Systematic Errors in Analysts and Market-Implied Expectations of Commodity Prices

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Motivation

- Full-information rational expectations (FIRE) hypothesis implies that forecast errors observed ex post are purely random.

  But:

- Analyst forecasts display **systematic, predictable errors** consistent with overreaction to new information (Bordalo et al., 2019, 2020, 2024).
- Halperin and Mazlish (2025) show strong horizon dependence for macroeconomic indicators: short-term underreaction, long-term overreaction.
- D'Arienzo (2020) provides evidence from market-implied expectations: long-term yields overreact increasingly with maturity.
- Evidence for **commodities** is scarce.

Methodology

- Coibion and Gorodnichenko (2015):

$$\underbrace{S_{t+h} - \mathbb{E}_t(S_{t+h})}_{\text{Forecast error}} = \alpha + \beta_1 \Big(\underbrace{\mathbb{E}_t(S_{t+h}) - \mathbb{E}_{t-1}(S_{t+h})}_{\text{Forecast revision}} \Big) + \varepsilon_{t+h},$$

$$\beta_1 < 0 \Rightarrow \text{overreaction},$$

$$\beta_1 > 0 \Rightarrow \text{underreaction}$$

- Bordalo et al. (2024):

$$\underbrace{S_{t+h} - \mathbb{E}_t[S_{t+h}]}_{\text{Forecast error}} = \alpha + \beta_1 \Big(\underbrace{\mathbb{E}_t[S_{t+h}] - \mathbb{E}_{t-1}[S_{t+h}]}_{\text{Forecast revision}} \Big) + \beta_2 \underbrace{\mathbb{E}_{t-1}(S_{t+h})}_{\text{Lagged forecast}} + \varepsilon_{t+h},$$

$$\beta_2 < 0 \Rightarrow \text{over-extremity},$$

$$\beta_2 > 0 \Rightarrow \text{under-extremity}$$

Interpreting the coefficients

Over-extremity vs. under-extremity. $\beta_2 < 0$ implies that a higher level of the lagged forecast is associated with the forecast being too high relative to the outcome. This means that high lagged forecasts are too high while low forecasts are too low. Thus we term $\beta_2 < 0$ as overextremity and correspondingly $\beta_2 > 0$ as under-extremity (Halperin and Mazlish, 2025).

Z-normalization. Interpretation of the coefficients needs to account for the fact that we z-score expectations with respect to asset and horizon: the β_i coefficients should be interpreted as "relative to what is typical". So, the interpretation of β_1 is: "when expectations revise a large amount relative to what is typical for horizon j and asset i, are forecast errors large or small relative to what is typical for that horizon j and asset i?" (Halperin and Mazlish, 2025).

Methodology

We estimate the Bordalo et al. (2024) regression for EIA analyst forecasts:

$$\underbrace{S_{t+m} - \mathbb{E}_t^{EIA}[S_{t+m}]}_{\text{Forecast error}} = \alpha + \beta_1 \Big(\underbrace{\mathbb{E}_t^{EIA}[S_{t+m}] - \mathbb{E}_{t-1}^{EIA}[S_{t+m}]}_{\text{Forecast revision}} \Big) + \beta_2 \underbrace{\mathbb{E}_{t-1}^{EIA}[S_{t+m}]}_{\text{Lagged forecast}} + \varepsilon_{t+m}.$$

- S_{t+m} is the monthly average spot price realized in month $t+m$.
- $\mathbb{E}_t^{EIA}[S_{t+m}]$ is the EIA forecast of the spot price S_{t+m}.
- $\mathbb{E}_{t-1}^{EIA}[S_{t+m}]$ is the EIA forecast made one month earlier for the same spot price S_{t+m}.
- m is the forecast horizon, measured in months.

Futures as expectation proxies

- Futures prices can be decomposed as follows (Fama and French, 1987):

$$\underbrace{F_t(S_{t+h})}_{\text{Futures price}} = \underbrace{\mathbb{E}_t[S_{t+h}]}_{\text{Expected spot price}} + \underbrace{\mathbb{E}_t[RP_{t+h}]}_{\text{Expected risk premium}}$$

- Assuming that risk premia are relatively small and markets are sufficiently liquid, futures can adequately be characterized as unbiased predictors of future spot prices (Chinn and Coibion, 2014):

$$\underbrace{F_t(S_{t+h})}_{\text{Futures price}} \approx \underbrace{\mathbb{E}_t[S_{t+h}]}_{\text{Expected spot price}}$$

