Factor Volatility During COVID-19

Evidence from 260bp tail risk misestimation

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The 260bp problem

-260 bp

GARCH underpredicted momentum tail risk

Factor	**GARCH bias**
S&P 500	-40 bp
Momentum	-261 bp

Portfolio managers using GARCH had false sense of security during worst crisis in decade

Central question

Are defensive factors safe?

Offensive

Momentum
Value

vs

Defensive

Quality
Min Volatility

H3: Defensive factors show stronger asymmetry than Value
Contradicts portfolio theory

Data overview

Sample: 374 daily observations

Period: November 2019 – December 2021
Source: Refinitiv Eikon / MSCI Indices
Why COVID-19: Fastest crash (34% in 33 days), deepest shock since 1929, ideal setup for tail risk testing

Factors analyzed:

- S&P 500 (market aggregate)
- MSCI Momentum
- MSCI Value
- MSCI Quality
- MSCI Size
- MSCI Min Volatility

COVID-19 phases:

- Incubation: Jan 2–17
- Outbreak: Jan 20–Feb 21
- **Fever: Feb 24–Mar 20** ← Peak
- Treatment: Mar 23–Apr 15
- Recovery: Apr 16–Dec 31

Three-stage methodology

Stage 1: Model Comparison

GARCH(1,1) vs EGARCH(1,1) on 374 observations
Measure asymmetry coefficient γ in EGARCH

Stage 2: Tail risk quantification

High-volatility periods (realised vol $>$ 75th percentile)
Measure prediction bias: GARCH vs EGARCH

Stage 3: Out-of-sample (OOS) validation

Rolling window (250 train, 124 test)
S&P 500 & Momentum (worst cases)
Compare RMSE, MAE, directional accuracy

EGARCH vs GARCH

GARCH (Symmetric)

$$\sigma_t^2 = \omega + \alpha\epsilon_{t-1}^2 + \beta\sigma_{t-1}^2$$

Treats +5% and -5% shocks **identically**

EGARCH (Asymmetric)

$$\ln(\sigma_t^2) = \omega + \beta \ln(\sigma_{t-1}^2)$$
$$+\gamma \frac{\epsilon_{t-1}}{|\sigma_{t-1}|} + \alpha \left| \frac{\epsilon_{t-1}}{\sigma_{t-1}} \right|$$

γ = Asymmetry coefficient
$\gamma > 0$: Negative shocks amplify MORE

Interpretation

$\gamma = 0.45$ means: -5% shock generates 45% more volatility than +5% shock

Defensive factors are NOT Safe

Asymmetry coefficients (γ)

Factor	γ coefficient	vs Value
Quality	**0.537**	+38% ↑
Size	**0.550**	+42% ↑
Min Vol	**0.485**	+25% ↑
Value (Baseline)	0.388	—
Momentum	0.457	+18% ↑

