# Cross-Impact Analysis of Order Flow Imbalance in Equity Markets

Saatvik Pradhan
Date: January 8, 2025

## Abstract

This research explores the cross-impact of Order Flow Imbalance (OFI) on equity market price changes. Using data from multiple stocks (e.g., AAPL, TSLA), multi-level OFI metrics were computed, integrated using Principal Component Analysis (PCA), and analyzed for their predictive power regarding price changes. Regression analysis revealed stock-specific variations, with some stocks exhibiting stronger correlations between OFI and price changes. These findings provide insights into the dynamics of order flow and implications for trading strategies.

## 1 Methodology

### 1.1 Order Flow Imbalance Calculation

Order Flow Imbalance (OFI) was computed at multiple order book levels using the following formula:

$$\text{OFI}_{\text{level}} = \frac{\text{Bid Size} - \text{Ask Size}}{\text{Bid Size} + \text{Ask Size} + \epsilon},$$

where $\epsilon$ prevents division by zero. The OFI was further scaled by order size to calculate volume-weighted imbalance.

### 1.2 Principal Component Analysis (PCA)

To reduce dimensionality, multi-level OFI metrics were integrated into a single feature using PCA. The first principal component was retained, explaining the majority of the variance in the imbalance metrics.

### 1.3 Regression Analysis

For each stock, regression models were fitted to predict price changes using the integrated OFI metric and additional features, such as lagged OFI and volume-weighted imbalance. A time-based train-test split ensured temporal consistency.

## 2 Results

Key findings include:

- $R^2$ scores for price prediction varied significantly across stocks, indicating stock-specific dynamics.

- Heatmaps revealed strong correlations between integrated OFI and price changes for certain stocks.
- Scatter plots for AAPL (best-performing stock) and TSLA (worst-performing stock) highlight variations in OFI-price relationships.

### 2.1 Visualizations

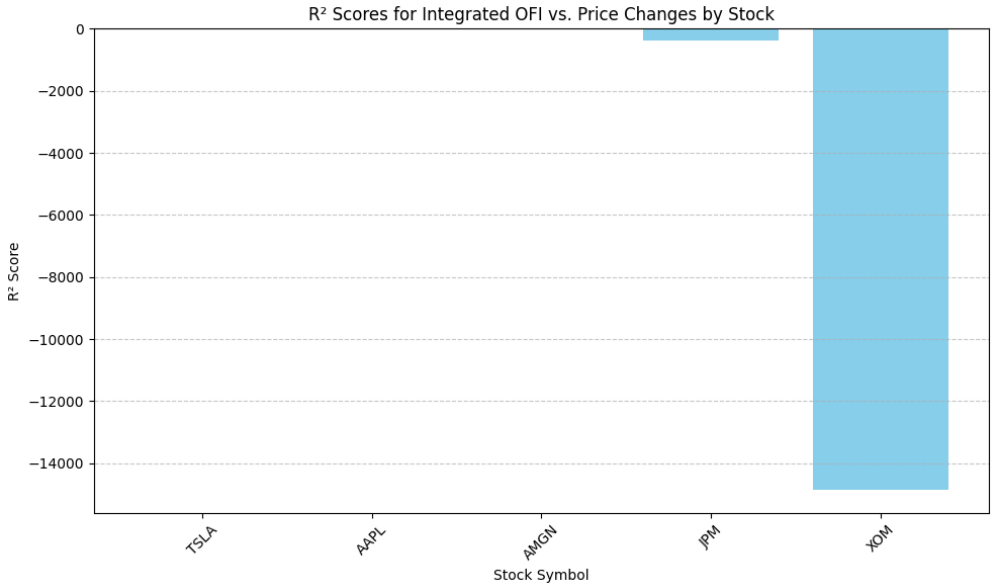


Figure 1: $R^2$ scores for Integrated OFI vs. Price Changes by Stock.

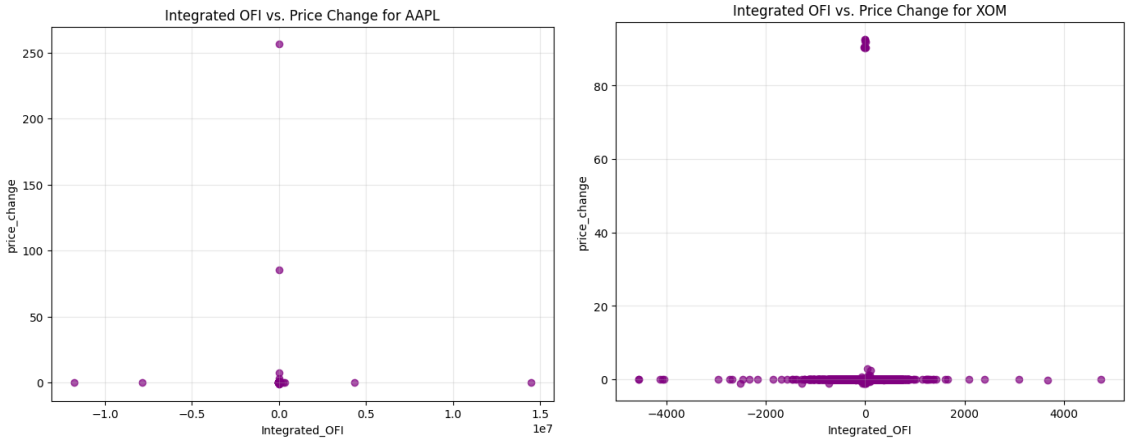


Figure 2: Scatter plots for best (AAPL) and worst (AAPL) performing stocks.

## 3 Discussion

The results demonstrate that OFI metrics, particularly when integrated via PCA, can capture significant dynamics in stock price movements. However, the effectiveness varies by stock, suggest-

ing that OFI's impact is context-dependent. For instance, AAPL exhibited a strong relationship between OFI and price changes, whereas TSLA showed weak predictability.

These findings highlight the potential for OFI metrics to inform trading strategies, especially for stocks with high predictability. Future work could explore nonlinear models and additional features to enhance prediction accuracy.

# 4 Conclusion

This study investigated the cross-impact of OFI on equity markets, using PCA-integrated metrics and regression analysis. While results varied across stocks, the methodology provides a foundation for exploring order flow dynamics. Future research could focus on extending this approach to other asset classes or incorporating more advanced machine learning models.

# References


- R. Cont, M. Cucuringu, and C. Zhang, "Cross-impact of order flow imbalance in equity markets," Quantitative Finance, vol. 23, no. 10, pp. 1373–1393, Aug. 2023, doi: 10.1080/14697688.2023.2236159.
- Databento, "Databento," Databento. https://www.databento.com/