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Ministry of Higher Education and Scientific Research
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Enhanced Temporal Decay Sentiment-Enhanced Financial Forecasting with FinBERT-TFT Architecture

Presented by
Diafi Mohammed Nazim Ilies

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Dr. BENDAOUADE .F

Pr. RAHMOUN .A

Dr. MALKI .A

President of the Jury

Thesis Supervisor

Examiner

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Abstract

Financial markets generate massive volumes of textual data daily, creating unprecedented opportunities for enhanced forecasting through sentiment analysis. Modern algorithmic trading accounts for over 85% of equity trading volume, with institutional asset managers managing more than \$100 trillion globally, driving demand for sophisticated forecasting systems that can process both market data and textual information effectively. Contemporary sentiment analysis approaches achieve 85-95% accuracy through domain-adapted models like FinBERT, representing substantial advancement over early lexicon-based methods. However, current forecasting applications employ primitive temporal aggregation methods that ignore empirical evidence from behavioral finance research demonstrating exponential sentiment decay patterns with measurable half-lives of 0.8 to 3.2 trading days. This disconnect between sophisticated sentiment classification and basic temporal modeling represents a systematic underutilization of available information, creating substantial opportunities for performance improvement in institutional financial forecasting.

This thesis develops and validates the first systematic framework integrating temporal decay mechanisms with advanced sentiment analysis for financial forecasting applications. The methodology combines FinBERT sentiment extraction with Temporal Fusion Transformer (TFT) architectures, implementing horizon-specific exponential decay parameters: $\lambda = 0.15$ for tactical (5-day), $\lambda = 0.08$ for operational (30-day), and $\lambda = 0.03$ for strategic (90-day) forecasting periods. The temporal decay mechanism applies: $\text{sentiment_weighted} = \frac{\sum_{i=1}^n \text{sentiment}_i \times \exp(-\lambda_h \times \text{age}_i)}{\sum_{i=1}^n \exp(-\lambda_h \times \text{age}_i)}$, where λ_h represents horizon-specific decay parameters optimized for different institutional decision-making timeframes.

Experimental validation across 2,171 trading days (2018-2023) covering diverse market regimes demonstrates significant performance improvements with statistical significance ($p < 0.001$): directional accuracy increases from 62.2% to 68.3%, Sharpe ratio enhancement from 0.64 to 1.02 (59.4% improvement), and error reduction of 29-31% in RMSE and MAE. All three research hypotheses achieve validation: temporal decay effectiveness, horizon-specific optimization, and enhanced forecasting performance. For institutional portfolios, even modest forecasting improvements can translate to millions in additional annual value, with the achieved Sharpe ratio above 1.0 justifying systematic strategy implementation.

The production-ready implementation provides cross-platform compatibility, systematic API integration, and comprehensive hardware compatibility, enabling institutional deployment without specialized infrastructure requirements. The framework bridges behavioral finance theory with machine learning practice, establishing temporal decay sentiment integration as a viable enhancement for financial forecasting with substantial implications for

both academic research and institutional investment management applications.

Keywords: Financial forecasting, sentiment analysis, temporal decay, FinBERT, Temporal Fusion Transformer, behavioral finance, machine learning, institutional finance