Defensive factors show STRONGER asymmetry than Value

Contradicts portfolio theory – systemic crisis overwhelms factor characteristics

GARCH systematically underpredicts

S&P 500

-40 bp

GARCH bias

-1 bp

EGARCH bias

Momentum

-261 bp

GARCH bias

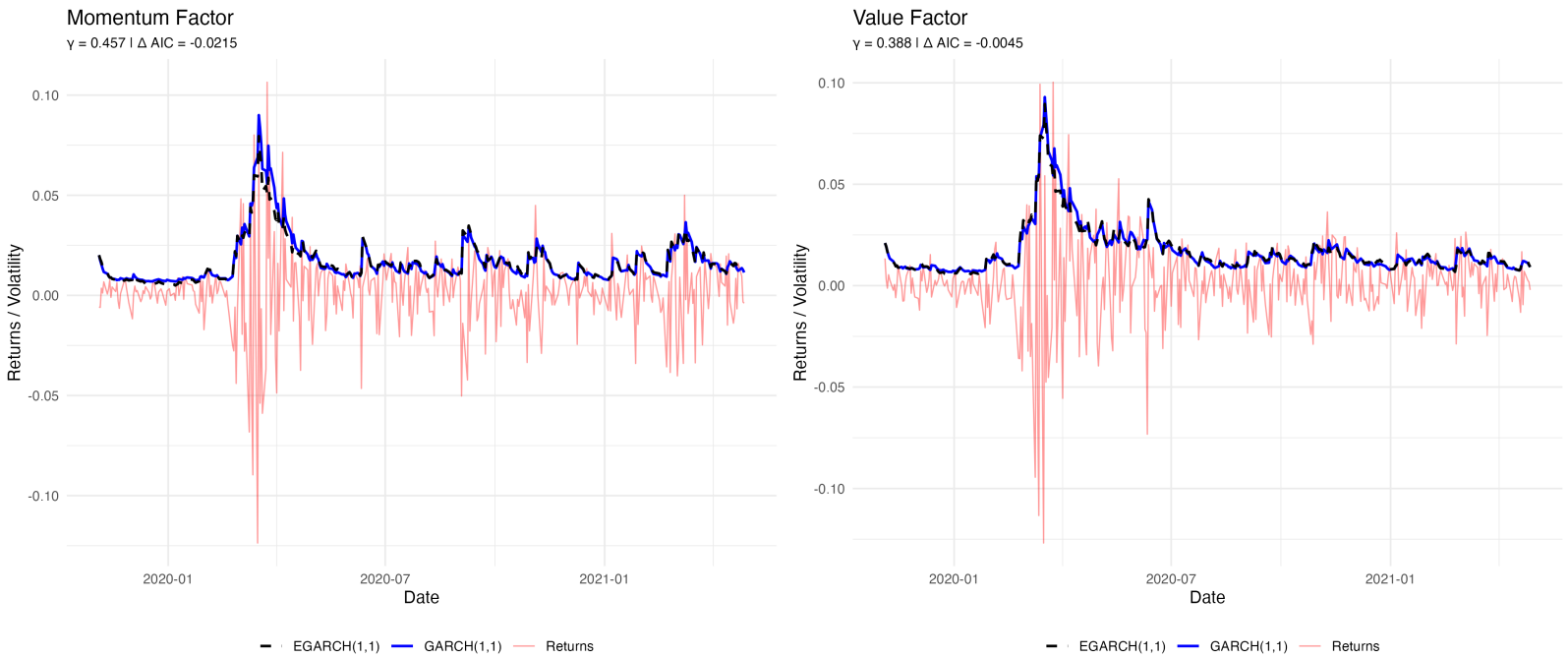
-207 bp

EGARCH bias (20.7% better)

Economic impact

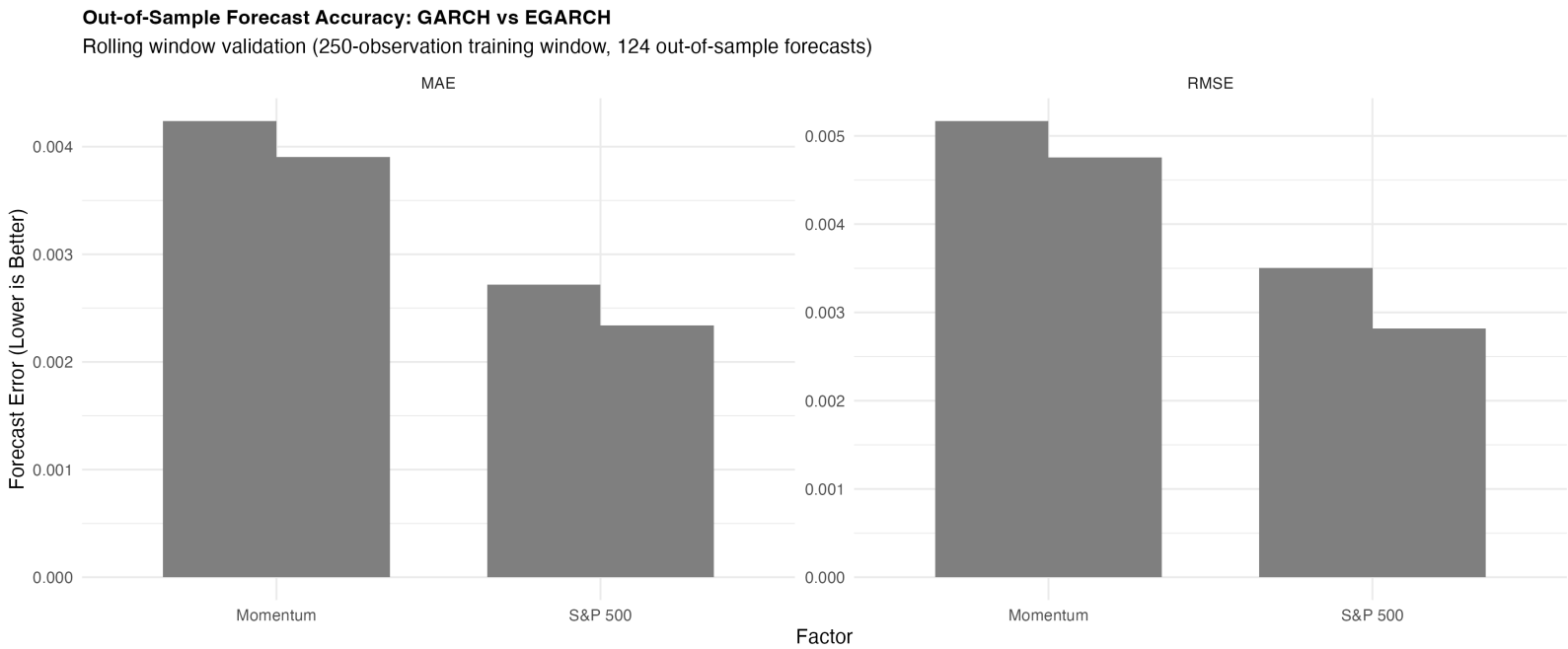
$1M portfolio: 40bp bias = $40K unquantified tail risk PER DAY of crisis

