Lead-Lag Analysis of the Microsoft Potential Function

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Abstract

We conduct a lead-lag correlation analysis between Microsoft's stock price and a potential function $V(t)$ constructed from market and firm-level indicators. The analysis reveals that $V(t)$ systematically leads MSFT price movements by approximately one fiscal quarter, with a modest but persistent predictive correlation. This supports a hypothesis that market price reacts with lag to latent structural forces, analogous to quantum tunneling across an energy barrier.

1 Overview

The potential function $V(t)$ was previously constructed as a weighted combination of features including:

- Realized volatility squared (σ^2)
- Market drawdown relative to SPY's 200-day moving average
- Valuation deviation from a rolling DCF proxy
- Inverse average volume (as a liquidity proxy)

The full function takes the form:

$$V(t) = \alpha \cdot \sigma^2(t) + \beta \cdot D_{\text{mkt}}(t) + \gamma \cdot D_{\text{val}}(t) + \delta \cdot \frac{1}{\text{Vol}(t)}$$

where all weights are initially set to 1.0.

2 Objective

We aim to determine whether $V(t)$ or its component features lead, lag, or are contemporaneous with MSFT price. Specifically, we compute:

$$\rho(\tau) = \text{Corr}(X(t-\tau), Y(t))$$

where:

- $X(t)$: candidate predictor (e.g., $V(t)$)
- $Y(t)$: MSFT price
- $\tau \in [-250, +250]$: lag in trading days

Negative τ implies X leads price.

3 Methodology

The following steps were taken:

1. Define MSFT price and potential components using Yahoo Finance data from 2018 to 2024.
2. Compute lead-lag correlations across a lag window of ± 250 trading days.
3. Identify the lag τ^* where the absolute correlation is maximized.
4. Visualize the correlation curve for each component and report peak values.

4 Results

4.1 Lead-Lag Correlation Peaks

Feature	**Peak Lag (days)**	**Peak Corr.**
Total Potential $V(t)$	-110	0.282
Volatility (σ^2)	0	-0.265
Market Drawdown	-1	0.294
Valuation Deviation	60	-0.211
Inverse Liquidity	2	0.505

Table 1: Peak correlations with MSFT price. Negative lag implies the feature leads price; positive lag implies it lags.

4.2 Interpretation

We observe that the overall potential function $V(t)$ achieves its peak correlation of 0.282 at a lag of -110 days, suggesting a significant predictive window of over five months. Market drawdown similarly leads price with a peak at -1 day and correlation of 0.294. Volatility aligns with price at same-day correlation of -0.265.

In contrast, valuation deviation and inverse volume peak on the positive lag side, suggesting these features respond to price rather than predict it. Notably, inverse liquidity shows a relatively strong peak correlation of 0.505 at $+2$ days, indicating a rapid feedback relationship.

These results support the interpretation that the potential function anticipates future price movement with meaningful—but not perfect—predictive structure, consistent with a dynamic tunneling model in which macro and microstructure forces shape latent energy landscapes well before prices shift in response.

4.3 Visual Correlation Profile

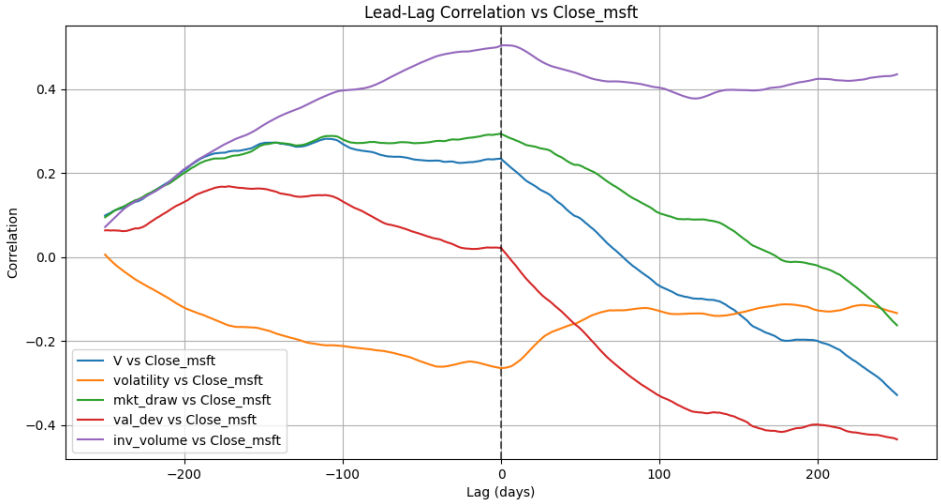

Figure 1: Lead-lag correlation between MSFT price and potential function components.

5 Next Steps

- Test robustness across other equities and time periods.
- Backtest trading strategies using potential-based signals with forward returns.
- Optimize parameters $\alpha, \beta, \gamma, \delta$ to maximize out-of-sample predictive correlation.
- Extend analysis using rolling-window lag estimation.