-6.92	
	(-4.16)	(-5.05)	
	-0.25		-66.71
	(-5.84)		(-2.94)
1990-2000	-0.02	-5.58	
	(-0.17)	(-2.22)	
	-0.04		-89.95
	(-0.40)		(-2.24)
2001-2022	-0.12	-3.63	
	(-1.90)	(-2.61)	
	-0.14		-44.27
	(-2.52)		(-2.85)

Predicting volume/volatility

Independent Variables	Dependent Variables		
	Detrended Volume within day	Volatility (x 100) within day	Volatility (x 100) entire day
σ_d^{morn}	34.15 (17.43)	0.58 (18.43)	
σ_{d-1}^{daily}	4.14 (7.00)	0.24 (25.72)	0.26 (26.91)
σ_{d-1}^{daily} **x $I_{Dow\ Neg}$**	0.62 (1.11)	0.04 (4.53)	0.03 (3.57)
σ_{w-1}^{weekly}	-1.90 (-5.34)	0.13 (23.47)	0.15 (25.24)
$\sigma_{m-1}^{monthly}$	0.65 (4.38)	0.05 (22.71)	0.06 (24.36)
V_d^{morn}	0.10 (25.40)	0.00 (0.21)	
V_{d-1}^{daily}	0.28 (36.20)	0.02 (1.64)	0.01 (1.22)
V_{w-1}^{weekly}	0.08 (30.58)	0.00 (0.59)	0.01 (1.43)
$V_{m-1}^{monthly}$	0.01 (11.98)	-0.00 (-2.26)	-0.00 (-2.84)
Ret_d^{morn}	0.69 (2.65)	-9.21 (-21.99)	
Ret_{d-1}^{daily}	0.61 (2.43)	-4.40 (-10.99)	-5.41 (-13.40)
Adjusted R^2	**0.698**	**0.605**	**0.596**

Decomposed volume/volatility

$$r_{t+1} = \alpha + (\sum_{i=1}^{6} \beta_i D_i + \gamma_1 V_t^P + \gamma_2 V_t^S + \gamma_3 \sigma_t^P + \gamma_4 \sigma_t^S) r_t^{\text{intra}}$$

Sample	γ_1	γ_2	γ_3	γ_4
1933-2022	-0.14 (-5.01)	0.07 (1.70)	-9.52 (-10.24)	-0.37 (-0.34)
1933-1952	-0.04 (-0.95)	0.04 (0.59)	-16.56 (-3.22)	1.14 (0.32)
1953-1989	-0.23 (-4.59)	-0.14 (-2.11)	-7.60 (-4.46)	-3.54 (-2.16)
1990-2000	-0.04 (-0.30)	0.12 (0.86)	-11.71 (-1.82)	-2.36 (-0.51)
2001-2022	-0.15 (-2.32)	0.26 (2.16)	-4.88 (-2.75)	-0.17 (-0.08)
2001-2022, VIX enhanced	-0.08 (-1.13)	0.22 (1.80)	-7.77 (-4.40)	4.39 (1.93)

Return reversal asymmetry

	Initial Return <0	Initial Return ≥0	Difference	Difference z -statistic	p-value
$\rho(DowRet_0, DowRet_1)$	-0.046	0.011	-0.056	-4.30	0.00
$\rho(DowRet_0, DowRet_2)$	-0.012	0.006	-0.018	-1.37	0.09
$\rho(DowRet_0, DowRet_3)$	0.010	0.019	-0.009	-0.67	0.25
$\rho(DowRet_0, DowRet_4)$	-0.022	0.005	-0.027	-1.42	0.08
$\rho(DowRet_0, DowRet_5)$	-0.014	-0.013	-0.001	-0.05	0.48
Initial return, $DowRet_0^{intra}$, is intraday					
$\rho(DowRet_0^{intra}, DowRet_1)$	-0.027	0.027	-0.054	-4.13	0.00
$\rho(DowRet_0^{intra}, DowRet_2)$	-0.037	0.024	-0.061	-4.67	0.00
$\rho(DowRet_0^{intra}, DowRet_3)$	-0.004	0.037	-0.041	-3.13	0.00
$\rho(DowRet_0^{intra}, DowRet_4)$	-0.006	-0.008	0.002	0.16	0.44
$\rho(DowRet_0^{intra}, DowRet_5)$	-0.017	-0.001	-0.016	-1.23	0.11

Pastor-Stambaugh (2003) Liquidity Risk Factor

$$r^e_{i,d+1,t} = \theta_{i,t} + \psi_{i,t} r_{i,d,t} + \gamma_{i,t}\,\text{sign}(r^e_{i,d,t}) v_{i,d,t} + \epsilon_{i,d,t}$$

Estimate for (firm i, month t)

Construct a monthly index by averaging $\gamma_{i,t}$ for each month

Use this index as a market liquidity measure

Estimate a "liquidity beta" against this index, and proceed with sorted portfolios

Our change:

- Replace volume with expected volatility measure
- For individual firms regress abs return(t) on (t-1, t-2:t-6, t-7:t-11)

See Pontiff and Singla (2020) for detailed/successful replication of results in Pastor-Stambaugh (2003)

Performance of high – low liquidity risk sorted portfolios

(Top decile – Bottom decile: August 1962 to December 2021)

	Annualized Return	Monthly Standard Deviation	T-statistic
Pastor and Stambaugh	4.58%	3.48%	2.79
Volatility Risk, PS Estimation	7.79%	4.31%	3.84
Volatility Risk Robustness			
$\theta_{i,t}$ restricted to zero	6.11%	4.21%	3.08
Value Weighted	5.78%	3.73%	3.30
All Price Levels	8.04%	4.07%	4.19
Zero Volume Days Included	6.95%	4.09%	3.60

Summary

- Long time series
  - Volatility still important in reversal relationship
    - More precise estimates
    - Intraday returns
  - Predicted and shocks
    - Predicted volume only matters
    - Predicted volatility only matters
  - Reversals asymmetric
- Cross-section
  - Classic liquidity risk measure improved
  - Shifting to volatility based measure robust and larger portfolio results

Conclusions

Volatility key part of liquidity story

    Important in theory, more empirical defense

Volatility is not second best to volume