Methodology

We estimate the Bordalo et al. (2024) regression for futures:

$$\underbrace{S_{t+h} - F_t(S_{t+h})}_{\text{Forecast error}} = \alpha + \beta_1 \Big(\underbrace{F_t(S_{t+h}) - F_{t-k}(S_{t+h})}_{\text{Forecast revision}} \Big) + \beta_2 \underbrace{F_{t-k}(S_{t+h})}_{\text{Lagged forecast}} + \varepsilon_{t+h}.$$

- S_{t+h} is the spot price realized on day $t+h$.
- $F_t(S_{t+h})$ is the futures price quoted on day t for a contract expiring on day $t+h$; it serves as the market-implied forecast of S_{t+h}.
- $F_{t-k}(S_{t+h})$ is the futures price quoted k days earlier for a contract with the same expiration date.
- h is the forecast horizon.
- k is the forecast-revision window. In the baseline specification, we set $k = 21$ trading days ≈ 1 month.

Graphical intuition

- The regression variables are constructed according to the following scheme:

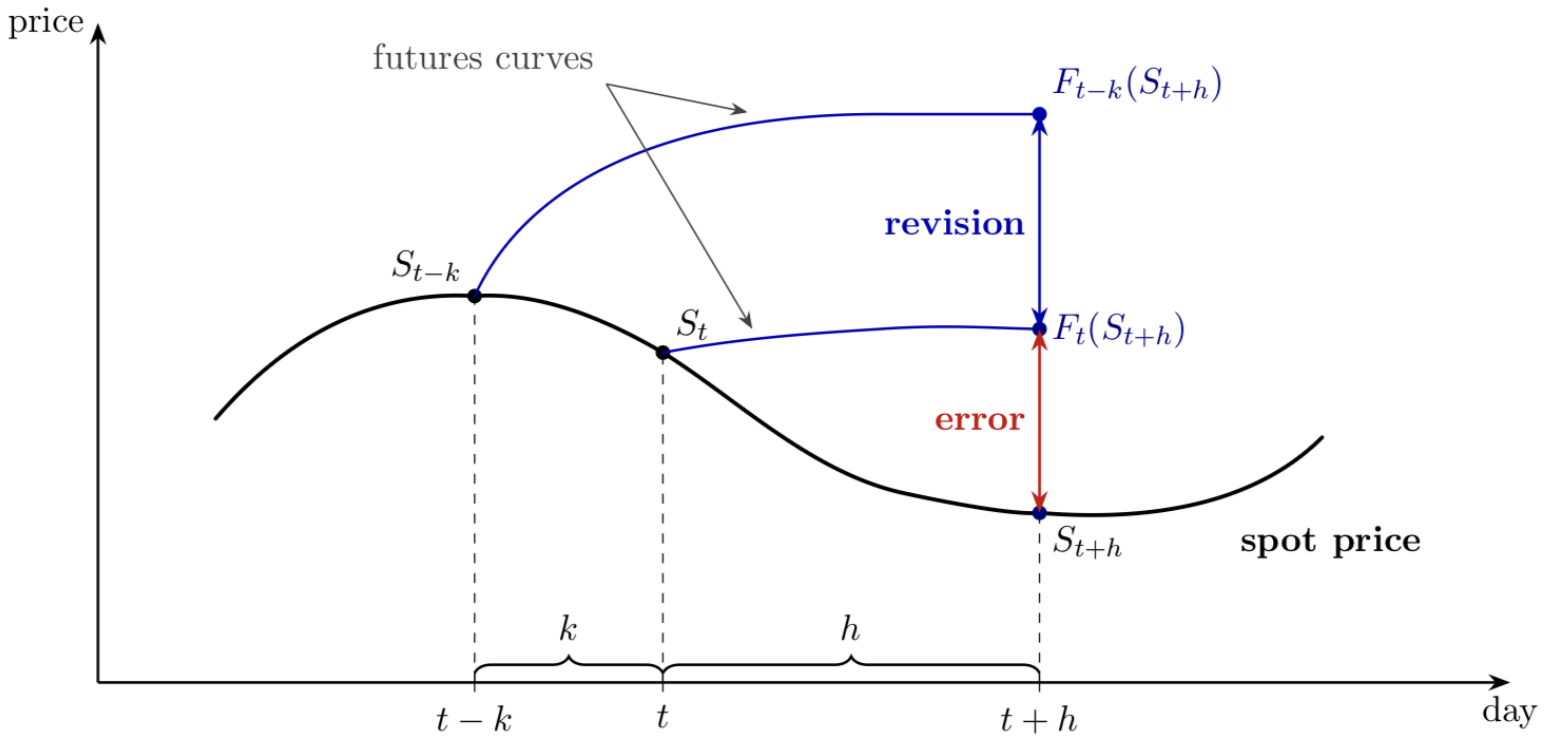

Figure 1: Construction of forecast revisions and forecast errors

Data

Analyst forecasts

- Source: EIA *Short-Term Energy Outlook*
- Sample: 2005–2026
- Series: WTI, gasoline, diesel, natural gas