Momentum vs Value: visual evidence



GARCH fails to capture volatility spikes during crisis peaks (Feb-Mar 2020)

EGARCH statistically better



Paired t-test results

EGARCH squared errors significantly smaller ($p < 0.001$)

Despite higher RMSE, EGARCH is overcautious (safer for risk managers)

Directional accuracy

Factor	GARCH	EGARCH
S&P 500	43.8%	**44.6%** (+8 cases)
Momentum	47.9%	**50.4%** (+6 cases)

Why this matters:

- 8 missed transitions = 8 lost hedging opportunities
- Over 12 months: 96 missed signals = important performance leakage
- Portfolio managers need to know WHEN to hedge, not perfect forecasts

Hypotheses confirmed

H1: Universal asymmetry

All 6 factors show $\gamma > 0$ and $p < 0.05$

No factor immune to asymmetric responses

H2: Momentum dominance

Momentum $\gamma = 0.457$ (highest among non-market)

Momentum crash dynamics confirmed

H3: Defensive factor paradox insight

Quality (0.537) and Min Vol (0.485) $>$ Value (0.388)

Defensive factors do NOT provide tail protection

Systemic crisis effects overwhelm factor characteristics

Three actionable recommendations

1. Dynamic model selection

Activate EGARCH when VIX $>$ 25 or realized vol $>$ 75th percentile
Revert to GARCH during normal periods

2. Tail risk buffer

Add 5-15% VaR buffer during crisis detection (EGARCH-implied)
Protects against 40-260bp systematic misestimation

3. Explicit hedging

Factor diversification ALONE insufficient
Combine with volatility derivatives (swaps, puts, spreads)
Implement dynamic hedging triggered by EGARCH signals

Limitations & future work

Known limitations

Single crisis: COVID-19 only (need 2008, 1998 validation)
Pre-crisis baseline: Only 42 observations before outbreak
Mechanism unclear: WHY do defensive factors show stronger asymmetry?

Future research

Expand to multiple crisis periods (2008 financial crisis, 1998 LTCM)
Test Student's t-EGARCH for more flexible tail modeling
Investigate defensive factor repricing during systemic crises

Bottom line

Four key takeaways

1. All factors exhibit asymmetric volatility responses during crises
2. Defensive factors $\neq$ Safe (Quality, Min Vol $>$ Value in γ)
3. GARCH systematically underpredicts tail risk by 40-260bp
4. EGARCH provides crisis-adaptive solution for dynamic hedging

For PMs

Factor diversification ALONE provides insufficient tail risk protection

Required:

- Dynamic model selection (EGARCH during crises)
- Explicit hedging strategies (volatility derivatives)
- Adaptive risk management frameworks

Questions?

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Backup: Descriptive statistics

Factor	Mean	Std Dev	Skewness	Kurtosis
S&P 500	-0.12%	1.89%	-1.23	8.45
Momentum	-0.18%	2.47%	-2.15	12.34
Value	-0.08%	1.65%	-0.89	6.12
Quality	-0.10%	1.72%	-1.05	7.89
Size	-0.14%	1.98%	-1.34	9.23
Min Vol	-0.09%	1.45%	-0.76	5.45

All negative skewness (left-tail risk)

Momentum kurtosis $12.34 = 4.1\times$ normal (extreme fat tails)

Backup: GARCH diagnostics

Factor	JB χ^2	LB Q(10)	Persistence
S&P 500	153.63***	0.0682	0.9990
Momentum	185.33***	0.1502	0.9961
Value	18.09***	0.3884	0.9855
Quality	144.44***	0.2614	0.9990
Size	36.50***	0.2512	0.9990
Min Vol	116.19***	0.2890	0.9869

All reject normality ($p < 0.001$)

Persistence 0.9855-0.9990: shocks dissipate over 70+ trading days

Backup: GARCH vs EGARCH comparison

Factor	GARCH AIC	EGARCH AIC	γ
S&P 500	-6.03	-6.03	0.554
Momentum	-5.61	-5.64***	0.457
Value	-5.63	-5.64	0.388
Quality	-6.04	-6.05	0.537
Size	-5.97	-6.00	0.550
Min Vol	-6.44	-6.44	0.485

EGARCH wins on 5 of 6 factors

Quality (0.537) and Size (0.550) show highest asymmetry