Extending Macroeconomic Regime Detection with News Sentiment & Topic Modeling

COLUMBIA | ENGINEERING
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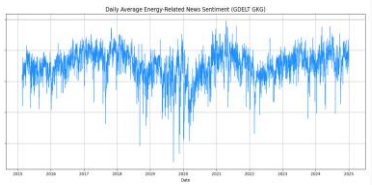
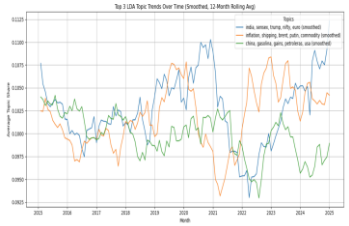
Abstract

We extend last year's energy-sector framework by adding news signals - **headline sentiment** and **topics**. We build a leakage-safe monthly panel (2015–2025) and evaluate XLE return forecasts with **LSTM/CNN-LSTM under walk-forward validation**, and map regimes with **Gaussian HMMs**. Sentiment consistently sharpens regime flips; **BERT** topics capture mood/turbulence, **LDA** aligns with macro balance; forecasting lift is modest but more stable when text augments the three-macro block, yielding interpretable states aligned with major energy events.

Data & Features

- **VADER news title sentiment** (GDELT GKG, 2015–2025)
- **LDA** topic proportions (levels & MoM changes) vs **BERT + UMAP + HDBSCAN**
- **Macro-indicators**: Industrial Production, WTI Crude, USD Money Supply
- XLE monthly log return

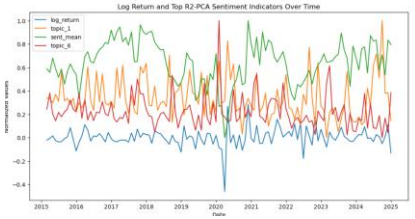


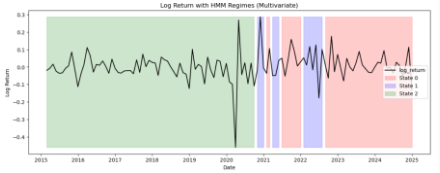


Key Findings

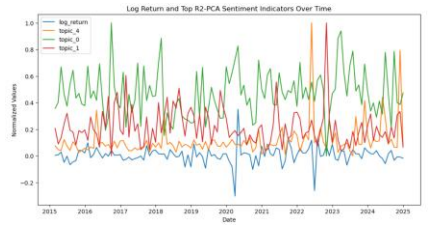
- Adding sentiment and topics turns a fuzzy returns-only map into clearer "calm / stress / recovery" states.
- **BERT** emphasizes psychological/turbulence nuances (useful for hedging/timing), while **LDA** tracks macro balance (useful for cyclical vs. defensive tilts). Forecast gains are incremental but **more reliable** when text augments the three-macro panel.
- Crucially, **walk-forward** exposes over-optimism from random splits and delivers regime-aware, interpretable results.

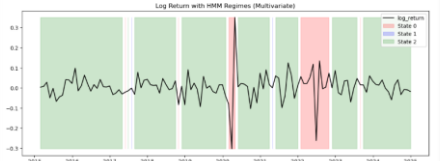
HMM with LDA





HMM with BERT+UMAP+HDBSCAN





Method

- **Expanding walk-forward:** train through $t-1$, predict month t
- **Forecasting:** LSTM/CNN-LSTM on a curated feature set; metrics: MSE and directional accuracy
- **Regimes:** 2-state returns-only baseline and 3-state multivariate HMM (returns + topics + sentiment + macro) with StandardScaler and KMeans init. Two parallel pipelines differ only in the topic block (LDA vs. BERT)

Conclusion & Future Work

- **Macro trio + sentiment/topics** → clearer, stable 3-state regimes; sentiment often leads price and improves HMM timing
- **BERT** captures turbulence/mood while **LDA** tracks fundamentals
- **Future Work:**

1. Hybrid topic block (BERT + LDA) and time-aware macro selection (Lasso/Elastic Net; compare with R^2-PCA/R^2-RD)
2. Non-circular validation with OVX, HY energy spreads and crack-spread/curve slopes, etc.
3. Robustness & ops: benchmark vs change-point/MS-VAR/MS-GARCH; ship a monthly real-time pipeline and dashboard