Futures prices

- Source: historical quotations from `barchart.com`
- Sample: 2005–2026
- Contracts: CL, RB, HO, NG

Forecast-horizon dependence

Table 1: Bordalo et al. (2024) regression for WTI Crude Oil

Horizon in months		$m = 1$	$m = 3$	$m = 6$	$m = 12$	$m = 18$
β_1: forecast revision	Analysts	0.262***	0.105	-0.035	-0.114*	-0.139***
		(0.068)	(0.087)	(0.045)	(0.068)	(0.048)
	Futures	0.267**	0.045	-0.057	-0.131**	-0.115**
		(0.117)	(0.076)	(0.045)	(0.065)	(0.046)
β_2: lagged forecast	Analysts	-0.214***	-0.353***	-0.441***	-0.492***	-0.529***
		(0.039)	(0.096)	(0.154)	(0.122)	(0.156)
	Futures	-0.102***	-0.245***	-0.343**	-0.446***	-0.523***
		(0.035)	(0.087)	(0.153)	(0.131)	(0.132)
Sample size	Analysts	249	249	249	249	120
	Futures	249	249	249	249	249

Note. Robust standard errors (HAC). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.
Sample period: August 2005 - May 2026.

- β_1 **changes sign** from positive to negative as the forecast horizon increases.
- β_2 **decreases** monotonically.

Forecast-horizon dependence

- For both analysts and futures, β_1 decreases monotonically as the forecast horizon increases, indicating stronger **overreaction** at longer horizons.

