

Assignment:2

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Aim

This research presents a comprehensive analysis of tick-by-tick order book data, providing insights into market microstructure, trading patterns, and order flow dynamics. By examining the most granular form of market data—individual orders as they are placed, modified, executed, or canceled—we can observe the mechanisms that drive price formation and market efficiency. Our analysis includes volume distribution across trading hours, order execution patterns, large order impact, and anomaly detection techniques. Results reveal distinct intraday trading patterns, order fulfillment behaviors, and significant price impact from large orders. The findings contribute to better understanding of market microstructure and offer practical applications for trading strategy development, risk management, and market surveillance.

Methodology and Results

0.1 Trading Volume Analysis

To analyze trading volume patterns, we aggregated trade events ('T' order types) by minute intervals with valid order numbers, summing the volume field to calculate the total traded quantity in each minute. This minute-by-minute volume profile provides insights into intraday trading intensity and helps identify periods of high and low market activity.

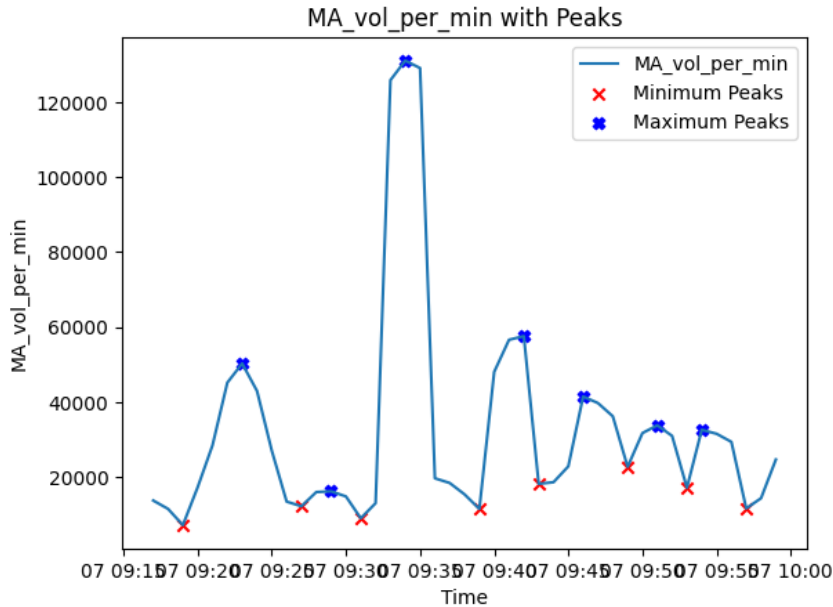


Figure 1: Trade Volume per minute vs. Time

We apply a modest rolling mean with window = 3 and employ a maximum and minimum peak detecting algorithm. We find that **the peak trading time seems to be between 9:30 to 9:35. The least trading activity occurs from 9:15 to around 9:17. Majority of the volume per minute traded was less than 50000.**

0.2 Order Execution Analysis

For analyzing trades with unusual order number patterns (order_no or $\text{order_no2} = 0$), we filtered the dataset to isolate these specific cases and examined their characteristics. Around 12.7% of trade orders are unusual, while 94% of them are usual valid orders. We compared the distribution of various attributes (time of day, price, volume) between these unusual trades and the general population to identify distinguishing patterns. This approach helps understand whether these unusual order number patterns are associated with specific market conditions or trading behaviors.

Time-series Comparison: While the usual trade volumes seems to show generic distribution with maximum volumes traded in the middle of the time frame, the volume of unusual orders peak towards the later stage of our interval at around 9:45.

