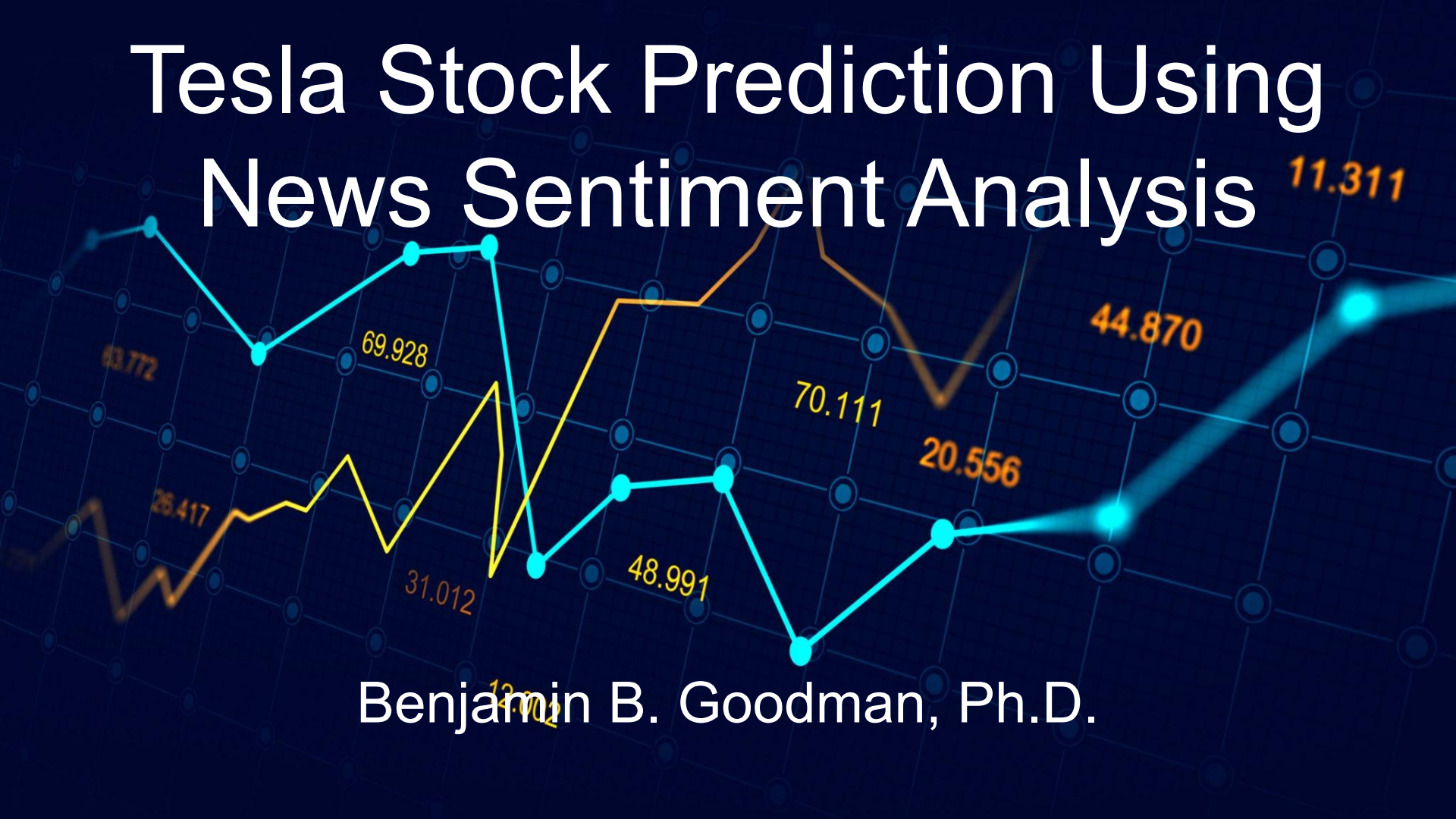
Tesla Stock Prediction Using News Sentiment Analysis



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Overview

1. Problem Statement & Approach
2. Data Collection
3. Sentiment Analysis & Key Findings
4. Feature Engineering
5. Model Development & Results
6. Business Applications
7. Limitations & Next Steps

Problem Statement

Research Question:

- Does daily news sentiment contain predictive signals for Tesla's short-term stock price direction?

Approach:

- Predict 5-day forward trend (up vs. down) using:
  - NLP sentiment analysis
  - Feature engineering
  - Traditional ML methods

Why Predict 5-Day Trends (Not Next-Day)?