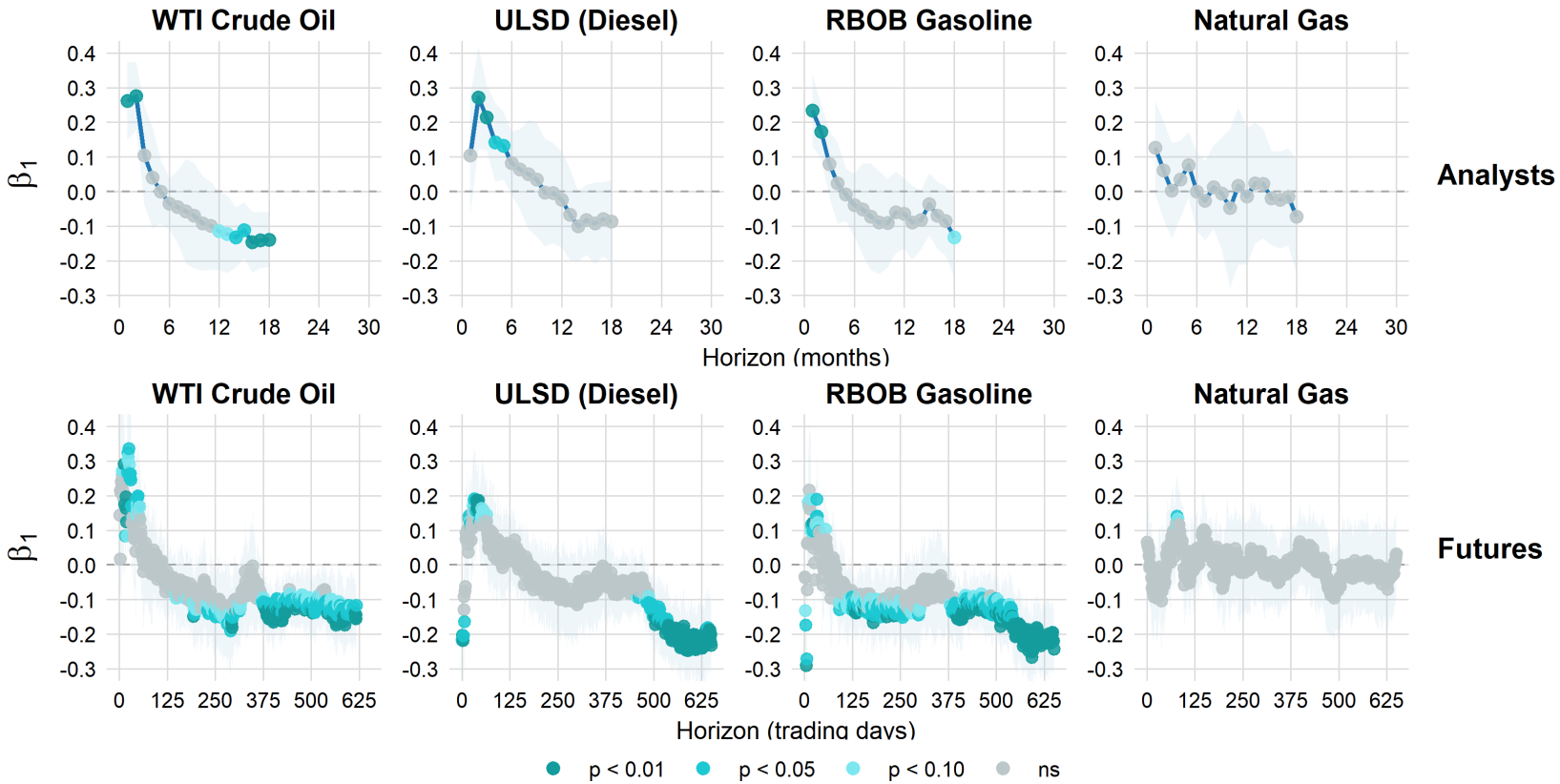

Figure 2: Coefficient β_1 (1-month forecast revision) across forecast horizons. HAC robust s.e.

Forecast-horizon dependence

- For both analysts and futures, β_2 decreases monotonically as the forecast horizon increases, indicating stronger **over-extremity** at longer horizons.

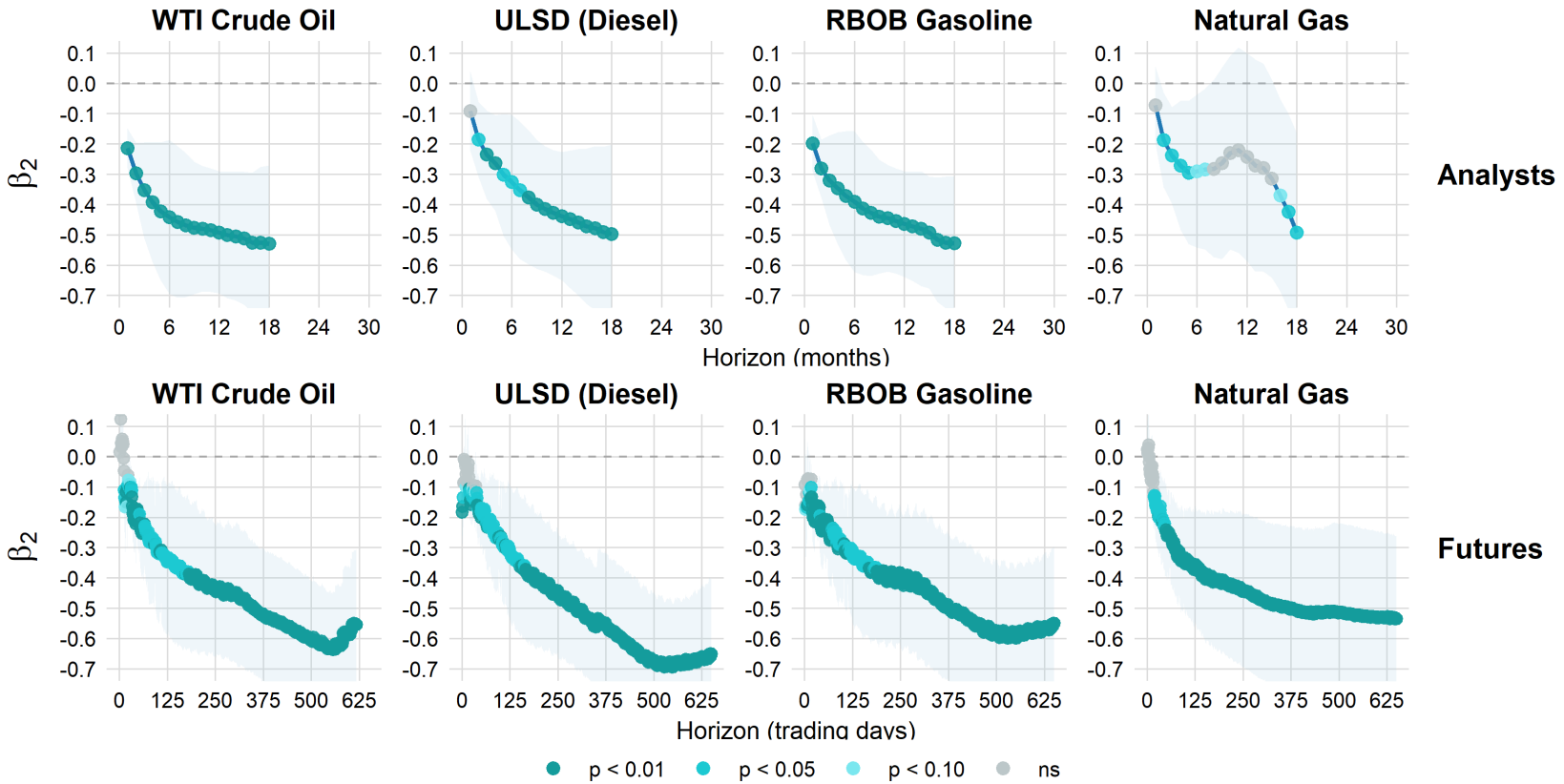

Figure 3: Coefficient β_2 (1-month lagged forecast) across forecast horizons. HAC robust s.e.

