Forecasting Microsoft Stock Prices using Time Series Analysis

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1. Introduction

This project aims to analyze and forecast the monthly closing prices of Microsoft Corporation (MSFT) using various time series models. The purpose is to identify trends, seasonality, and make accurate predictions to support data-driven investment decisions in the financial sector.

2. Dataset Description

- Source: Yahoo Finance

- Timeframe: January 2019 – December 2024

- Frequency: Monthly

- Variables used: Open, High, Low, Close, Volume

3. Data Preparation

- Loaded MSFT data using `quantmod`.
- Converted relevant columns into time series objects.
- Handled formatting and alignment for modeling purposes.
- Visualized series to identify seasonal patterns and long-term trends.

4. Methodology

We applied and compared the following forecasting techniques:
- Simple Exponential Smoothing (SES)
- Holt's Linear Trend Model
- Holt-Winters Additive and Multiplicative

- ARIMA (Auto ARIMA)

Each model was trained on 75% of the data and validated using the remaining 25%.

5. Model Evaluation

We used RMSE (Root Mean Square Error) to assess model accuracy. The results were as follows:

Method	RMSE
SES	75.65597
Holt	46.46542
HW-ADD	45.61141
HW-MULT	47.43589

The Holt-Winters Additive model yielded the lowest RMSE, suggesting it is the most accurate for forecasting MSFT prices.

6. Business Insights

- MSFT stock shows an upward long-term trend and yearly seasonality.
- Accurate forecasting of prices can assist investors, analysts, and financial planners in making timely decisions.
- Holt-Winters Additive's performance shows its reliability for stable, seasonal datasets like MSFT.

Project Justification

This project demonstrates a practical application of time series analysis in financial forecasting, a critical task in business and investment decision-making.

Why this problem is significant

Forecasting stock prices is essential for portfolio management, risk assessment, and strategic planning. Microsoft, being a key player in the tech industry, is a valuable target for such analysis.

Data preparation challenges

- Adjusting the time series to monthly frequency.
- Selecting appropriate columns for analysis.
- Managing training vs. testing splits for robust evaluation.

Model effectiveness

- Holt-Winters Additive was the most effective, based on RMSE.
- Compared to Holt, SES, and Multiplicative Holt-Winters, this model better captured both the trend and seasonality of the MSFT stock.
- Evaluation metrics and visual forecasts validated its accuracy.