Daily movements are dominated by noise:

- Random market fluctuations, highly volatile
- Initial model attempt: Essentially random (coin flip accuracy)

5-day trends help filter volatility and capture signal:

- Sentiment takes time to propagate through market
- Improved model: Meaningful predictive signal

Result: More realistic, actionable predictions

Data Sources

Stock Prices:

- Yahoo Finance, Daily OHLCV data (2024-2025)

News Articles:

- Google News feeds
- 25,398 articles across, 732 days (2024-2025)

Earnings Calls:

- 9 quarterly transcripts (Q4 2023 - Q4 2025)

SEC Filings:

- Collected from SEC EDGAR but not analyzed (time scope)

Sentiment Analysis Tool

FinBERT: Financial domain-adapted BERT model

- Pre-trained on earnings calls, analyst reports, financial news
- Understands finance-specific language

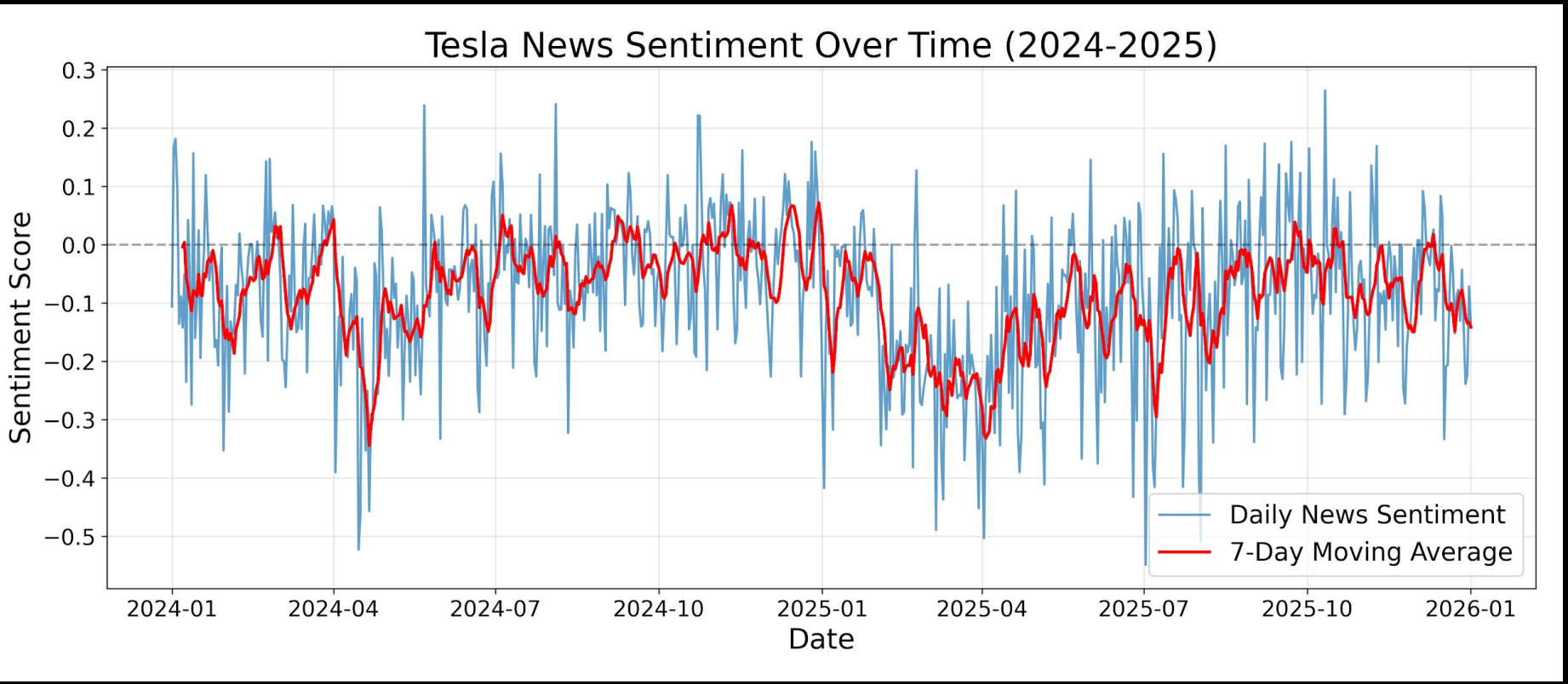
Outputs:

- Positive/negative/neutral sentiment and confidence score

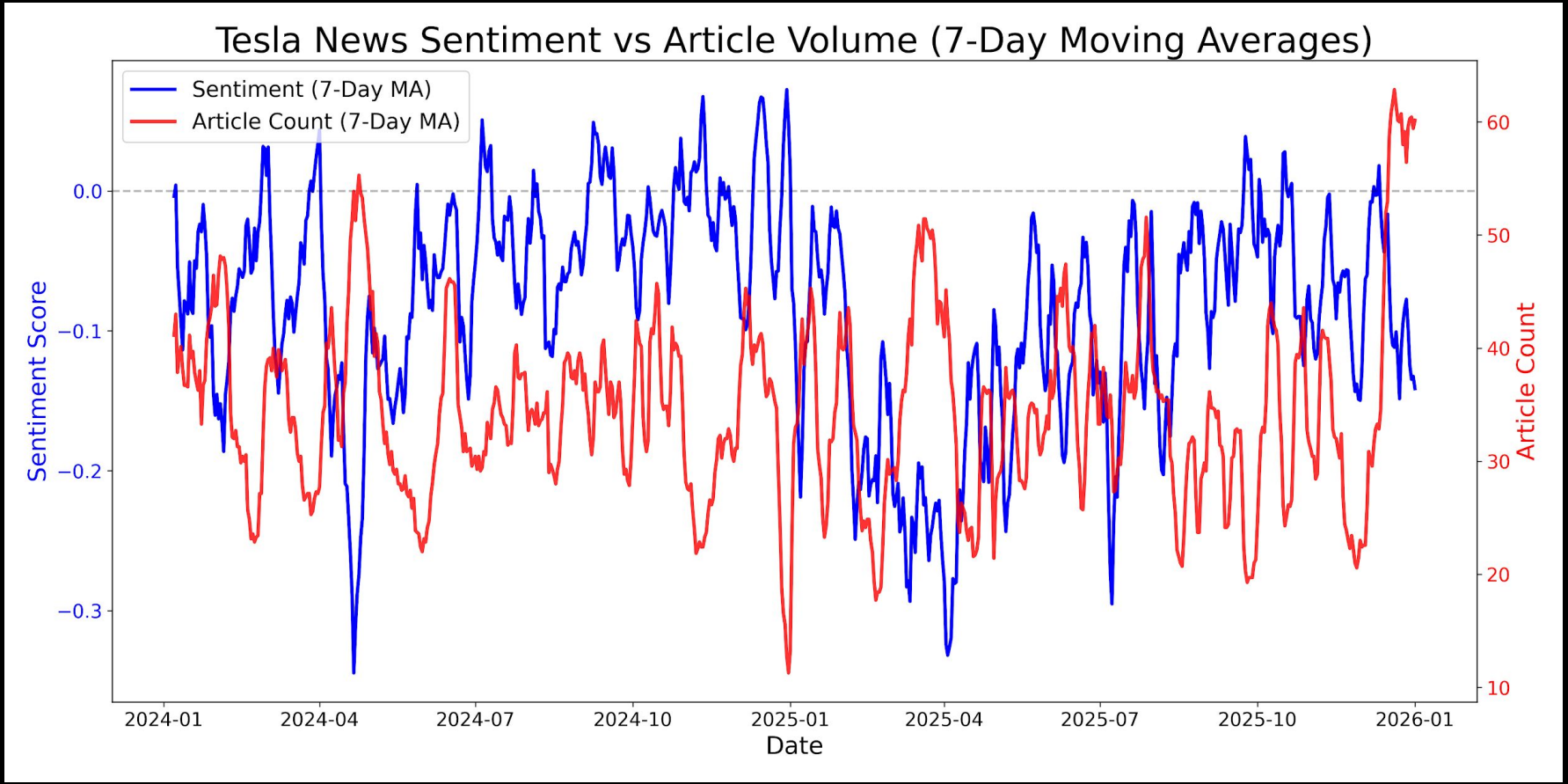
Applied to:

- News headlines (daily aggregation)
- Earnings transcripts (quarterly aggregation)