Revision-window dependence

- The results support accumulated overreaction: small daily distortions compound and become significant over longer revision windows.

$$S_{t+h} - F_t(S_{t+h}) = \alpha + \beta_1 \Big(F_t(S_{t+h}) - F_{t-k}(S_{t+h}) \Big) + \beta_2 F_{t-k}(S_{t+h}) + \varepsilon_{t+h}$$

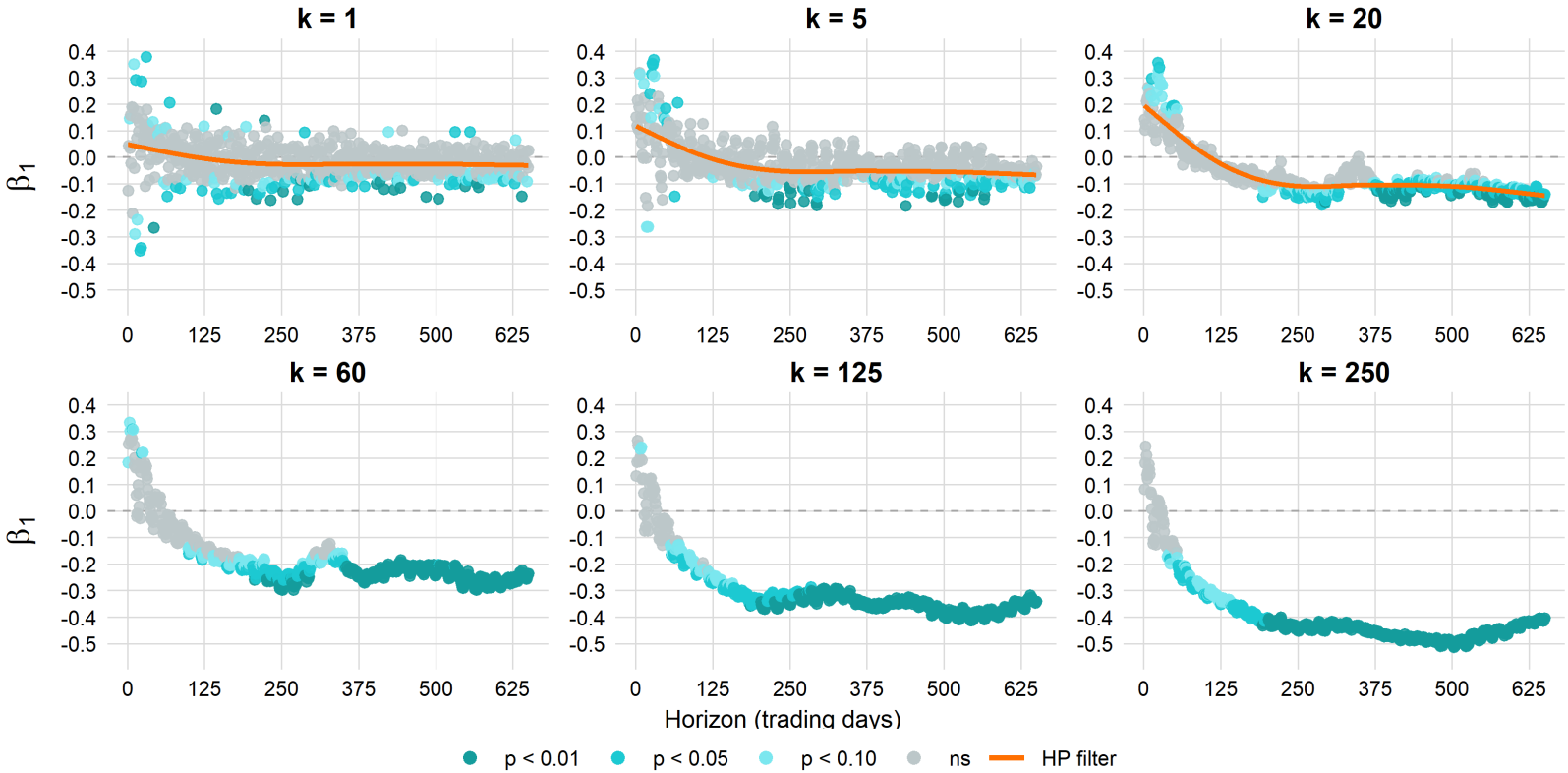

Figure 4: Sensitivity of the coefficient β_1 to the width of the revision window (k) for WTI Crude Oil

Forecasting performance

- Correction procedure, $F_t(S_{t+h}) + \widehat{error}$, yields significant accuracy improvements.

