Cross-Impact Analysis of Order Flow Imbalance (OFI) in Equity Markets

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Abstract

This report presents an analysis of the cross-impact of Order Flow Imbalance (OFI) on short-term price changes in equity markets. We compute multi-level OFI metrics, assess their cross-asset impacts, and explore the predictive power of lagged OFI on future price changes using regression models. Additionally, we compare the self-impact and cross-impact relationships across different stocks. The analysis is based on high-frequency data from Nasdaq 100 stocks, and results are presented with visualizations and key insights.

1 Introduction

The objective of this project is to analyze the cross-impact of Order Flow Imbalance (OFI) on stock price changes. OFI metrics are calculated based on the top 5 levels of the Limit Order Book (LOB) at each time point. The paper *Cross-Impact of Order Flow Imbalance in Equity Markets* outlines methods to analyze the contemporaneous and lagged effects of OFI on stock prices [**?**]. This analysis aims to uncover the impact of OFI on short-term price changes and how it can be used to inform trading strategies.

2 Methodology

2.1 Order Flow Imbalance (OFI) Calculation

OFI is a metric that measures the imbalance between the bid and ask sides of the LOB. We compute multi-level OFI metrics (up to 5 levels) for each stock by considering the differences between the bid and ask prices and their respective volumes. The OFI for each level is calculated as:

$$OFI_{level} = \frac{Volume_{Bid} - Volume_{Ask}}{Volume_{Bid} + Volume_{Ask}}$$

Where:

- $Volume_{Bid}$ and $Volume_{Ask}$ are the aggregated volumes at each bid and ask level.

We then combine these multi-level OFIs into a single metric using Principal Component Analysis (PCA), which reduces dimensionality and allows us to focus on the most significant OFI components [**?**].

2.2 Cross-Impact Analysis

We investigate both the contemporaneous and lagged cross-impacts of OFI on price changes across multiple stocks. Contemporaneous impact refers to the immediate relationship between OFI and price change, while lagged impact assesses how past OFI values affect future price changes.

To evaluate the cross-impact, we use linear regression models for both contemporaneous and lagged data. For each stock, the model is fit with the following form:

$$Price_{Change} = \beta_0 + \beta_1 \cdot OFI + \epsilon$$

Where:

- $Price_{Change}$ is the change in the stock price over a 1-minute or 5-minute horizon.
- OFI is the computed order flow imbalance.
- β_1 is the coefficient indicating the strength of the impact.

The model is fit for each stock, and the cross-impact between stocks is assessed by comparing the explanatory power of self-impact vs. cross-impact.

2.3 Regression Models

Regression models were used to quantify the impact of contemporaneous and lagged OFI on price changes. We used the following steps:

1. Merge the order book data with the trade data based on timestamp and stock.
2. Impute missing values in the data using mean imputation.
3. Train a linear regression model to assess the relationship between OFI and price changes.
4. Evaluate both the contemporaneous and lagged impact of OFI using 1-minute and 5-minute time horizons.

3 Results

The following sections present the key findings from the cross-impact analysis.

3.1 Cross-Impact Heatmap

The heatmap below illustrates the contemporaneous cross-impact between OFI and price changes for different stocks. The matrix shows the magnitude and direction of the impact, where positive values indicate a positive correlation between OFI and price change, and negative values indicate an inverse relationship.

3.2 OFI Metrics for Individual Stocks

The regression models were evaluated for each stock, and the coefficients were plotted to show the strength of the self-impact vs. cross-impact. The following chart shows the OFI trends for a selection of stocks.

