Behavior-Finance-Aware Transformer via Sentiment-Driven Attention for Multi-Asset Time-Series

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Working Paper

Abstract

Unexpected events and emotional contagion heighten market volatility and irrational behavior, complicating multi-asset prediction. We propose BFTformer, a Transformer that fuses emotion perception with a behavioral-finance attention mechanism to jointly model and dynamically adjust sentiment and price sequences. Using daily trading and multi-source sentiment data from 2017–2024 for Apple (AAPL), Johnson & Johnson (JNJ), Shell (SHEL), and Bitcoin (BTC), we build standardized time-series samples. A sentiment embedding layer and BF-Attention enable cross-modal integration and regime-aware control. Experiments show that BFTformer outperforms DLinear, PatchTST, and iTransformer in accuracy and trend recognition, achieving MSE 0.003 ± 0.0002, MAPE 0.015 ± 0.0004, and directional accuracy 0.794 ± 0.004, all statistically superior at the 1% level (p ¡ 0.01). Ablation results indicate that sentiment embedding, a gating module, and BF-Attention contribute independently and complementarily. For interpretability, BFTformer attains a SHAP value of 0.078 ± 0.003, exceeding comparative models and confirming the marginal contribution of sentiment features. Analyses of gating weights and attention distributions reveal that the model amplifies sentiment shocks in highly volatile markets while suppressing sentiment noise for defensive assets, demonstrating strong adaptability across market states. These findings illuminate mechanisms through which sentiment-driven factors shape price formation and cross-asset co-movements. The approach

provides methodological support for investment strategy optimization and risk management, and extends deep-learning applications to modeling irrational financial behavior. By unifying behavioral finance priors with attention, BFTformer links human emotions to price discovery, clarifies asset co-movement channels, and offers a practical, interpretable tool for robust cross-asset forecasting, allocation, and risk control under turbulent conditions.

Overall Framework

BFTformer is a behavioral-finance-aware, sentiment-driven Transformer for multi-asset time series forecasting. It consists of a sentiment-driven module and a BF-Attention module that jointly model price and sentiment sequences.

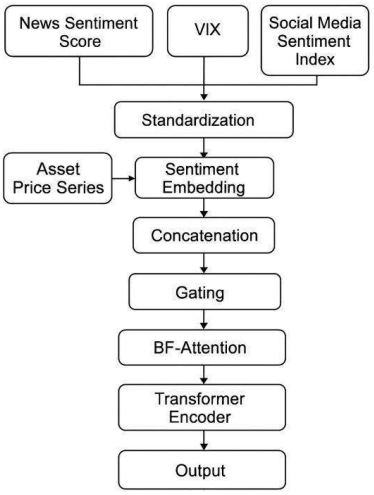

Figure 1: Overall architecture of BFTformer.

Selected Experimental Results

We evaluate BFTformer against three strong baselines, including DLinear, PatchTST, and iTransformer on joint forecasting of AAPL, JNJ, SHEL, and BTC. As shown in Table 1, BFTformer achieves the lowest prediction errors and the highest directional accuracy, significantly outperforming all baselines at 1% level. It also attains the largest SHAP score (0.078 ± 0.003), indicating stronger interpretability and a larger marginal contribution from sentiment features than competing models.

Table 1: Model performance on multi-asset forecasting (mean ± std over $n = 10$ runs).

Model	**MSE** ↓	**MAPE** ↓	**DA** ↑	**SHAP** ↑
BFTformer	$\mathbf{0.003 \pm 0.0002}$	$\mathbf{0.015 \pm 0.0004}$	$\mathbf{0.794 \pm 0.004}$	$\mathbf{0.078 \pm 0.003}$
DLinear	0.005 ± 0.0003	0.022 ± 0.0006	0.741 ± 0.005	0.052 ± 0.002
PatchTST	0.004 ± 0.0002	0.018 ± 0.0005	0.768 ± 0.004	0.064 ± 0.002
iTransformer	$\mathbf{0.003 \pm 0.0002}$	0.018 ± 0.0005	0.774 ± 0.004	0.069 ± 0.002

Note. 95% confidence intervals (CI) are calculated as mean $\pm\, t_{n-1,0.975}\,(\mathrm{std}/\sqrt{n})$, where std denotes the standard deviation and n the number of repeated runs. For $n = 10$, $t_{9,0.975} = 2.262$, and all improvements of BFTformer over baselines are significant at the 1% level ($p < 0.01$).

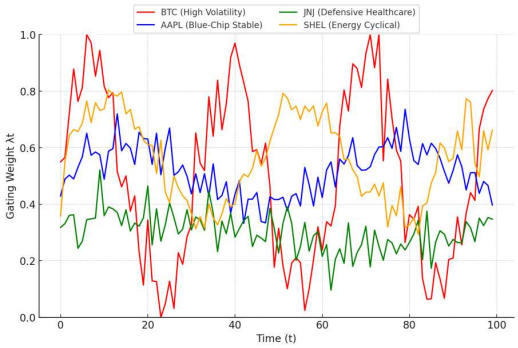

Figure 2: Dynamic gating weights λ_t for different assets, showing how BFTformer amplifies sentiment for volatile assets (e.g., BTC) while suppressing sentiment noise for defensive stocks (e.g., JNJ).

Across AAPL, JNJ, SHEL, and BTC, the learned gating weights λ_t act as a dynamic switch that controls how much sentiment enters the forecasting pipeline. As shown in Fig. 2, λ_t spikes toward 1 under major sentiment shocks for BTC and SHEL, so sentiment features dominate the update, but remains low (around 0.2–0.3) for defensive assets like JNJ, where prices are mainly fundamentals-driven. This pattern shows that BFTformer selectively amplifies sentiment in highly volatile markets while suppressing sentiment noise for more stable assets.