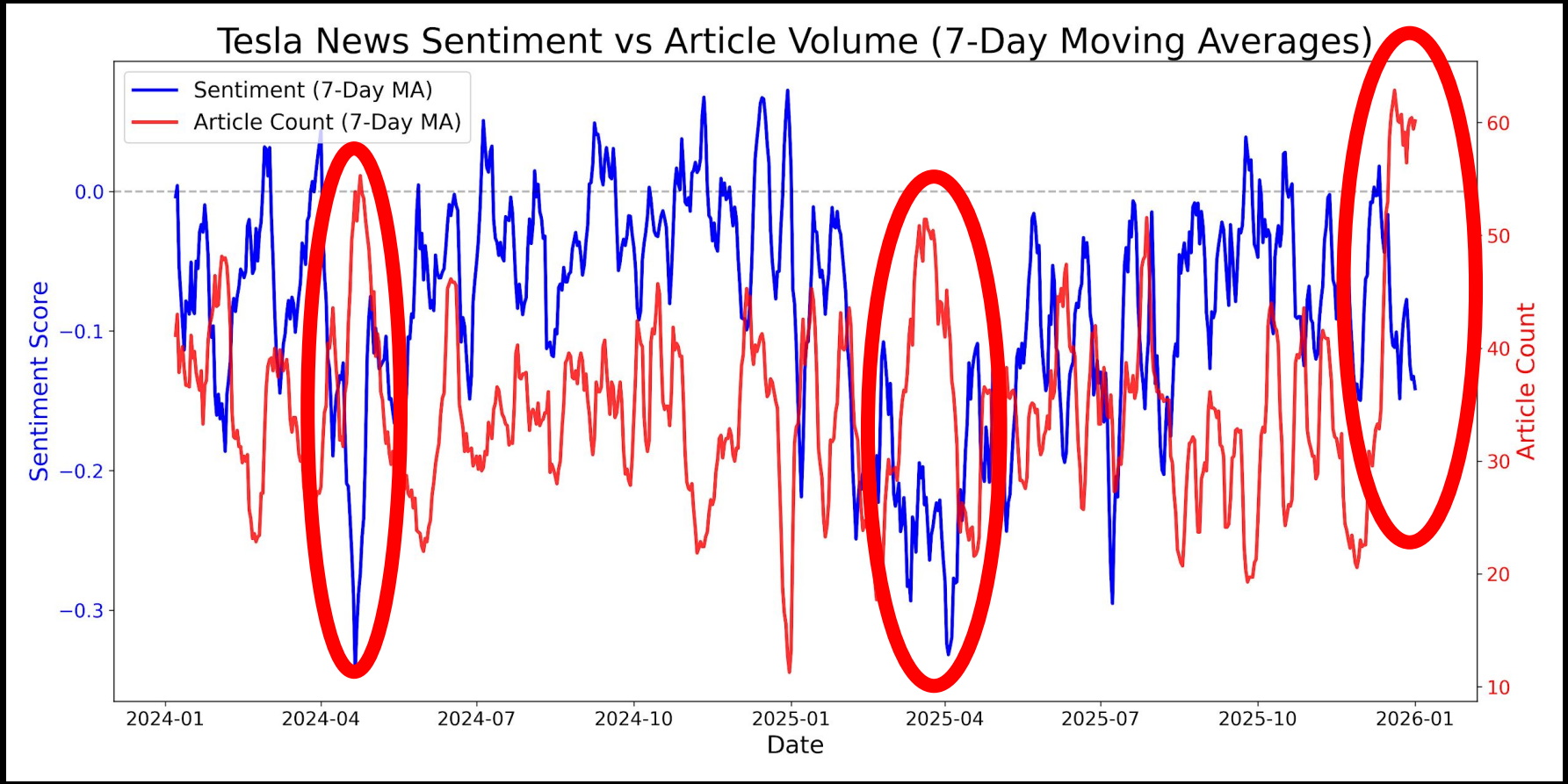
News Sentiment Over Time



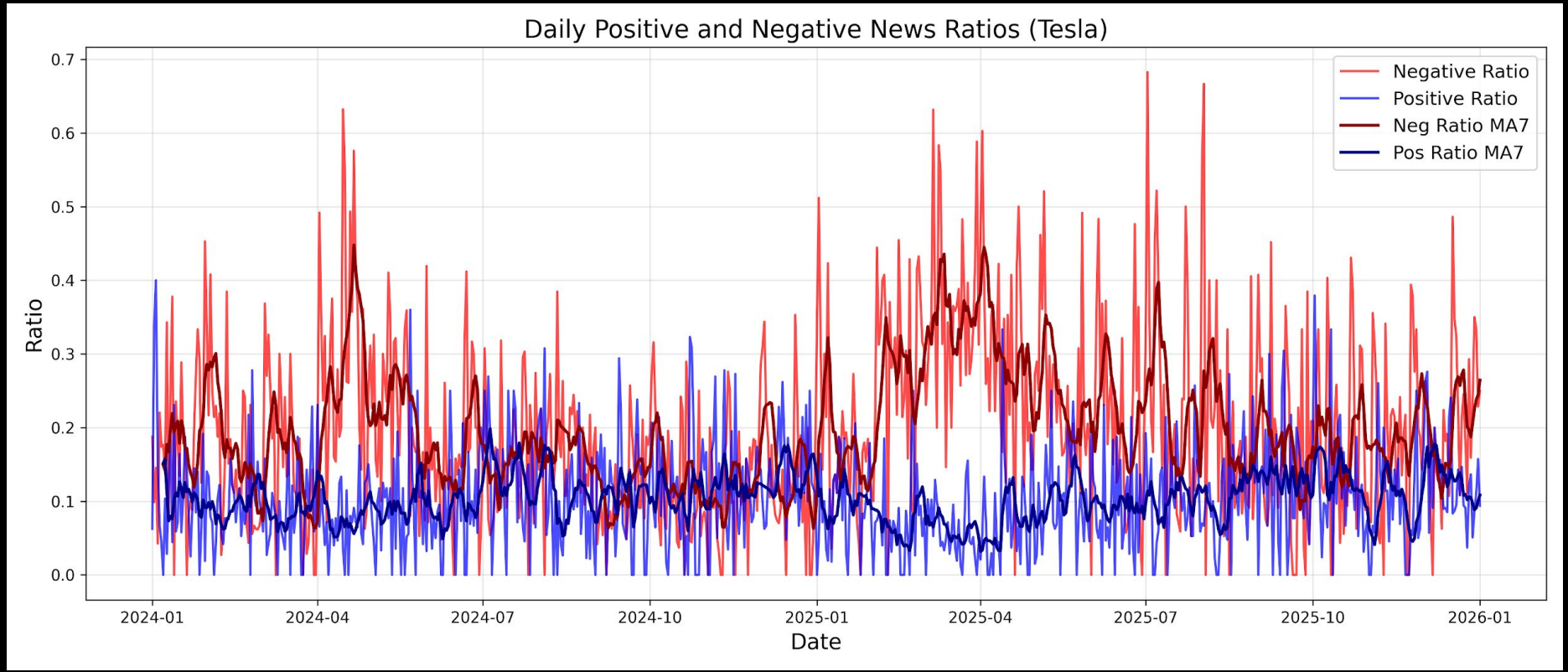
Key Discovery: Sentiment vs. Volume



Article Volume Spikes Align with Sentiment Drop



Article Sentiment Distribution



Most Tesla news is negative: Explains high volume → negative sentiment

Statistical Validation

A/B Test: High vs. Low Article Volume Days (split by median)

- High-volume days:
  - Average sentiment = -0.097
- Low-volume days:
  - Average sentiment = -0.071

Difference: -0.026

Statistical significance: p-value < 0.00001

Conclusion: High-volume days are reliably more negative.

Feature Engineering

Sentiment Features:

- Average sentiment score: Daily, 7 day moving average, Previous day (lagged)

Volume Features:

- Article count: Daily, 7 day moving average, Previous day (lagged)

Interaction Term:

- Sentiment × Article count (captures effect: one is low/high vs the other)

Stock Features:

- Daily return, 5-day moving average return, volume change

Earnings:

- Latest quarterly earnings call sentiment score (forward-filled)

Earnings Call Analysis

Process:

1. Collected 9 earnings call transcripts (quarterly calls).
2. Chunked text into 512-character segments.
3. Analyzed sentiment per chunk (FinBERT).
4. Aggregated average sentiment to create quarterly score.

Application:

Forward-filled quarterly scores between calls to provide management tone signal for daily predictions.

Train/Test Split (Avoiding Data Leakage)

- Training:
  - Jan 1, 2024 - Jan 31, 2025 (257 samples)
- Buffer (prevents overlap from 7-day moving averages):
  - Feb 1-9, 2025 (10 days, discarded)
- Test:
  - Feb 10, 2025 - End of 2025 (225 samples)

Ensures no look-ahead or look-behind bias.

Class Balance:

- Train: 50% up / 50% down
- Test: 52% up / 48% down

Model Selection

Logistic Regression (L2): AUC 0.57 ✓

XGBoost: AUC 0.52

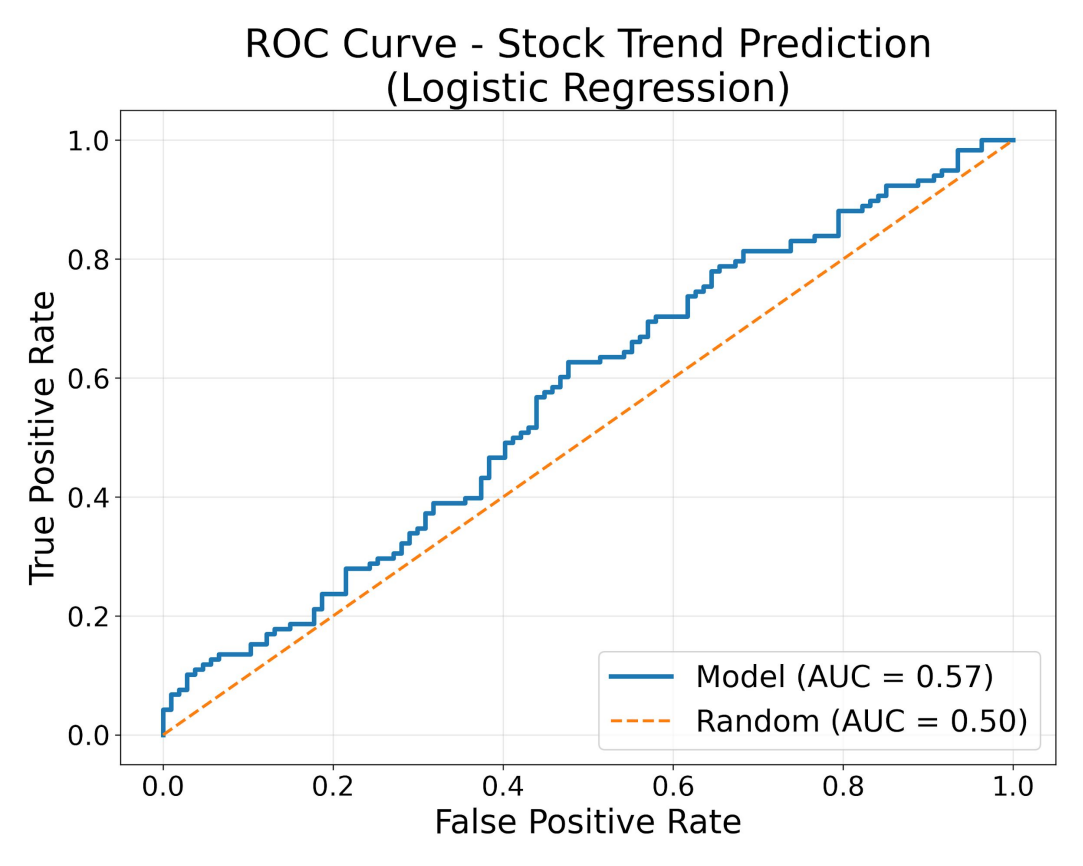
Why Logistic Regression?

- Better performance on small dataset.
- Interpretable coefficients.
- Well-suited for linear relationships.

XGBoost underperformed due to:

- Limited training data (257 samples).
- Linear feature relationships.

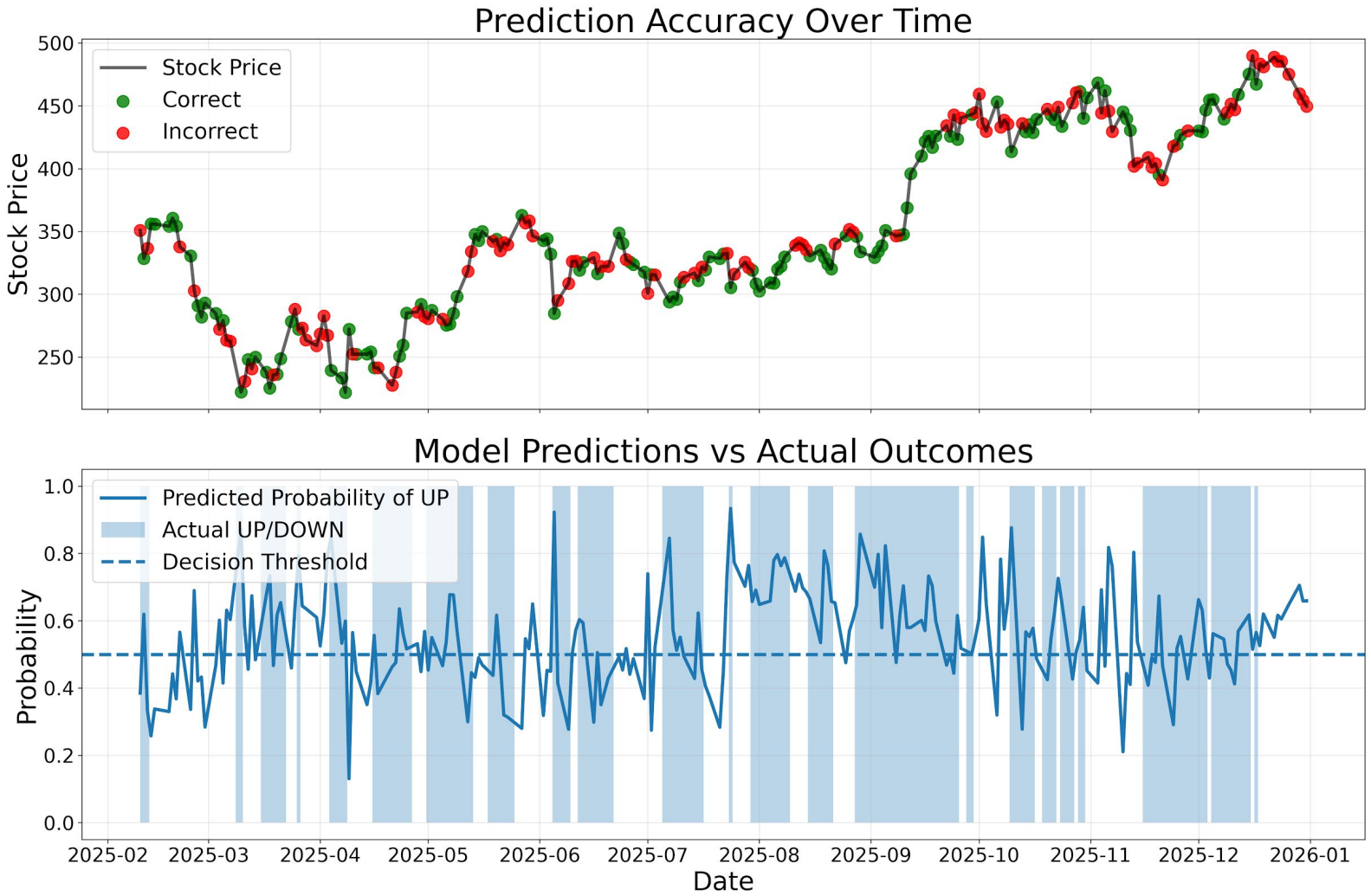
ROC Curve (Receiver Operating Characteristic)



