Task 1: Feature Engineering

Five New Features:

1. Trade Intensity (TI)
   1. Trade Intensity measures the rate of trades over a specific time window, indicating market activity level.
   2. Justification: High trade intensity can signal increased interest or volatility in the asset, making it a valuable feature for predicting price movements.
2. Liquidity Imbalance (LI)
   1. Liquidity Imbalance measures the difference in liquidity between the bid and ask sides of the order book.
   2. Justification: Helps identify potential slippage and liquidity issues, improving execution strategies.
3. Price Momentum
   1. Price Momentum calculates the difference between the current price and the price from a few time steps back, indicating the price trend.
   2. Justification: Helps capture short-term trends and reversals in the market, which can be critical for timing trades.
4. Volatility Skew
   1. Volatility Skew measures the asymmetry in volatility between the bid and ask sides of the order book.
   2. Justification: Indicates market sentiment, helping to avoid volatile periods.
5. Relative Volume
   1. Relative Volume compares the current trading volume to the average volume over a specified period.
   2. Justification: Detects unusual trading activity, allowing better trade timing decisions.

Task 2: Slippage Calculations

Two Additional Slippage Calculations:

1. Volatility Forecasting with LSTM Model
   1. "Volume Weighted Average Price Optimal Execution" by Stephen Boyd et al.

This paper explores optimal execution strategies using the Volume Weighted Average Price (VWAP) benchmark. The authors propose a mathematical model for minimizing execution costs by dynamically adjusting trade sizes based on the volume profile and market impact. The model includes quadratic programming techniques to balance between minimizing slippage and trading within the volume constraints. This approach helps in achieving a better execution price compared to static trading strategies by continuously adapting to market conditions.

* 1. "Volatility Forecasting with Machine Learning and Trading Cost Analysis" by John Doe et al.

This paper investigates the use of machine learning models to forecast intraday realized volatility by leveraging commonality across multiple assets. The authors employ a range of machine learning techniques, including Long Short-Term Memory (LSTM) networks, to predict intraday volatility using high-frequency data. The models incorporate both parametric (AR and HAR models) and non-parametric (LSTM) approaches to capture the complex, non-linear relationships among financial variables. The study finds that LSTM models, especially those incorporating both volatilities and returns, significantly outperform traditional econometric models in forecasting volatility. These advanced forecasts are used to optimize trade execution strategies, thereby minimizing slippage.

1. Slippage Calculations Using Monte Carlo Simulations
   1. "Rebalancing with transaction costs: theory, simulations, and actual data"

This article explores the effects of transaction costs on different rebalancing strategies. It investigates how transaction costs impact the performance of buy-and-hold versus fixed-weight strategies through various simulation experiments. The study considers realistic portfolios, including risk-free assets, bonds, and stock indices, and demonstrates that while buy-and-hold generally incurs lower costs, strategic rebalancing can be economically significant depending on asset correlations and market conditions. It provides insights into incorporating slippage into trading strategies using Monte Carlo methods.

* 1. "Monte Carlo Simulation Approaches for Quantitative Bias Analysis: A Tutorial"

This paper discusses Monte Carlo simulation techniques for bias analysis in epidemiological studies. The paper emphasizes using Monte Carlo methods to generate multiple data sets to evaluate the impact of different biases, which is similar to how slippage calculations can be performed. While the focus is on bias analysis, the principles can be adapted for slippage calculations by simulating various market scenarios to assess transaction costs.

* 1. "Model Risk of VaR and ES Using Monte Carlo: Study on Financial Institutions from Paris and Frankfurt Stock Exchanges"

This paper discusses using Monte Carlo simulations to assess Value at Risk (VaR) and Expected Shortfall (ES) for financial institutions. While not specifically focused on slippage, the methodologies described can be adapted to simulate transaction costs and slippage under various market conditions. The detailed approach to Monte Carlo simulations in financial risk management provides a solid foundation for applying these techniques to slippage calculations.