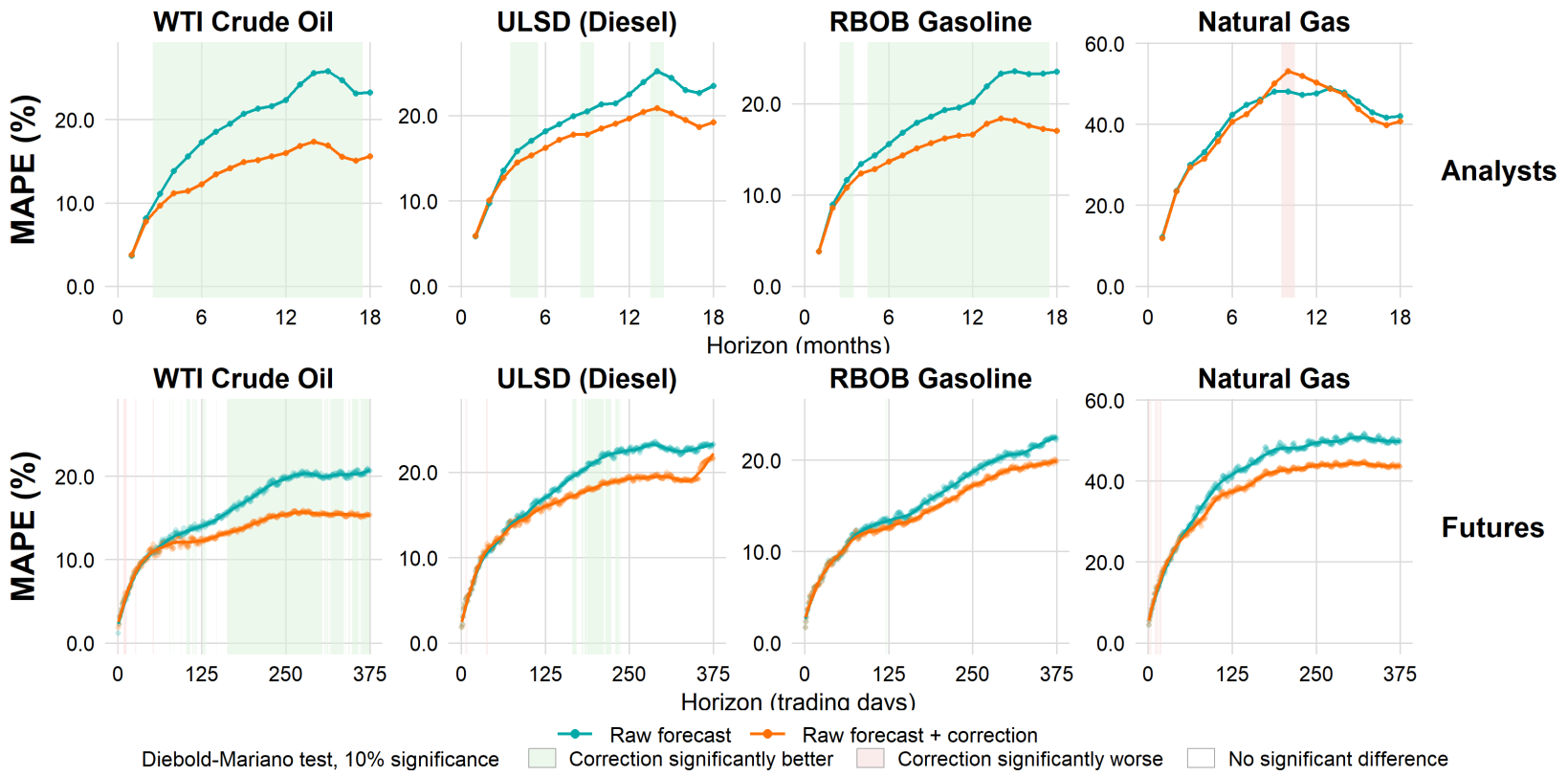

Figure 5: Out-of-sample forecast accuracy for energy commodities, 2021–2026

Forecasting performance

- Correction procedure performs particularly well during periods of extremely low or high prices.