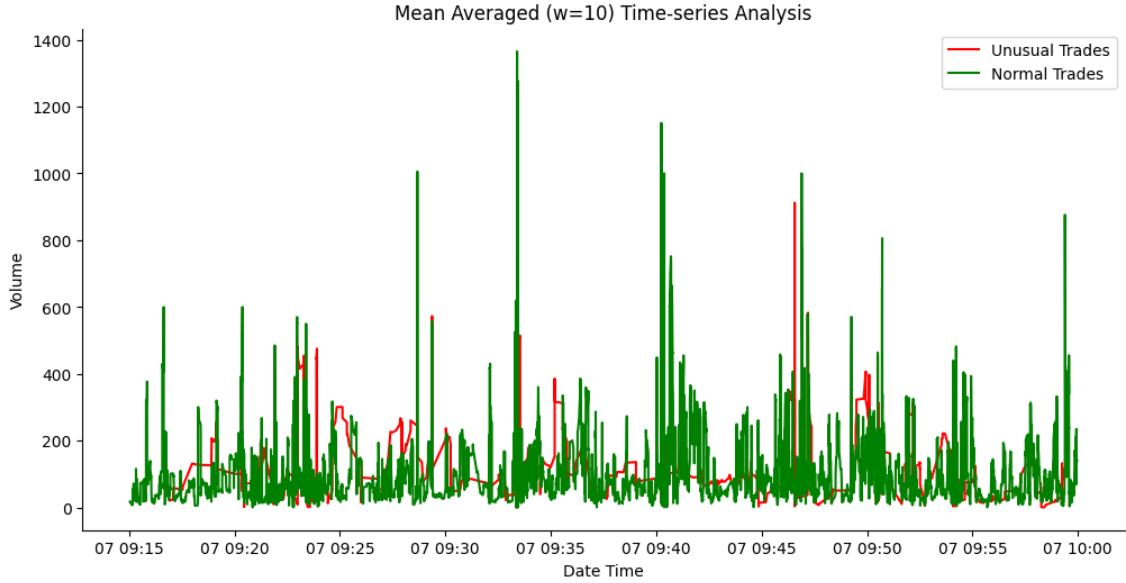


Figure 2: Usual vs. Unusual Orders - Time analysis

0.3 Orders Fulfilled in one row Vs. Multiple Rows

We track new orders that were not modified and cancelled throughout the duration and were 'fulfilled', i.e. their total volume at new order must be equal to the sum of the volumes of the subsequent rows (which can be 1 or more). **We find that around 2.01% of new orders were fulfilled within one row while around 0.52% of them took multiple rows.**

0.4 Market Impact Analysis

The analysis of large orders (volume $> 1,000$) revealed significant price impact in both short and longer time frames. Large buy orders show an average immediate price impact of around 0.12%

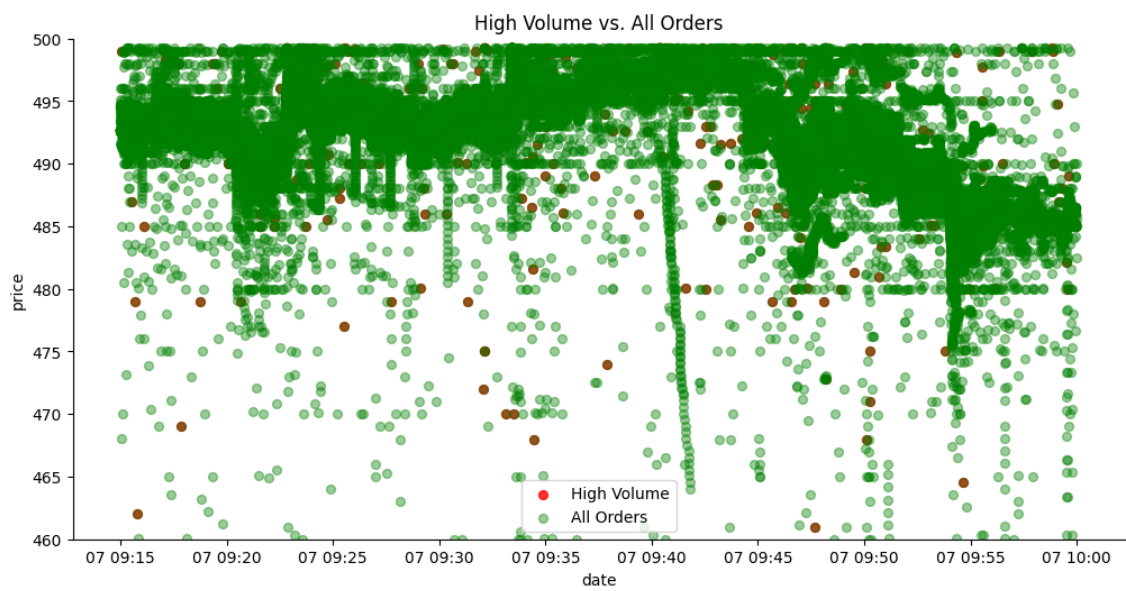


Figure 3: Usual vs. Unusual Orders - Time analysis