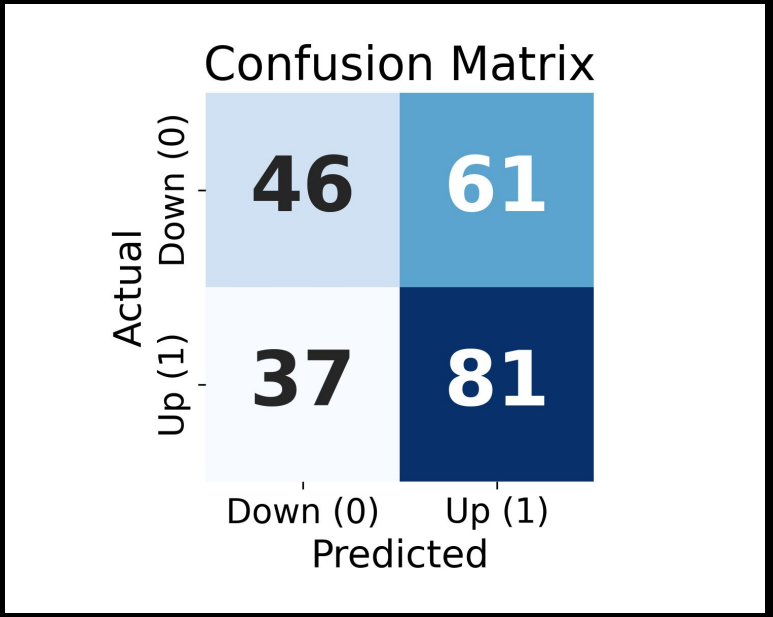
AUC: 0.57 → 14% improvement over random guessing (0.50)

Interpretation:

- Model successfully extracts signal from noisy data.


Prediction Accuracy Over Time
Stock Price
Correct
Incorrect
Stock Price
500
450
400
350
300
250
Model Predictions vs Actual Outcomes
Predicted Probability of UP
Actual UP/DOWN
Decision Threshold
Probability
1.0
0.8
0.6
0.4
0.2
0.0
2025-02
2025-03
2025-04
2025-05
2025-06
2025-07
2025-08
2025-09
2025-10
2025-11
2025-12
2026-01
Date

Confusion Matrix



Accuracy: 56% (percent of correct predictions)

Precision (Up): 57%

(when predicting “Up”, correct 57% of the time)