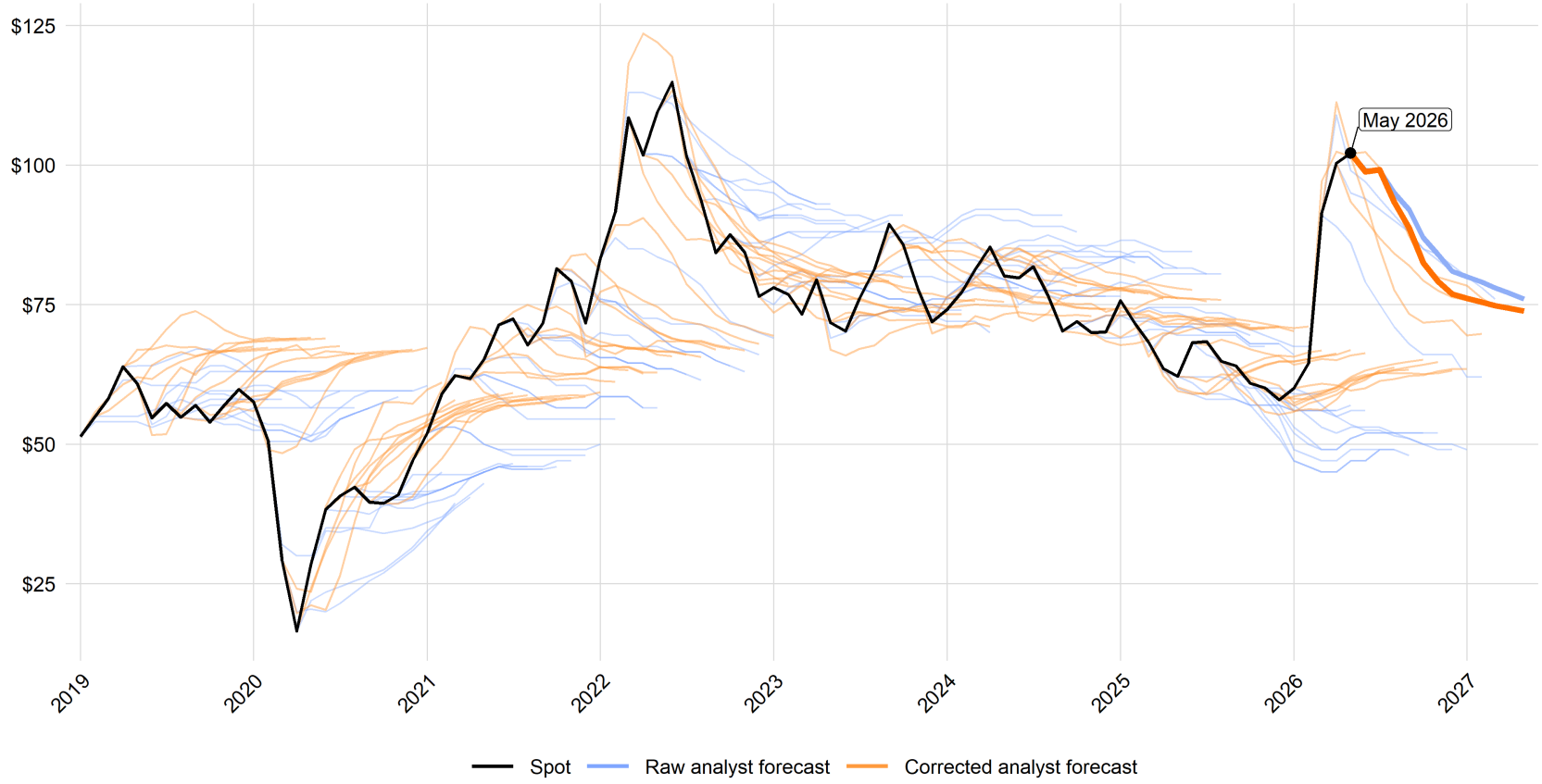

Figure 6: Real-time EIA WTI forecast trajectories and correction-adjusted paths

Conclusion

1. Both analysts and market-implied expectations **underreact at short** horizons and **overreact at longer** horizons.
2. Overreaction and over-extremity **increase with** the forecast **horizon.**
3. Results support **accumulated overreaction:** small daily distortions compounding over time.
4. Correcting forecasts for systematic errors **improves out-of-sample accuracy.**

References I

[1] Coibion, Olivier, and Yuriy Gorodnichenko. 2015. "Information Rigidity and the Expectations Formation Process: A Simple Framework and New Facts." *American Economic Review* 105 (8): 2644–2678.

[2] Bordalo, Pedro, Nicola Gennaioli, Rafael La Porta, and Andrei Shleifer. 2019. "Diagnostic Expectations and Stock Returns." *Journal of Finance* 74 (6): 2839–2874.

[3] Bordalo, Pedro, Nicola Gennaioli, Yueran Ma, and Andrei Shleifer. 2020. "Overreaction in Macroeconomic Expectations." *American Economic Review* 110 (9): 2748–2782.

