Only Intraday Volatility Matters

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What Moves Intraday and Overnight Returns?

- Boudoukh et al. (2019): there is much more public info in overnight returns (earnings announcements, macro news) than in intraday returns
- Barardehi et al. (2021): overnight returns are information-driven (and thus should not be used to measure price impact)
- Aboody et al. (2018): overnight returns are driven by sentiment

Who Trades During the Day/Night?

- Berkman et al. (2012): overnight trading is primarily done by individuals
- Bogousslavsky (2021): arbitrageurs/institutions close their positions at the end of the day
- Hendershott et al. (2020): CAPM works in overnight returns; beta is negatively priced in intraday returns; maybe overnight returns are driven by long-term, risk-conscious investors
- Lou et al. (2019), Akbas et al. (2022): intraday and overnight clienteles are often in a tug-of-war: high intraday returns beget low overnight returns and vice versa

Main Hypotheses

- Barardehi et al. (2026) find that sorting on past intraday returns creates momentum and short-term reversal, while sorting on past overnight returns creates long-term reversal
- I look at intraday and overnight volatility and ask what drives the IVol effect of Ang et al. (2006) and related anomalies
- Signal hypothesis: intraday and overnight volatility mean different things and are therefore priced differently
- Clientele hypothesis: the intraday clientele cares about intraday volatility and prices it according to its tastes, while the overnight clientele does the same with overnight volatility

Main Variables

$$IDRet_t = \frac{close_t - open_t}{open_t}$$

$$ONRet_t = \frac{1 + CtCRet_t}{1 + IDRet_t} - 1$$

- Intraday volatility – standard deviation of IDRet within a month
- Overnight volatility – standard deviation of ONRet within a month

Intraday Volatility Sorts

	Low	Quint2	Quint3	Quint4	High	L-H
α_{CAPM}	0.498	0.402	0.332	0.173	-0.597	1.095
t-stat	*3.48*	*2.56*	*1.96*	*1.04*	*-2.87*	*4.53*
$\alpha_{Carhart}$	0.412	0.318	0.277	0.167	-0.485	0.897
t-stat	*4.65*	*4.21*	*3.34*	*2.28*	*-4.41*	*5.63*
α_{FF5}	0.282	0.149	0.106	0.041	-0.305	0.587
t-stat	*3.13*	*2.13*	*1.39*	*0.66*	*-3.56*	*4.56*

- Sorting on intraday volatility produces alphas as big as the ones in Ang et al. (2006)
- Ang et al. (2006) sort on close-to-close volatility

Overnight Volatility Sorts

	Low	Quint2	Quint3	Quint4	High	L-H
α_{CAPM}	0.337	0.225	0.175	0.102	-0.217	0.553
t-stat	*2.47*	*1.33*	*1.04*	*0.60*	*-1.26*	*2.78*
$\alpha_{Carhart}$	0.242	0.139	0.111	0.094	-0.144	0.386
t-stat	*2.83*	*1.52*	*1.34*	*1.22*	*-1.77*	*3.01*
α_{FF5}	0.108	-0.034	-0.032	-0.003	-0.045	0.153
t-stat	*1.27*	*-0.42*	*-0.47*	*-0.04*	*-0.61*	*1.41*

- Sorting on overnight volatility creates alphas at least twice smaller than the ones in intraday volatility sorts
- No relation between overnight volatility and alphas exists in five-factor alphas

Intraday Volatility Conditional on Overnight Volatility

	Low	Quint2	Quint3	Quint4	High	L-H
α_{CAPM}	0.537	0.416	0.284	0.020	-0.603	1.140
t-stat	*3.49*	*2.69*	*1.89*	*0.13*	*-3.18*	*5.00*
$\alpha_{Carhart}$	0.459	0.372	0.249	0.022	-0.523	0.982
t-stat	*5.23*	*5.43*	*3.62*	*0.32*	*-6.37*	*7.25*
α_{FF5}	0.327	0.225	0.108	-0.036	-0.321	0.648
t-stat	*3.62*	*3.23*	*1.84*	*-0.61*	*-4.95*	*5.62*

- Results are a bit stronger than in unconditional sorts
- Orthogonalizing intraday volatility to overnight volatility produces similar results

Overnight Volatility Conditional on Intraday Volatility

	Low	Quint2	Quint3	Quint4	High	L-H
α_{CAPM}	0.127	0.086	0.045	0.060	0.026	0.102
t-stat	*0.84*	*0.57*	*0.30*	*0.41*	*0.17*	*0.76*
$\alpha_{Carhart}$	0.058	0.035	0.007	0.054	0.046	0.012
t-stat	*0.62*	*0.44*	*0.11*	*0.95*	*0.64*	*0.11*
α_{FF5}	-0.063	-0.075	-0.074	0.028	0.098	-0.161
t-stat	*-0.70*	*-1.13*	*-1.41*	*0.59*	*1.28*	*-1.51*

- The part of overnight volatility that is unrelated to intraday volatility is also unrelated to future alphas
- Orthogonalizing overnight volatility to intraday volatility produces similar results