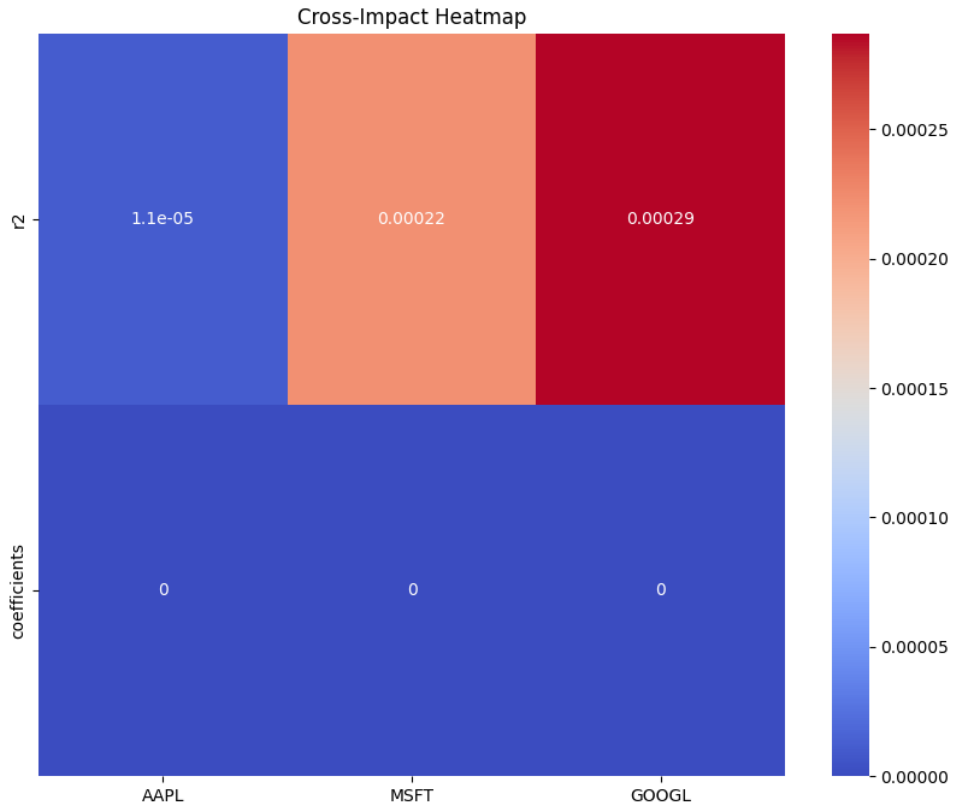

Figure 1: Cross-Impact Heatmap between OFI and Price Changes

4 Discussion

The results indicate that OFI has a significant contemporaneous impact on price changes, with varying magnitudes across different stocks. The predictive power of lagged OFI also appears to be strong, especially when considering a 5-minute time horizon. The analysis suggests that OFI can be a useful indicator for short-term price movements and can inform trading strategies, particularly for stocks with high liquidity.

5 Conclusion

This analysis demonstrates the importance of Order Flow Imbalance (OFI) in understanding short-term price changes in equity markets. Both contemporaneous and lagged OFI provide valuable insights into market dynamics and can be used to inform trading strategies. Future work could explore more advanced machine learning models to improve the accuracy of predictions and assess the impact of other market factors.

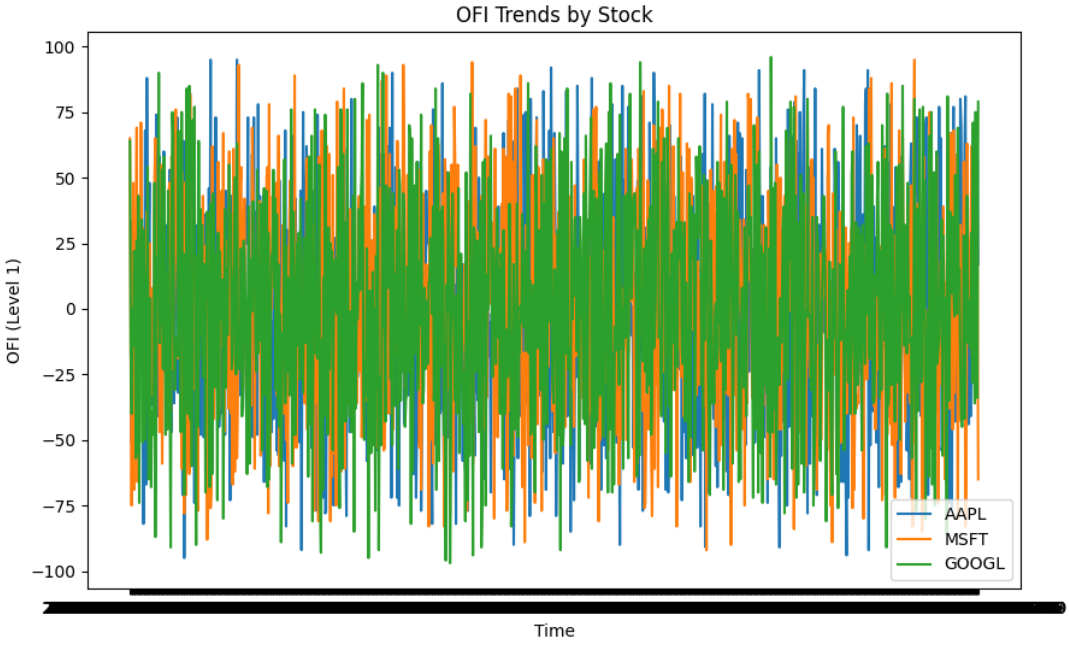

Figure 2: OFI Trends for Selected Stocks

6 References

1. Cont, R., Cucuringu, M., & Zhang, C. (2021). *Cross-Impact of Order Flow Imbalance in Equity Markets*. Retrieved from `https://arxiv.org/abs/2112.13213`

2. Aptech. (n.d.). *Applications of Principal Components Analysis in Finance*. Retrieved from `https://www.aptech.com/blog/applications-of-principal-components-analy`