[4] Bordalo, Pedro, Nicola Gennaioli, Rafael La Porta, and Andrei Shleifer. 2024. "Belief Overreaction and Stock Market Puzzles." *Journal of Political Economy* 132 (5): 1450–1484.

[5] Chinn, Menzie D., and Olivier Coibion. 2014. "The Predictive Content of Commodity Futures." *Journal of Futures Markets* 34 (7): 607–636.

References II

[6] Fama, Eugene F., and Kenneth R. French. 1987. "Commodity Futures Prices: Some Evidence on Forecast Power, Premiums, and the Theory of Storage." *The Journal of Business* 60 (1): 55–73.

[7] Halperin, Basil, and J. Zachary Mazlish. 2025. "Overreaction and Forecast Horizon: Longer-term Expectations Overreact More, Shorter-term Expectations Drive Fluctuations." Economics Series Working Papers No. 1076, University of Oxford.

[8] D'Arienzo, Daniele. 2020. "Maturity Increasing Overreaction and Bond Market Puzzles." SSRN Working Paper No. 3733056.

[9] Hamilton, James D., and Jing Cynthia Wu. 2014. "Risk Premia in Crude Oil Futures Prices." *Journal of International Money and Finance* 42: 9–37.

Forecast-horizon dependence

- As a robustness check, we compare raw futures with risk-premium-adjusted futures based on Hamilton and Wu (2014).
- Both measures yield very similar β_1 and β_2 dynamics across horizons.

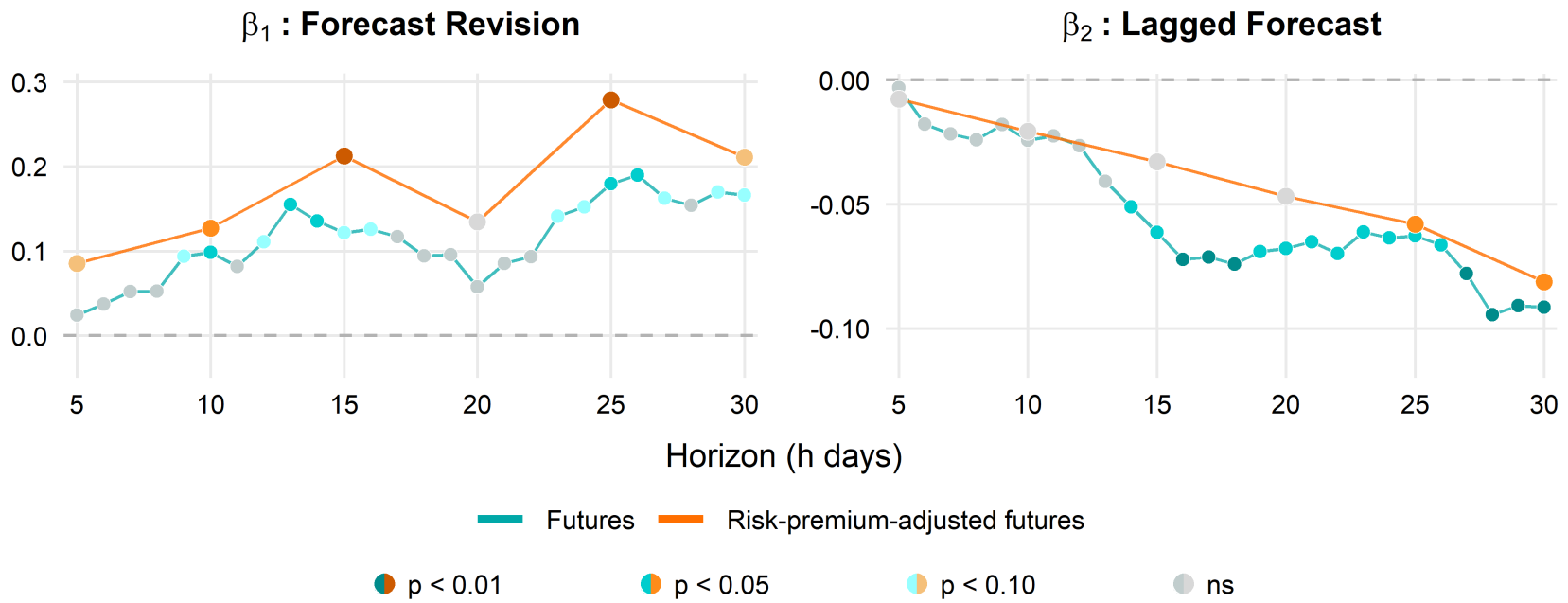

Figure 7: Comparison of Model Coefficients for Raw and Risk-Premium-Adjusted WTI Crude Oil Futures