Precision (Down): 55%

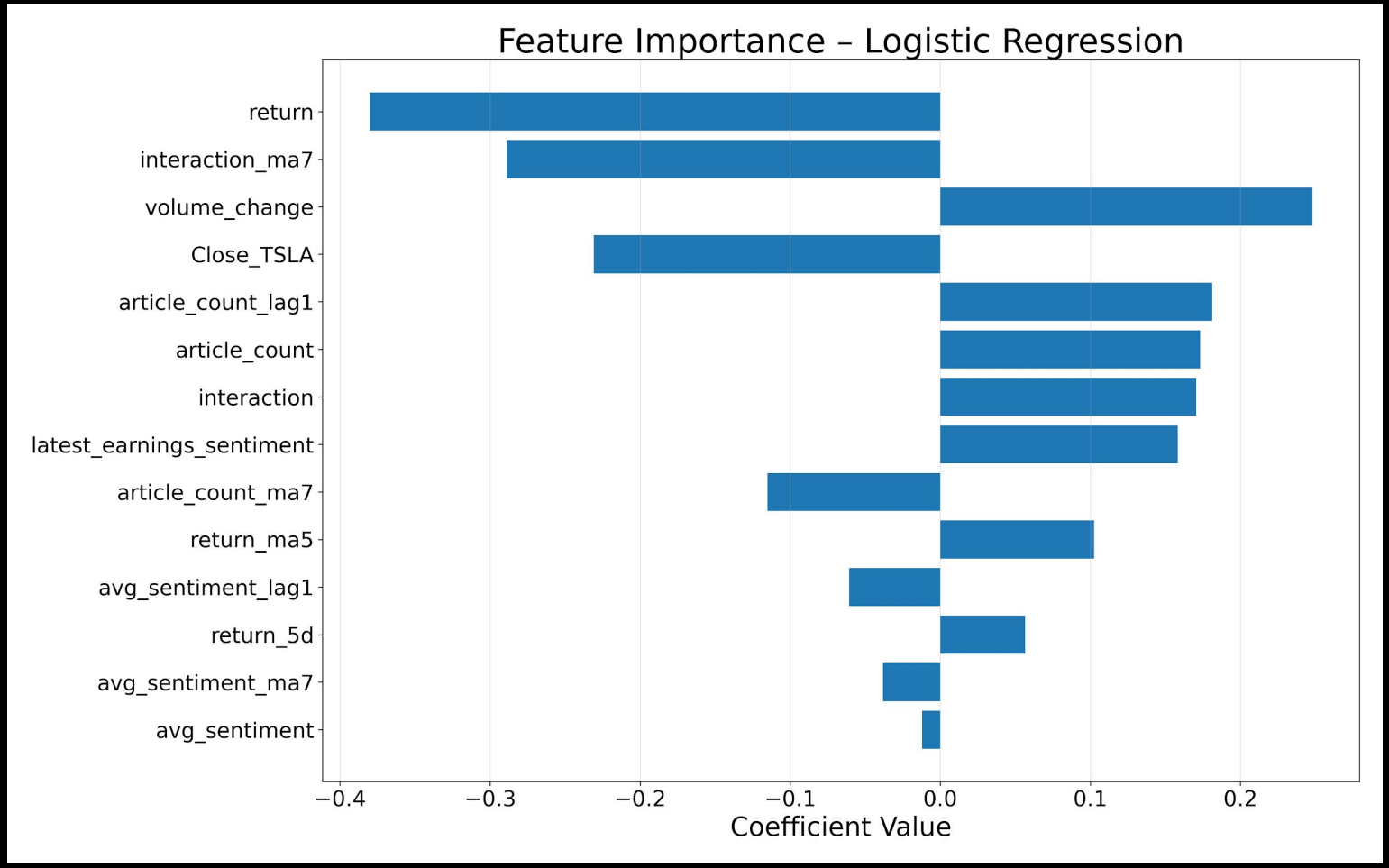
(when predicting “Down”, correct 55% of the time)

Recall (Up): 69% (catch 69% of actual “Up”)

Recall (Down): 43% (catch 43% of actual “Down”)

Model better at predicting upward trends (over downward).

Feature Importance



Conclusion

Does news sentiment contain predictive signals? YES.

Evidence:

✓ Sentiment × article count interaction moving average: Top 5 feature

✓ Article count (lagged day): Top 5 feature

✓ Article count (current day): Top 5 feature

✓ Model AUC 0.57 vs 0.50 random (14% improvement)

Implication:

News sentiment is a valuable supplementary signal for short-term Tesla stock prediction.

Business Applications

- Early Warning System:
  - Detect unusual negative sentiment spikes.
- Investment Timing:
  - Use sentiment as additional signal for investment.
- Portfolio Monitoring:
  - Track sentiment across multiple holdings.
  - Identify companies facing negative media attention.
- Scalable Framework:
  - Same approach works for any publicly traded company.
  - Can analyze simultaneously.
- Automated System:
  - Daily updates: new articles → sentiment scores → predictions

Limitations & Next Steps

Limitations:

- Small dataset (257 training samples).
- Single company (Tesla-specific patterns).
- News sentiment only (excludes social media).

Next Steps:

- Expand to multiple companies/sectors.
- Add social media sentiment (Twitter/Reddit).
- Longer time horizons (weekly/monthly trends).