Main Result

- Intraday and overnight volatility, taken together, have three parts:
  - The part of intraday volatility that is unrelated to overnight volatility – this one is strongly and negatively priced and seems to be driving the IVol effect in Ang et al. (2006)
  - The part of overnight volatility that is unrelated to intraday volatility – this one cannot predict future returns/alphas
  - The part intraday and overnight volatility have in common (their overlap) – this one is priced, because otherwise overnight volatility would not be priced in unconditional sorts

Cross-Sectional Regressions with Idiosyncratic Volatility

log(IVol)	-14.77				-5.516
t-stat	*-2.88*				*-1.53*
log(IVolID)		-17.33		-22.39	-12.49
t-stat		*-2.69*		*-3.63*	*-1.88*
log(IVolON)			-3.681	10.38	
t-stat			*-0.72*	*2.89*	
Controls	YES	YES	YES	YES	YES

- Intraday volatility matters, overnight volatility does not – or one can even argue it is positively priced

Signal Hypothesis and Clientele Hypothesis

- Signal hypothesis: intraday and overnight volatilities mean different things and all investors (intraday and overnight clienteles) agree
  - Then intraday volatility should be negatively priced in both intraday and overnight returns
  - Overnight volatility should be not priced in both intraday and overnight returns (controlling for intraday volatility)
- Clientele hypothesis: intraday investors price intraday and overnight volatility negatively, and overnight investors price both volatilities positively
- So, let's orthogonalize intraday volatility to overnight volatility (and vice versa) and look at intraday and overnight returns separately

Intraday Volatility Sorts: Intraday Returns

	Low	Quint2	Quint3	Quint4	High	L-H
α_{CAPM}	0.411	0.228	0.021	-0.235	-1.158	1.569
t-stat	*4.67*	*3.26*	*0.41*	*-4.00*	*-9.04*	*9.50*
$\alpha_{Carhart}$	0.395	0.226	0.005	-0.276	-1.094	1.489
t-stat	*5.11*	*3.37*	*0.08*	*-5.21*	*-9.11*	*9.03*
α_{FF5}	0.321	0.140	-0.055	-0.253	-0.919	1.241
t-stat	*3.54*	*2.23*	*-0.95*	*-4.13*	*-7.84*	*7.75*

- Intraday volatility effect is stronger in intraday returns than in close-to-close returns
- The same would be true if we sorted on close-to-close volatility (see Lou et al., 2019)

Intraday Volatility Sorts: Overnight Returns

	Low	Quint2	Quint3	Quint4	High	L-H
α_{CAPM}	-0.247	-0.124	-0.097	0.054	0.655	-0.902
t-stat	*-3.64*	*-2.24*	*-2.61*	*1.57*	*5.92*	*-5.83*
$\alpha_{Carhart}$	-0.318	-0.092	-0.068	0.117	0.555	-0.873
t-stat	*-6.16*	*-1.82*	*-1.88*	*3.68*	*6.12*	*-7.27*
α_{FF5}	-0.319	-0.047	0.021	0.105	0.345	-0.664
t-stat	*-5.43*	*-0.92*	*0.65*	*3.17*	*3.96*	*-5.36*

- Intraday volatility is positively priced in overnight returns, consistent with the clientele effect, but not the signal effect
- Intraday and overnight investors seem to disagree on what intraday volatility means and how to price it

Overnight Volatility Sorts: Intraday Returns

	Low	Quint2	Quint3	Quint4	High	L-H
α_{CAPM}	-0.605	-0.159	-0.009	-0.023	-0.274	-0.331
t-stat	*-4.86*	*-2.23*	*-0.16*	*-0.45*	*-4.21*	*-2.37*
$\alpha_{Carhart}$	-0.615	-0.172	-0.063	-0.018	-0.238	-0.377
t-stat	*-5.68*	*-2.28*	*-1.21*	*-0.38*	*-3.72*	*-2.82*
α_{FF5}	-0.416	-0.178	-0.127	-0.074	-0.211	-0.204
t-stat	*-4.04*	*-2.41*	*-2.36*	*-1.63*	*-2.78*	*-1.39*

- Overnight volatility is slightly positively priced in intraday returns, consistent with signal hypothesis, but not clientele hypothesis
- If I perform conditional sorts instead of orthogonalization, overnight volatility is slightly negatively priced
- Intraday investors believe that intraday and overnight volatility mean different things

Overnight Volatility Sorts: Overnight Returns

	Low	Quint2	Quint3	Quint4	High	L-H
α_{CAPM}	0.363	0.005	-0.125	-0.098	0.302	0.061
t-stat	*3.74*	*0.12*	*-3.29*	*-2.63*	*5.24*	*0.57*
$\alpha_{Carhart}$	0.268	0.052	-0.080	-0.086	0.213	0.055
t-stat	*3.58*	*1.21*	*-2.29*	*-2.44*	*5.17*	*0.68*
α_{FF5}	0.072	0.050	-0.019	-0.039	0.130	-0.057
t-stat	*1.04*	*1.06*	*-0.59*	*-1.06*	*2.91*	*-0.65*

