High-Tension Regime Detection in U.S. Treasuries

One-Page Summary

Key Questions Addressed

Theme	Question
Latent Geometry for Rates	Can curvature and volume anomalies from 5-Year Treasury futures serve as transparent indicators of latent regime shifts in interest rate markets?
Operational Usability	Can regime signals be defined in a way that is interpretable, sparse, and suitable for trading or risk dashboards without requiring complex model recalibration?
Multi-Signal Integration	How does this framework align with broader market structure indicators such as volatility proxies and yield curve slope measures?

Conceptual Ideas Proposed

- A **curvature–volume regime detection framework** combines z-score–normalized second-difference curvature and log-volume anomalies from 5-Year Treasury futures, using simple threshold-based overlays.
- **Threshold grid sweeps** balance hit rate and alert frequency, selecting curvature and volume cutoffs that trade off early warnings against operational noise.
- Trading days are classified into **High**, **Medium**, and **No Tension** regimes based on calibrated thresholds, supporting sparse yet informative regime overlays.
- The setup is optimized for **operational usability**, focusing on clean visual markers rather than complex predictive models, with extensions possible via multi-instrument overlays and joint regime-switching frameworks.

Key Results

- Hit rates range from **35% to 56%** for detecting large 20-day moves, with the **2.5 curvature / 1.5 volume threshold** achieving the highest precision.
- **High Tension regimes occur on 0.44% of days**, and **Medium Tension on 2.48%**, keeping the combined signal frequency under **3%** of trading days from 2010–2025.
- Regime starts visibly align with periods of **elevated TLT volatility** and **yield curve slope shifts**, validating the overlay's relevance as a market structure signal.
- The framework provides a **transparent, low-burden alternative** to formal regime-switching models, suitable for integration into fixed income trading and risk dashboards.

Illustrative Figures and Tables

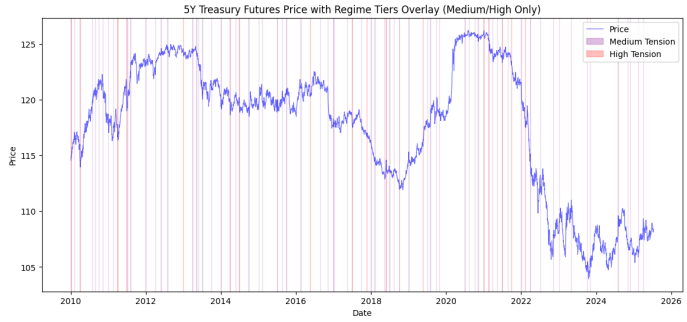

Figure 1: **5-Year Treasury Futures price with regime tier overlay (2010–2025).** High Tension (dark red) and Medium Tension (light violet) periods align with major price inflections, illustrating the signal's selectivity.

θ_C	θ_V	Flags	Hit rate
1.5	1.5	114	0.553
1.5	2.0	78	0.500
1.5	2.5	32	0.375
2.0	1.5	72	0.514
2.0	2.0	53	0.434
2.0	2.5	26	0.346
2.5	1.5	45	**0.556**
2.5	2.0	33	0.485
2.5	2.5	17	0.471

Table 1: **Hit rate grid sweep.** $\theta_C = 2.5$, $\theta_V = 1.5$ achieves the highest hit rate (56%), balancing precision and alert count.