- Overnight volatility is not priced in overnight returns, consistent with signal hypothesis, but not clientele hypothesis
- Overnight investors also understand that intraday and overnight volatility pick up different things, and they now agree with intraday investors that overnight volatility should not be priced

Putting the Pieces Together

- Both intraday and overnight investors agree that intraday and overnight volatilities pick up different things and should be priced differently
- They also agree that overnight volatility is either unimportant or represents diversifiable risk that should not be priced
- Intraday and overnight investors disagree though on how to price intraday volatility
- Intraday investors are overexcited about firms with high intraday volatility – those firms are overpriced and have large and negative intraday alphas
- Overnight investors perceive intraday volatility as danger and therefore overnight alphas of firms with high intraday volatility are large and positive

Intraday Volatility and MAX Effect

log(TVol)		-24.40	
t-stat		*-4.51*	
log(TVolID)			-25.32
t-stat			*-4.21*
log(Max)	-3.973	1.752	1.138
t-stat	*-2.59*	*1.36*	*1.24*
Controls	YES	YES	YES

- MAX effect is strong in the recent sample
- Both close-to-close and intraday volatility can explain the MAX effect
- Since intraday volatility seems to be driving the pricing of close-to-close volatility, intraday volatility is also driving the MAX effect

Intraday Volatility and AD Effect

log(TVol)		-12.61	
t-stat		*-2.73*	
log(TVolID)			-13.41
t-stat			*-2.18*
log(Disp)	-0.537	-0.078	-0.063
t-stat	*-2.34*	*-0.36*	*-0.30*
Controls	YES	YES	YES

- Analyst disagreement effect is strong in the recent sample
- Both close-to-close and intraday volatility can explain the AD effect
- Since intraday volatility seems to be driving the pricing of close-to-close volatility, intraday volatility is also driving the MAX effect

Stambaugh et al. Mispricing Measure

- Pick 11 popular variables that create anomalies (market-to-book, momentum, equity issuance, default probability, etc.)
- Rank firms on each variable 0 to 100, with 100 for the most overpriced firm (e.g., highest market-to-book) and 0 for the most underpriced firm (e.g., lowest market-to-book)
- Then, for each firm-month, average the 11 ranks – that's your firm's current composite mispricing score (the higher it is, the lower the alpha of this firm is expected to be)
- The low-minus-high strategy based on the composite mispricing score has huge alphas of around 1.5% per month

Hypothesis Development

- On the one hand, arbitrageurs tend to trade during the day, so they should be concerned about intraday volatility
- On the other hand, arbitrageurs are known to be wary of leaving their position open overnight, so maybe overnight volatility scares them more if they have to do strategies that require positions to be kept open for at least a month
- So, let's orthogonalize intraday and overnight volatility to each other and then do double sorts on the mispricing measure and intraday/overnight volatility
- Then we will look, across volatility quintiles, at the alphas of the long-short strategy based on the mispricing measure

Mispricing Strategy Alphas across Intraday Volatility Quintiles

	Low	Quint2	Quint3	Quint4	High	H-L
α_{CAPM}	0.928	0.854	1.014	0.739	1.826	0.898
t-stat	*3.56*	*3.59*	*3.47*	*3.00*	*5.67*	*2.71*
$\alpha_{Carhart}$	0.607	0.569	0.679	0.396	1.270	0.662
t-stat	*2.63*	*2.58*	*2.62*	*1.75*	*4.15*	*2.03*
α_{FF5}	0.713	0.503	0.665	0.481	1.404	0.691
t-stat	*2.50*	*2.30*	*2.29*	*1.84*	*4.54*	*1.95*

- There is a strong spike in mispricing in the top intraday volatility quintile
- In equal-weighted returns, the increase would be more monotonic and a bit stronger
- Intraday volatility is a good limits-to-arbitrage measure, arbitrageurs are concerned and do not trade against mispricing as much when intraday volatility is high

Mispricing Strategy Alphas across Overnight Volatility Quintiles

	Low	Quint2	Quint3	Quint4	High	H-L
α_{CAPM}	1.424	0.906	1.076	1.150	1.379	-0.044
t-stat	*4.66*	*3.62*	*4.82*	*4.58*	*5.12*	*-0.17*
$\alpha_{Carhart}$	1.069	0.584	0.809	0.756	0.837	-0.232
t-stat	*4.17*	*2.67*	*4.15*	*3.31*	*3.68*	*-0.81*
α_{FF5}	1.064	0.565	0.729	0.863	0.841	-0.223
t-stat	*4.19*	*2.61*	*3.41*	*3.83*	*3.39*	*-0.78*

- There is no relation between mispricing and the part of overnight volatility that is orthogonal to intraday volatility
- Overnight volatility is not a good mispricing measure

Only Intraday Volatility Matters

- Intraday volatility is priced in the cross-section, overnight volatility is not (once intraday volatility is controlled for)
- Intraday volatility can explain several anomalies, overnight volatility cannot
- Intraday volatility is a good limits-to-arbitrage proxy, overnight volatility is not (once intraday volatility is controlled for)
- Intraday and overnight investors price intraday volatility differently, but neither of them care about the part of overnight volatility that is orthogonal to intraday volatility